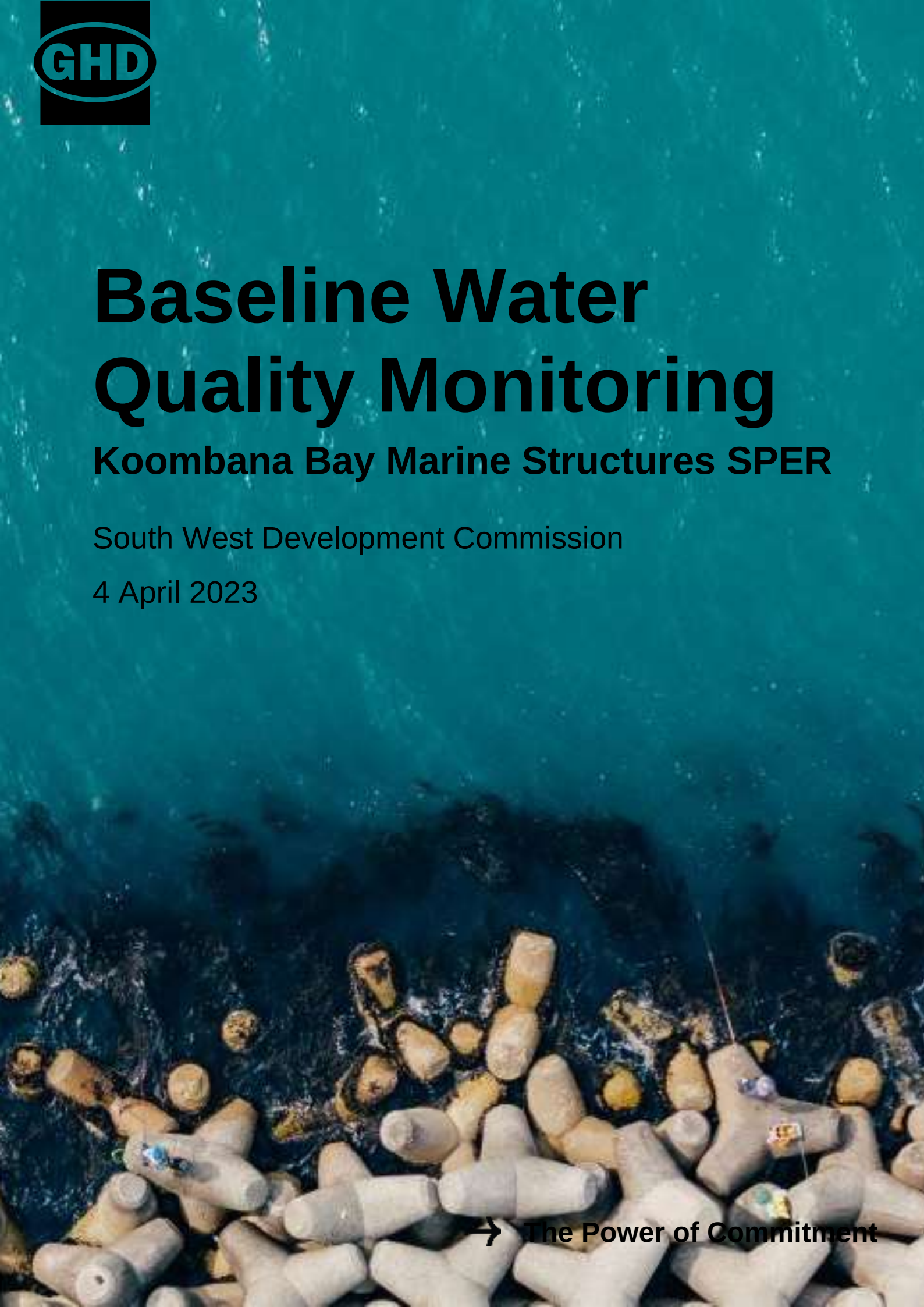
Baseline Water Quality Monitoring

Koombana Bay Marine Structures SPER

South West Development Commission

4 April 2023



The Power of Commitment

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Executive summary

The South West Development Commission is the proponent for the Koombana Bay Marine Structures (KBMS) proposal. The Western Australia Environmental Protection Authority has determined it to be assessed as a Strategic Proposal (SPER). The KBMS strategic proposal is located within the City of Bunbury, about 174 kilometres south of Perth, Western Australia. The KBMS strategic proposal is comprised of three (3) future proposals of the following marine structures within Koombana Bay that will be construct and operated independently:

1. Casuarina Boat Harbour.
2. Koombana Bay Sailing Club (KBSC) marina.
3. Dolphin Discovery Centre (DDC) finger jetty.

The purpose of this report is to characterise the baseline water quality and sediment quality to inform the evaluation of potential impacts on marine environmental quality, and benthic communities and habitats from the construction and operations of two (2) of the three (3) future KBMS SPER proposals (i.e. the DDC finger jetty does not have any material impact on marine environmental quality and benthic communities and habitats), and to inform the preparation of the construction and operational management plans.

This report that describes in detail the methodology and results of the:

– 2016-2017 baseline water quality monitoring of Koombana Bay and Casuarina Boat Harbour.
– 2016 surficial particle size distribution (PSD) of Casuarina Boat Harbour sediments.

Additionally, this report summarises the following baseline studies carried out for the KBMS proposal:

– 2020 baseline water and sediment quality monitoring of Leschanault Inlet (O2 Marine 2021).
– 2016 baseline sediment quality of Casuarina Boat Harbour (RPS 2017).
– 2020 PSD of the sediments of the proposed Casuarina Boat Harbour northern breakwater footprint (O2 Marine 2020).
– 2021 baseline sediment quality of KBSC marina (Cardno 2021).

2016-2017 Koombana Bay and Casuarina Boat Harbour baseline monitoring

The 2016-2017 baseline water quality monitoring consisted of five (5) transects (one [1] in Casuarina Boat Harbour and the remainder in Koombana Bay), each with three (3) sites (inshore, mid-depth and central bay) where vertically integrated water samples (metals/metalloids, nutrients, chl-a, suspended solids) and vertical sonde profiles (temperature, salinity, dissolved oxygen, pH, turbidity) were collected. On one survey surficial sediment grab samples were collected in Casuarina Boat Harbour for preliminary characterisation of the PSD and organic content. Continuous logging instruments at two (2) shallow sites in southern Koombana Bay measured temperature, turbidity and underwater light climate.

The meteorology over the baseline monitoring period was typical of regional climatic patterns. Several Preston River and Collie River inflow events over the baseline monitoring period influenced the salinity, suspended solids and water quality of Koombana Bay.

An overview of the continuous logger data includes:

– Both logger sites were in ~3-4 m water depth with water level variations in the range of predicted (astronomical) tides.
– Water temperatures at the two (2) sites co-varied with maximum temperatures of ~23°C in January-March 2016 and minimum temperatures of 14-15°C in August 2016.
– The near seabed turbidity co-varied at both sites during periods of low (<5 NTU, November 2016- March 2017) and high (>5 NTU, May-September 2017) measurements.
– Higher light levels at the seabed occurred in summer (December 2016-February 2017) than spring (September-October 2016) and winter (August 2017) due to peaks in seasonal insolation and lower turbidity.

Low winter levels of seabed light resulted from higher turbidity (from river sediment loads and perhaps decomposed seagrass wrack) and seasonal minima in insolation.

The relation between light attenuation coefficient (LAC) and turbidity provides a manner to predict the effects of construction activities (e.g. dredging, breakwater construction) and the influence of riverine suspended sediments on the underwater light climate. Linear relations between LAC and the daily median turbidity were significantly correlated at both logger sites (west r^2=83%, east r^2=79%). These linear regressions were used to estimate gaps in turbidity from LAC when light measurements were available. Further, LAC estimates from the LAC-turbidity regression were strongly correlated to daily LAC values calculated from the continuous light data at both sites (west r^2=80%, east r^2=74%), and were used to estimate gaps in the underwater light data from turbidity data. The daily percentage of light at the seabed typically ranged between 10-25% from December 2016-April 2017, and tended to be lower and more variable at other times. Daily LAC estimates (in log 10) ranged from ~0.2 1/m from mid-November 2017 to April 2017 to >0.4 1/m after substantial winter river inflow events.

The daily median turbidity generally was low (<5 NTU) during December 2016-April 2017 except for several episodic short-lived events. The daily median turbidity was greater during elevated river discharge from September-November 2016 (5-50 NTU), May-June 2017 (5-30 NTU), August 2017 (5-90 NTU) and the latter half of September 2017 (5-80 NTU). Profiles generally exhibited increased turbidity in the lower ~0.5-1 m of the water column, approximately coincident with the continuous logging instrument depths above the seabed. Hence, continuous turbidity measurements are likely to be greater than much of the water column. Nonetheless, LAC and near seabed light estimates from daily median turbidity near the seabed explained much of the observed variability in these parameters as described previously, and are considered reliable to fill data gaps.

Monitoring and management of benthic communities and habitats (BCH) from turbidity-generating construction activities (such as the proposed dredging and breakwater construction) generally rely on quantitative trigger value criteria. The 50th and 80th percentiles of the daily median turbidity (from 0900 to 1500) are 2.3 NTU and 3.3 NTU in summer and 7.1 NTU to 15.6 NTU in winter, respectively. Higher turbidity with greater variability occurs in winter relative to summer, so the BCH of southern Koombana Bay are likely seasonally adapted to winter turbidity increases. In contrast, during low turbidity in summer the potential for turbidity-generating construction impacts to affect BCH primary producers is greater than winter.

Generally, with the exception of turbidity, all of the sonde parameters exhibited low vertical variability through the water column though vertical salinity stratification was observed during periods of elevated river inflows.

Nutrients and TSS are generally moderately higher in Casuarina Boat Harbour than Koombana Bay and typically below or near relevant guideline values, particularly during the summer. Elevated winter nutrient levels are likely in response to elevated river inflows and/or seagrass wrack decomposition.

In contrast to nutrients, chl-a levels were ~3-10 fold greater than the relevant guideline values for inshore coastal waters. As with nutrients and TSS, chl-a was greater in the harbour than bay.

Many of the metals and metalloids (aluminium, chromium, manganese, iron, nickel, cadmium and mercury) water measurements across all surveys were predominately at (or near) the laboratory limit of reporting, and well below relevant guideline criteria. Copper, zinc, arsenic and lead had at least several measurements above the relevant guideline criteria.

The preliminary particle size characterisation of the Casuarina Boat Harbour surficial sediments found <7% was clay to very fine silt.

2020 Leschenault Inlet baseline monitoring

Baseline monitoring of Leschenault Inlet was carried out at three (3) sites that included physico-chemical profiling (temperature, salinity, dissolved oxygen saturation, pH, turbidity), water quality grab sampling (nutrients, metals/metalloids, chla), TSS and continuous measurements of underwater light and turbidity above the seabed at two (2) sites from January to July 2020 (O2 Marine 2021). Additionally, sediment samples were collected at the three (3) sites and analysed for metals/metalloids, organochlorine and organophosphate pesticides, nutrients and TBT during January 2020.

A ‘representative’ time series of turbidity for Leschenault Inlet was estimated from the most reliable periods of data from the two (2) sites. The median and 80th percentile turbidity were 2.7 and 3.8 NTU, respectively. The median and 80th percentile of TSS from grab samples was 2.5 mg/L (half the laboratory limit of reporting) and 9 mg/L,

respectively. Assuming a 1:1 ratio of turbidity:TSS, then the median TSS is in reasonable agreement with the continuous turbidity time series.

LAC was calculated for two (2) characteristic depths of 1.5 m and 2.5 m with the representative underwater light time series from the two (2) measurement sites. The range in LAC of ~0.2-0.4 1/m was comparable to the those estimated for the 2016-2017 Koombana Bay baseline monitoring.

Vertical sonde profiles were generally vertically homogeneous and similar to the 2016-2017 baseline monitoring, even with increased turbidity in the lower ~0.5 m of the water column.

Except for chl-a, NH_X and TP, the summer nutrient water quality of Leschenault Inlet meets or is in close proximity to guideline criteria. During winter exceedances of the nutrient guideline criteria occur regularly. Zinc regularly and iron occasionally exceeded the guideline criteria.

Leschenault Inlet has good sediment quality with only one (1) exceedance by mercury of guideline criteria. All pesticides were below the laboratory limit of reporting.

2017 Casuarina Boat Harbour sediment quality

RPS (2017) evaluated the suitability of the proposed dredged material from Casuarina Boat Harbour for offshore disposal and/or onshore reclamation. Sediments were comprised of ~12% clay, ~15% silt and ~71% sand. Mercury and TBT were the only analytes to exceed the guideline criteria (but not the high guideline criteria). Elutriate analyses indicated the potential for nitrogen-based productivity stimulation during dredging activities.

2020 PSD of sediments below the Casuarina Boat Harbour northern breakwater footprint

Galt (2019) found that the proposed dredged material was ~50% silt on the basis of several bore holes, which renders the substrate geotechnically unsuitable for placement of the breakwater. O2 Marine (2020) sediment sampling at seven (7) sites across the proposed northern breakwater footprint confirmed the high silt content (62%) and the need for capital dredging.

2021 sediment quality of the proposed KBSC marina footprint

Cardno (2021) evaluated the suitability of the proposed dredged material within the KBSC marina. The sediments were comprised of ~1% clay, ~12% silt and ~84% sand. No potential contaminants (i.e. metals and metalloids, TBT, PAH, BTEX, TRH, OC/OP) exceeded the guideline criteria.

Comparative Baseline Water Quality

Nutrient levels in Leschenault Inlet are substantially greater than Koombana Bay and Casuarina Boat Harbour, yet algae (chl-a) levels are relatively similar among the three (3) water bodies. TSS levels are also similar across the three (3) water bodies so light limitation is not likely a causal factor. Toxicity from organic contaminants (i.e. BTEX, PAH, TRH, OC/OP) is not likely as the three (3) water bodies consistently have concentrations below LoR. Though most metal and metalloid analytes are well below relevant guideline values, Zn is an exception. The median and 80th percentile concentration of Zn in the inlet was at or above the ANZG (2018) guideline value, whereas concentrations were much lower in the bay and harbour, and well below this criterion.

PSD of Sediment to be Dredged

The dredged material of two (2) of the three (3) proposed dredging regions, namely Casuarina Boat Harbour and KBSC marina, are predominantly sand (>70%), whereas the Casuarina Boat Harbour northern breakwater footprint is predominantly silt (>60%). It follows, all other factors being equal, that turbid plumes generated during dredging of the northern breakwater footprint will remain suspended in the water column for longer because the settling velocities of these smaller diameter clay and silt particles are substantially lower. As a result, these fine (silt, clay) particles will be transported over greater distances with potentially greater impact than the harbour and marina sediments.

Comparative Baseline Sediment Quality

The sediments of the KBSC marina footprint (Cardno 2021) pose limited risk in terms of toxicity to the marine environment during dredging activities. TBT levels in a small pocket of sediments (~10,000 m^3) of Casuarina Boat Harbour (RPS 2017) warrant onshore disposal with the remainder slated for offshore disposal. Leschenault Inlet sediments do not pose a material risk to the environment (O2 Marine 2021).

This report is subject to, and must be read in conjunction with, the limitations, assumptions and qualifications contained throughout the Report.

Contents

Table index

Figure index

Appendices

Acronyms and abbreviations

Acronym / Abbreviation	Description
Ag	Silver
Al	Aluminium
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines
ARI	Annual Recurrence Interval
As	Arsenic
BCH	Benthic Communities and Habitat
BHD	Backhoe Dredge
BoM	Bureau of Meteorology
BTEX	Benzene, Toulene, Ethylbenzene and Xylene
CD	Chart Datum
Cd	Cadmium
Chl-a	Chlorophyll-a
Chl-b	Chlorophyll-b
Chl-c	Chlorophyll-c
CoC	Chain of Custody
Co	Cobalt
Cr	Chromium
CrIII	Chromium III
CrVI	Chromium VI
Cu	Copper
DDC	Dolphin Discovery Centre
DGVPC	Default Guideline Value for Physical and Chemical Stressors
DGVTS	Default Guideline Value for Toxicants in Sediments
DGVTS -high	High Default Guideline Value for Toxicants in Sediments
DGVT	Default Guideline Value for Toxicants
DO	Dissolved Oxygen
DoT	Department of Transport
DoW	Department of Water
DTVPC	Default Trigger Value for Physical and Chemical Stressors
DWER	Department of Water and Environmental Regulation
E	Einstein
EFG	Environmental Factor Guideline
EPA	Environmental Protection Authority
ESD	Environmental Scoping Document
Fe	Iron

Acronym / Abbreviation	Description
FRP	Filterable Reactive Phosphorus
ha	Hectare
Hg	Mercury
hr	Hour
Hz	Hertz
ID	Identifier
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
I_S	Net daily subsurface PAR just above air-water interface
I_{SS}	Net daily subsurface PAR just below air-water interface
J	Joule
km/hr	Kilometers per Hour
KBMS	Koombana Bay Marine Structures
KBSC	Koombana Bay Sailing Club
KEF	Key Environmental Factor
km	Kilometre
LAC	Light Attenuation Coefficient
LOI	Loss on Ignition
LoR	Limit of Reporting
LSP	Level of Species Protection
m	Metre
MAFRL	Murdoch University Marine and Freshwater Research Laboratory
MEQ	Marine Environmental Quality
MLLW	Mean Low Lower Water
m^3	Cubic Meters
mm	Millimetre
Mn	Manganese
mV	Millivolts
NH_X	Reduced inorganic nitrogen (ammonia plus ammonium)
Ni	Nickel
NO_X	Oxides of nitrogen (nitrate plus nitrite)
NTU	Nephlometric Turbidity Unit
OC/OP	Organochlorine and Organophosphate Pesticides
ORP	Oxidation Reduction Potential
PAH	Polycyclic Aromatic Hydrocarbons
PAR	Photosynthetic Available Radiation
Pb	Lead
PSD	Particle Size Distribution
psu	Practical Salinity Units
QA/QC	Quality Assurance / Quality Control
r^2	Coefficient of Determination

Acronym / Abbreviation	Description
RPD	Relative Percentage Difference
s	Second
Sb	Antimony
Se	Selenium
SPER	Strategic Public Environmental Review
SWDC	South West Development Commission
TBT	Tributyltin
TG	Technical Guidance
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
TSS	Total Suspended Solids
TTV	Toxicant Trigger Value
uE	Microeinsteirn
um	Micrometre
V	Vanadium
WQIF	Water Quality Instrument Frame
z	Path length between the water surface and the PAR logger
Zn	Zinc
~	Approximately
°C	Degrees Celsius
°	Degrees
%SI	Percent Surface Irradiance
α	Albedo

1. Introduction

1.1 Proposal

The South West Development Commission (SWDC) is the proponent for the Koombana Bay Marine Structures (KBMS) proposal. In March 2015 the SWDC referred the KBMS proposal to the Western Australia Environmental Protection Authority (EPA), which determined the KBMS proposal to be assessed at the level of “Strategic Proposal” (Public Environment Review or SPER). The EPA approved an Environmental Scoping Document (ESD) for the KBMS SPER (Assessment Number 2049) on 26 June 2015.

The KBMS proposal (or the strategic proposal) is located within the City of Bunbury, about 174 kilometres (km) south of Perth, Western Australia. The marine structures subject to the KBMS strategic proposal are situated within Koombana Bay which neighbours the Bunbury Central Business District and the Marlston North residential and waterfront developments. Figure 1 illustrates the indicative KBMS proposal.

The KBMS strategic proposal aims to construct and operate the following marine structures within Koombana Bay:

1. Casuarina Boat Harbour.
2. Koombana Bay Sailing Club (KBSC) marina.
3. Dolphin Discovery Centre (DDC) finger jetty.

Collectively, the three (3) individual marine structures (Casuarina Boat Harbour, KBSC marina and the DDC finger jetty) are referred to as the KBMS strategic proposal. Individually, and because they will be constructed over different timescales, the three (3) individual marine structures are referred to as "future proposals”. This is consistent with the EPA’s assessment process and terminology under the *Environmental Protection Ac, 1986.*

1.1.1 General description of KBMS strategic proposal

A general description of the KBMS strategic proposal is provided in Table 1.

Table 1 General strategic proposal description

Strategic proposal title	Koombana Bay Marine Structures
Strategic proponent name	South West Development Commission
Short description	The strategic proposal is to develop areas in Koombana Bay for small craft marine infrastructure (Figure 1). The proposed marine infrastructure includes jetties, boat ramps and boat pens. The identified future proposals under the strategic proposal are for the construction and operation of: – **Casuarina Boat Harbour** – **Koombana Bay Sailing Club Marina** – **Dolphin Discovery Centre Finger Jetty** The construction of future proposals will be undertaken in stages. The marine infrastructure is located adjacent to, or in close proximity to existing infrastructure in Koombana Bay, Bunbury.

1.1.2 Identified future proposal description and elements

A description and elements of the KBMS future proposals are provided in Table 2.

Table 2 Identified future proposal description and elements

Casuarina boat harbour This future proposal includes a dredging and dredge spoil disposal, piling activities, land reclamation and construction of a breakwater and revetment walls. The marine infrastructure includes the construction and operation of floating jetties, boat ramps and boat pens.		
Proposal element	**Location / Description**	**Maximum Extent, Capacity or Range**
Physical elements		
Development Envelope	Figure 1	Up to 40 ha
(Indicative) Casuarina Boat Harbour (CBH) disturbance footprint	Figure 1	Up to 32 ha within CBH disturbance footprint
Breakwater	Figure 1	Up to 3.5 ha within CBH disturbance footprint
Reclamation	Figure 1	Up to 3.5 ha within CBH disturbance footprint
Marine infrastructure	Within CBH	Floating jetties, boat ramps and boat pens within CBH disturbance footprint.
Koombana Bay Sailing Club marina This future proposal includes a dredging component, a piling component, land reclamation (including onshore dredge spoil disposal) and construction of breakwaters. The marine infrastructure includes the construction and operation of floating jetties, boat ramps and boat pens.		
Proposal element	**Location / Description**	**Maximum Extent, Capacity or Range**
Physical elements		
Development Envelope	Figure 1	Up to 16 ha
(Indicative) Koombana Bay Sailing Club (KBSC) marina disturbance footprint	Figure 1	Up to 10 ha within KBSC disturbance footprint
Breakwaters	Figure 1	Up to 2.5 ha within KBSC disturbance footprint
Reclamation	Figure 1	Up to 2 ha within KBSC disturbance footprint
Marine infrastructure	Within KBSC	Floating jetties, boat ramps and boat pens within KBSC disturbance footprint
Dolphin Discovery Centre finger jetty This future proposal includes a finger jetty, a piling component and a temporary onshore construction laydown area.		
Proposal element	**Location / Description**	**Maximum Extent, Capacity or Range**
Physical elements		
Development Envelope	Figure 1	Up to 0.5 ha
(Indicative) Dolphin Discovery Centre (DDC) jetty disturbance footprint	Figure 1	Up to 0.15 ha within DDC disturbance footprint
Marine infrastructure	Figure 1	Jetty up to 110 metres long

Figure 1 ***Development envelope, indicative disturbance footprint and marine elements***

1.2 Purpose of this report

Four (4) key environmental factors (KEFs) were identified in the ESD, namely:

1. ***Marine Environmental Quality*** (MEQ) with the EPA objective 'to maintain the quality of water, sediment and biota so that the environmental values (both ecological and social) are protected'.
2. ***Benthic Habitats*** with the EPA objective 'to protect benthic communities and habitats so that biological diversity and ecology integrity are maintained'.
3. ***Marine Fauna*** with the EPA objective 'to protect marine fauna so that biological diversity and ecological integrity are maintained'.
4. ***Coastal Processes*** with the EPA objective 'to maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected'.

The ESD sets out the information that the EPA will require to allow evaluation of the impacts of the strategic proposal on the basis of these KEFs.

This report describes the baseline water quality monitoring for the KBMS SPER, and has been prepared to meet some of the EPA requirements set out in the ESD for the KEF of Marine Environmental Quality. This report presents water quality monitoring data to characterise:

– Natural seasonal water quality variability within the vicinity of the KBMS, an objective of EPA Environmental Factor Guideline [EFG] Marine Environmental Quality (EPA 2016a).
– Tolerances of benthic community habitats (BCH) to changes in water quality, an objective of EPA Environmental Factor Guideline (EFG) Benthic Communities and Habitats (EPA 2016b).
– Provision of site specific data and relations to demonstrate to regulatory authorities the basis for predicting potential dredging impacts to the marine environment, an objective of EPA Technical Guidance (TG) Environmental Impact Assessment of Marine Dredging Proposals (EPA 2016c).

Additionally, preliminary characterisation of the surficial sediments of the Casuarina Boat Harbour was carried out to inform predictive modelling of proposed dredging. This baseline monitoring serves to inform the marine environmental impact assessment of the construction and operational activities of the three (3) future proposals, and the preparation of relevant construction and operational management plans.

Specifically, this document is the primary report that describes the methodology and results of the:

– 2016-2017 baseline water quality monitoring of Koombana Bay and Casuarina Boat Harbour.
– 2016 surficial particle size distribution (PSD) of Casuarina Boat Harbour.

Additionally, this report summarises the following baseline studies carried out for the KBMS SPER:

– O2 Marine (2021) 2020 baseline water and sediment quality monitoring of Leschanault Inlet.
– O2 Marine (2020) 2020 PSD of the sediment of the proposed Casuarina Boat Harbour northern breakwater.
– RPS (2017) 2016 baseline sediment quality of Casuarina Boat Harbour.
– Cardno (2022) 2021 baseline sedimental quality of the proposed Casuarina Boat Harbour northern breakwater and the nominated offshore disposal area.

1.3 Limitations

This report: has been prepared by GHD for South West Development Commission and may only be used and relied on by South West Development Commission for the purpose agreed between GHD and South West Development Commission as set out in this report.

GHD otherwise disclaims responsibility to any person other than South West Development Commission arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Methodology

2.1 2016-2017 Koombana Bay and Casaurina Harbour monitoring

2.1.1 Monitoring sites

Baseline water quality monitoring included one (1) Casuarina Boat Harbour transect (T1) and four (4) Koombana Bay transects (T2-T5) (Figure 2, Table 3). Each transect was comprised of three (3) cross-shore sites (inshore, mid-depth and central bay). The spatial arrangement of transects was similar to Oceanica (2008) (quarterly monitoring over 9 months during 2007-2008), which allows comparative analysis of water quality changes over the intervening decade.

During the first survey in September 2016, surficial sediment grab samples were collected in Casuarina Boat Harbour (Figure 2, Table 3) to characterise the PSD and the organic content expressed as loss on ignition (LOI).

Loggers at two (2) shallow sites in southern Koombana Bay (Figure 2, Table 3) were used to characterise the temperature, turbidity and underwater light climate on a continuous basis over the baseline monitoring period.

Table 3 ***Summary of 2016-2017 water quality, sediment and logger monitoring sites of Koombana Bay and Casuarina Boat Harbour***

Transect	Site ID	Latitude	Longitude	Description
T1	T1-A	-33.31242	115.63893	Water sampling sites
	T1-B	-33.31190	115.63976	
	T1-C	-33.31096	115.64156	
T2	T2-A	-33.31721	115.64102	
	T2-B	-33.31547	115.64214	
	T2-C	-33.31202	115.64405	
T3	T3-A	-33.31763	115.64473	
	T3-B	-33.31639	115.64548	
	T3-C	-33.31120	115.64588	
T4	T4-A	-33.31909	115.64857	
	T4-B	-33.31268	115.64828	
	T4-C	-33.31060	115.64919	
T5	T5-A	-33.31673	115.65199	
	T5-B	-33.31281	115.65120	
	T5-C	-33.31126	115.65097	
NA	WQIF-E	-33.31913	115.65154	Logger sites
	WQIF-W	-33.31890	115.64593	
NA	SS-1	33.31252	115.63899	Sediment sampling sites
	SS-2	33.31197	115.63982	
	SS-3	33.31129	115.64043	
	SS-4	33.31137	115.64185	
	SS-5	33.31150	115.64130	
	SS-6	33.31356	115.64019	
	SS-7	33.31218	115.63821	
	SS-8	33.31329	115.63947	

Figure 2 ***Location of 2016-2017 Koombana Bay and Casuarina Boat Harbour baseline monitoring sites.***

2.1.2 Field methods and monitoring equipment

2.1.2.1 Loggers

Water quality instrument frames (WQIF) were deployed at the two (2) southern Koombana Bay locations with the following continuous measuring loggers:

– WetLabs (Oregon, USA) ECO-NTU-SB turbidity logger.
– JFE Advantech (Kobe, Japan) Compact-LW (ALW-CMP) photosynthetic available radiation (PAR) logger.
– RBR (Ottowa, Canada) TDR-2050 temperature and pressure logger.

The measurement frequency of these instruments was set so that battery power lasted over the duration of the 4-8 week survey frequency. The turbidity and PAR loggers collected 'bursts' of 11 and 10 measurements, respectively, at a frequency of 1 hertz (Hz) at 15 minute intervals. The RBR temperature/pressure loggers collected a single measurement every 15 minutes.

The PAR and turbidity loggers have automatic sensor wipers integrated into their housings. These wipers activate prior to each burst to reduce (or eliminate) sensor biofouling and thereby reduce the collection of compromised data. The 15 minute sampling and concomitant wiper activation frequency reduce biofouling and obtain high temporal resolution data.

2.1.2.2 Sonde profiler and secchi depth

Vertical profiles with a manually lowered sonde with conductivity, temperature, turbidity, oxidation-reduction potential (ORP), pH, dissolved oxygen (DO) and pressure sensors were collected at each site at a vertical resolution of <0.5 m. After acquisition of each sonde vertical profile, the secchi depth was measured.

2.1.2.3 Water samples

A 2-3 m vertically integrated water sample was collected at each of the 15 sites with a van Dorn sampler. Water samples were dispatched to Murdoch University Marine and Freshwater Research Laboratory (MAFRL) for analysis of the following:

– Reduced inorganic nitrogen (NH_X), filtered reactive phosphorus (FRP), oxidised inorganic nitrogen (NO_X), total nitrogen (TN), total phosphorus (TP), chlorophyll a (chl-a), chlorophyll b (chl-b), chlorophyll c (chl-c) and totals suspended solids (TSS).
– For eight (8) of the ten (10) water quality surveys, filtered metals including aluminium (Al), chromium (Cr), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), cadmium (Cd), lead (Pb) and mercury (Hg).

2.1.2.4 Sediment samples

Sediment samples were collected with a van Veen grab sampler on 6 September 2016 at eight (8) sites in Casuarina Boat Harbour, and were analysed via sieving (larger particle sizes) and a hydrometer (smaller particle sizes) by MAFRL.

2.1.3 Survey tasks

Water quality tasks associated with each field survey included:

– Retrieval, data download, servicing and re-deployment of the WQIFs at the two (2) sites.
– Collection of vertically integrated water samples at all monitoring sites.
– Collection of sonde profiles at all monitoring sites.

On the first survey (September 2016), sediment grab samples were collected at eight (8) locations.

All water (and sediment) samples were stored in an esky on ice and after the survey dispatched to MAFRL for laboratory analysis on the same day of (or the day after) sampling, well under relevant holding times.

2.1.4 Survey dates

The water quality survey and WQIF servicing dates are summarised in Table 4. In total 19 field trips were carried out over the baseline monitoring period, ten (10) for water sampling (and on 1 occasion sediment sampling) and the remainder associated with retrieval and deployment of WQIFs.

Table 4 ***Summary of survey dates and activities during 2016-2017 baseline monitoring of Koombana Bay and Casuarina Boat Harbour***

Survey Number	Date	Casuarina Boat Harbour Sediment Samples	Water Samples	East Site WQIF	West Site WQIF
1	6 Sep 2016	PSD, LOI	Metals & Nutrients	WQIFs Deployed	
2	26 Oct 2016	No Additional Sediment Sampling	Nutrients	No WQIF Retrieved – Too Turbid	
3	8 Nov 2016		None	No WQIF Retrieved – Too Turbid	
4	14 Nov 2016			WQIF Retrieved & Deployed	No WQIF Retrieved – Too Turbid
5	21 Nov 2016				WQIF Retrieved
6	24 Nov 2016			WQIF Retrieved & Deployed	WQIF Deployed
7	14 Dec 2016		Metals & Nutrients	No WQIFs Retrieved – Not Located	
8	22 Dec 2016		None	No WQIFs Retrieved – Not Located	
9	17 Jan 2017		Metals & Nutrients	WQIF Retrieved & Deployed	No WQIF Retrieved – Not Located
10	2 Feb 2017		None		WQIF Retrieved & Deployed
11	22 Feb 2017		Metals & Nutrients	No WQIFs Retrieved – Not Located	
12	28 Feb 2017		None	WQIF Retrieved & Deployed	
13	30 Mar 2017		Metals & Nutrients	No WQIFs Retrieved – Not Located	
14	3 Apr 2017		None	WQIF Retrieved & Deployed	
15	26 Jun 2017		Metals & Nutrients	WQIF Retrieved & Deployed	No WQIF Retrieved – Not Located
16	4 Jul 2017		None	WQIF Retrieved & Deployed	No WQIF Retrieved – Not Located (WQIF)
17	4 Aug 2017		Metals & Nutrients	WQIF Retrieved & Deployed	New WQIF Deployed
18	31 Aug 2017		Metals & Nutrients	WQIFs Retrieved & Deployed	
19	28 Sep 2017		Nutrients	WQIFs Retrieved	

2.1.5 Quality assurance and quality control

2.1.5.1 Loggers

Logger data are susceptible to environmental influences that can yield incorrect (erroneous) measurements. After each survey, downloaded logger data was scanned for outliers such as anomalous recordings, prolonged identical and elevated readings, or mechanical problems with the instruments. Though some of these outliers may be accurate recordings, they were removed if not representative of the time series of logger measurements before and after the segment of data in question, or through comparisons with the second site. All omitted data were retained for quality assurance and quality control (QA/QC) records.

2.1.5.2 Water quality

Replicate water quality samples (two [2] samples from the same site) were collected at two (2) sites during each survey. The relative percentage differences (RPD) of the analytes were calculated for each replicate pair of samples to assess the confidence in the water quality data due to the aggregate of potential errors from sampling, storage and transport methods, and laboratory analysis. An RPD of <30% is often used as a quantitative criteria for QA/QC acceptability if the concentrations are greater than 5 times the limit of reporting (LoR), which was adopted here.

2.1.6 Data analysis

2.1.6.1 Climate and meteorology

Climate and weather data for the Bureau of Meteorology's (BoM) Bunbury meteorological station (Station No: 9965) were accessed through their online data facility. BoM estimates daily solar exposure from an atmospheric model that uses satellite measurements from the top of the earth's atmosphere as inputs. The model accounts for all wavelengths between 0.3-2.8 microns (µm) (ultraviolet to near-infrared). Photosynthetic active radiation (PAR, wavelengths of 0.4-0.7 µm) accounts for ~45% of the total exposure energy in this range and was adopted here.

The underwater PAR loggers measure irradiance through photon or quanta counts in units of microeinsteins per square meter per second (µE/m^2/s), which were converted to the SI unit of joules per square meter per second (J/m^2/s) with the appropriate conversion factor.

2.1.6.2 Logger percent surface irradiance

The percent surface irradiance (%SI) is defined as the percentage of the surface PAR at the air-water interface that reaches the near seabed logger. Here the total measured surface PAR was estimated as 45% of the daily BoM solar exposure estimates at Bunbury.

2.1.6.3 Logger LAC

The light attenuation coefficient (LAC) characterises the amount of PAR that is absorbed per meter of water column. A daily LAC value was calculated as there were no available sub-daily measurements of surface irradiance. The difference between PAR at the seabed and the surface is attributable to both attenuation (absorption) through the water column and reflection at the surface. The portion of reflected PAR at the water surface (i.e. albedo) was calculated with Fresnels Law. The albedo (α) was calculated on basis of the solar angle at noon for each day. The PAR immediately below the air-water interface, I_{SS}, was calculated as.

$$I_{SS} = I_S(1 - \alpha)$$

where I_S is the PAR just above the air-water interface. The LAC was then calculated from the net daily subsurface PAR (I_{SS}) with the Lambert-Beer Law in base 10 as follows:

$$LAC = \frac{log_{10}\left(\frac{I_B}{I_{SS}}\right)}{-z}$$

where z is the path length between the water surface and the PAR logger, and I_B is the daily total near-seabed PAR measured by the logger. LAC was calculated on the basis of logger depth data or estimates of the water depth, and the seasonal solar angle. The path length was adjusted with Snell's Law to account for refraction at the air-water interface. The characteristic path length was estimated between the hours of 0900 and 1500 when most of the daily irradiance occurs accounting for average water depth above the sensor and the path length angle. Where depth measurements were not available, depths were estimated from temporally proximal depth measurements.

2.1.6.4 Water quality

Water quality data was compared to relevant ANZG (2018) default guideline values for toxicants (DGVT) (i.e. metals/metalloids) and physical and chemical stressors (DGVPC). DGVPCs were based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA 4.0) ecoregion of Leeuwin-Naturaliste in which Koombana Bay is located. For analytes with no ANZG (2018) DGVPC (e.g. TP, NH_4) or DGVT (e.g Al) then the ANZECC (2000) default trigger values for physical and chemical stressors of South West Australia (DTVPC) and recommended toxicant trigger values at the recommended level of species protection (95% or 99% level of species protection) for slight-moderately disturbed ecosystems (TTV) were adopted respectively. For aluminium (Al), antimony (Sb), arsenic (As), iron (Fe) and selenium (Se) the ANZECC (2000) low reliability trigger values (LRTV) were adopted.

2.2 2020 Leschenault Inlet monitoring

The objective of the 2020 Leschenault Inlet monitoring was to establish the baseline for this water body to complement that of southern Koombana Bay and Casuarina Boat Harbour. Refer to O2 Marine (2021) for an overview of the baseline monitoring methodology of the monthly water quality monitoring, continuous measurements of turbidity and underwater light, and sediment sampling of the Leschenault Inlet from January-August 2020. A brief summary of key methodology elements is provided in this section.

Baseline monitoring of Leschenault Inlet was carried out at three (3) sites that included physico-chemical profiling (temperature, salinity, dissolved oxygen saturation, pH, turbidity), water quality grab sampling (nutrients [TN, TKN, TP, FRP, NOx, NHx], metals/metalloids [Al, As, Cd, Cr, CrIII, CrVI, Cu, Fe, Pb, Mn, Hg, Ni, Zn], chla), TSS and continuous measurements of underwater light and turbidity above the seabed at two (2) sites (Figure 3, Table 5).

Table 5 Summary of 2020 water quality, sediment and logger monitoring sites in Leschenault Inlet

Site ID	Easting	Northing	Description
LI1	33.32394	115.64437	Western inlet site Sonde profiles, water quality, sediment quality, loggers
LI2	33.32677	115.65062	Middle inlet site Sonde profiles, water quality, sediment quality
LI3	33.32716	115.65695	Eastern inlet site Sonde profiles, water quality, sediment quality, loggers

Figure 3 Location of 2020 baseline Leschenault Inlet monitoring sites.

On the first survey, sediment samples were collected at the three (3) sites and analysed for metals/metalloids (Ag, Cd, Se, Co, Sb, Cu, Pb, Zn, Cr, Ni, As, V, Mn, Hg), organochlrine and organophosphate pesticides, nutrients (TN, NHx, NOx, TP, FRP) and TBT.

A summary of the survey dates is provided in Table 6. In total seven (7) field trips were carried out over the baseline monitoring period.

Table 6 Summary of survey dates and activities during 2020 baseline monitoring of Leshenault Inlet

Survey Number	Date	Sediment Samples	Water Samples	Loggers
1	14 Jan 2020	PSD & Sediment Quality	Profiling & Water Quality	Mobilisation
2	19 Feb 2020			Download & Servicing
3	17 Mar 2020			Download & Servicing
4	14 Apr 2020			Download & Servicing
5	12 May 2020			Download & Servicing
6	15 Jun 2020			Download & Servicing
7	15 Jul 2020			Demobilisation

2.3 2017 Casuarina Boat Harbour sediment survey

The objective of this 2017 survey was to ascertain the suitability of the proposed dredged material from within this water body for offshore disposal and/or onshore reclamation. Approximately 107,000 m^3 of sediment will be dredged in accordance with the DoT dredging design of -1.15 m CD immediately adjacent to the causeway, -2.5 m CD (south-eastern and western mooring shelves), -3.0 m CD (inner channel) and -3.5 m CD (outer channel and north-eastern mooring shelf). Refer to RPS (2017) for an overview of methodology of the October 3-5 2017 sediment quality survey of Casuarina Boat Harbour. Sediment samples were collected at nineteen sites across the proposed dredge area (Figure 4) with sub-samples at various core depths analysed for:

Figure 4 *2017 Casuarina Boat Harbour sediment sampling locations (RPS 2017a).*

– PSD
– Metals and metalloids (Al, Ag, Cd, Se, Co, Sb, Cu, Pb, Zn, Cr, Ni, As, V, Mn, Hg, U, Th)
– Organotins (tributyl tin [TBT])
– Benzene, toulene, ethyl benzene and xylene (BTEX)
– Total recoverable hydrocarbons (TRH)
– Polycyclic aromatic hydrocarbons (PAH)
– Organochlorine and organophosphate pesticides (OC/OP)
– Nutrients
– Acid sulfate soils.

PAHs, TRH/BTEX and OC/OP pesticides wer normalised to 1% total organic carbon (TOC) on the basis of the 95% upper confidence limit of the total organic carbon samples (1.88%) as per ANZG (2018).

Sediment quality data was compared to ANZG (2018) toxicant default guideline values for sediment quality (DGVTS). If the DGVTS was exceeded then it was compared to the ANZG (2018) high toxicant default guideline values for sediment quality (DGVTS-High).

2.4 2020 Casuarina Boat Harbour northern breakwater sediment survey

The objective of this survey was to confirm through PSD analyses of sediment cores that the proposed dredged material at this location is ~50% silt as reported in Galt Geotechnics (2019) on the basis of several bore holes, which renders the material geotechnically unsuitable for placement of a breakwater (thereby necessitation dredging). Refer to O2 Marine (2020) for an overview of methodology of 2020 PSD of the sediment of the proposed Casuarina Boat Harbour northern breakwater footprint. A brief summary of key methodology elements is provided in this section.

Sediment sampling of seven (7) sites in water depths of ~6 m (S3, S4, S5, S7), ~8 m (S6) and ~10 m (S1, S2) across the proposed Casuarina Boat Harbour northern breakwater footprint was carried out in June 2020 (Figure 5, Table 7) to characterise PSD of the sediments.

Table 7 ***Summary of 2020 surficial sediment monitoring of the proposed Casuarina Boat Harbour northern breakwater footprint***

Site ID	Easting	Northing	Description
S1	33.30844	115.64184	Core refusal due to rocky bottom, addition of sites S6 & S7 during survey
S2	33.30849	115.64161	Samples from 0 & 0.5 m
S3	33.30987	115.64367	Samples from 0 , 0.5 & 1 m
S4	33.31113	115.64372	Samples from 0 , 0.5 & 1 m
S5	33.31027	115.64309	Samples from 0 & 0.5 m
S6	33.30878	115.64220	Samples from 0 & 1 m
S7	33.30925	115.64191	Samples from 0 & 0.5 m

Figure 5 ***Location of 2020 sediment sampling of the proposed Casuarina Boat Harbour northern breakwater footprint.***

2.5 2021 KBSC marina sediment survey

The objective of this 2021 survey was to ascertain the suitability of the proposed dredged material from the KBSC marina footprint for offshore disposal and/or onshore reclamation. Approximately 26,000 m^3 of sediment will be dredged to -3.5 m AHD. Refer to Cardno (2021) for an overview of methodology of the 22 April 2021 sediment quality survey. Sediment samples were collected at eleven sites across the proposed dredge area with coring to a maximum depth of 1 m (Figure 6) with sub-samples at the intervals of 0-0.5 m and 0.5-1.0 m analysed for:

- PSD
- Metals and metalloids (Al, Ag, Cd, Se, Co, Sb, Cu, Pb, Zn, Cr, Ni, As, V, Mn, Hg, Fe, U, Th)
- TBT
- BTEX
- TRH
- PAH

– OC/OP
– Nutrients
– Acid sulfate soils.

Sediment quality data was compared to NAGD (2009) screening levels.

Figure 6 *2021 KBSC marina footprint sediment sampling locations (Cardno 2021).*

2.6 2021 Casuarina Boat Harbour northern breakwater and spoil ground sediment survey

The objective of this survey was to determine the suitability of the dredged material from the proposed Casuarina Boat Harbour northern breakwater footprint and to characterise the sediment quality of the nominated offshore disposal ground. The This SAP implementation report was not available to summarise in this report.

3. 2016-2017 Koombana Bay and Casuarina Boat Harbour results

3.1 Climate, meteorology, river inflows and astronomical tides

In this section a brief description of the long-term climate of Bunbury (BoM station No: 9965) is provided, followed by an overview of the daily meteorology over the baseline monitoring period.

3.1.1 Climate

Bunbury has a temperate climate (latitude 33.36 ºS) with marked seasonality in solar insolation (Figure 7). Seasonal maxima and minima in solar exposure occurs from November-February (summer) and May-July (winter), respectively. Though the diel (i.e. 24 hour) range in air temperatures is relatively constant over the year (10-15°C), seasonal minima and maxima lag approximately one (1) to two (2) months relative to solar exposure seasonality (Figure 8). Average monthly patterns illustrate that the majority of rainfall occurs during the months of May to September (Figure 9).

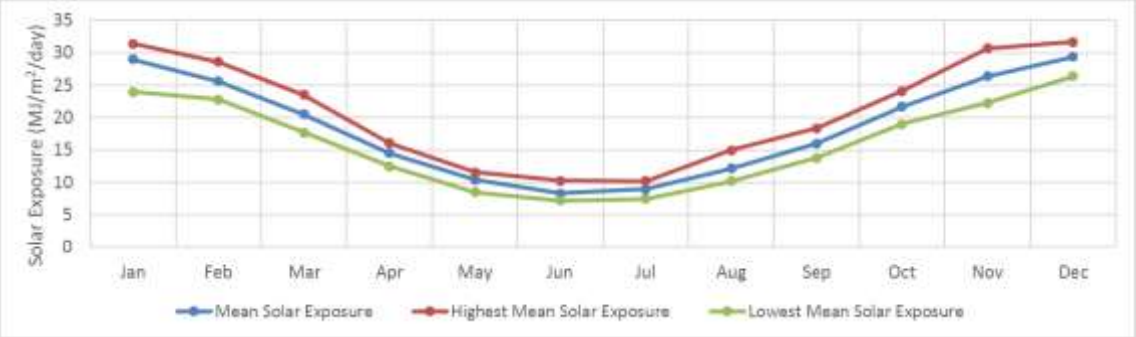

Figure 7 *Mean total daily solar exposure (MJ/m²/day) (1990-2010).*

Figure 8 *Monthly means of the maximum, minimum, 0900 and 1500 temperatures (1995-2017).*

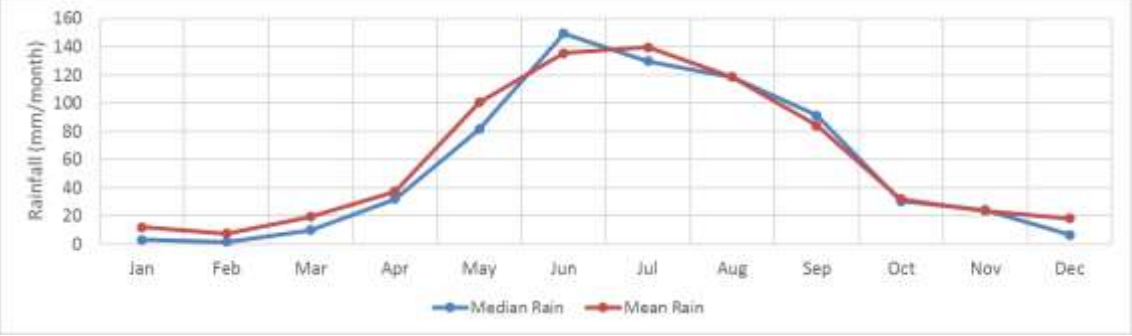

Figure 9 *Monthly mean and median rainfall (1995-2017).*

Figure 10 *Monthly means of the 0900 and 1500 wind speeds (1995-2010).*

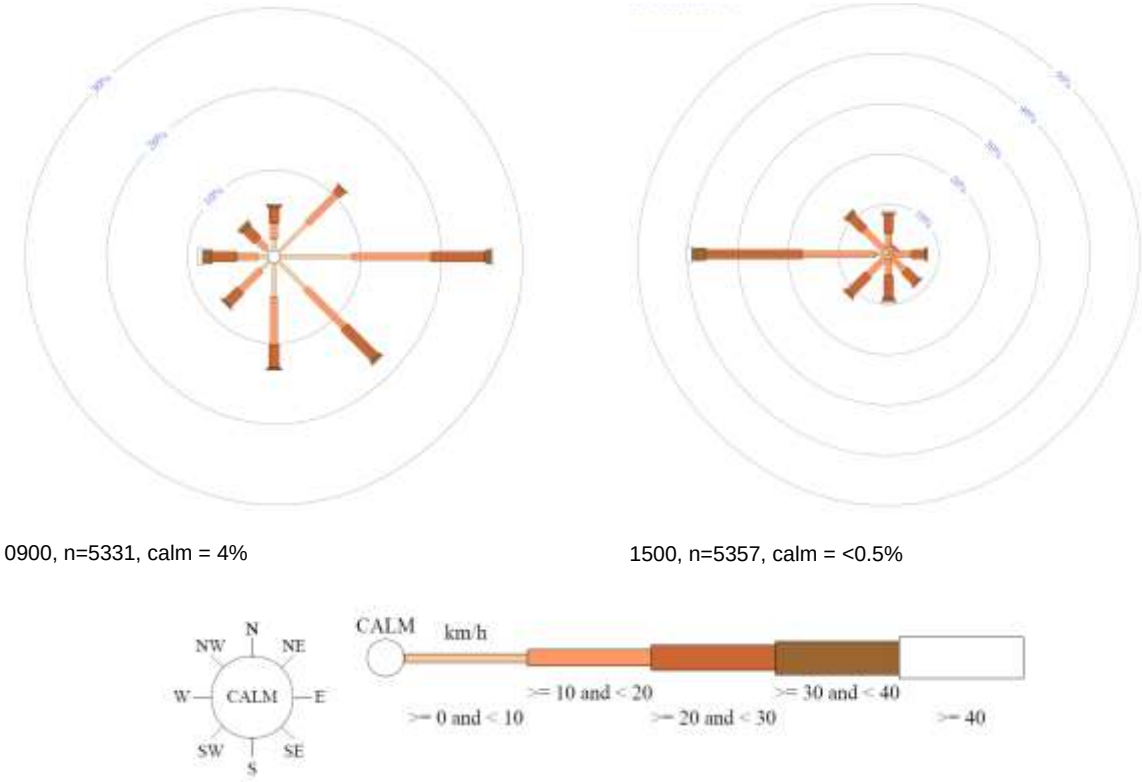

Figure 11 *Wind roses (km/hr) during 0900 and 1500 (1995-2010).*

Average monthly afternoon (1500) wind speeds are typically greater than those in the morning (0900), and the monthly averages are greater in summer (November-February) than winter (May-July) (Figure 10). Wind roses of 0900 and 1500 wind speeds show the strong predominance of morning easterlies and afternoon westerlies (Figure 11).

3.1.2 Daily meteorology

Daily meteorology from the Bunbury BoM station (No: 9965) over the baseline monitoring period is summarised in Figure 12. The meteorology was consistent with the climatic patterns described in Section 3.1.1 with peak and minimum solar insolation in November-February and July-August, respectively, peak and minimum temperatures from December-March and July-September, respectively, afternoon westerly winds generally greater than morning easterly winds, and the majority of the annual rainfall from May-September.

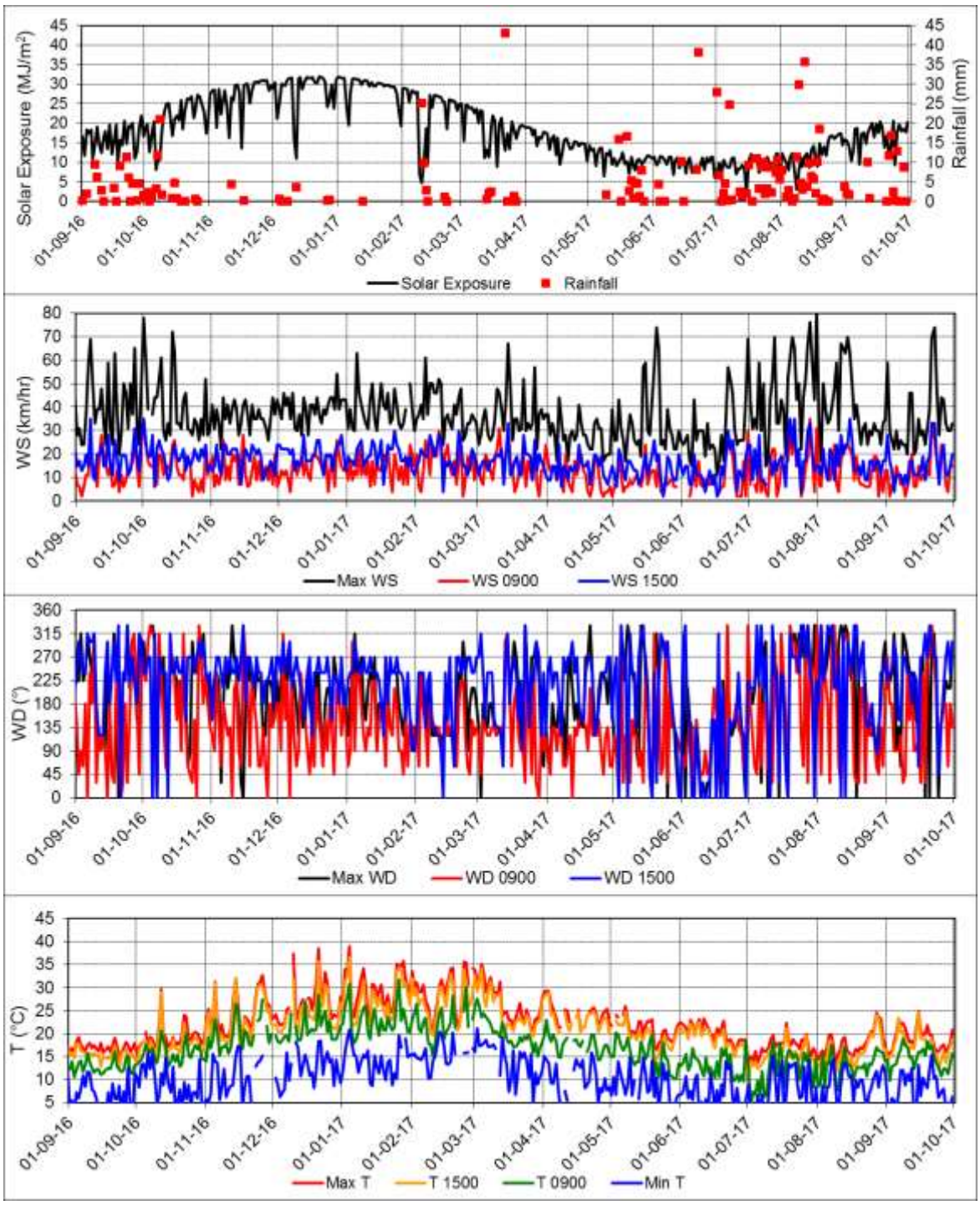

Figure 12 ***Daily BoM meteorological measurements at Bunbury (station no. 9965).***

3.1.3 Bi-Weekly meteorology

Averages of the daily meteorology data over fifteen day intervals more clearly identify seasonal trends than daily data. Solar exposure was greatest from November-mid-January and then decreased thereafter into winter (Figure 13). Air temperatures were generally greatest from mid-December-February (Figure 14). Wind speeds were greater in the afternoon than morning throughout the year, and averages of daily maximum wind speeds were typically 30-40 km/hr (Figure 15). Throughout the winter, winds were generally southeasterly in the mornings and shifted to southwesterly in the afternoons (Figure 16).

Figure 13 *Fifteen day average daily solar exposure (MJ/m²/day) and total rainfall.*

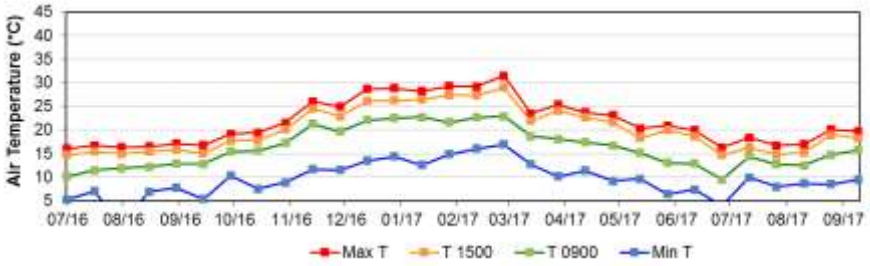

Figure 14 *As Figure 13 for maximum, afternoon (1500), morning (0900) and minimum air temperatures.*

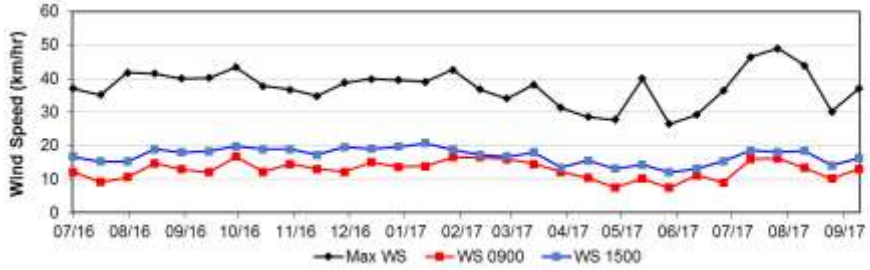

Figure 15 *As Figure 13 for maximum, morning (0900) and afternoon (1500) wind speeds (km/hr).*

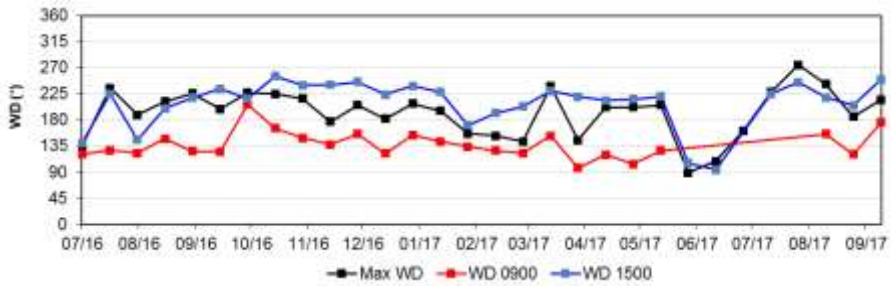

Figure 16 *As Figure 13 for maximum, morning (0900) and afternoon (1500) wind direction.*

3.1.4 River discharge

The Collie and Preston rivers discharge into Leschenault Estuary, and can influence the salinity, suspended solids and water quality climate of Koombana Bay upon exiting the Cut. Discharge from these two (2) primary rivers were estimated with the following Department of Water (DoW) measurement sites:

– Preston River:
  - DoW gauge No. 611004 at Boyanup Bridge on the Preston River.
  - DoW gauge No. 611007 at Southwest Highway on the Ferguson River.
– Collie River:
  - DoW gauge No. 612043 at Rose Road on the Collie River.
  - DoW gauge No. 612032 at Cross Farm on the Brunswick River.

Several inflow events in August, late September and early October of 2016 were near the 1 year annual recurrence interval (ARI) discharge level of 57 m^3/s, and influenced the salinity, suspended solids and water quality of Koombana Bay (Figure 17). Further, elevated inflow events at the end of July, mid-August (above the 1 year ARI) and late September 2017 also affected the bay's salinity, suspended solids and water quality climate (Figure 17).

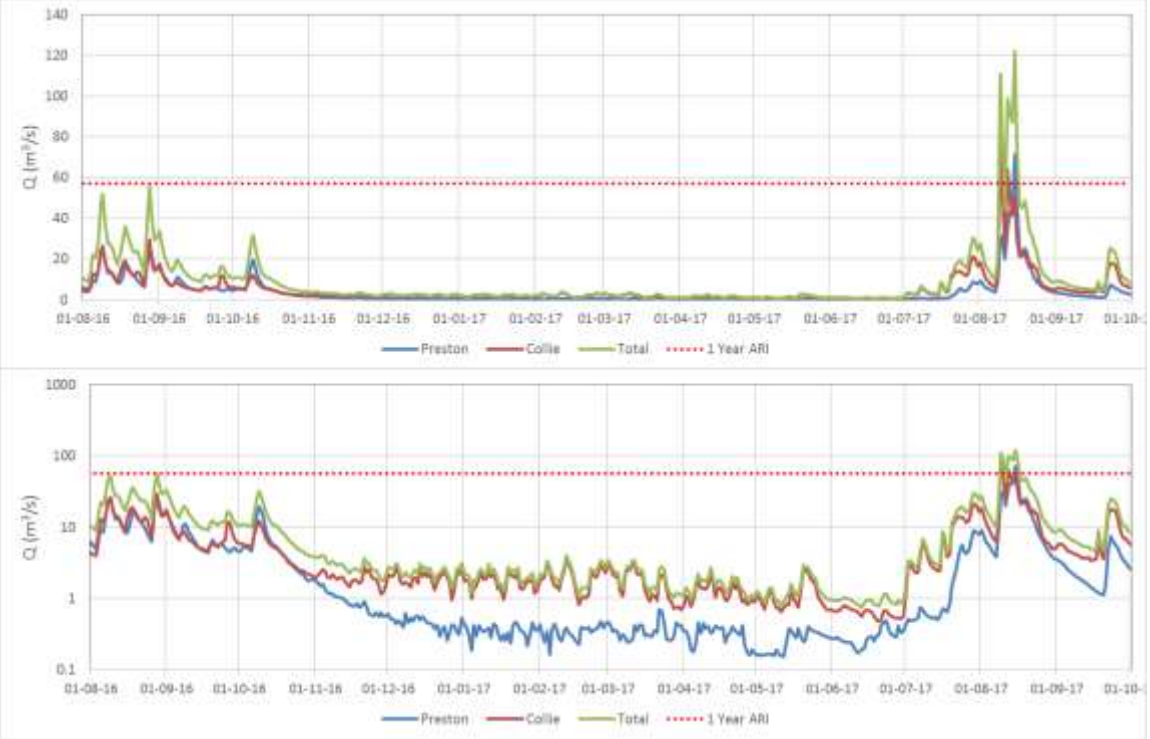

Figure 17 ***River discharge from 1 August 2016 to 1 October 2017 of the Collie and Preston rivers, as well as the total discharge.***

3.1.5 Astronomical tides

Astronomical (predicted) tides at the Port of Bunbury ranged between 0.1 m to 1.1 m MLLW[1] over the baseline period (Figure 18). The tidal range typically spanned from 0.8 m during large spring tides to approximately 0.2 m during small neap tides.

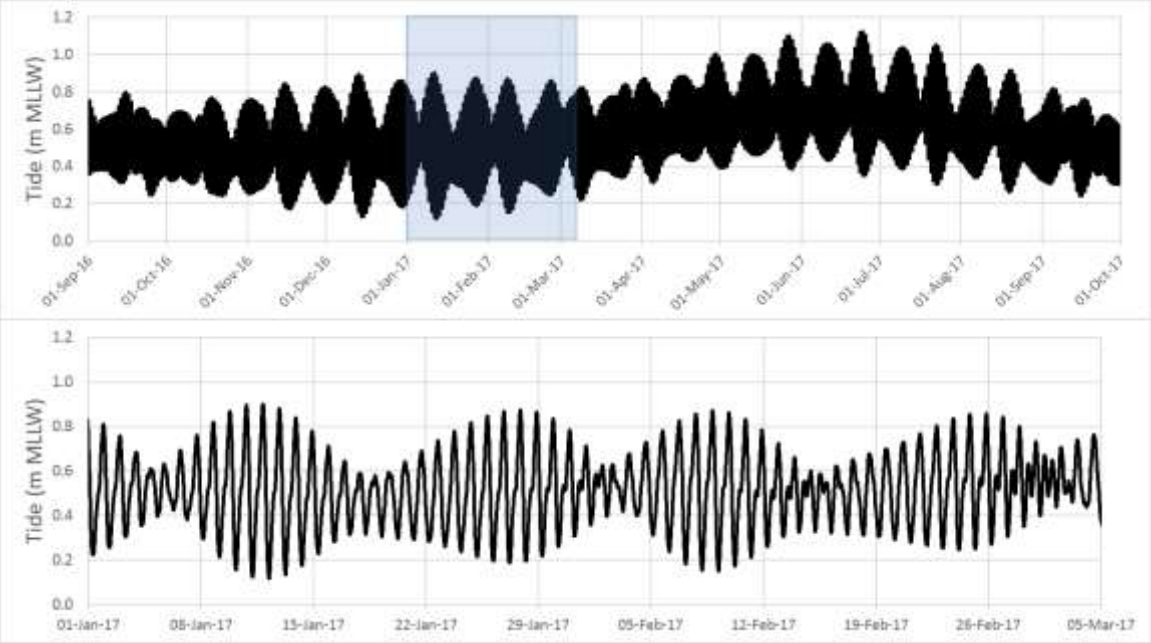

Figure 18 ***Predicted tides at Bunbury from 1 September 2016 to 1 October 2017 (top) and zoomed in from 1 January 2017 to 5 March 2017[2].***

3.2 Continuous logger measurements

This section provides and overview of the continuous logger measurements that were acquired at the east and west WQIF sites along the southern inshore waters of Koombana Bay. Data gaps occurred due to biofouling, logger malfunction, loss of a WQIF, and inability to recover WQIFs during turbid conditions (refer to Table 4 in Section 2.1.4). Estimates to fill in these gaps are presented with the daily values of logger data in Section 3.3. The data gap with the largest duration was from late June to early August 2017, which could not be filled with estimates due to lack of both turbidity and light measurements over this period. Generally, the east WQIF site had greater data capture than the west site.

3.2.1 Water levels

Figure 19 shows that both the east and west WQIF sites were deployed in ~3-4 m water depth with tidal variations in the range of the predicted (astronomical) tides in Figure 18.

[1] Mean lower low water.
[2] Source WWW Tide and Current Predictor at tbone.biol.sc.edu, datum Mean Lower Low Water [MLLW]

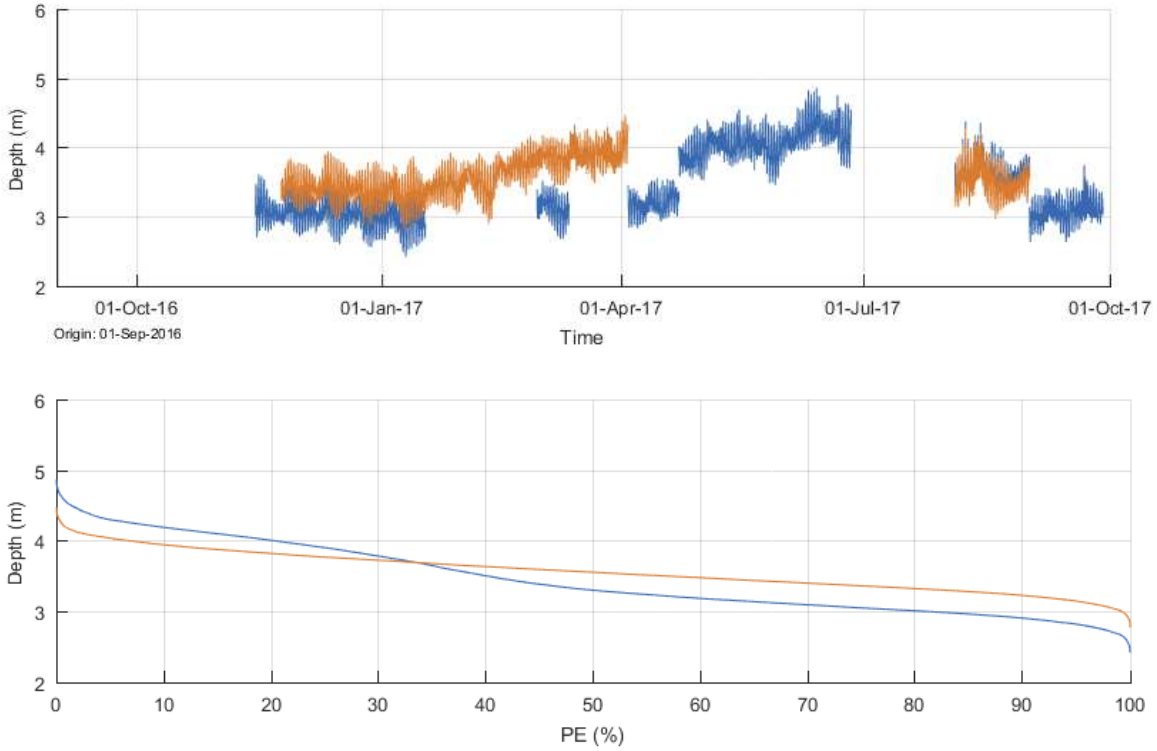

Figure 19 ***2016-2017 Koombana Bay time series (top) and probability exceedance (bottom) water level measurements at the east (blue) and west (orange) WQIF sites.***

3.2.2 Water temperature

Water temperatures at the east and west WQIF sites co-varied with maximum temperatures of ~22-23°C in December-March 2017 and minimum temperatures of 14-15°C in August 2017 (Figure 20). Diel (i.e 24 hour) variations were ~0.5-1 °C in summer and <0.5 °C in winter, which indicates a predominately well-mixed and thermally homogenous water column.

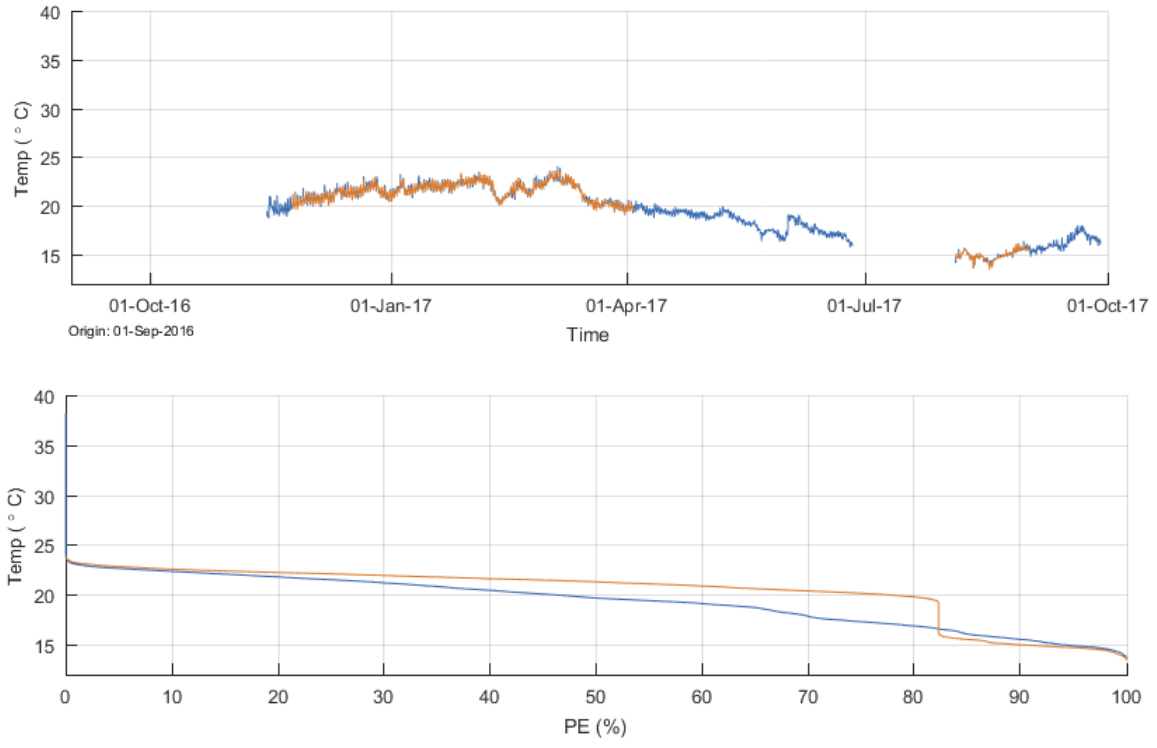

Figure 20 ***As Figure 19 for water temperature.***

3.2.3 Turbidity

Near seabed turbidity co-varied at the two sites during low (typically <5 NTU, November 2016- March 2017) and high (typically >5 NTU, May-September 2017) turbidity periods (Figure 21)[3]. Brief elevated turbidity during the low turbidity period was primarily associated with elevated winds and resuspension events. During winter, prolonged periods of elevated turbidity were associated with elevated river discharge events and subsequent wind-induced resuspension.

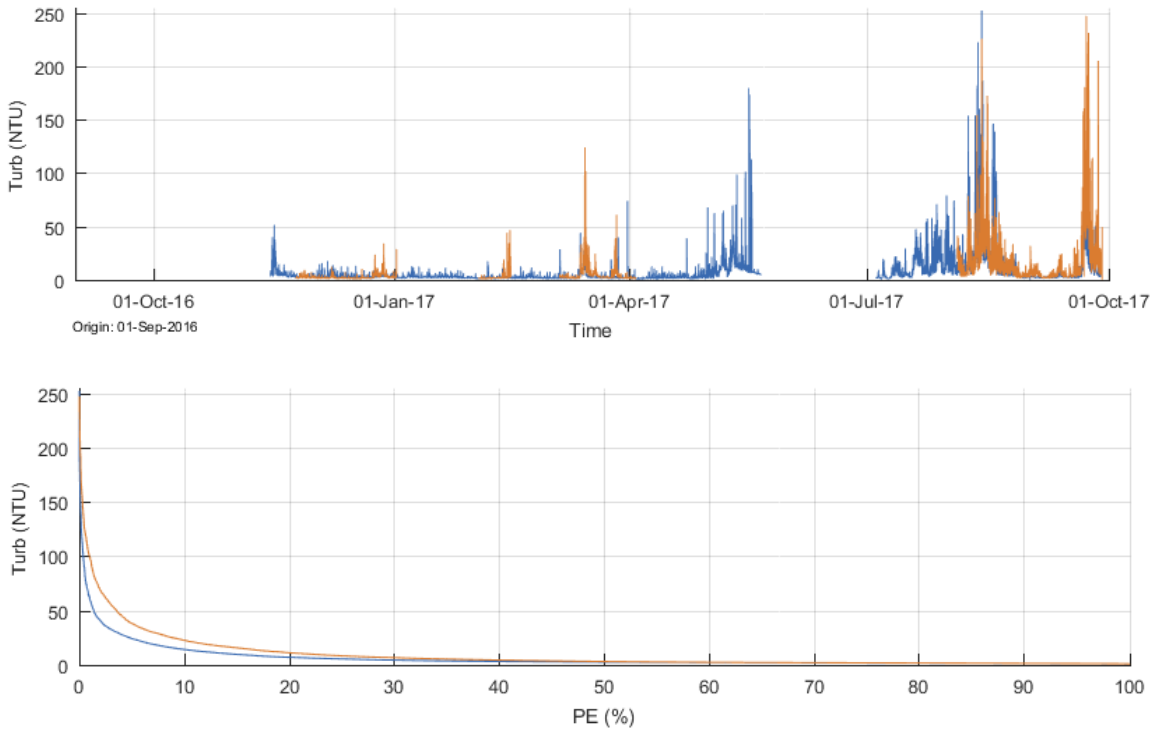

Figure 21 ***As Figure 19 for median daily turbidity.***

3.2.4 PAR

Higher PAR at the seabed occurred in summer (December 2016-February 2017) than spring (September-October 2016) and winter (August 2017) (Figure 22) due to peak seasonal insolation and low turbidity. In contrast, elevated turbidity (from river sediment loads and perhaps decomposed seagrass wrack) and seasonal minimum insolation yielded considerably lower near seabed PAR in winter. Generally, daily integrated PAR was in agreement between sites and followed the aforementioned seasonality (Figure 23).

[3] Both loggers malfunctioned during the initial deployment in September 2016, but insights into the turbidity climate are inferred from underwater PAR measurements during September and October (prior to start of the turbidity record, see Section 3.2.4).

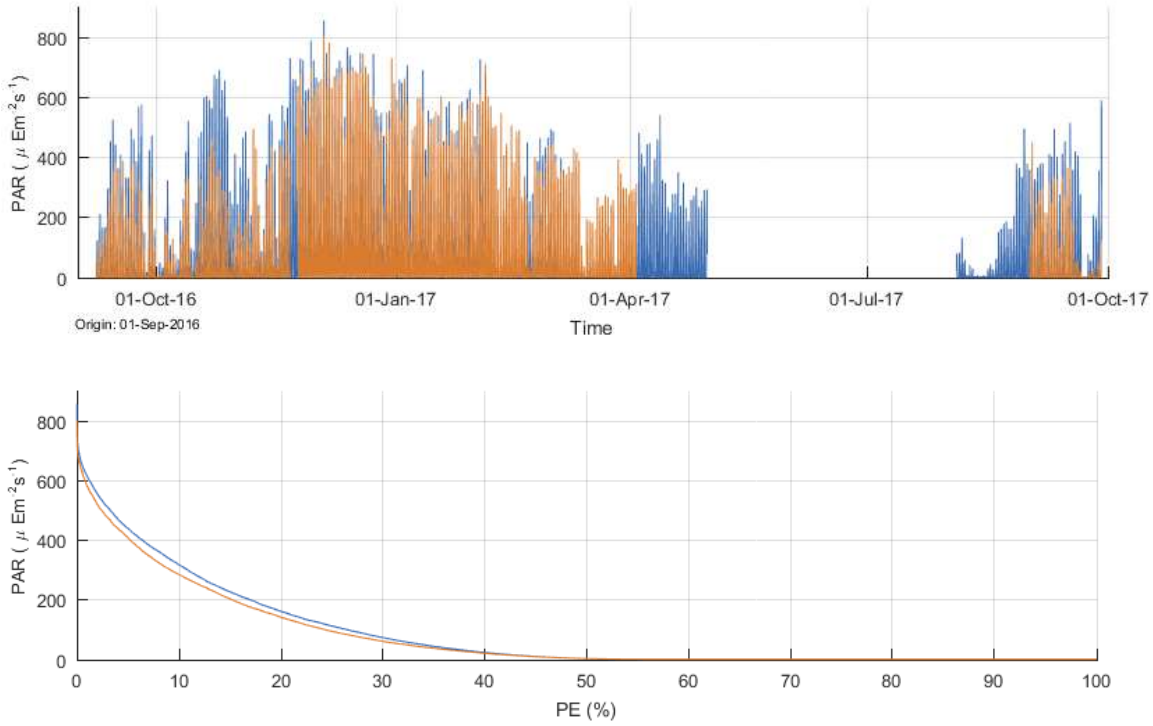

Figure 22 ***As Figure 19 for daily total PAR.***

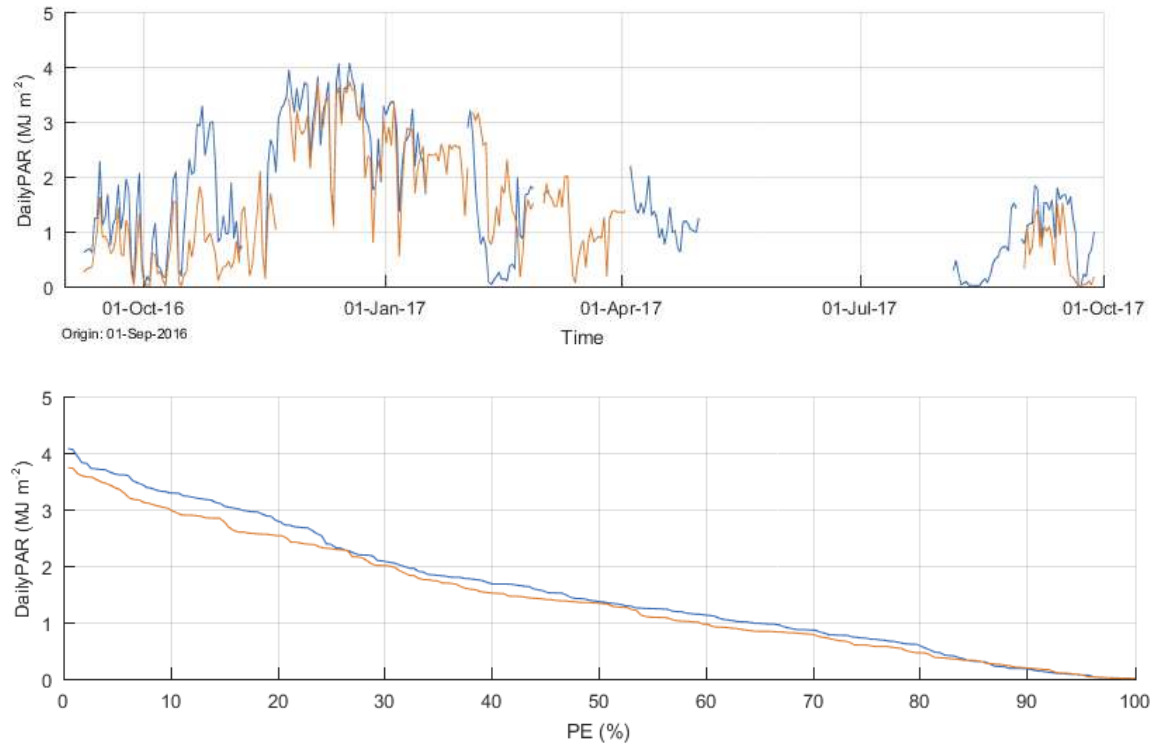

Figure 23 ***As Figure 19 for daily integrated PAR.***

3.3 Daily logger data

In this section, the following analyses of daily estimates from logger measurements are described:

– %SI near the seabed (refer to Section 2.1.6.2).
– LAC (refer to Section 2.1.6.3).
– Daily median logger turbidity between 0900 and 1500.

Relations between turbidity and LAC were developed to fill data gaps in PAR or turbidity when measurements for one of these parameters (but not the other) was available. The daily values in this section underwent further QA/QC than described in Section 2.1.5.1, including:

– Daily median turbidity (from 0900 to 1500) was compared between sites when daily estimates from both sites were available and to the corresponding daily integrated PAR to remove any erroneous values.
– Daily integrated PAR was compared between sites between sites when daily estimates from both sites were available and to corresponding daily median turbidity to remove any erroneous values.

In Section 3.3.1 linear regression relations between daily LAC and daily median turbidity are provided prior to the presentation of the daily time series of these parameters in Sections 3.3.3 and 3.3.4, respectively. These linear regression relations were used to estimate values when only one (1) of two (2) of these parameters had measurements on a particular day. Hence, the daily plots for %SI (Section 3.3.2, gaps filled using LAC estimated from median turbidity), LAC (Section 3.3.3) and median turbidity (Section 3.3.4) differentiate values by site and whether they are estimates to fill gaps.

3.3.1 Relations between daily LAC and daily median turbidity

As mentioned previously, LAC characterises the light absorption property of water, and is not dependent on insolation (such as near seabed PAR) or water depth (such as %SI). As turbidity is an integrative measure of the suspended particle climate, relations between LAC and turbidity, if statistically significant, provides a manner to predict the effects of construction turbidity-generating activities (e.g. dredging, breakwater construction) on the underwater light climate.

The relation between LAC and daily median turbidity (between 0900 and 1500) was substantially correlated at both the west (r^2=83%) and east (r^2=79%) WQIF sites (Figure 24). These relations at both WQIF sites indicate that the inherent (turbidity of 0 NTU) LAC of the inshore marine waters is ~0.017 1/m (y-intercepts for east and west WQIF sites 0.0163 and 0.0183 1/m, respectively). The estimated specific attenuation coefficient (increase in LAC per unit NTU increase in turbidity) was ~0.016 1/m / NTU (0.0161 and 0.0156 1/m / NTU for east and west WQIF sites, respectively). The use of these linear regressions to estimate turbidity from LAC (i.e. periods with available logger PAR measurements and turbidity data gaps) explained the same degree of variability for the west (r^2=83%) and east (r^2=79%) WQIF sites, and yields ~1:1 correlation (Figure 24). Further, LAC estimates from the LAC-turbidity regression and daily LAC values from measurements were substantially correlated at both the west (r^2=80%) and east (r^2=74%) sites (Figure 24), which provides confidence that LAC can be estimated from turbidity for gaps in the PAR data.

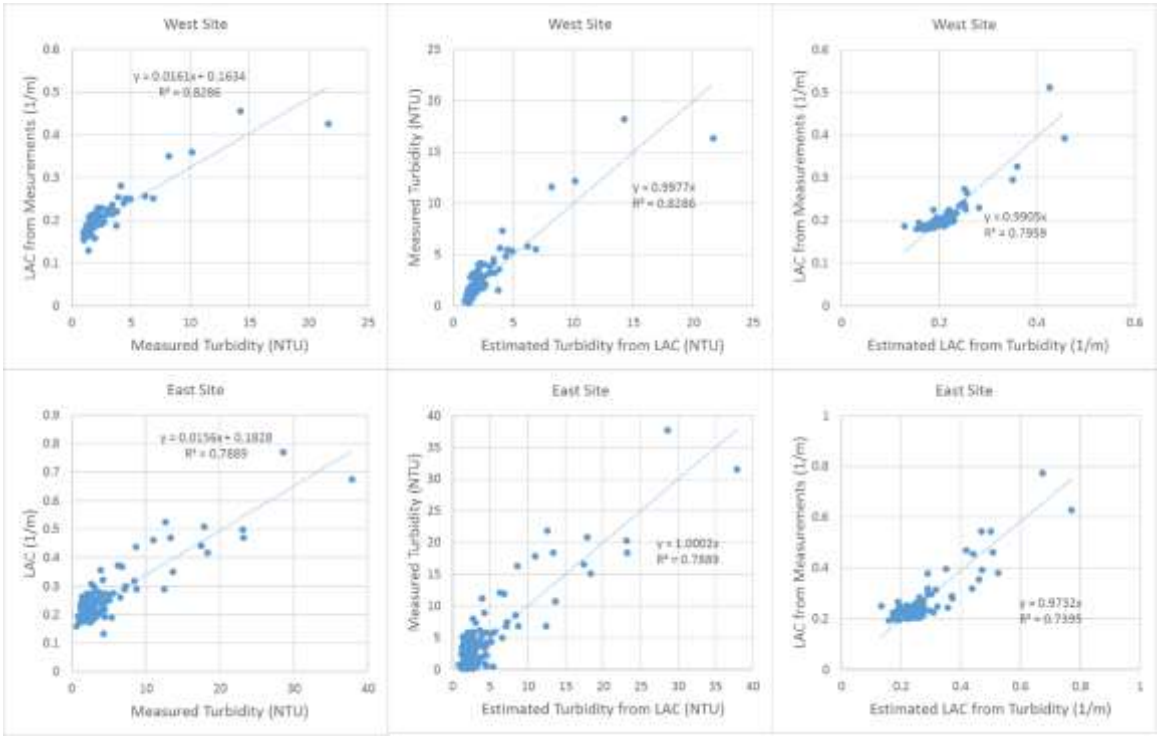

Figure 24 ***Linear regression relations between daily LAC and daily median turbidity at the east and west WQIF sites for the 2016-2017 Koombana Bay deployment.***

3.3.2 %SI at the seabed

PAR at the seabed is a major driver of BCH primary producers and their health. Generally, the 1% surface PAR irradiance level is assumed to represent the primary producer compensation point (i.e. underwater light level at which photosynthetic production balances respiratory losses with no net growth or loss). The daily %SI estimates typically ranged between 10-25% from December 2016-April 2017, and tended to be lower (at times less than <1%) with greater variability at other times of year (Figure 25).

Figure 25 ***Daily %SI at the east and west WQIF sites during the 2016-2017 Koombana Bay deployment.***

3.3.3 LAC

LAC complements %SI estimates to characterise the light climate because it is not depth or insolation dependent, but rather a function of the light absorption properties of the water column (e.g. inorganic and organic suspended solids, phytoplankton, dissolved organic matter). Daily base 10 LAC estimates were ~0.2 1/m from mid-November 2017 to April 2017, whereas LAC underwent substantially greater variability at other times with peaks >0.4 1/m generally following substantial winter river inflow events (Figure 26).

Figure 26 ***Daily averages and estimated depths (top), and daily calculated and estimated LAC (bottom) at the east and west WQIF sites during the 2016-2017 Koombana Bay deployment.***

3.3.4 Turbidity

The daily median turbidity between 0900 and 1500 at the two logger sites generally was low (<5 NTU) throughout December 2016-April 2017 except for several episodic short-lived events (Figure 24). The daily median turbidity was substantially greater during elevated river discharge periods during September-November 2016 (5-50 NTU), May-June 2017 (5-30 NTU), August 2017 (5-90 NTU) and the latter half of September 2017 (5-80 NTU).

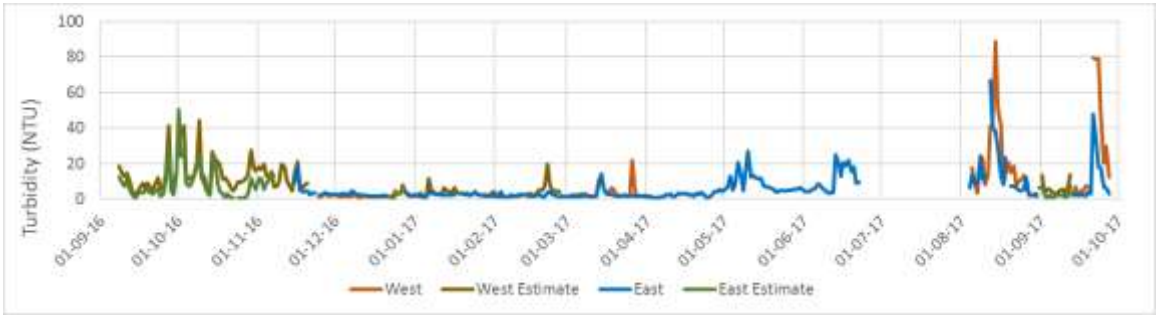

Figure 27 ***Measured and estimated daily median turbidity at the east and west WQIF sites during the 2016-2017 Koombana Bay deployment.***

Turbidity profiles at stations T4-C (deeper [~6 m] waters of Koombana Bay) and T4-A (shallower [~4 m] waters between the east and west WQIF sites) generally exhibited an increase in turbidity in the lower ~0.5-1 m of the water column above the seabed (see Section 3.4), approximately coincident with the level of the loggers above the seabed. Hence, it is likely that the logger turbidity measurements were greater to some degree than occurred through the bulk of the water column. Nonetheless, this method to estimate LAC (and thereby %SI) from daily median turbidity near the seabed explains much of the observed variability in these parameters, and thereby estimates to fill in gaps in turbidity are considered reliable.

Monitoring and management of BCH in the zones of influence and moderate impact from the proposed dredging and breakwater construction activities generally rely on quantitative trigger value criteria. Figure 28 summarises the average daily median turbidity levels (between 0900 and 1500) at ~0.5 m above the seabed from both sites. The 50th and 80th percentile turbidity are 2.3 NTU and 3.3 NTU in summer and 7.1 NTU to 15.6 NTU in winter, respectively. Clearly, higher natural turbidity with greater variability occurs in winter relative to summer, so BCH are likely seasonally adapted to higher and more variable winter turbidity in southern Koombana Bay (e.g. seasonal versus perennial species). In contrast, low turbidity with relatively small variations occurs during the summer. Potential construction

impacts from turbidity-generating construction activities during summer are likely to affect BCH primary producers to a greater degree than winter because of higher seasonal productivity and larger absolute decreases to the seabed light intensity.

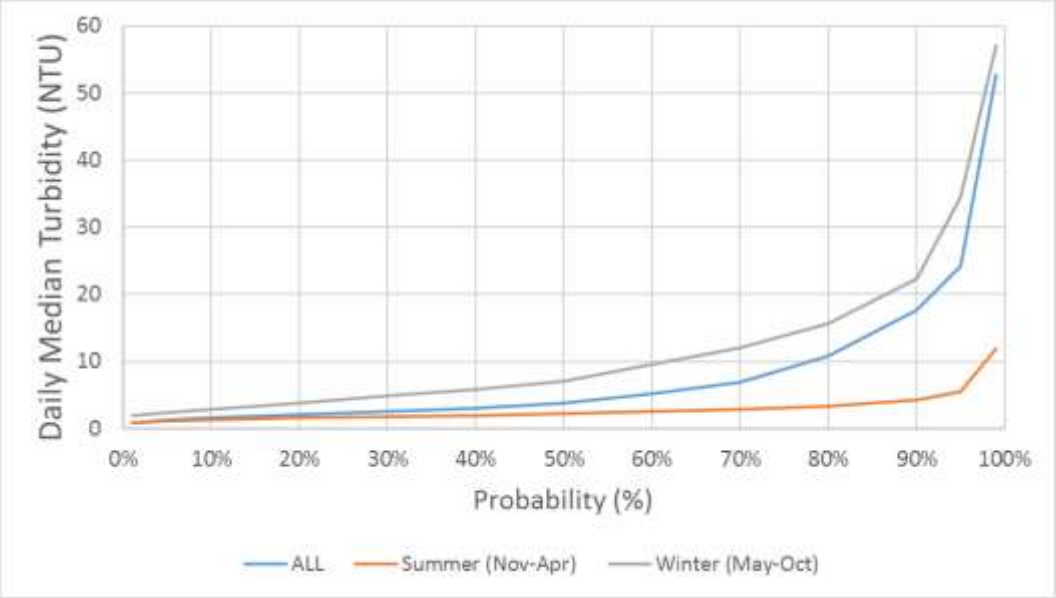

Figure 28 ***Percentile distribution of all, summer and winter averages of daily median turbidity from both inshore sites along southern Koombana Bay during the 2016-2017 Koombana Bay deployment.***

3.4 Sonde profiles

The maximum, minimum and median of the vertical sonde profiles across all stations during each survey is summarised in Table 8. Generally, with the exception of turbidity, all of the sonde parameters exhibited low variability through the water column with medians similar to averages. As mentioned previously, turbidity consistently exhibited the highest variation, primarily with increases in the ~0.5-1 m above the seabed, particularly during the spring and early summer of 2016, and winter of 2017.

Table 8 provides summary statistics of the sonde profiles of data from all sites for each survey, and indicates the following:

– Temperatures ranged from ~14°C in winter to ~23°C in summer in agreement with the temperature logger data (Section 3.2.2) with relatively weak stratification (if any) (i.e. temperature range of ~1 °C across all measurements during a survey).
– Salinity in summer was ~36 psu and vertically and horizontally homogeneous, whereas in winter it decreased to ~34.5 psu. In winter there was typically lower salinity in the surface waters from the elevated winter river inflows.
– Turbidity was relatively low through much of the water column during surveys (generally calm conditions), but usually increased within ~0.5-1 m of the seabed, particularly during the winter and spring when riverine and/or decomposed seagrass wrack particles occur.
– pH was generally ~8.1, typical of seawater.
– ORP was generally 250-350 mV throughout most of the water column, and during some surveys decreased to ~150-200 mV immediately adjacent to the seabed.
– DO was always >90% of saturation, and generally >100% of saturation in the surface waters with minimum values during a survey always occurring in proximity to the seabed.

Example sonde profiles from stations T4-A (between the east and west WQIF sites in ~4 m depth of water) and T4-C (in deeper waters of central Koombana Bay [~6 m]) are shown in Figure 29 and Figure 30, respectively, to illustrate the seasonal and vertical trends that were summarised in Table 8, which include:

– Weak or no thermal stratification (inverse temperature stratification on 4 August 2017).

– Generally weak or no salinity stratification, except on 28 September 2017 where a lower salinity in the upper 1 m (likely from river inflow and rainfall) established strong salinity stratification at station T4-C and low salinity at station T4-A.
– pH was generally uniform through the water column with small scale vertical variability.
– Turbidity was typically low throughout much of the water column, and generally increased in the ~0.5-1 m above the seabed.
– Typically, the percentage of DO saturation was greater at the surface and decreased with proximity to the seabed, albeit remaining >90%.

Even though surveys typically occurred during relatively calm conditions (i.e. low vertical mixing due to low winds), vertical variations in water quality were limited with the following exceptions:

– The establishment of horizontal and vertical salinity gradients in response to elevated river discharge events.
– Increased turbidity in the ~0.5-1 m region above the seabed due to particles from elevated river inflow events and/or seagrass wrack, both of which are periodically resuspended.

Table 8 ***Summary statistics of vertical sonde profiles across all stations during the 2016-2017 Koombana Bay baseline monitoring.***

Date		26 October 2016	14 December 2016	17 January 2017	22 February 2017	30 March 2017	26 June 2017	4 August 2017	31 August 2017	28 September 2017	Comment
Start Time		9:27	15:05	14:31	9:53	9:35	9:14	9:25	9:10	10:30	
End Time		12:33	19:13	16:57	12:22	12:18	12:48	11:35	12:40	13:00	
Max Depth (m)		6.8	7.4	6.6	7.8	7.6	7.9	7.5	7.5	7.0	
Temperature (°C)	Max	18.2	22.8	23.2	21.4	19.9	16.3	15.0	16.6	16.5	Consistent with logger Typical seasonality
	Median	16.9	21.7	22.7	21.1	19.6	16.0	14.1	15.8	15.9	
	Min	16.6	21.0	21.9	20.5	18.4	14.5	13.6	15.5	15.6	
Salinity (psu)	Max	36.1	Sensor Mal-function	36.2	36.2	36.3	34.7	35.2	35.0	34.9	Low spatial variability and seasonality MAFRL measurements of integrated samples on 17 January 2017 shown
	Median	35.9		35.8	36.1	36.1	34.6	34.1	34.9	33.3	
	Min	35.1		35.1	35.7	36.0	34.1	30.8	33.7	31.9	
Turbidity (NTU)	Max	138.8	33.3	Sensor Malfunction	14.0	10.1	6.2	20.5	23.1	12.4	High values in October attributed to river inflow and/or decomposed seagrass wrack Low median values with low seasonality
	Median	1.4	1.2		1.8	1.5	1.1	3.3	2.0	2.3	
	Min	0.8	0.5		0.7	0.8	0.5	2.3	1.0	1.9	
pH	Max	8.13	8.32		8.29	8.14	8.12	8.00	7.98	8.12	Low spatial and temporal variability
	Median	8.12	8.26		8.17	7.90	8.09	7.98	7.95	8.09	
	Min	8.05	7.86		7.93	7.58	8.02	7.91	7.92	8.02	
ORP (mV)	Max	327.1	321.9		359.9	387.4	297.8	Sensor Malfunction			Moderate variability among sites and depths Low temporal variability
	Median	227.5	292.4		272.1	263.3	256.5				
	Min	129.9	184.8		205.0	171.4	191.2				
DO Saturation (%)	Max	103.3	110.4	109.5	104.5	106.5	103.6	103.6	99.8	99.6	Low spatial and temporal variability
	Median	101.8	104.8	98.9	96.2	98.0	97.1	96.8	94.4	96.3	
	Min	93.2	92.3	91.9	91.5	93.6	93.7	90.6	85.3	91.3	

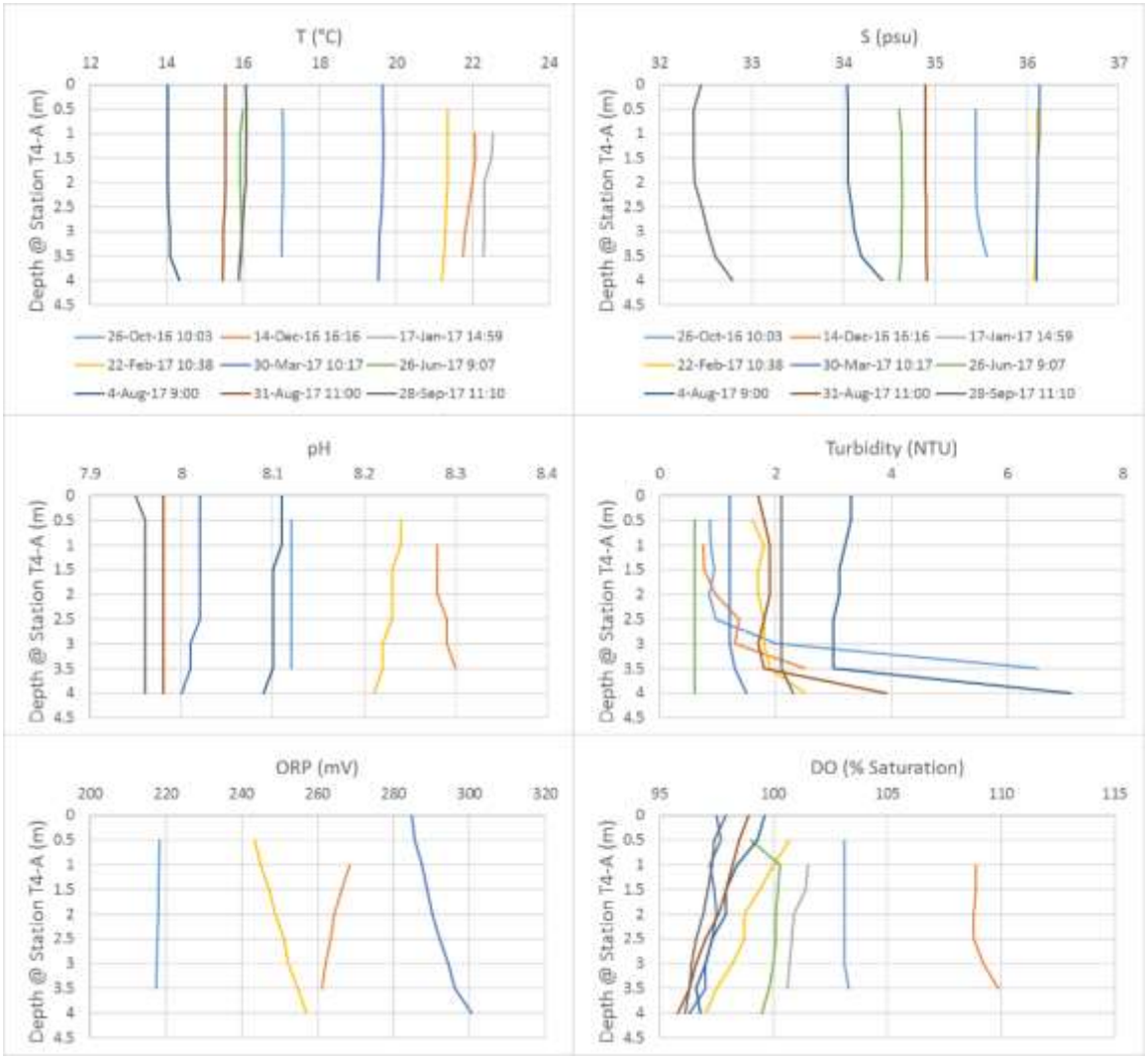

Figure 29 ***Sonde profiles from station T4-A during the 2016-2017 Koombana Bay baseline monitoring.***

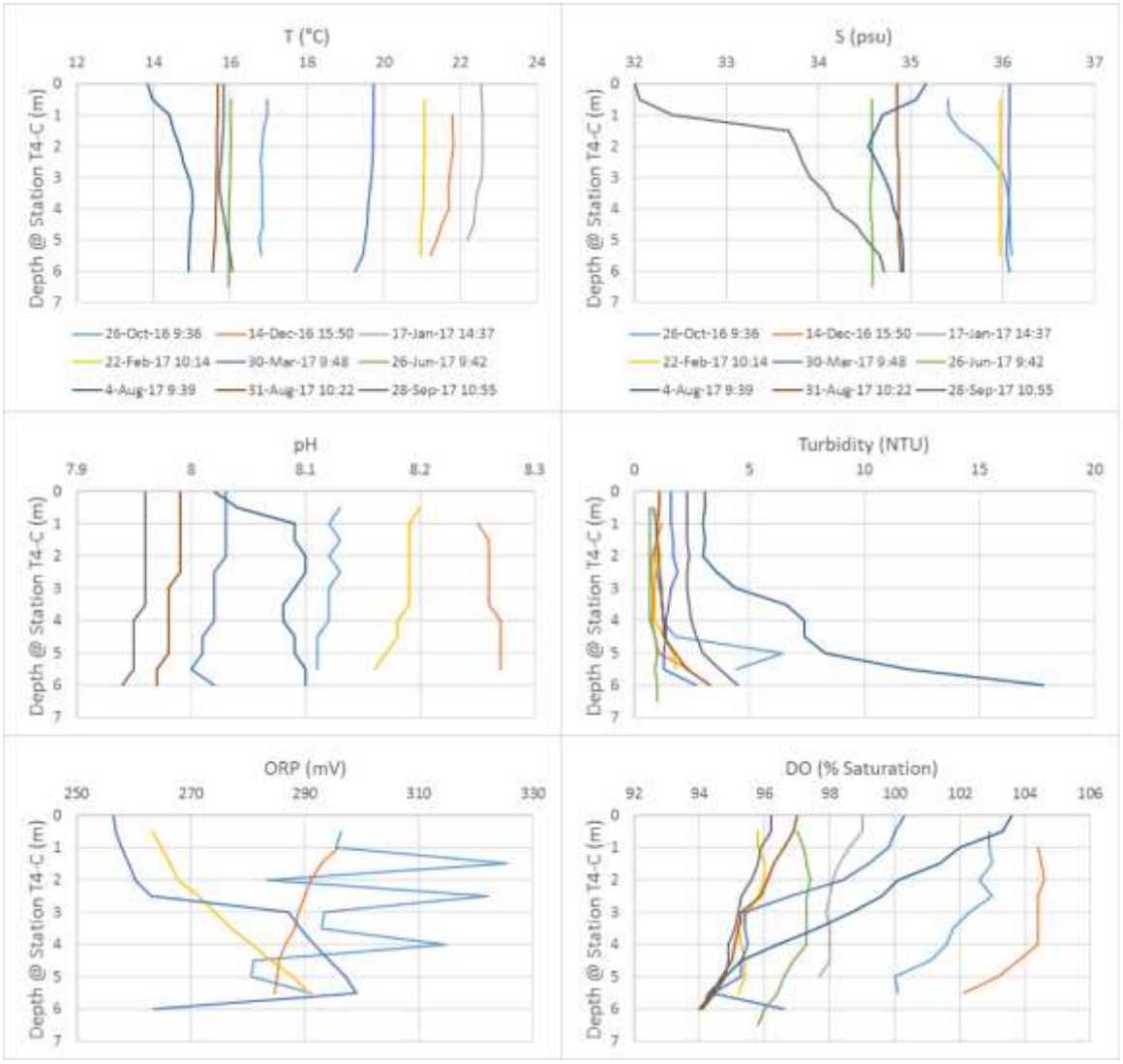

Figure 30 ***Sonde profiles from station T4-C during the 2016-2017 Koombana Bay baseline monitoring.***

3.5 Water quality

Chain of custody (CoC) documentation and laboratory certificates of analysis for laboratory water quality analyses are provided in Appendix A and Appendix B, respectively. Appendix C provides the RPDs of the QA/QC replicate water quality samples, which demonstrates a high level of confidence in the measurements. As common practice, all LoR values were assigned a value of 50% of LoR for plotting, statistical and QA/QC purposes.

3.5.1 Nutrients, chl-a, TSS and secchi depth

Figure 31 summarises the nutrient, chl-a, TSS and secchi depth measurements in Casuarina Boat Harbour and Koombana Bay. The key results are:

– Generally, NH_X, NO_X, TN and TSS were elevated in both the harbour and bay during winter during river inflows with corresponding low secchi depths (~1.5 m), while they were lower during summer presumably from less influence of winter catchment inputs and/or seagrass wrack decomposition.

– NH_X was generally higher in the harbour with summer and winter levels typically above and below, respectively, the ANZECC (2000) DTVPC. A similar pattern for NO_X levels occured in relation to the seasonally varying ANZG (2018) DGVPC.

– Average NH_X and NO_X across all stations for each survey had similar seasonal patterns in excess of ANZECC (2000) DTVPC and seasonally varying ANZG (2018) DGVPC, respectively, in early

August and late September of 2017. In late June 2017 NH_X was greater than the ANZECC (2000) DTVPC whereas NO_X was just below the seasonally varying ANZG (2018) DGVPC. Further,

– As with NH_X and NO_X, TN was typically greater in the harbour than the bay, but was typically less the than the ANZECC (2000) DTVPC except in early September 2016 in the bay only and early August 2017 in both water bodies.
– FRP levels were very similar in the bay and harbour and below the seasonally varying ANZG (2018) DGVPC.
– TP was greater in the harbour than the bay. Levels in the bay were typically just below or ablve the summer ANZECC (2000) DTVPC (20 ug/L) from spring to autumn, and well below the winter ANZECC (2000) DTVPC (40 ug/L) during winter. The seasonal TP pattern was similar to TN, which suggests that particulate nutrients factor into peak levels which are potentially associated with the occurrence of seagrass wrack.
– Chl-a levels were consistently higher in the harbour than the bay. Both water bodies had levels substantially greater than the seasonally varying ANZG (2018) DGVPC ~3-10 fold. This suggests that DGVPC is not appropriate for relatively protected (e.g. waves and currents) Koombana Bay and semi-enclosed Casuarina Boat Harbour.
– Harbour TSS was generally moderately greater than the bay and generally followed patterns similar to TN and TP. Because of the higher levels of TSS and chl-a in the bay, secchi depths were generally lower than the harbour. Secchi depths ranged from ~2-4.5 m in the bay and ~1.5-4 m in the harbour. Generally, secchi depths were greater in the deeper offshore than inshore waters of the bay (not shown).

Though NH_X, NO_X, TN, FRP and TP are below or near the relevant guideline (i.e. seasonally varying ANZG (2018) DGVPC or ANZECC (2000) DTVPC), chl-a is ~3-10 fold greater than the seasonally varying ANZG (2018) DGVPC. In short, except for chl-a, the summer nutrient water quality of Koombana Bay and Casuarina Boat Harbour typically meets or is in close proximity to the relevant guideline criteria, and exceedances are generally in response to the external and predominantly winter mechanisms of elevated river inflows and/or seagrass wrack decomposition.

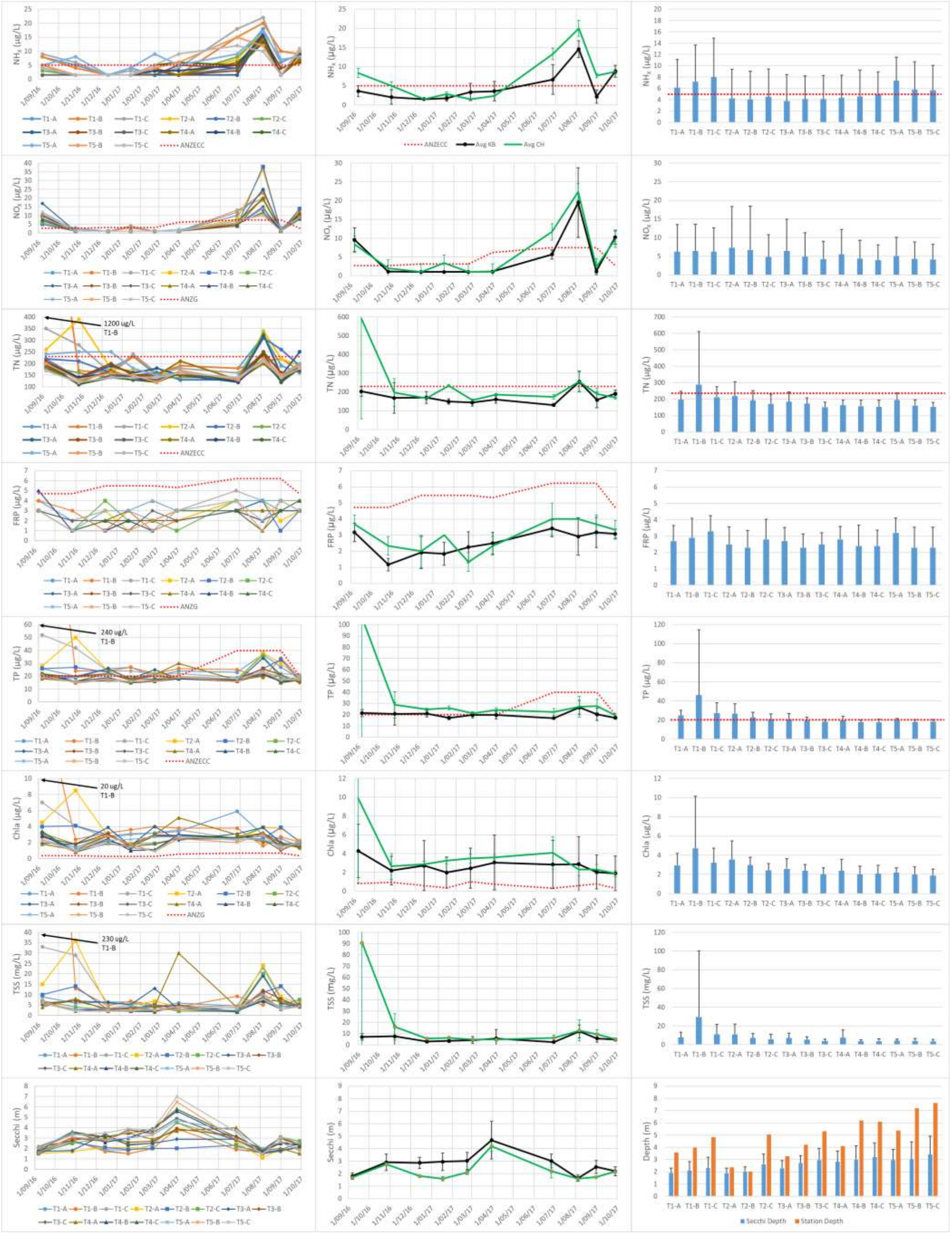

Figure 31 ***Laboratory measurements of vertically integrated water samples (left), average across Casuarina Boat Harbour and Koombana Bay sites per survey (centre) and average per site across surveys (right) of NH_X, NO_X, TN, FRP, TP, Chla, TSS and secchi depth during the 2016-2017 Koombana Bay baseline monitoring. Relevant ANZECC (2000) and ANZG (2018) assessment criteria denoted by dotted red lines.***

3.5.2 Metals and metalloids

Many of the metal and metalloid analytes had concentrations across all surveys that were LoRs or nearly so, and well below relevant seasonally varying ANZG (2018) DGVT, ANZECC (2000) TTV and ANZECC (2000) LRTV including:

– Al was above LoR (<5 ug/L) at all sites on 17 January 2017 (5-7 ug/L) and below LoR at all sites on 4 August 2017. Generally, all other surveys had concentrations of LoR (68 of 90 samples), 5 ug/L (12 of 90 samples), 6 ug/L (6 of 90 samples), 7 ug/L (2 of 90 samples) or 8 ug/L (2 of 90 samples) ug/L. The maximum Al concentration was 8 ug/L.
– Cr was less than the LoR (<0.2 ug/L) on every survey, well below the ANZG (2018) DGTV at a 95% LSP default guideline value for Cr(VI) of 4.4 ug/.
– Mn was low and ranged from 0.9-5.2 ug/L, well below the ANZG (2018) DGVT of uncertain LSP of 80 ug/L.
– On every survey Fe was low in the range of LoR (<1 ug/L)-2 ug/L, well below the ANZECC (2000) LRTV of 18 ug/L.
– Ni was low across all surveys in the range of LoR (<0.3 ug/L)-0.8 ug/L, well below the ANZG (2018) DGVT at a 99% LSP of 7 ug/L.
– Cd was less than the LoR (<0.1 ug/L) on every survey, well below the ANZG (2018) DGVT at a 99% SLP of 0.7 ug/L except for one (1) sample collected at T5-A on 26 June 2017 with a value of 0.9 ug/L.
– Hg was less than the LoR (<0.0001 ug/L) on every survey, below the ANZG (2018) DGVT at a 99% SLP of 0.1 ug/L.

Figure 31 summarises the metals and metalloids levels that had at least several measurements above the relevant guideline criteria including:

– Cu exceeded the ANZG (2018) DGVT at a 95% SLP of 1.3 ug/L on two (2) occasions (December 2016 and January 2017) at nearshore site T5-A in proximity to the Inner Harbour, at two (2) sites in Casuarina Boat Harbour (T1-A and T1-B) on 17 January 2017, and on one (2) occasion in Casuarina Boat Harbour (T1-C) on 26 June 2017. However, typically levels in Koombana Bay were 0.4-0.7 ug/L and 0.6-1 ug/L in Casuarina Boat Harbour.
– Zn was generally marginally greater than the LoR (<1 ug/L) in the range of 1-3 ug/L, but well below the ANZG (2018) DGVT at a 95% SLP of 8 ug/L except for one (1) sample at site T4-A on 31 August 2017 with a value of 17 ug/L.
– As ranged from 1.2-2.3 ug/L across all surveys, just at or below the ANZECC (2000) LRTV of 2.3 ug/L. The toxicant low reliability trigger value was equalled (2.3 ug/L) for three (3) samples at T2-C and T3-C on 14 December 2016, and T4-A on 22 February 2017.
– Pb exceeded the ANZG (2018) DGVT at a 95% SLP of 4.4 ug/L on four (4) samples at T1-C and T5-A on 17 January 2017, and T5-A and T5-B on 4 August 2017. However, Pb generally ranged from <0.1 to 0.5 ug/L.

In short, metals and metalloids levels in Koombana Bay meet or are in close proximity to the relevant guideline criteria with occasional exceedances by Cu, Zn, As and Pb.

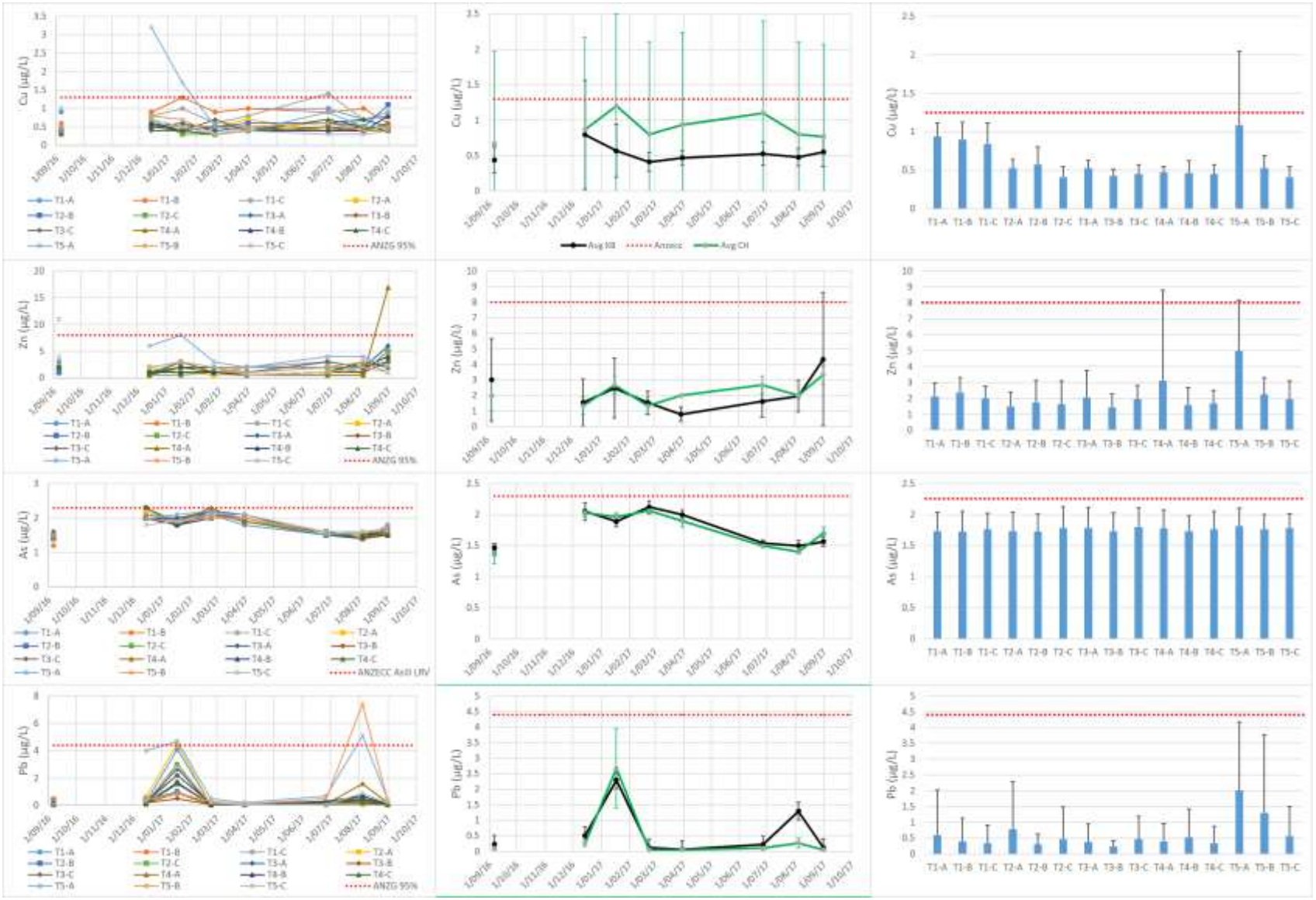

Figure 32 *As Figure 31 for filterable Cu, Zn, As and Pb.*

3.6 PSD of surficial sediments of Casuarina Boat Harbour

CoC documentation and laboratory certificates of analysis for the surficial sediment analyses of Casuarina Boat Harbour are provided in Appendix D and Appendix E, respectively. Figure 33 summarises the measurements, which indicates the surficial sediments of the Casuarina Boat Harbour have:

– Coarser sediments at sites SS-6 and SS-8 (to the south of the existing pens) than the other sites.
– Characteristic d_{10}, d_{50} and d_{90} particle diameters of ~7 um (very fine silt), ~50 um (coarse silt) and ~220 um (fine sand).
– 10-20% organic content expressed as LOI.
– D_{10} and d_{50} settling velocities of ~3 m/day and ~100 m/day, respectively, yielding ~500 and ~15 minutes to settle 1 m, respectively.

In short, the surficial sediments are comprised of <7% clay to very fine silt that will remain in suspension for lengthy durations during dredging operations in the harbour. RPS (2017) report on the sediment quality of Casuarina Boat Harbour of cores collected at 19 locations in September 2017.

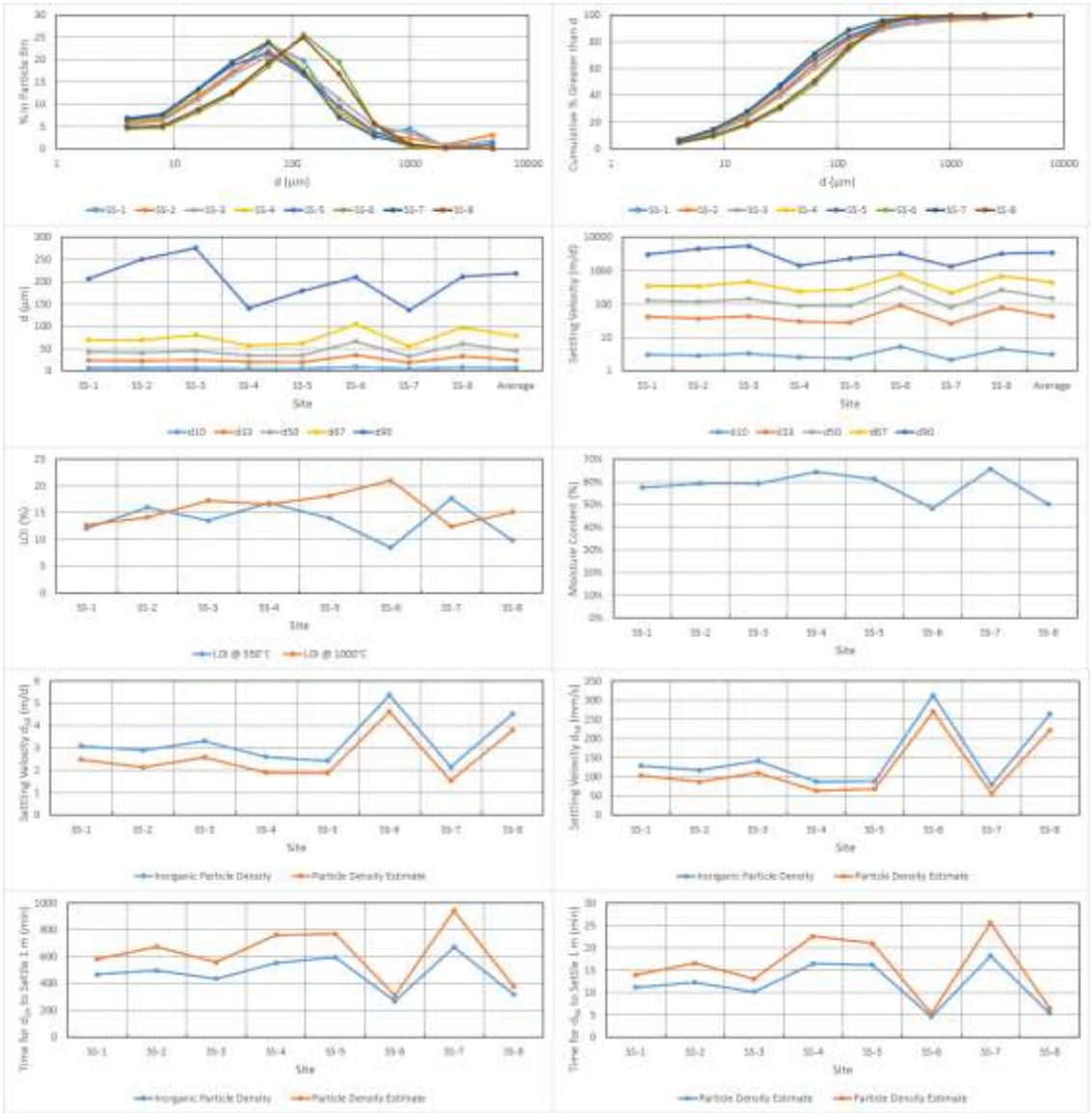

Figure 33 ***Sediment particle diameters by bins (left) and cumulatively (right) (top), characteristic diameters (left) and settling velocities (right) (2nd row), LOI (left) and moisture content (right) (3rd row), and d_{10} (left) and d_{50} (right) settling velocity estimates (4th row) and time to settle 1 m (bottom) assuming inorganic and estimated particle densities (bottom) of September 2016 survey of Casuarina Boat Harbour sites.***

4. 2020 Leschenault Inlet results

4.1 Continuous logger measurements

This section provides and overview of the continuous logger measurements that were acquired at Leschenault Inlet at sites LI1 and LI3. Data gaps occurred due to logger malfunction, fouling/biofouling and limited periods when acceptable data from both sensors were acquired. Additional QA/QC and data analysis is provided in this section beyond that in O2 Marine (2021).

4.1.1 Turbidity

Near seabed turbidity time series data supplied by O2 Marine (2021) underwent the following additional analyses:

– Removed all 30 minute turbidity measurement in excess of 50 NTU. This is a somewhat arbitrary value, but it is likely that fouling/biofouling/malfunction causes turbidity in excess of this value.
– Applied 24 hour moving average to time series of 30 minute measurements.
– Removed all 24 hour moving average values in excess of 25 NTU.

The resultant time series for the LI1 and LI3 sites is shown in the upper panel of Figure 34.

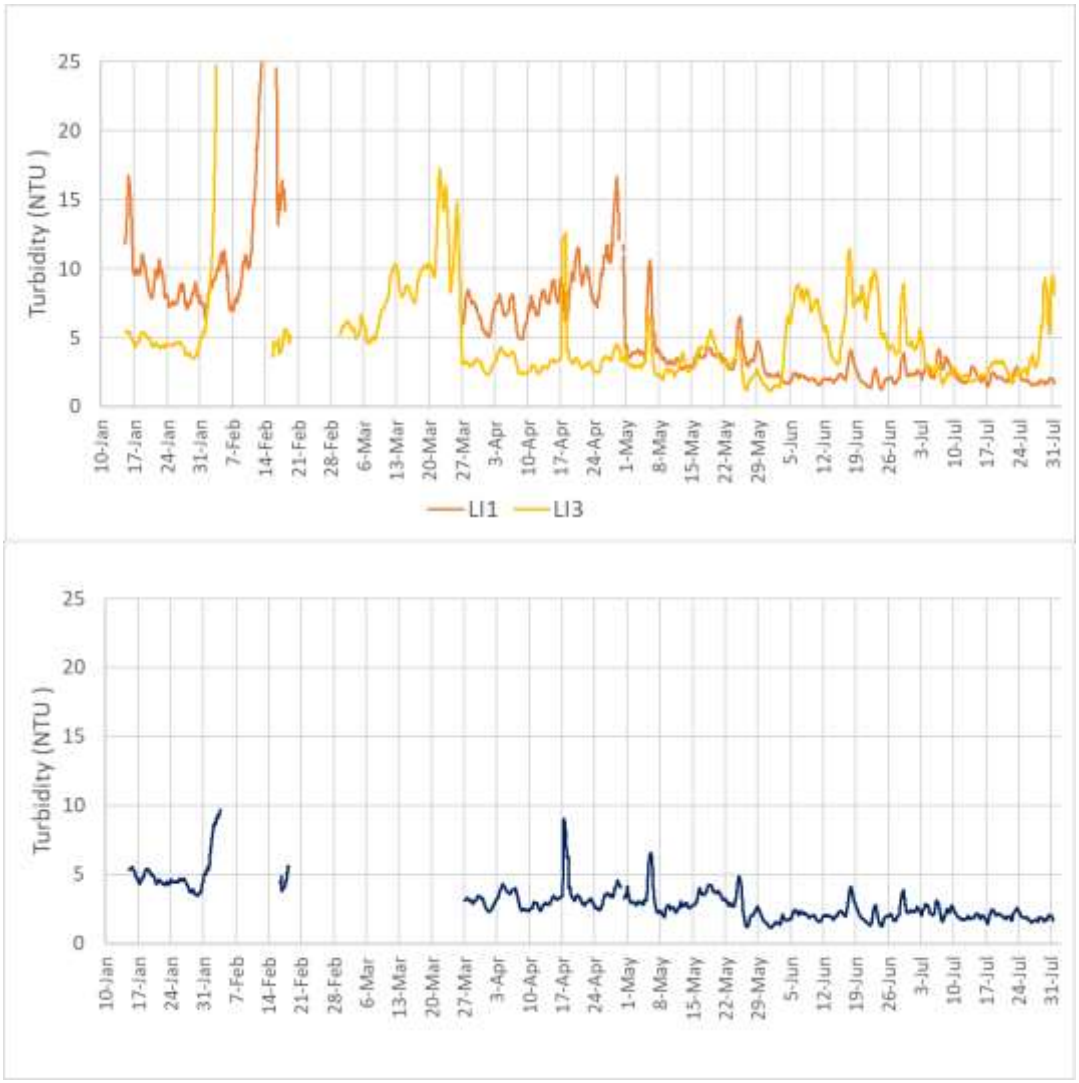

Figure 34 ***24-hour moving averages of turbidity over 30 minute intervals at sites LI1 and LI3 (top panel) and amalgamated time series when measurements at both sites and lowest turbidity value selected (bottom panel) during the 2020 Leschenault baseline monitoring.***

Variations between the resultant time series for sites LI1 and LI3 are too large over extended periods. Hence, a 'representative' time series of turbidity for Leschenault Inlet was prepared by selecting the lower of the two 24 hour moving average turbidity for each 30 minute interval, therefore data periods presented had both sensors potentially functioning which is illustrated in the lower panel of Figure 34. A percentile plot of the resultant turbidity time series is presented in Figure 35. The median and 80th percentile turbidity were 2.7 and 3.8 NTU, respectively. TSS grab sample measurements in Leschenault Inlet in Section 4.3.1 have a median and 80th percentile of 3 mg/L and 9 mg/L, which assuming a 1:1 ratio of turbidity:TSS, the median is in reasonable agreement with the continuous turbidity time series

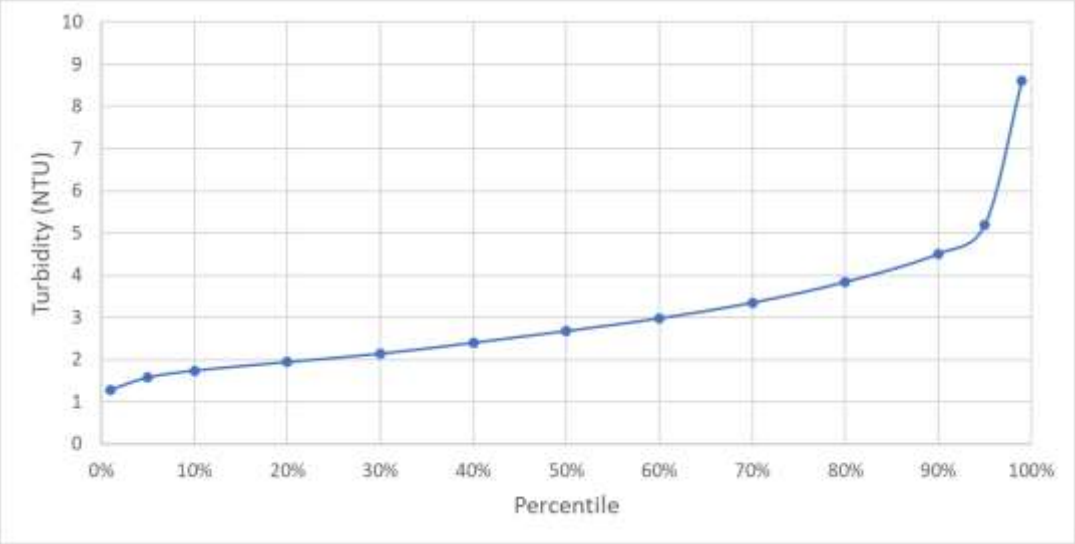

Figure 35 ***Percentiles of turbidity from the amalgamated LI1/LI3 time series during the 2020 Leschenault baseline monitoring.***

4.1.2 PAR

Average daily underwater PAR time series data supplied by O2 Marine (2021) underwent the following additional analyses:

– When LI1 and LI3 daily values available on the same day, remove lower daily measurement if difference is greater than 33%.
– Determine linear regression between underwater light measured at site LI3 as a function of site LI1 measurements.
– Fill in data gaps with linear regression standardised to LI3 water depth.
– Average the two time series and plot alongside incoming PAR radiation to the air-water interface. Data downloaded from BoM as incoming shortwave radiation (MJ/m^2). Convert to PAR just below the air-water interface assuming 45% of shortwave is PAR, 5% surface albedo and 4.57 E equals 1 MJ (McCree 1972).
– Calculate light attenuation coefficient assuming a representative water depth of 1.5 m and 2.5 m for LI1 and LI3, respectively.

These data processing steps are illustrated in Figure 36.

LAC of ~0.2-0.4 1/m was comparable to those of the 2016-2017 Koombana Bay and Casuarina Boat Harbour baseline monitoring (Section 3.3.3).

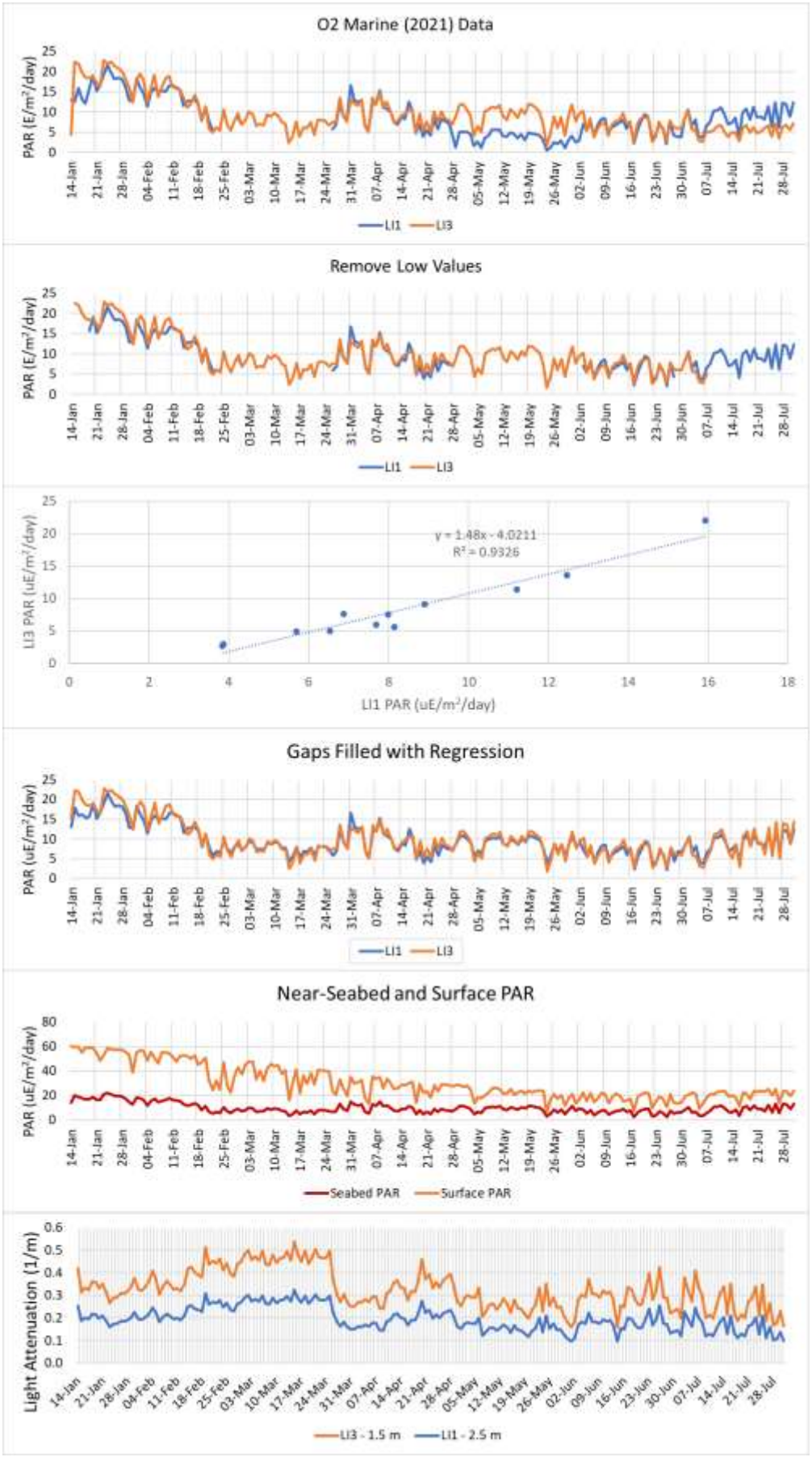

Figure 36 ***Daily PAR during the 2020 Leschenault baseline monitoring supplied by O2 Marine (2021) (1st panel), remove low values (2nd panel), linear regression between LI1 and LI3 (3rd panel), data gaps filled with linear regression equation (4th panel), average of underwater PAR from gap-filled time series of the two sites and incoming PAR below the air-water interface (5th panel), and LAC estimates for water column depth of 1.25 m and 1.5 m.***

4.2 Sonde profiles

The statistics (maximum, minimum and median) of the vertical sonde profiles at each station during each survey are shown in Table 9. Generally, except for turbidity and dissolved oxygen, the sonde parameters exhibited low variability through the water column. As with the 2016-2017 Koombana Bay sonde profiles, turbidity consistently exhibited the highest variation, primarily with increases in the ~0.5-1 m above the seabed. Figure 37 illustrates sonde profiles from station LI2 (~2-2.75 m depth), which indicate the following:

– Temperatures ranged from ~16°C in winter to ~25°C in summer with relatively weak stratification (if any) (i.e. temperature range of ~1 °C across all measurements during each survey).
– Absolute salinity measurements with the sonde were not considered reliable. However, relative differences in salinity are likely represented which indicates that stable salinity stratification occurs during the winter.
– Turbidity was relatively low through much of the water column during surveys (generally calm conditions), but usually increased within ~0.5-1 m of the seabed, particularly during the winter and spring when riverine and/or decomposed seagrass wrack particles occur.
– pH was generally ~8.1, typical of seawater, and uniform through the water column.
– DO was generally >90% of saturation in the surface waters but often decrease below this value in proximity to the seabed.

Table 9 ***Summary statistics of vertical sonde profiles across all stations during the 2020 Leschenault Inlet baseline surveys.***

Date		14 January 2020	19 February 2020	26-March-2020	29 April 2020	3 June 2020	3 July 2020	5 August 2020	Comment
Max Depth (m)		1.7	2	2.5	2.2	2.5	2.75	2.25	
Temperature (°C)	Max	24.9	24.3	22.9	18.2	16.2	15.6	15.9	Warmer summer temperatures by ~1°C than the 2016-2017 Koombana Bay measurements.
	Median	24	22.3	22.4	17.8	16	15	15.6	
	Min	23.6	22	22	16.9	15.1	14.2	15.4	
Salinity (psu)	Max	38.63	38.95	34.31	37.66	35.79	33.54	40.66	Absolute values suspect, however relatively low spatial variability except for salinity stratification during winter
	Median	38.48	38.67	34.24	37.29	35.34	32.44	39.69	
	Min	37.79	37.82	34.10	36.83	34.63	29.78	39.30	
Turbidity (NTU)	Max	10.7	6.7	8.0	10.8	7.8	7.2	6.7	Minimum turbidity in surface waters and maximum turbidity in bottom waters, median and minimum greater than Koombana Bay 2016-2017 measurements but maximum lower.
	Median	6.3	2.2	2.4	4.9	2.2	2.6	1.7	
	Min	4.3	0.0	1.7	3.0	1.3	1.6	0.2	
pH	Max	8.19	8.24	8.11	7.93	7.91	8.00	8.00	Low spatial and temporal variability, elevated surface water values in June and July when lower surface salinity.
	Median	8.10	8.06	7.86	7.84	7.81	7.97	7.96	
	Min	7.90	7.86	7.78	7.81	7.50	7.47	7.90	
DO Saturation (%)	Max	98.6	122.4	99.7	95.1	99.3	93.4	96.9	Low spatial and temporal variability at surface (typically maximum) and median, greater variability in bottom waters with lowest values in June and July during salinity stratification that are lower than 2016-2017 measurements in Koombana Bay
	Median	95.3	102.6	93.5	91.5	95.6	87.7	91.1	
	Min	83.4	94.6	78.8	83.9	68.0	69.4	87.2	

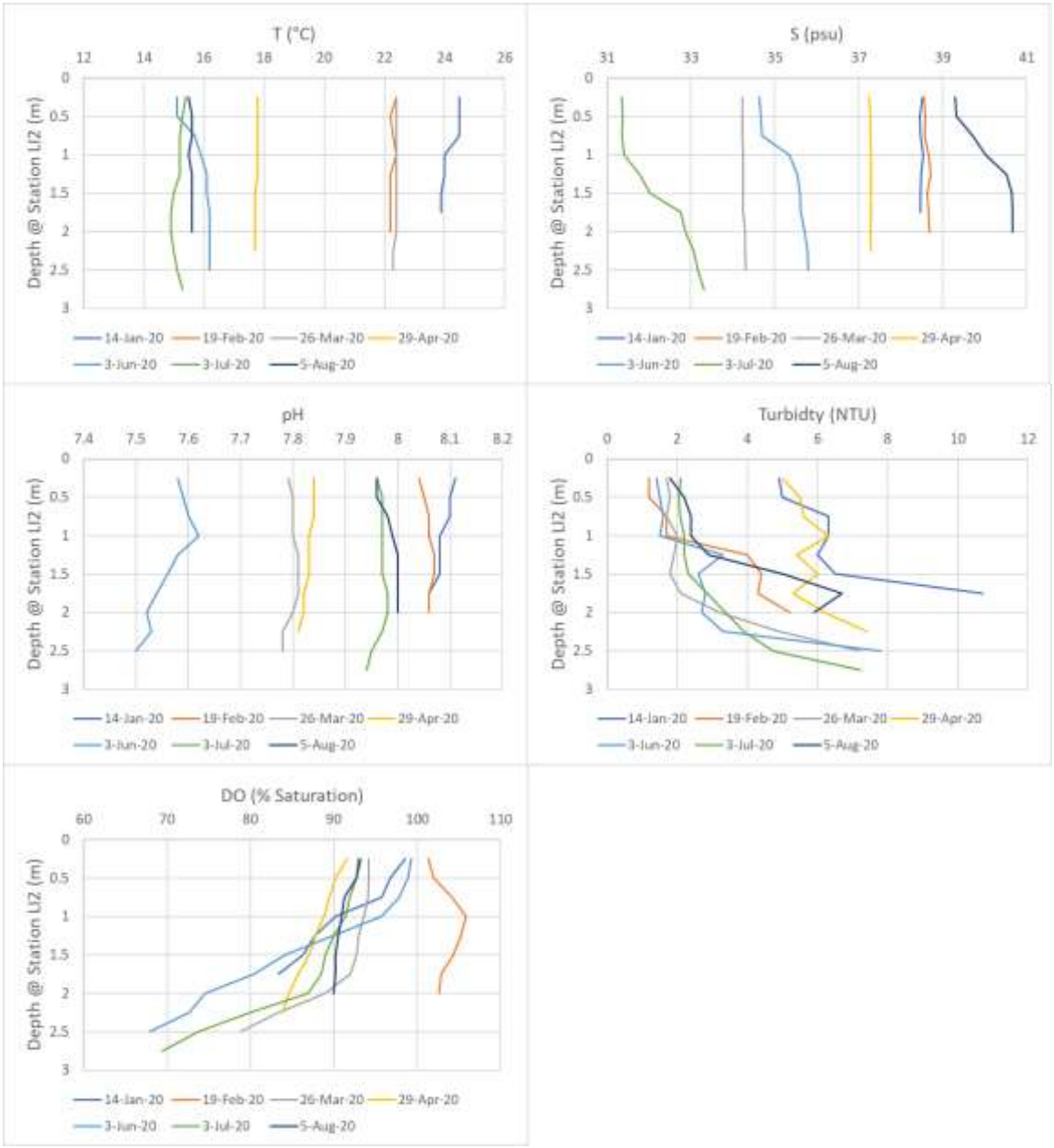

Figure 37 ***Sonde profiles from station LI2 during the 2020 Leschenault baseline surveys.***

4.3 Water quality

4.3.1 Nutrients, chl-a and TSS

Figure 39 summarises the nutrient, chl-a, TSS and secchi depth measurements. The key results are:

- NH_X in Leschenault Inlet is well above the ANZECC (2000) DTVPC with elevated levels in summer and autumn, and decreasing in winter. Further, there was a gradient of higher to lower concentrations from the eastern site (L3) to the western site (L1) on most sampling occasions.
- NO_X is below or near the seasonally varying ANZG (2018) DGVPC in summer but increases above in excess of the guideline values in winter.
- TN had a similar seasonal pattern as NO_X with exceedance of the ANZECC (2000) DTVPC during autumn and winter sampling events.
- FRP during each survey was below or near the seasonally varying ANZG (2018) DGVPC.
- TP was generally above the summer ANZECC (2000) DTVPC (20 ug/L), and often the winter ANZECC (2000) DTVPC of 40 ug/L as well.

– Chl-a was substantially greater than the seasonally varying ANZG (2018) DGVPC. Peak phytoplankton biomass occurs in summer and decreased substantially in winter. As with NH_X there tended to be a gradient of higher to lower concentrations from the eastern site (L3) to the western site (L1) on a number of sampling occasions
– TSS was greater during summer than winter.

In short, except for chl-a, NH_X and TP, the summer nutrient water quality of Leschenault Inlet meets or is in close proximity to the relevant guideline criteria. However, during the winter exceedances of the guideline criteria of nutrients regularly occurs.

4.3.2 Metals and metalloids

Many of the metal and metalloid analytes had concentrations across all surveys that were LoRs or nearly so except for Zn and Fe (Figure 38), both of which have ANZG (2018) DGVT at a 95% LSP and ANZECC (2020) LRVT. On three (3) of the seven (7) surveys Zn was elevated above the ANZG (2018) DGVT of 8 µg/L. Though Fe did not exceed the ANZECC (2000) LRTV of 18 µg/L, generally it increased during the winter.

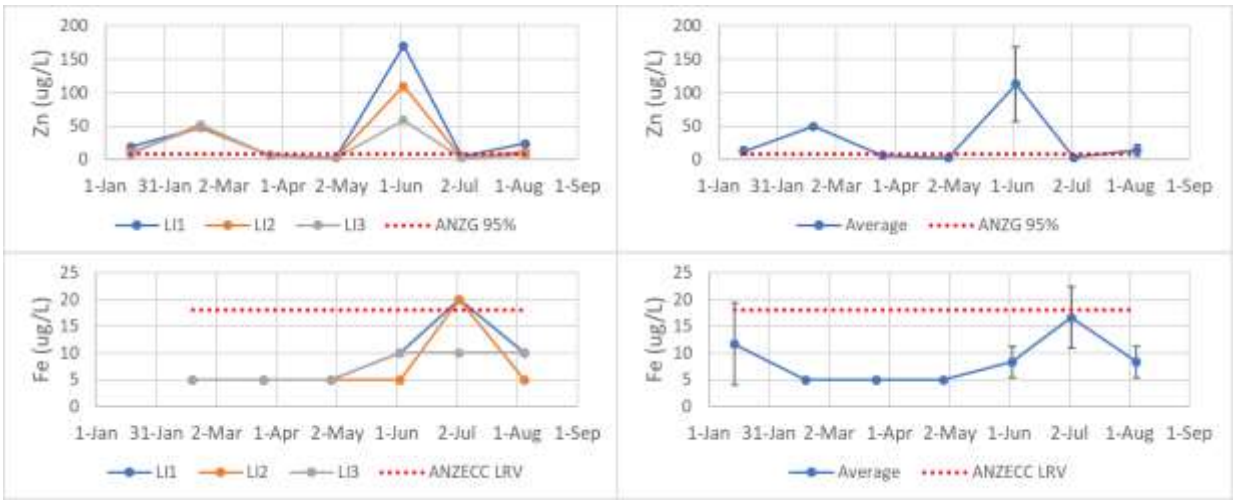

Figure 38 ***Filterable Zn and Fe from the 2020 Leschenault Inlet monitoring. Relevant ANZG (2018) and ANZECC (2000) toxicant default guideline values denoted by dotted red lines.***

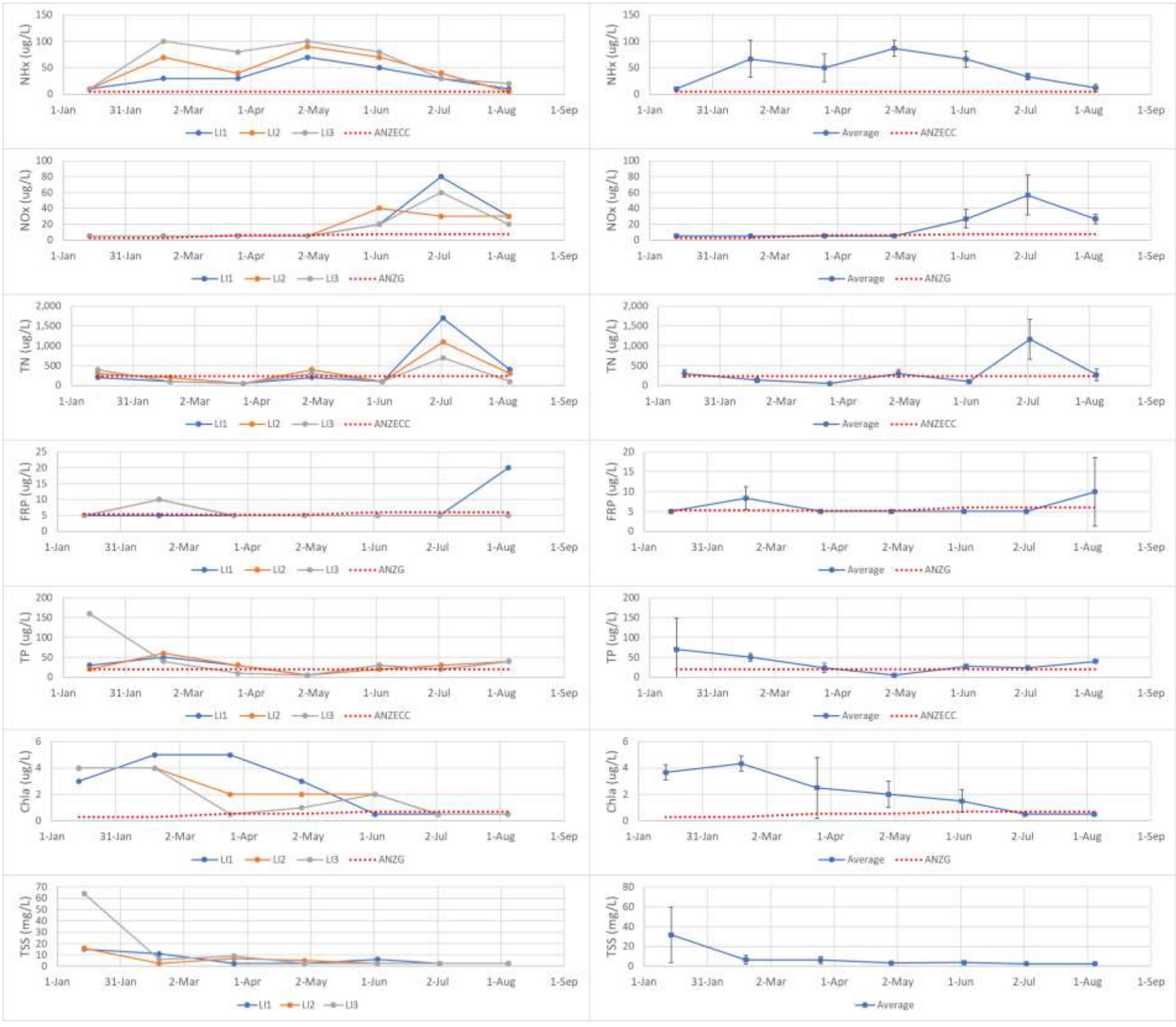

Figure 39 ***Laboratory measurements of vertically integrated water samples of the 2020 Leschenault Inlet water quality (left) and averaged across sites per survey (right) of NH_X, NO_X, TN, FRP, TP, Chla and TSS. ANZG (2018) and ANZECC (2000) guideline criteria represented by dotted red lines.***

4.4 Sediments

Leschenault Inlet has good sediment quality with only one (1) sample exceedance just above the ANZG (2018) DGTV for Hg, but well below the DGVT-high (Table 10). All pesticides (OC/OP) were below LoR.

Table 10 2020 Leschenault Inlet sediment quality (O2 Marine 2021)

Analyte	Unit	ANZG (2018) DGVT	ANZG (2018) DGVT-high	LoR	Site		
					LI1	LI2	LI3
TN	mg/kg	-	-	10	1,400	1,400	1,200
NH_X	mg/kg	-	-	10	20	10	10
NO_X	mg/kg	-	-	1	<1	<1	<1
TP	mg/kg	-	-	1	88	96	63
FRP	mg/kg	-	-	1	<1	<1	<1
TBT	µg Sn/kg	9	70	0.5	<1.2	<0.8	<0.5
Antimony	mg/kg	2	25	2	<2	<2	<2
Arsenic	mg/kg	20	70	5	10	11	6
Cadmium	mg/kg	1.5	10	0.1	<0.1	<0.1	<0.1
Cobalt	mg/kg	-	-	1	3	4	2
Copper	mg/kg	65	270	1	18	23	10
Chromium	mg/kg	80	370	1	16	21	11
Lead	mg/kg	50	220	1	20	41	19
Manganese	mg/kg	-	-	1	110	190	120
Mercury	mg/kg	0.15	1	0.02	0.12	0.16	0.05
Nickel	mg/kg	21	52	1	4	5	3
Selenium	mg/kg	-	-	2	<2	<2	<2
Silver	mg/kg	1	4	1	<1	<1	<1
Vanadium	mg/kg	-	-	2	25	34	19
Zinc	mg/kg	200	410	1	68	110	46

5. 2017 Casuarina Boat Harbour sediment quality

The proposed dredged material in Casuarina Boat Harbour is dark brown/grey silty sediments. Though individual samples from depth intervals across cores ranged from predominantly silty to sandy sediments, the average PSD was ~12% clay (0-4 µm), ~15% silt (4-63 µm) and ~71% sand (63-2000 µm).

Mercury was the only metal/metalloid contaminant of potential concern that exceeded the ANZG (2018) DGVTS of 0.15 mg/kg (but not the DGVTS-high of 1.0 mg/kg) in five (5) of the 26 samples that were analysed. The mean, median and 95% UCL concentrations of mercury were below the ANZG (2018) DGVTS.

Six (6) samples exceeded the TBT ANZG (2018) DGVTS (9 µg Sn/kg) of which two (2) exceeded the ANZG (2018) DGVTS-high of 70 µg Sn/kg of the 16 samples analysed. The maximum concentration of 287 µg Sn/kg was adjacent to the boat maintenance facility, and the other sampling sites that exceeded the default guideline value were along the western boundary of the dredge area. The mean

and 95% UCL concentrations of TBT exceeded with the ANZG (2018) DGVTS though the median was below the ANZG (2018) DGVTS.

Total PAH was well below the ANZG (2018) DGVTS of 10,000 µg/L for all samples.

TRH concentrations (5-65 mg/L) were well below the ANZG (2018) DGVTS for total petroleum hydrocarbons (TPH) of 280 mg/L for all samples. TRH and TPH concentrations are generally proximal, so this guideline criterion is used as an indicative measure.

The LoRs for dieldrin and endrin are marginally above the ANZG (2018) DGVTS, however no samples were measured above the LoR. DDT was measured above the ANZG (2018) DGVTS of 0.0028 mg/kg in one (1) sample (0.0056 mg/kg). No other pesticides were detected above relevant guideline criteria with only DDD in one (1) sample and DDE in two (2) samples detected above relevant LoRs.

Elutriate analyses of metals/metalloids and nutrients were carried out on 14 sediment samples. Metals/metalloids were below the ANZG (2018) DGVT. Mean FRP and NH_X concentrations of 0.084 mg/L and 1.83 mg/L, respectively, are substantially greater than ANZECC (2000) TTV of 0.005 mg/L for ammonia and the seasonal ANZG (2018) DGVT ranges of 0.005-0.006 mg/L for FRP. Hence, there is likely to be some degree of nutrient stimulation, particularly nitrogen, during dredging activities in this semi-enclosed water body.

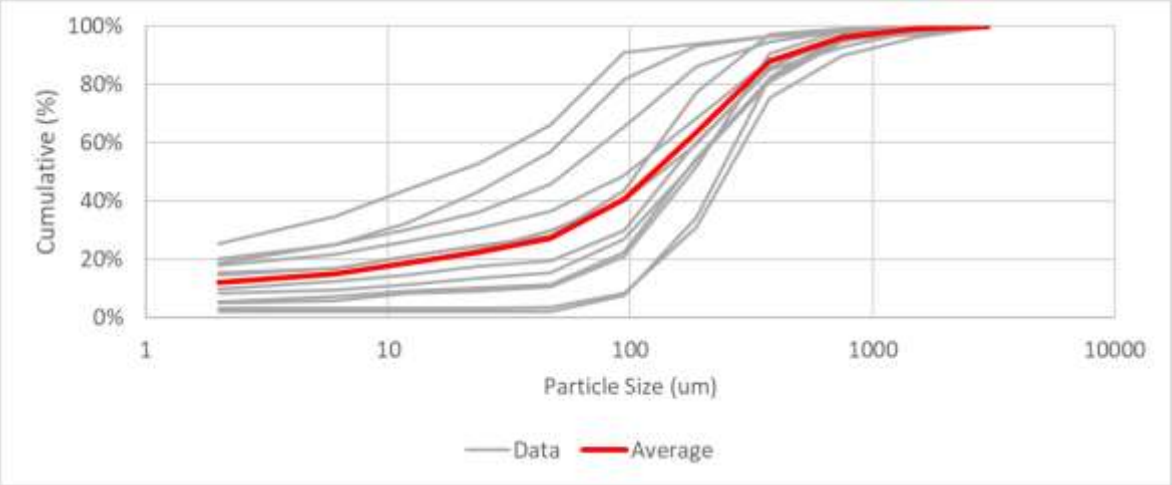

Figure 40 *PSD of sediment samples from 2017 Casuarina Boat Harbour survey.*

6. 2020 PSD of the proposed Casuarina Boat Harbour northern breakwater footprint sediments

O2 Marine (2020) PSD results are illustrated in Figure 41 and summarised tabularly in the Wentworth classification system in Table 11. On average silt comprises 62% of the sediments, sand 31% and clay 6%. Approximately 60% of the material is comprised of medium silt to very fine sand (16-125 µm diameter).

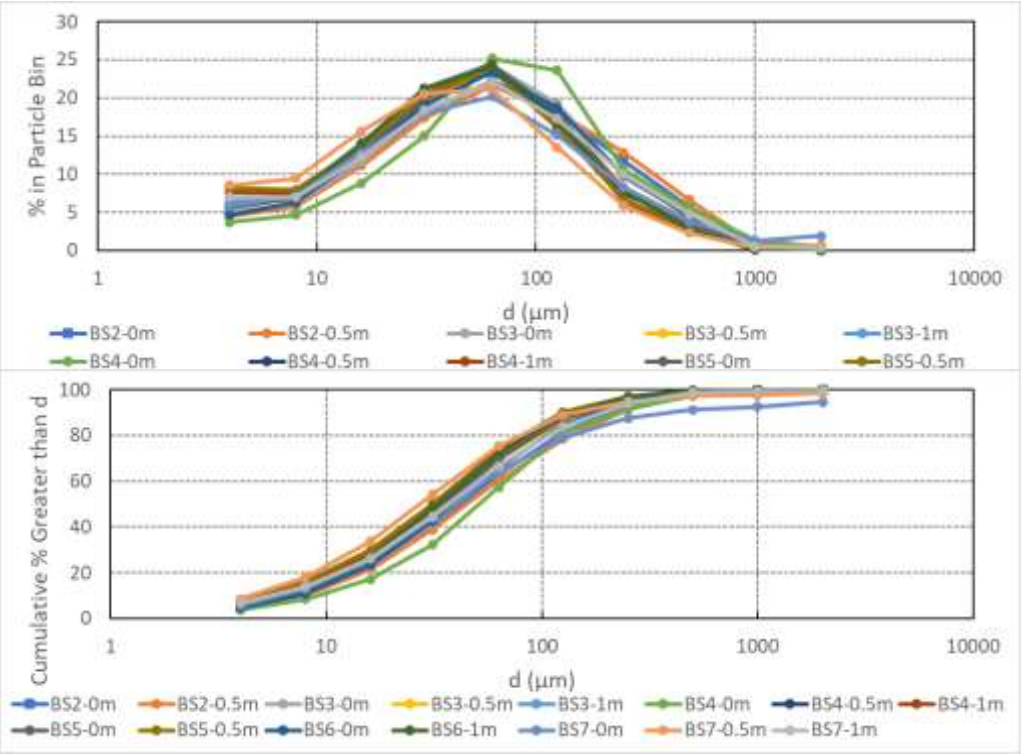

Figure 41 ***Percentage of surficial sediment particle diameters (top) and cumulative distribution (bottom) of proposed Casuarina Boat Harbour northern breakwater during the 2020 northern breakwater survey.***

Table 11 ***Percent of sediments by Wentworth classification of the sediments of the proposed Casuarina Boat Harbour northern breakwater during the 2020 northern breakwater survey.***

Wentworth Size Classifications / Sample Description	BS2-0m	BS2-0.5m	BS3-0m	BS3-0.5m	BS3-1m	BS4-0m	BS4-0.5m	BS4-1m	BS5-0m	BS5-0.5m	BS6-0m	BS6-1m	BS7-0m	BS7-0.5m	BS7-1m	Average	StdDev
Total Clay (0-4 µm)	**4.8**	**4.5**	**5.0**	**6.4**	**6.3**	**3.7**	**5.9**	**7.6**	**5.7**	**8.2**	**4.7**	**5.7**	**5.8**	**8.6**	**7.0**	**6.0**	**1.4**
Very Fine Silt (4-8 µm)	6.1	5.7	6.1	7.1	7.5	4.6	7.1	7.5	6.9	8.0	6.3	7.2	7.2	9.5	7.0	6.9	1.1
Fine Silt (8-16 µm)	11.7	11.1	11.7	12.9	14.1	8.9	13.2	13.3	13.0	13.7	12.4	14.1	12.9	15.7	12.3	12.7	1.6
Medium Silt (16-31 µm)	18.1	17.4	18.7	19.3	21.3	15.0	20.0	20.5	19.9	20.3	19.1	21.3	18.0	20.6	18.4	19.2	1.7
Course Silt (31-63 µm)	22.3	21.6	24.3	23.7	24.6	25.2	24.1	24.5	24.4	23.7	23.4	24.2	20.2	21.2	22.1	23.3	1.5
Total Silt (4-63 µm)	**58.2**	**55.8**	**60.7**	**63.0**	**67.5**	**53.7**	**64.4**	**65.8**	**64.1**	**65.7**	**61.2**	**66.7**	**58.2**	**66.9**	**59.7**	**62.1**	**4.3**
Very Fine sand (63-12 5µm)	18.3	18.1	19.3	17.7	16.3	23.6	17.4	16.5	18.0	16.2	18.7	16.8	15.2	13.5	17.3	17.5	2.2
Fine sand (125-250 µm)	11.7	12.9	9.7	8.4	6.7	10.7	7.5	6.5	8.0	6.7	9.9	7.8	8.3	5.9	10.0	8.7	2.0
Medium sand (250-500 µm)	5.7	6.7	4.7	4.1	2.7	5.6	3.9	2.7	3.5	3.0	4.6	2.8	3.8	2.3	4.8	4.1	1.3
Coarse sand (500-1000 µm)	0.9	0.8	0.3	0.3	0.3	1.4	0.5	0.4	0.3	0.1	0.4	0.1	1.3	0.4	0.5	0.5	0.4
Very Coarse sand (1000-2000 µm)	0.2	0.3	0.2	0.2	0.1	0.5	0.2	0.1	0.2	0.0	0.2	0.0	1.9	0.7	0.3	0.3	0.5
Total Sand (63-2000 µm)	**36.9**	**38.8**	**34.2**	**30.6**	**26.2**	**41.7**	**29.4**	**26.2**	**30.0**	**26.0**	**33.8**	**27.5**	**30.5**	**22.9**	**33.0**	**31.2**	**5.3**
Total Gravels (>2000 µm)	**0.1**	**0.9**	**0.1**	**0.0**	**0.0**	**0.8**	**0.3**	**0.4**	**0.2**	**0.1**	**0.3**	**0.0**	**5.5**	**1.7**	**0.3**	**0.7**	**1.4**

7. 2021 KBSC marina sediment quality survey

The proposed dredged material in the KBSC marina footprint is generally sand with some shell, rock, mud and plant material. The representative PSD across all samples was ~1.4% clay (0-4 µm), ~12% silt (4-63 µm) and ~84% sand (63-2000 µm).

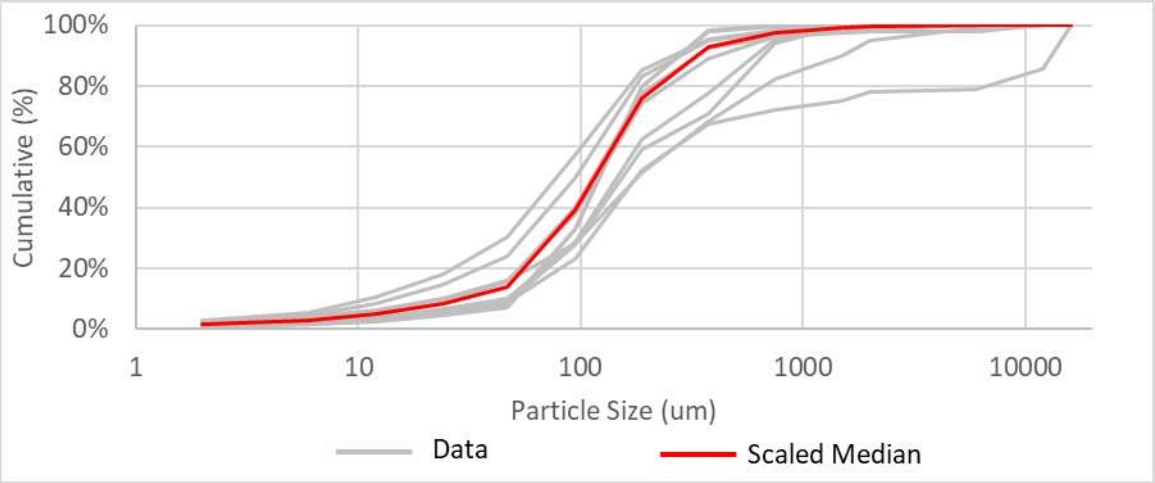

Figure 42 Cumulative PSD of sediment samples from 2020 KBSC marina footprint survey.

All metals and metalloids were below NAGD (2009) screening levels.

All twenty samples were below LoR for TBT except for one, but it was below the NAGD (2009) screening level.

Total PAH was well below the ANZG (2018) DGVTS of 10,000 µg/L for all samples.

BTEX, TRH, PAH and OC/OP concentrations were all below LoRs in all samples.

8. Discussion

8.1 Baseline water quality of Koombana Bay, Casuarina Boat Harbour and Leschenault Inlet

A comparison of the median and 80th percentile water quality concentrations of the baseline monitoring data of Koombana Bay, Casuarina Boat Harbour and Leschenault Inlet are provided in Table 12 with the following summary:

– NH_X is substantially greater in the inlet than the harbour and bay. The medians of NH_X were above the ANZECC (2018) DTVPC in the harbour and inlet, whereas only the 80th percentile exceeded this criterion in the bay. Further, a gradient in concentrations from the eastern to western inlet was measured during summer and autumn.

– NO_X is greater in the inlet than the harbour and the bay. The median NO_X was above the ANZG (2018) DGVPC in the inlet, whereas only the 80th percentiles exceeded this criteria in the bay and harbour.

– As with the dissolved inorganic forms of nitrogen, TN was substantially greater in the bay relative to the other two water bodies. The 80th percentile TN in the inlet and harbour were above the ANZECC (2000) DTVPC, whereas the 80th percentile in the bay was below this criterion.

- FRP was slightly higher in the inlet than the harbour and bay. The 80th percentile FRP was below the ANZG (2018) DGVPC in the inlet and bay, however the median was above this criteria in the inlet.
- TP was also higher in the inlet than the harbour and bay. The 80th percentile TP exceeded the ANZECC (2000) DVTPC in the bay, whereas the medians in the harbour and inlet were greater than this criterion.
- Chl-a was similar in the three (3) water bodies, even though there was substantially greater nutrient levels in the inlet than the bay and harbour. The medians in all three (3) water bodies were substantially greater than the ANZG (2018) DGVPC. Similar to chl-a, a gradient in concentrations from the eastern to western inlet was measured on a number of sampling locations.
- As with chl-a, TSS was similar in the three (3) water bodies. Differences between the 80th percentile and median concentrations of TSS were 3, 4.6 and 6 mg/L in the bay, harbour and inlet, respectively. These TSS differences can serve as guideline values (or impact thresholds) to define the allowable levels of TSS above background due to construction-related turbidity generation. RPS (2023) established an impact threshold of 2 mg/L for the KBMS SPER, which on the basis of the available measurements is an environmentally conservative threshold.
- Al was lower in the bay than the other two semi-enclosed water bodies. However, the ANZECC (2000) LRTV of 0.5 µg/L is seemingly too low and therefore was not adopted here.
- Cr, Cd and Hg measurements were all LoR, which are reported in Table 12 as half LoR.
- The 80th percentiles of Mn, Fe, Ni, Cu, As and Pb were always below the guideline criteria.
- The median and 80th percentile of Zn were at and greater than the ANZG (2018) DGVT in the inlet, respectively. However, the median of Zn was below this criterion in the bay and harbour.

To summarise nutrients in the inlet are generally greater than bay and harbour, yet algae (chl-a) levels are similar among the three (3) water bodies. As TSS is similar in all three (3) water bodies then variations in the degree of light limitation is not likely a causal factor. Toxicity from organic contaminants (i.e. BTEX, PAH, TRH, OC/OP) in the inlet is not likely as all measurements in the three (3) water bodies were below LoR. Though most metal and metalloid analytes are well below relevant guideline values, Zn is an exception. The median and 80th percentile concentration of Zn are at or above the ANZG (2018) DGVT in the inlet, whereas concentrations were much lower in the bay and harbour, and well below this criterion. Zn levels in the sediments of Leschenault Inlet are below the ANZG (2018) DGVT (and DGVT-High) (Section 4.4), so it is unlikely that this is the source of elevated Zn.

Table 12 ***Median and 80th percentile recent water quality of Koombana Bay, Casuarina Boat Harbour and Leschenault Inlet where yellow and pink shading indicate 80th percentile and median greater than default guideline value, respectively.***

Analyte	Guideline Value	2016-2017 Koombana Bay Median (and 80th percentile)	2016-2017 Casuarina Boat Harbour Median (and 80th percentile)	2020 Leschenault Inlet Median (and 80th percentile)
NHx	ANZECC (2000) 5 ug/L	3 (8.2)	6 (9.2)	40 (80)
NOx	ANZG (2018) 3.1 (sum), 6.1 (aut), 7.5 (win) & 2.6 (spr) ug/L	1 (9.2)	3 (10)	5 (30)
TN	ANZECC (2000) 230 ug/L	160 (200)	180 (232)	200 (400)
FRP	ANZG (2018) 5.5 (sum), 5.3 (aut), 6.2 (win) & 4.7 (spr) ug/L	3 (3)	3 (4)	5 (5)
TP	ANZECC (2000) 20 ug/L	19 (22)	24 (27)	30 (40)
Chla	ANZG (2018) 0.27 (sum), 0.55 (aut), 0.71 (win) & 0.36 (spr) ug/L	2.3 (3)	3 (3.8)	2 (4)
TSS		4 (7)	6 (10.6)	3 (9)
Al		2.5 (5)	2.5 (5.4)	5 (5)
Cr	ANZG (2018) 99th percentile species protection level for CrIII 4.4 ug/L	0.1 (0.1)	0.1 (0.1)	0.5 (0.5)

Analyte	Guideline Value	2016-2017 Koombana Bay Median (and 80th percentile)	2016-2017 Casuarina Boat Harbour Median (and 80th percentile)	2020 Leschenault Inlet Median (and 80th percentile)
Mn	ANZG (2018) Unknown 80 ug/L	2.6 (3.4)	3 (4.1)	5 (5)
Fe	ANZECC (2000) Low Reliability Value18 ug/L	1 (1)	1 (2)	5 (10)
Ni	ANZG (2018) 95th percentile species protection level 7 ug/L	0.2 (0.3)	0.2 (0.3)	0.5 (0.5)
Cu	ANZG (2018) 95th percentile species protection level 1.3 ug/L	0.5 (0.6)	0.9 (1)	0.5 (1)
Zn	ANZG (2018) 95th percentile species protection level 8 ug/L	2 (3)	2 (3)	8 (49)
As	ANZG (2018) Low Reliability Value for AsIII 2.3 ug/L	1.8 (2)	1.8 (2)	2 (2)
Cd	ANZG (2018) 99th percentile species protection level 0.7 ug/L	0.5 (0.5)	0.5 (0.5)	0.5 (0.5)
Pb	ANZG (2018) 95th percentile species protection level 4.4 ug/L	0.2 (0.6)	0.1 (0.3)	0.5 (0.5)
Hg	ANZG (2018) 99th percentile species protection level 0.1 ug/L	0.05 (0.05)	0.05 (0.05)	0.05 (0.05)

8.2 Sediment PSD of proposed dredge material

Table 13 collates the sediment survey data that has been collected during preparation of the KBMS SPER, which are summarised on the Wentworth classification scale, whereby:

– Though the GHD (2016) analysis of the surficial sediments of Casuarina Boat Harbour were dominated by silt (56.3%) with lower percentages of clay (5.8%) and sand (37.1%), subsampling of cores as described in RPS (2017) yielded a higher proportion of sand (71.8%), greater clay content (12.2%) and a sizeable reduction in silt (15%).
– The high silt-clay content of 50% from five (5) samples over the proposed Casuarina Boat Harbour northern breakwater footprint reported by Galt (2019) was verified by the O2 Marine (2021) with a silt content of 62.1% along with relatively low clay (6%) and sizeable sand (31.1%) components.
– Galt (2019) on the basis of three (3) samples over the proposed eastern KBSC marina breakwater footprint determined a clay-silt content of 26% and sand content of 67.3%. Cardno (2021) found a much lower clay-silt content of 14% and higher sand content of 85.6% with their more comprehensive spatial coverage survey.

In short, the dredged material of two (2) of the three (3) proposed dredging regions, namely Casuarina Boat Harbour and KBSC marina, are predominantly sand (>70%), whereas the Casuarina Boat Harbour northern breakwater footprint is predominantly silt (>60%). It follows, all other factors being equal, that turbid plumes generated during dredging of the northern breakwater footprint will remain suspended in the water column for longer because the settling velocities of the smaller diameter clay and silt particles are substantially lower. As a result, these fine (silt, clay) particles will be transported over greater distances with potentially greater impact than the harbour and marina sediments.

Table 13 PSD of proposed sediments to be dredged in Wentworth classification intervals

Location	Reference	Clay (0-4 um)	Very Fine Silt (4-8 um)	Fine Silt (8-16 um)	Medium Silt (16-32 um)	Coarse Silt (32-63 um)	Very Fine Sand (63-125 um)	Fine Sand (125-250 um)	Medium Sand (250-500 um)	Coarse Sand (500-1000 um)	Very Coarse Sand (1000-	Gravel (>2000 um)	Organic Content	Comments
2016 (Sep) Casuarina Boat Harbour	This Report	5.8	6.5	11.4	16.7	21.7	19.7	11.1	4.1	1.8	0.4	0.9	13.5% LOI	Surficial sediments from 8 sites
2017 (Oct) Casuarina Boat Harbour	RPS (2017)	12.2	2.8	3.6	3.8	4.8	13.4	23.1	24.3	8.3	2.7	1.1	1% TOC	18-26 samples from intervals of 0-0.25 m, 0.25-0.5 m, 0.5-1 m, 1-1.5 m, 1.5-2 m

Location	Reference	Clay (0-4 um)	Very Fine Silt (4-8 um)	Fine Silt (8-16 um)	Medium Silt (16-32 um)	Coarse Silt (32-63 um)	Very Fine Sand (63-125 um)	Fine Sand (125-250 um)	Medium Sand (250-500 um)	Coarse Sand (500-1000 um)	Very Coarse Sand (1000-	Gravel (>2000 um)	Organic Content	Comments
														from cores at 19 sites.
2018 (Nov-Dec) Proposed northern breakwater	Galt (2019)	50					49.4					0	11.2% LOI	5 samples from 3 bore holes
2020 (Jun) Proposed northern breakwater	O2 Marine (2020)	6.0	6.9	12.7	19.2	23.3	17.5	8.7	4.1	0.5	0.3	0.7	-	15 samples from 6 sites
2018 (Nov-Dec) Proposed KBSC marina breakwaters	Galt (2019)	26					67.3					3	12.0% LOI	3 samples from 2 bore holes
2021 (April) Proposed KBSC marina	Cardno (2021)	1.4	1.2	2.2	3.6	5.2	25.6	36.8	16.8	4.7	1.8	0.8	0.4% TOC	20 samples from 10 locations of 1 m cores

8.3 Comparative sediment quality

The proposed KBSC marina footprint has good sediment quality (Cardno 2021) with limited risk in terms of toxicity to the marine environment during the proposed dredging activities.

Only the contaminant TBT for a small pocket of sediments in Casuarina Boat Harbour (~10,000 m^3) (RPS 2017) has been determined to present elevated risk for offshore disposal. Therefore, this small pocket of sediment will undergo onshore disposal.

O2 Marine (2021) sampling of Leschenault Inlet indicated the sediments do not pose a material risk to the environment in terms of metals and metalloids, TBT and OC/OP. Specifically, Zn was well below the ANZG (2018) DGVT and thereby is unlikely to be the source of elevated levels in the inlet.

9. References

ANZECC (2000) Australian and New Zealand Guideline for Fresh and Marine Water Quality. October 2000.

ANZG (2018) Australian and New Zealand Guideline for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at ww.waterquality.gov.au/anz-guidelines

Cardno (2021) SAP Implementation Report: Dredge Spoil Sediment Sampling – Koombana Bay Sailing Club Marina Development. Prepared for South West Commission. Job RefCW1168500. Rev0.

EPA (2016a) Environmental Factor Guideline: Marine Environmental Quality. December 2016.

EPA (2016b) Environmental Factor Guideline: Benthic Communities and Habitats. December 2016.

EPA (2016c) Technical Guide: Environmental Impact Assessment of Marine Dredging Proposals. December 2016.

Galt Geotechnics (2019) Factual Report on Geotechnical Study Transforming Bunbury's Waterfront Stage 3 Coastal & Marine Structures. Prepared for Seashore Engineering. Ref: J18011186 002 R Rev0. 30 May 2019.

McCree, KJ (1972) Test of current definitions of photosynthetically active radiation against leaf photosynthesis data. Agric. Meteorol. 10:443-453

NAGD (2009) National Assessment Guidelines for Dredging 2009. Department of Environment, Water, Heritage and the Arts. 2009.

O2 Marine (2021) Sediment and Marine Water Quality Monitoring of the Leschenault Inlet. Prepared for Department of Primary Industries and Regional Development. Report No. R200188Rev2.

O2 Marine (2020) Bunbury TW3 Casuarina Harbour Sediment Sampling and Analysis. Technical Memorandum prepared for Department of Transport. Reference 20WAU-0024 (T200140) 10 July 2020.

Oceanica (2008a) Bunbury Waterfront Project: Stage 1 Marine and Coastal Baseline Studies – Baseline Water Quality Report. Prepared for Strategen. Report No 580_002/1. September 2008.

Oceanica (2008b) Bunbury Waterfront Project: Stage 1 Marine and Coastal Baseline Studies – Baseline Sediment Quality Report. Prepared for Strategen. Report No 580_003/1. May 2008.

RPS (2017) SAP Implementation Report: Casuarina Harbour. Prepared for Department of Transport. Doc No. EEC16056.006:2.

RPS (2023) Benthic Communities and Habitat Study. Prepared for South West Development Commission for KBMS SPER. Doc No. EEL16056.A00.

Wave Solutions (2012) Technical Report 19: Koombana Bay Baseline Marine Monitoring Report. (Bunbury Port Berth 14 Expansion and Coal Storage Loading Facility [Assessment No. 1886]). Prepared for Lanco Resources Australia Pty Ltd. Doc. No. 2636-001-001-001. 21 October 2012.

Appendices

Appendix A

Chain of Custody Documentation for 2016-2017 Water Quality Samples

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: Kristina Downey
Address: Murdoch University, Loading Zone 1,	Address: 999 Hay Street
Phys Sc Room 3.026, 90 South St, Murdoch 6150	perth
Phone: 08 93602907	Phone: 6222 8181 Fax:
Email:	Email: kristinadowney@ghd.com
Courier Details:	Job Number: 61-34786 PO/ Account #:

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Nutrients	Dissolved metals	TSS	Chl a/b/c				
1	T1-A	6 Sept 2016	✓	✓	✓	✓				
2	T1-B	6 Sept 2016	✓	✓	✓	✓				
3	T1-C	6 Sept 2016	✓	✓	✓	✓				
4	T2-A	6 Sept 2016	✓	✓	✓	✓				
5	T2-B	6 Sept 2016	✓	✓	✓	✓				
6	T2-C	6 Sept 2016	✓	✓	✓	✓				
7	T3-A	6 Sept 2016	✓	✓	✓	✓				
8	T3-B	6 Sept 2016	✓	✓	✓	✓				
9	T3-C	6 Sept 2016	✓	✓	✓	✓				
10	T4-A	6 Sept 2016	✓	✓	✓	✓				
11	T4-B	6 Sept 2016	✓	✓	✓	✓				
12	T4-C	6 Sept 2016	✓	✓	✓	✓				
13	T5-A	6 Sept 2016	✓	✓	✓	✓				
14	T5-B	6 Sept 2016	✓	✓	✓	✓				
15	T5-C	6 Sept 2016	✓	✓	✓	✓				
16	QA-1	6 Sept 2016	✓	✓	✓	✓				
17	QA-2	6 Sept 2016	✓	✓	✓	✓				
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
Kristina Downey	7 Sept 2016	09:40	VG	7/9/16	9.45	CHO16-1
Sample Condition:						

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

Dissolved metals (as per email) => Al, Fe, Mn, As, Cd, Cr(II), Cr(VI), Cu, Pb, Ni, Zn and Hg

Nutrients => TN, TP, NO_x, NH_x, FRP

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch University

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: GHD
Address: Murdoch University, Loading Zone 1,	Address: 16 VICTORIA ST
Phys Sc Room 3.026, 90 South St, Murdoch 6150	BUNBURY WA 6230
Phone: 08 93602907	Phone: 08 9721 0721 Fax:
Email:	Email: lemuel.cabahug@ghd.com
Courier Details:	Job Number: 6134827 PO/ Account #:

Sample Preservation: None / Warm / Cool / (On Ice) / Frozen / Acidified / Filtered / Other: _____

Sample Type: (Water) / Bore / Fresh / Estuarine / (Marine) / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Total N (TN)	Total P (TP)	Ammonia (NH_3)	Chlorophyll a/b/c	TSS	NO_3+NO_2	ortho-P	
1	T1-A	26/10/2016	✓	✓	✓	✓	✓	✓	✓	
2	T1-B		✓	✓	✓	✓	✓	✓	✓	
3	T1-C		✓	✓	✓	✓	✓	✓	✓	
4	T2-A		✓	✓	✓	✓	✓	✓	✓	
5	T2-B		✓	✓	✓	✓	✓	✓	✓	
6	T2-C		✓	✓	✓	✓	✓	✓	✓	
7	T3-A		✓	✓	✓	✓	✓	✓	✓	
8	T3-B		✓	✓	✓	✓	✓	✓	✓	
9	T3-C		✓	✓	✓	✓	✓	✓	✓	
10	T4-A		✓	✓	✓	✓	✓	✓	✓	
11	T4-B		✓	✓	✓	✓	✓	✓	✓	
12	T4-C		✓	✓	✓	✓	✓	✓	✓	
13	T5-A		✓	✓	✓	✓	✓	✓	✓	
14	T5-B		✓	✓	✓	✓	✓	✓	✓	
15	T5-C		✓	✓	✓	✓	✓	✓	✓	
16	QA-1		✓	✓	✓	✓	✓	✓	✓	
17	QA-2		✓	✓	✓	✓	✓	✓	✓	
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
LEM CABAHUG	26/10/2016	3PM	Amy	27/10/16	1:15	GHD16-3

Sample Condition:

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: Tom Sullivan - GHD
Address: Murdoch University, Loading Zone 1,	Address: 999 Hay St, Perth WA
Phys Sc Room 3.026, 90 South St, Murdoch 6150	6000
Phone: 08 93602907	Phone: 6222 8780 Fax: 6222 8555
Email:	Email: tom.sullivan@ghd.com
Courier Details:	Job Number: 61378604 PO/ Account #: 61378604 / GHD Acc.

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			TN	TP	NO_x	NH_x	FRP	TSS	Chl a/b/c	Ultra Trace metals
1	T1-A	14/12/16	✓	✓	✓	✓	✓	✓	✓	✓
2	T1-B	"								
3	T1-C	"								
4	T2-A	"								
5	T2-B	"								
6	T2-C	"								
7	T3-A	"								
8	T3-B	"								
9	T3-C	"								
10	T4-A	"								
11	T4-B	"								
12	T4-C	"								
13	T5-A	"								
14	T5-B	"								
15	T5-C	"								
16	T5-C REP	"								
17	T3-C REP	"								
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
	15.12.16	09:15		15/12/16	9:30 pm	61378604

Sample Condition: GHD16-4

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: Tom Sullivan
Address: Murdoch University, Loading Zone 1,	Address: 999 Hay St Perth
Phys Sc Room 3.026, 90 South St, Murdoch 6150	
Phone: 08 93602907	Phone: 6222 8780 Fax:
Email:	Email: tom.sullivan@ghd.com
Courier Details:	Job Number: 61378604 PO/ Account #:

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			TN	TP	NO_x	FRP	TSS	Chl a/b/c	Ultra Trace Diss. metals	NH_x
1	T1-A	17/01								
2	T1-B									
3	T1-C									
4	T2-A									
5	T2-B									
6	T2-C									
7	T3-A									
8	T3-B									
9	T3-C									
10	T4-A									
11	T4-B									
12	T4-C									
13	T5-A									
14	T5-B									
15	T5-C									
16	T5-C REP									
17	T3-C REP									
18										
19										
20										

NH_x added as per client request 18/1/17 VG

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
	18.01.17	9:20	VG	18/1/17	9.20	GHD17-1

Sample Condition:

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Phone: 93602907

Murdoch UNIVERSITY

To: Marine and Freshwater Research Laboratory	From: LEMUEL CABAHUG
Address: Murdoch University, Loading Zone 1,	Address: 999 HAY ST, PERTH WA 6000
Phys Sc Room 3.026, 90 South St, Murdoch 6150	
Phone: 08 93602907	Phone: 9721 0721 Fax:
Email:	Email: lemuel.cabahug@ghd.com
Courier Details:	Job Number: 61347860 PO/ Account#:

Sample Preservation: None / Warm / (Cool) / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / (Marine) / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Nutrients	Dissolved metals	chl a/b/c	TSS	Salinity			
1	T1-A	22/2/17	✓	✓	✓	✓	✓			
2	T1-B									
3	T1-C									
4	T2-A									
5	T2-B									
6	T2-C									
7	T3-A									
8	T3-B									
9	T3-C									
10	T4-A									
11	T4-B									
12	T4-C									
13	T5-A									
14	T5-B									
15	T5-C									
16	QC-1									
17	QC-2	↓	↓	↓	↓	↓	↓			
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
LEMUEL CABAHUG	23/2/17		Marjan	24/02/17		GHD17-2
Sample Condition:						

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

NUTRIENTS: TN, TP, NO_x, NH_x, FRP

DISSOLVED METALS (ULTRA TRACE): Al, Fe, Mn, As, Cd, Cr(II), Cr(IV), Cu, Pb, Ni, Zn, Hg

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: LEMUEL CABAHUG
Address: Murdoch University, Loading Zone 1,	Address: 999 HAY ST, PERTH WA 6000
Phys Sc Room 3.026, 90 South St, Murdoch 6150	
Phone: 08 93602907	Phone: 9721 0721 Fax:
Email:	Email: lemuel.cabahug@ghd.com
Courier Details:	Job Number: 61347804 PO/ Account#:

Sample Preservation: None / Warm / (Cool) / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / (Marine) / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Nutrients	Dissolved metals	Chl a/b/c	TSS	Salinity			
1	T1-A	30/3/17	✓	✓	✓	✓	✓			
2	T1-B	↓	↓	↓	↓	↓	↓			
3	T1-C									
4	T2-A									
5	T2-B									
6	T2-C									
7	T3-A									
8	T3-B									
9	T3-C									
10	T4-A									
11	T4-B									
12	T4-C									
13	T5-A									
14	T5-B									
15	T5-C									
16	QC-1									
17	QC-2	↓	↓	↓	↓	↓	↓			
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
LEMUEL CABAHUG	30/3/17		JU	31/3/17	1100	GHO17-3

Sample Condition:

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

MAFRL LAB 1:NATA:Proformas:Lab Proformas: Chain of Custody (C2a) 10/6/15

NUTRIENTS: TN, TP, NO_x, NH_x, FRP

DISSOLVED METALS (ULTRA TRACE): Al, Fe, Mn, As, Cd, Cr(II), Cr(IV), Cu, Pb, Ni, Zn, Hg

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch University

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: Lemuel Cabahug
Address: Murdoch University, Loading Zone 1,	Address: 10 Victoria Street
Phys Sc Room 3.026, 90 South St, Murdoch 6150	Bunbury 6230 WA
Phone: 08 93602907	Phone: 9721 072 Fax:
Email:	Email: lemuel.cabahug@ghd.com
Courier Details:	Job Number: 61-34786-04 PO/ Account #:

Sample Preservation: None / Warm / (Cool) / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / (Marine) / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Nutrients	Dissolved Metals	Chl a/b/c	TSS	Salinity			
1	T1-A	26/6/17	✓	✓	✓	✓	✓			
2	T1-B									
3	T1-C									
4	T2-A									
5	T2-B									
6	T2-C							metals and	bottle cracked leaking	
7	T3-A									
8	T3-B									
9	T3-C							metals and	bottle cracked leaking	
10	T4-A									
11	T4-B									
12	T4-C									
13	T5-A									
14	T5-B									
15	T5-C									
16	QC-1									
17	QC-2	↓	↓	↓	↓	↓	↓			
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
Lemuel Cabahug	27/6/17		VG	27/6/17	1030am	GH0174
Sample Condition:						

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

Nutrients: TN, TP, NO_x, NH_x, FRP

Dissolved Metals: Al, Fe, Mn, As, Cd, Cr (II), Cr (IV), Cu, Pb, Ni, Zn, Hg

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: Tom Sullivan
Address: Murdoch University, Loading Zone 1,	Address: 999 Hay St Perth WA
Phys Sc Room 3.026, 90 South St, Murdoch 6150	
Phone: 08 93602907	Phone: 6222 8780 Fax:
Email:	Email: tom.sullivan@ghd.com
Courier Details:	Job Number: 61378604 PO/ Account #:

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Nutrients	Diss. Metals	Chl a/b/c	TSS	Turbidity			
1	T1-A	4/8/17								
2	T1-B									
3	T1-C									
4	T2-A									
5	T2-B									
6	T2-C									
7	T3-A									
8	T3-B									
9	T3-C									
10	T4-A									
11	T4-B									
12	T4-C									
13	T5-A									
14	T5-B									
15	T5-C									
16	~~REP1~~ QC1									
17	~~REP2~~ QC2									
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
Tom Sullivan	4/8/17	16:30	JW	4/8/17	1630	GHD17-5
Sample Condition: Cold						

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

Nutrients: TN, TP, NO_x, NH_x, FRP

Diss. Metals: Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Cd, Pb, Hg (Ultra Trace)

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: Lemuel Cabahug
Address: Murdoch University, Loading Zone 1,	Address: Level 1, 10 Victoria Street
Phys Sc Room 3.026, 90 South St, Murdoch 6150	Bunbury WA 6230
Phone: 08 93602907	Phone: 08 9721 0724 Fax:
Email:	Email: lemuel.cabahug@ghd.com
Courier Details:	Job Number: 61-34786-04 PO/Account #:

Sample Preservation: None / Warm / Cool / (On Ice) / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / (Marine) / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Nutrients	Dissolved Metals	Chl a/b/c	TSS	Turb			
1	T1	31 Aug 17	✓	✓	✓	✓	✓			
2	T1									
3	T1									
4	T2									
5	T2									
6	T2									
7	T3									
8	T3									
9	T3									
10	T4									
11	T4									
12	T4									
13	T5									
14	T5									
15	T5									
16	QC-1									
17	QC-2									
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
L Cabahug	31 Aug 17	1530	JW	1/9/17	1300	GHD178

Sample Condition:

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

Nutrients: TN, TP, NO_x, NH_x, FRP

Dissolved metals: Al, Fe, Mn, As, Cd, Cr(II), Cr(IV), Cu, Pb, Ni, Zn, Hg

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: Tom Sullivan
Address: Murdoch University, Loading Zone 1,	Address: 999 Hay St Perth WA 6000
Phys Sc Room 3.026, 90 South St, Murdoch 6150	
Phone: 08 93602907	Phone: 6222 8222 Fax:
Email:	Email: tom.sullivan@ghd.com
Courier Details:	Job Number: PO/ Account #: 61-34786-04

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			Nutrients	Chl a/b/c	TSS	Turb				
1	T1-A	28 Sep 17	✓	✓	✓	✓				
2	T1-B									
3	T1-C									
4	T2-A									
5	T2-B									
6	T2-C									
7	T3-A									
8	T3-B									
9	T3-C									
10	T4-A									
11	T4-B									
12	T4-C									
13	T5-A									
14	T5-B									
15	T5-C									
16	QC-1									
17	QC-2									
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
Tom S	28/9/17	4:30	JW	28/9/17	4:30 pm	GHD17-10

Sample Condition:

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

NUTRIENTS: TN, TP, NO_x, NH_x, FRP

Appendix B

Laboratory Certificates of Analysis for 2016-2017 Water Quality Samples

Marine and Freshwater
Research Laboratory
Environmental Science
Telephone: +61 8 93602907 Facsimile: +61 8 93606613

Accreditation Number: 10603
This document is issued in accordance with
NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.

Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 26/09/2016
Date Received: 07/09/2016
Our Reference: GHD16-1
Your Reference: 61-34786

METHOD	Sampling	2000	4100	2100	4700	2700	3020	3020	3020	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	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit		<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<1
File			16091201			16090801		16091502		160914
T1-A	6/09/2016	8	4	9	26	220	2.7	0.2	0.6	9
T1-B	6/09/2016	8	4	9	240	1200	20	<0.1	2.2	230
T1-C	6/09/2016	9	3	7	52	350	7.0	0.1	1.4	33
T2-A	6/09/2016	<3	3	10	28	260	4.5	<0.1	0.8	15
T2-B	6/09/2016	<3	3	5	26	220	4.0	<0.1	0.7	10
T2-C	6/09/2016	3	3	6	22	190	3.2	<0.1	0.6	7
T3-A	6/09/2016	4	3	17	18	180	1.9	0.1	0.4	5
T3-B	6/09/2016	4	3	9	21	210	2.7	<0.1	0.7	6
T3-C	6/09/2016	<3	3	7	20	190	3.1	<0.1	0.5	6
T4-A	6/09/2016	5	3	11	18	180	1.8	<0.1	0.3	4
T4-B	6/09/2016	4	5	10	22	200	2.9	<0.1	0.5	6
T4-C	6/09/2016	5	3	8	22	200	3.4	<0.1	0.6	7
T5-A	6/09/2016	5	3	12	20	240	2.4	<0.1	0.5	6
T5-B	6/09/2016	5	3	11	21	200	2.4	<0.1	0.5	7
T5-C	6/09/2016	4	3	9	19	170	2.2	<0.1	0.4	6

Signatory: Lirong Han
Date: 26/09/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

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WATER QUALITY DATA

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 26/09/2016
Date Received: 07/09/2016
Our Reference: GHD16-1
Your Reference: 61-34786

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	ICP006
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L	Hg mg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1	<0.0001
File		16092101	16092101	16092101	16092101	16092101	16092101	16092101	16092101	16092101	16092101	16092101
T1-A	6/09/2016	5	<0.2	3.0	<1	<0.3	0.9	3	1.4	<0.1	0.2	<0.0001
T1-B	6/09/2016	<5	<0.2	1.3	<1	<0.3	0.6	1	1.2	<0.1	<0.1	<0.0001
T1-C	6/09/2016	<5	<0.2	1.8	<1	<0.3	0.5	2	1.5	<0.1	<0.1	<0.0001
T2-A	6/09/2016	5	<0.2	2.8	<1	<0.3	0.4	2	1.4	<0.1	0.3	<0.0001
T2-B	6/09/2016	<5	<0.2	2.1	<1	<0.3	0.4	1	1.4	<0.1	0.2	<0.0001
T2-C	6/09/2016	<5	<0.2	2.4	<1	<0.3	0.3	2	1.5	<0.1	0.2	<0.0001
T3-A	6/09/2016	<5	<0.2	3.2	<1	<0.3	0.4	2	1.4	<0.1	0.5	<0.0001
T3-B	6/09/2016	<5	<0.2	2.6	<1	<0.3	0.4	2	1.4	<0.1	0.5	<0.0001
T3-C	6/09/2016	<5	<0.2	2.5	<1	<0.3	0.3	2	1.6	<0.1	0.2	<0.0001
T4-A	6/09/2016	<5	<0.2	3.1	<1	<0.3	0.4	2	1.5	<0.1	0.1	<0.0001
T4-B	6/09/2016	<5	<0.2	2.6	<1	<0.3	0.4	2	1.5	<0.1	<0.1	<0.0001
T4-C	6/09/2016	<5	<0.2	2.4	<1	<0.3	0.4	2	1.5	<0.1	0.1	<0.0001
T5-A	6/09/2016	5	<0.2	2.9	1	0.3	1.0	11	1.5	<0.1	0.5	<0.0001
T5-B	6/09/2016	<5	<0.2	2.4	<1	<0.3	0.4	4	1.4	<0.1	0.5	<0.0001
T5-C	6/09/2016	<5	<0.2	2.4	<1	<0.3	0.4	4	1.5	<0.1	<0.1	<0.0001

Signatory: Lirong Han
Date: 26/09/2016

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WATER QUALITY DATA

Contact: Lem Cabahug
Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 9/11/2016
Date Received: 27/10/2016
Our Reference: GHD16-3
Your Reference: 6134827

METHOD SAMPLE CODE	Sampling Date	2000 AMMONIA µg.N/L	4100 ORTHO-P µg.P/L	2100 NO3+NO2 µg.N/L	4700 TOTAL-P µg.P/L	2700 TOTAL-N µg.N/L	3020 CHLORO 'a' µg/L	3020 CHLORO 'b' µg/L	3020 CHLORO 'c' µg/L	2540D TSS mg/L
Reporting Limit		**<3**	**<2**	**<2**	**<5**	**<50**	**<0.1**	**<0.1**	**<0.1**	**<1**
File			**16110101**			**16110801**			**16110201**	**161102**
T1-A	26/10/2016	5	2	2	20	140	1.4	0.2	0.3	6
T1-B	26/10/2016	4	3	<2	24	170	2.4	0.3	0.5	13
T1-C	26/10/2016	6	2	3	42	280	4.1	0.2	0.9	29
T2-A	26/10/2016	<3	<2	<2	50	390	8.5	0.2	1.6	36
T2-B	26/10/2016	<3	<2	<2	27	210	4.1	<0.1	0.7	14
T2-C	26/10/2016	<3	<2	<2	19	160	1.8	0.2	0.4	4
T3-A	26/10/2016	<3	2	<2	19	140	1.8	<0.1	0.3	7
T3-B	26/10/2016	<3	<2	<2	20	140	1.8	<0.1	0.4	7
T3-C	26/10/2016	<3	2	<2	16	110	1.0	0.1	0.2	3
T4-A	26/10/2016	<3	<2	<2	16	120	1.1	<0.1	0.3	8
T4-B	26/10/2016	<3	<2	<2	16	140	0.9	<0.1	0.2	3
T4-C	26/10/2016	<3	<2	<2	15	110	0.8	0.1	0.1	2
T5-A	26/10/2016	8	<2	2	19	250	1.1	0.2	0.1	3
T5-B	26/10/2016	<3	<2	<2	15	130	0.8	0.1	0.2	2
T5-C	26/10/2016	<3	<2	<2	16	120	1.0	0.2	0.2	2
QA-1	26/10/2016	<3	<2	<2	18	130	2.1	0.2	0.4	4
QA-2	26/10/2016	7	3	3	34	230	3.9	0.2	0.6	22

Signatory: Lirong Han
Date: 9/11/2016

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WATER QUALITY DATA

Contact: Lem Cabahug
Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 3/02/2017
Date Received: 27/10/2016
Our Reference: GHD16-3
Your Reference: 6134827

METHOD SAMPLE CODE	Sampling Date	9200 SALINITY psu	5060 Turbidity NTU
Reporting Limit			<0.1
File		170202	170202
T1-A	26/10/2016	35.6	
T1-B	26/10/2016	35.4	
T1-C	26/10/2016	35.0	
T2-A	26/10/2016	34.4	19
T2-B	26/10/2016	34.5	
T2-C	26/10/2016	34.7	
T3-A	26/10/2016	34.3	
T3-B	26/10/2016	34.6	
T3-C	26/10/2016	34.9	
T4-A	26/10/2016	34.5	
T4-B	26/10/2016	34.7	
T4-C	26/10/2016	34.8	
T5-A	26/10/2016	34.7	
T5-B	26/10/2016	34.8	
T5-C	26/10/2016	34.8	1.8
QA-1	26/10/2016	34.9	
QA-2	26/10/2016	34.9	

Signatory: Lirong Han
Date: 3/02/2017

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WATER QUALITY DATA

Contact: Tom Sullivan
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 17/01/2017
Date Received: 15/12/2016
Our Reference: GHD16-4
Your Reference: 613478604

METHOD	Sampling	2000	4100	2100	4700	2700	3020	3020	3020	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	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit		<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<0.5
File		16122201-17011601			17011001			16122201		161221
T1-A	14/12/2016	<3	2	<2	26	180	2.8	0.2	0.6	6.4
T1-B	14/12/2016	<3	<2	<2	24	160	3.2	0.2	0.6	4.7
T1-C	14/12/2016	<3	3	<2	24	160	2.6	<0.1	0.4	5.6
T2-A	14/12/2016	<3	3	<2	24	180	2.8	0.2	0.5	3.5
T2-B	14/12/2016	<3	<2	<2	23	160	3.0	0.2	0.5	2.8
T2-C	14/12/2016	<3	4	<2	22	140	2.8	<0.1	0.4	2.8
T3-A	14/12/2016	<3	2	<2	26	190	3.9	0.2	0.7	6.3
T3-B	14/12/2016	<3	<2	<2	22	200	3.1	0.2	0.5	3.1
T3-C	14/12/2016	<3	2	<2	22	150	2.2	<0.1	0.3	2.8
T4-A	14/12/2016	<3	2	<2	22	170	2.9	0.2	0.5	2.3
T4-B	14/12/2016	<3	<2	<2	19	160	2.5	<0.1	0.3	2.2
T4-C	14/12/2016	<3	2	<2	17	140	1.9	<0.1	0.3	2.0
T5-A	14/12/2016	<3	3	<2	21	250	2.3	<0.1	0.4	3.3
T5-B	14/12/2016	<3	<2	<2	18	160	2.8	<0.1	0.4	2.4
T5-C	14/12/2016	<3	<2	<2	16	140	1.8	<0.1	0.3	2.0
T5-C REP	14/12/2016	<3	<2	<2	17	140	1.8	<0.1	0.3	1.8
T3-C REP	14/12/2016	<3	3	<2	22	150	3.7	0.2	0.6	2.6

Signatory: Lirong Han
Date: 17/01/2017

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WATER QUALITY DATA

Contact: Tom Sullivan
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 17/01/2017
Date Received: 15/12/2016
Our Reference: GHD16-4
Your Reference: 613478604

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	ICP006
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L	Hg mg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1	<0.0001
File		16122101	16122101	16122101	16122101	16122101	16122101	16122101	16122101	16122101	16122101	16122001
T1-A	14/12/2016	5	<0.2	4.2	2	<0.3	0.9	1	2.1	<0.1	0.2	<0.0001
T1-B	14/12/2016	6	<0.2	3.9	2	<0.3	0.9	2	2.0	<0.1	0.4	<0.0001
T1-C	14/12/2016	5	<0.2	4.1	2	<0.3	0.8	1	2.0	<0.1	0.2	<0.0001
T2-A	14/12/2016	5	<0.2	3.7	1	<0.3	0.5	2	2.2	<0.1	0.6	<0.0001
T2-B	14/12/2016	<5	<0.2	3.9	1	<0.3	0.5	1	2.0	<0.1	0.4	<0.0001
T2-C	14/12/2016	<5	<0.2	5.2	1	<0.3	0.7	<1	2.3	<0.1	0.2	<0.0001
T3-A	14/12/2016	5	<0.2	3.1	2	<0.3	0.5	1	2.0	<0.1	0.1	<0.0001
T3-B	14/12/2016	<5	<0.2	3.3	1	<0.3	0.6	1	2.0	<0.1	0.2	<0.0001
T3-C	14/12/2016	<5	<0.2	5.2	2	<0.3	0.4	<1	2.3	<0.1	0.2	<0.0001
T4-A	14/12/2016	5	<0.2	3.3	1	<0.3	0.5	<1	2.0	<0.1	0.2	<0.0001
T4-B	14/12/2016	5	<0.2	3.7	1	<0.3	0.6	1	2.0	<0.1	0.2	<0.0001
T4-C	14/12/2016	<5	<0.2	3.7	1	<0.3	0.5	1	2.0	<0.1	0.1	<0.0001
T5-A	14/12/2016	7	<0.2	4.1	2	0.4	3.2	6	2.0	<0.1	4.0	<0.0001
T5-B	14/12/2016	5	<0.2	3.5	1	<0.3	0.8	2	2.0	<0.1	0.4	<0.0001
T5-C	14/12/2016	<5	<0.2	3.4	1	<0.3	0.7	2	1.8	<0.1	0.3	<0.0001
T5-C REP	14/12/2016	<5	<0.2	3.4	1	<0.3	0.7	1	1.9	<0.1	0.3	<0.0001
T3-C REP	14/12/2016	<5	<0.2	5.1	1	<0.3	0.4	1	2.3	<0.1	0.2	<0.0001

Signatory: Lirong Han
Date: 17/01/2017

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WATER QUALITY DATA

Contact: Tom Sullivan
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 3/02/2017
Date Received: 15/12/2016
Our Reference: GHD16-4
Your Reference: 613478604

METHOD SAMPLE CODE	Sampling Date	9200 SALINITY psu	5060 Turbidity NTU
Reporting Limit			<0.1
File		170202	170202
T1-A	14/12/2016	35.7	3.5
T1-B	14/12/2016	35.8	
T1-C	14/12/2016	35.6	
T2-A	14/12/2016	35.7	
T2-B	14/12/2016	35.8	
T2-C	14/12/2016	35.8	
T3-A	14/12/2016	35.8	
T3-B	14/12/2016	35.8	
T3-C	14/12/2016	35.8	
T4-A	14/12/2016	35.9	
T4-B	14/12/2016	35.8	
T4-C	14/12/2016	35.6	1.2
T5-A	14/12/2016	35.8	
T5-B	14/12/2016	35.8	
T5-C	14/12/2016	35.7	
T5-C REP	14/12/2016	35.7	
T3-C REP	14/12/2016	35.8	

Signatory: Lirong Han
Date: 3/02/2017

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WATER QUALITY DATA

Contact: Tom Sullivan
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 17/01/2017
Date Received: 15/12/2016
Our Reference: GHD16-4
Your Reference: 613478604

METHOD	Sampling	2000	4100	2100	4700	2700	3020	3020	3020	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	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit		<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<0.5
File		16122201-17011601			17011001			16122201		161221
T1-A	14/12/2016	<3	2	<2	26	180	2.8	0.2	0.6	6.4
T1-B	14/12/2016	<3	<2	<2	24	160	3.2	0.2	0.6	4.7
T1-C	14/12/2016	<3	3	<2	24	160	2.6	<0.1	0.4	5.6
T2-A	14/12/2016	<3	3	<2	24	180	2.8	0.2	0.5	3.5
T2-B	14/12/2016	<3	<2	<2	23	160	3.0	0.2	0.5	2.8
T2-C	14/12/2016	<3	4	<2	22	140	2.8	<0.1	0.4	2.8
T3-A	14/12/2016	<3	2	<2	26	190	3.9	0.2	0.7	6.3
T3-B	14/12/2016	<3	<2	<2	22	200	3.1	0.2	0.5	3.1
T3-C	14/12/2016	<3	2	<2	22	150	2.2	<0.1	0.3	2.8
T4-A	14/12/2016	<3	2	<2	22	170	2.9	0.2	0.5	2.3
T4-B	14/12/2016	<3	<2	<2	19	160	2.5	<0.1	0.3	2.2
T4-C	14/12/2016	<3	2	<2	17	140	1.9	<0.1	0.3	2.0
T5-A	14/12/2016	<3	3	<2	21	250	2.3	<0.1	0.4	3.3
T5-B	14/12/2016	<3	<2	<2	18	160	2.8	<0.1	0.4	2.4
T5-C	14/12/2016	<3	<2	<2	16	140	1.8	<0.1	0.3	2.0
T5-C REP	14/12/2016	<3	<2	<2	17	140	1.8	<0.1	0.3	1.8
T3-C REP	14/12/2016	<3	3	<2	22	150	3.7	0.2	0.6	2.6

Signatory: Lirong Han
Date: 17/01/2017

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WATER QUALITY DATA

Contact: Tom Sullivan
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 17/01/2017
Date Received: 15/12/2016
Our Reference: GHD16-4
Your Reference: 613478604

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	ICP006
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L	Hg mg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1	<0.0001
File		16122101	16122101	16122101	16122101	16122101	16122101	16122101	16122101	16122101	16122101	16122001
T1-A	14/12/2016	5	<0.2	4.2	2	<0.3	0.9	1	2.1	<0.1	0.2	<0.0001
T1-B	14/12/2016	6	<0.2	3.9	2	<0.3	0.9	2	2.0	<0.1	0.4	<0.0001
T1-C	14/12/2016	5	<0.2	4.1	2	<0.3	0.8	1	2.0	<0.1	0.2	<0.0001
T2-A	14/12/2016	5	<0.2	3.7	1	<0.3	0.5	2	2.2	<0.1	0.6	<0.0001
T2-B	14/12/2016	<5	<0.2	3.9	1	<0.3	0.5	1	2.0	<0.1	0.4	<0.0001
T2-C	14/12/2016	<5	<0.2	5.2	1	<0.3	0.7	<1	2.3	<0.1	0.2	<0.0001
T3-A	14/12/2016	5	<0.2	3.1	2	<0.3	0.5	1	2.0	<0.1	0.1	<0.0001
T3-B	14/12/2016	<5	<0.2	3.3	1	<0.3	0.6	1	2.0	<0.1	0.2	<0.0001
T3-C	14/12/2016	<5	<0.2	5.2	2	<0.3	0.4	<1	2.3	<0.1	0.2	<0.0001
T4-A	14/12/2016	5	<0.2	3.3	1	<0.3	0.5	<1	2.0	<0.1	0.2	<0.0001
T4-B	14/12/2016	5	<0.2	3.7	1	<0.3	0.6	1	2.0	<0.1	0.2	<0.0001
T4-C	14/12/2016	<5	<0.2	3.7	1	<0.3	0.5	1	2.0	<0.1	0.1	<0.0001
T5-A	14/12/2016	7	<0.2	4.1	2	0.4	3.2	6	2.0	<0.1	4.0	<0.0001
T5-B	14/12/2016	5	<0.2	3.5	1	<0.3	0.8	2	2.0	<0.1	0.4	<0.0001
T5-C	14/12/2016	<5	<0.2	3.4	1	<0.3	0.7	2	1.8	<0.1	0.3	<0.0001
T5-C REP	14/12/2016	<5	<0.2	3.4	1	<0.3	0.7	1	1.9	<0.1	0.3	<0.0001
T3-C REP	14/12/2016	<5	<0.2	5.1	1	<0.3	0.4	1	2.3	<0.1	0.2	<0.0001

Signatory: Lirong Han
Date: 17/01/2017

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

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Environmental Science
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WATER QUALITY DATA

Contact: Tom Sullivan
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 3/02/2017
Date Received: 18/01/2017
Our Reference: GHD17-1
Your Reference: 613478604

METHOD	Sampling	2000	4100	2100	4700	2700	3020	3020	3020	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	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit		<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<0.5
File			17012401			17012502		17012401		170118
T1-A	17/01/2017	4	3	3	27	230	3.1	0.5	0.6	6.4
T1-B	17/01/2017	<3	3	3	27	230	3.6	0.5	0.5	6.8
T1-C	17/01/2017	3	3	4	24	240	3.0	0.3	0.5	5.6
T2-A	17/01/2017	<3	<2	<2	19	170	1.8	0.1	0.3	4.9
T2-B	17/01/2017	<3	2	<2	17	150	1.8	<0.1	0.3	3.4
T2-C	17/01/2017	<3	2	<2	17	140	1.8	0.1	0.3	3.8
T3-A	17/01/2017	<3	2	<2	18	160	1.6	0.1	0.3	5.1
T3-B	17/01/2017	<3	2	<2	17	150	1.5	<0.1	0.3	3.5
T3-C	17/01/2017	<3	<2	<2	17	140	1.5	<0.1	0.3	3.8
T4-A	17/01/2017	<3	3	<2	18	140	1.7	0.2	0.4	3.1
T4-B	17/01/2017	<3	2	<2	15	140	1.0	<0.1	0.2	2.0
T4-C	17/01/2017	<3	2	<2	15	130	1.4	<0.1	0.3	2.3
T5-A	17/01/2017	4	3	<2	20	180	2.4	0.2	0.5	4.8
T5-B	17/01/2017	<3	<2	<2	16	150	1.8	<0.1	0.3	3.0
T5-C	17/01/2017	<3	<2	<2	16	140	1.5	<0.1	0.2	2.2
T5-C REP	17/01/2017	<3	2	<2	16	150	1.6	0.1	0.3	2.5
T3-C REP	17/01/2017	<3	<2	<2	16	140	1.6	0.1	0.3	3.2

Signatory: Lirong Han
Date: 3/02/2017

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Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Tom Sullivan
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 3/02/2017
Date Received: 18/01/2017
Our Reference: GHD17-1
Your Reference: 613478604

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1
File		17012401	17012401	17012401	17012401	17012401	17012401	17012401	17012401	17012401	17012401
T1-A	17/01/2017	6	<0.2	5.2	2	0.3	1.3	3	2.0	<0.1	4.1
T1-B	17/01/2017	7	<0.2	5.0	2	0.3	1.3	3	2.0	<0.1	2.2
T1-C	17/01/2017	7	<0.2	4.9	1	0.4	1.0	2	1.9	<0.1	1.7
T2-A	17/01/2017	5	<0.2	4.1	<1	<0.3	0.5	1	1.8	<0.1	4.5
T2-B	17/01/2017	5	<0.2	3.9	1	0.3	0.4	2	1.8	<0.1	1.0
T2-C	17/01/2017	5	<0.2	3.5	1	<0.3	0.3	<1	1.9	<0.1	3.0
T3-A	17/01/2017	5	<0.2	3.8	1	<0.3	0.6	2	2.0	<0.1	1.7
T3-B	17/01/2017	6	<0.2	3.7	1	<0.3	0.4	2	1.9	<0.1	0.5
T3-C	17/01/2017	5	<0.2	3.2	1	0.4	0.4	2	1.8	<0.1	2.2
T4-A	17/01/2017	6	<0.2	3.7	1	<0.3	0.5	3	1.9	<0.1	0.9
T4-B	17/01/2017	5	<0.2	3.5	1	<0.3	0.4	1	1.8	<0.1	2.7
T4-C	17/01/2017	5	<0.2	3.4	1	<0.3	0.4	2	1.9	<0.1	1.6
T5-A	17/01/2017	6	<0.2	4.3	1	0.4	1.7	8	2.1	<0.1	4.7
T5-B	17/01/2017	5	<0.2	3.5	1	<0.3	0.7	3	1.9	<0.1	0.9
T5-C	17/01/2017	6	<0.2	3.3	1	<0.3	0.5	3	1.9	<0.1	2.8
T5-C REP	17/01/2017	6	<0.2	3.5	1	0.3	0.6	4	1.9	<0.1	3.2
T3-C REP	17/01/2017	5	<0.2	3.2	1	<0.3	0.4	2	2.0	<0.1	2.2

Signatory: Lirong Han
Date: 3/02/2017

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WATER QUALITY DATA

Contact: Tom Sullivan
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 3/02/2017
Date Received: 18/01/2017
Our Reference: GHD17-1
Your Reference: 613478604

METHOD	Sampling	ICP006	9200	5060
SAMPLE CODE	Date	Hg	SALINITY	Turbidity
		mg/L	psu	NTU
Reporting Limit		<0.0001		<0.1
File		17012501A	170202	170202
T1-A	17/01/2017	<0.0001	35.9	
T1-B	17/01/2017	<0.0001	36.2	4.4
T1-C	17/01/2017	<0.0001	35.8	
T2-A	17/01/2017	<0.0001	35.6	
T2-B	17/01/2017	<0.0001	35.1	
T2-C	17/01/2017	<0.0001	35.3	
T3-A	17/01/2017	<0.0001	35.6	
T3-B	17/01/2017	<0.0001	35.3	
T3-C	17/01/2017	<0.0001	35.6	
T4-A	17/01/2017	<0.0001	35.6	
T4-B	17/01/2017	<0.0001	35.8	
T4-C	17/01/2017	<0.0001	36.0	1.7
T5-A	17/01/2017	<0.0001	35.9	
T5-B	17/01/2017	<0.0001	35.8	
T5-C	17/01/2017	<0.0001	35.9	
T5-C REP	17/01/2017	<0.0001	35.7	
T3-C REP	17/01/2017	<0.0001	35.9	

Signatory: Lirong Han
Date: 3/02/2017

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Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 15/03/2017
Date Received: 23/02/2017
Our Reference: GHD17-2
Your Reference: 613478604

METHOD	Sampling	9200	2000	4100	2100	4700	2700	3020	3020	3020	2540D
SAMPLE CODE	Date	SALINITY psu	AMMONIA µg.N/L	ORTHO-P µg.P/L	NO3+NO2 µg.N/L	TOTAL-P µg.P/L	TOTAL-N µg.N/L	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit			<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<0.5
File		170224		17022701,030701			17030101		17020301		170308
T1-A	22/02/2017	36.3	<3	<2	<2	20	150	3.2	<0.1	0.6	4.0
T1-B	22/02/2017	36.2	<3	<2	<2	22	160	4.0	<0.1	0.8	5.2
T1-C	22/02/2017	36.2	<3	2	<2	22	160	3.2	<0.1	0.6	4.9
T2-A	22/02/2017	36.2	<3	2	<2	22	160	2.9	<0.1	0.5	6.8
T2-B	22/02/2017	36.2	<3	2	<2	21	160	3.0	<0.1	0.6	5.1
T2-C	22/02/2017	36.2	<3	2	<2	20	140	1.9	<0.1	0.3	4.2
T3-A	22/02/2017	36.2	<3	2	<2	25	180	4.0	<0.1	0.6	13
T3-B	22/02/2017	36.1	3	2	<2	20	150	2.8	<0.1	0.5	4.1
T3-C	22/02/2017	36.1	<3	3	<2	18	130	1.8	<0.1	0.3	2.7
T4-A	22/02/2017	36.1	4	4	<2	21	150	3.0	<0.1	0.5	4.3
T4-B	22/02/2017	36.1	3	<2	<2	16	120	1.1	<0.1	0.2	1.8
T4-C	22/02/2017	36.1	5	2	<2	17	120	1.1	<0.1	0.2	1.9
T5-A	22/02/2017	36.2	9	4	<2	21	150	2.7	<0.1	0.5	2.6
T5-B	22/02/2017	36.1	4	2	<2	16	120	0.9	<0.1	0.2	2.4
T5-C	22/02/2017	36.1	5	<2	<2	20	140	0.9	<0.1	0.1	2.7
QC-1	22/02/2017	36.1	4	3	<2	17	130	1.1	<0.1	0.2	3.5
QC-2	22/02/2017	36.2	<3	2	<2	18	130	1.3	<0.1	0.2	2.6

Signatory: Jamie Woodward
Date: 15/03/2017

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WATER QUALITY DATA

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 15/03/2017
Date Received: 23/02/2017
Our Reference: GHD17-2
Your Reference: 613478604

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	ICP006
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L	Hg mg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1	<0.0001
File		17031001	17031001	17031001	17031001	17031001	17031001	17031001	17031001	17031001	17031001	17030102
T1-A	22/02/2017	<5	<0.2	2.4	1	<0.3	0.9	1	2.1	<0.1	<0.1	<0.0001
T1-B	22/02/2017	<5	<0.2	2.5	2	<0.3	0.9	2	2.0	<0.1	<0.1	<0.0001
T1-C	22/02/2017	<5	<0.2	2.1	1	<0.3	0.6	1	2.1	<0.1	<0.1	<0.0001
T2-A	22/02/2017	<5	<0.2	1.3	1	<0.3	0.5	<1	2.0	<0.1	<0.1	<0.0001
T2-B	22/02/2017	<5	<0.2	2.0	1	<0.3	0.5	1	2.1	<0.1	<0.1	<0.0001
T2-C	22/02/2017	<5	<0.2	2.1	2	<0.3	0.3	1	2.2	<0.1	<0.1	<0.0001
T3-A	22/02/2017	<5	<0.2	1.8	2	<0.3	0.4	2	2.2	<0.1	<0.1	<0.0001
T3-B	22/02/2017	<5	<0.2	1.5	2	<0.3	0.3	1	2.1	<0.1	<0.1	<0.0001
T3-C	22/02/2017	6	<0.2	2.8	2	<0.3	0.7	2	2.2	<0.1	0.2	<0.0001
T4-A	22/02/2017	<5	<0.2	2.1	2	<0.3	0.5	1	2.3	<0.1	<0.1	<0.0001
T4-B	22/02/2017	<5	<0.2	3.2	1	<0.3	0.3	1	2.0	<0.1	<0.1	<0.0001
T4-C	22/02/2017	5	<0.2	3.4	1	<0.3	0.3	2	2.1	<0.1	0.1	<0.0001
T5-A	22/02/2017	6	<0.2	2.7	2	<0.3	0.5	3	2.2	<0.1	0.5	<0.0001
T5-B	22/02/2017	<5	<0.2	3.3	2	<0.3	0.3	2	2.0	<0.1	0.3	<0.0001
T5-C	22/02/2017	8	<0.2	3.4	1	<0.3	0.3	2	2.1	<0.1	0.2	<0.0001
QC-1	22/02/2017	5	<0.2	3.5	1	<0.3	0.3	1	2.0	<0.1	0.2	<0.0001
QC-2	22/02/2017	<5	<0.2	2.7	2	<0.3	0.4	1	2.2	<0.1	0.1	<0.0001

Signatory: Jamie Woodward
Date: 15/03/2017

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WATER QUALITY DATA

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 20/04/2017
Date Received: 31/03/2017
Our Reference: GHD17-3
Your Reference: 613478604

METHOD	Sampling	9200	2000	4100	2100	4700	2700	3020	3020	3020	2540D
SAMPLE CODE	Date	Salinity PSU	AMMONIA µg.N/L	ORTHO-P µg.P/L	NO3+NO2 µg.N/L	TOTAL-P µg.P/L	TOTAL-N µg.N/L	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit			<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<1
File		170331		17041001		17041201-1901			17040501		170331
T1-A	30/03/2017	36.2	<3	2	<2	24	190	3.4	<0.1	0.6	6
T1-B	30/03/2017	36.2	<3	2	<2	26	190	3.8	<0.1	0.7	4
T1-C	30/03/2017	36.2	4	3	<2	22	180	3.6	0.1	0.6	4
T2-A	30/03/2017	36.2	<3	2	<2	20	160	2.9	<0.1	0.6	4
T2-B	30/03/2017	36.2	<3	3	<2	18	130	2.9	<0.1	0.5	3
T2-C	30/03/2017	36.1	<3	<2	<2	18	140	2.5	<0.1	0.5	2
T3-A	30/03/2017	36.1	<3	2	<2	18	150	2.3	<0.1	0.3	3
T3-B	30/03/2017	36.1	<3	2	<2	19	150	2.8	<0.1	0.4	5
T3-C	30/03/2017	36.1	5	2	<2	18	160	2.5	<0.1	0.3	3
T4-A	30/03/2017	36.1	<3	3	<2	30	210	5.1	<0.1	0.6	30
T4-B	30/03/2017	36.1	3	3	<2	18	170	3.0	<0.1	0.5	4
T4-C	30/03/2017	36.2	6	3	<2	19	160	2.8	<0.1	0.4	4
T5-A	30/03/2017	36.2	5	3	2	19	160	2.7	<0.1	0.4	3
T5-B	30/03/2017	36.1	6	3	<2	19	170	2.5	<0.1	0.4	3
T5-C	30/03/2017	36.1	9	3	<2	20	160	2.8	<0.1	0.4	4
QC-1	30/03/2017	36.2	5	3	<2	18	160	2.5	<0.1	0.3	3
QC-2	30/03/2017	36.2	<3	2	2	19	160	2.0	<0.1	0.3	2

Signatory: Jamie Woodward
Date: 20/04/2017

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

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WATER QUALITY DATA

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 20/04/2017
Date Received: 31/03/2017
Our Reference: GHD17-3
Your Reference: 613478604

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	ICP006
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L	Hg mg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1	<0.0001
File		17041802	17041802	17041802	17041802	17041802	17041802	17041802	17041802	17041802	17041802	17041301
T1-A	30/03/2017	<5	<0.2	2.3	<1	0.4	1.0	2	1.8	<0.1	<0.1	<0.0001
T1-B	30/03/2017	<5	<0.2	2.3	<1	<0.3	1.0	2	2.0	<0.1	<0.1	<0.0001
T1-C	30/03/2017	<5	<0.2	2.6	<1	0.3	0.8	2	1.9	<0.1	<0.1	<0.0001
T2-A	30/03/2017	<5	<0.2	2.5	<1	<0.3	0.7	<1	2.0	<0.1	<0.1	<0.0001
T2-B	30/03/2017	<5	<0.2	2.6	1	<0.3	0.6	1	2.0	<0.1	<0.1	<0.0001
T2-C	30/03/2017	<5	<0.2	2.6	1	0.5	0.4	1	1.9	<0.1	<0.1	<0.0001
T3-A	30/03/2017	<5	<0.2	3.0	1	<0.3	0.5	<1	2.1	<0.1	<0.1	<0.0001
T3-B	30/03/2017	<5	<0.2	2.6	1	<0.3	0.4	<1	2.0	<0.1	<0.1	<0.0001
T3-C	30/03/2017	<5	<0.2	2.2	1	<0.3	0.4	1	1.9	<0.1	<0.1	<0.0001
T4-A	30/03/2017	<5	<0.2	1.4	1	<0.3	0.5	<1	1.9	<0.1	<0.1	<0.0001
T4-B	30/03/2017	6	<0.2	2.4	1	<0.3	0.4	<1	2.0	<0.1	<0.1	<0.0001
T4-C	30/03/2017	<5	<0.2	2.3	1	<0.3	0.4	<1	2.1	<0.1	<0.1	<0.0001
T5-A	30/03/2017	<5	<0.2	2.3	1	0.3	0.4	2	2.0	<0.1	0.2	<0.0001
T5-B	30/03/2017	7	<0.2	2.3	1	<0.3	0.5	1	2.0	<0.1	0.1	<0.0001
T5-C	30/03/2017	<5	<0.2	2.3	1	<0.3	0.4	<1	2.1	<0.1	<0.1	<0.0001
QC-1	30/03/2017	<5	<0.2	2.4	1	<0.3	0.4	<1	2.1	<0.1	<0.1	<0.0001
QC-2	30/03/2017	5	<0.2	2.2	1	<0.3	0.5	1	2.0	<0.1	<0.1	<0.0001

Signatory: Jamie Woodward
Date: 20/04/2017

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: +61 8 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
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Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Lemuel Cabahug
Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 4/07/2017
Date Received: 27/06/2017
Our Reference: GHD17-4
Your Reference: 61-34786-04

METHOD	Sampling	9200	2000	4100	2100	4700	2700	3020	3020	3020	2540D
SAMPLE CODE	Date	Salinity PSU	AMMONIA µg.N/L	ORTHO-P µg.P/L	NO3+NO2 µg.N/L	TOTAL-P µg.P/L	TOTAL-N µg.N/L	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit			<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<0.5
File		170627		17062702		17062901			17070401		170627
T1-A	26/06/2017	34.9	7	3	10	23	180	5.9	0.8	1.0	4.5
T1-B	26/06/2017	35.0	15	4	12	25	180	3.8	0.4	0.7	9.2
T1-C	26/06/2017	35.0	18	5	13	19	160	2.5	0.2	0.5	4.6
T2-A	26/06/2017	35.1	7	4	8	16	120	2.3	<0.1	0.4	2.3
T2-B	26/06/2017	35.3	4	3	4	18	130	2.4	<0.1	0.5	2.0
T2-C	26/06/2017	35.1	8	4	7	18	140	2.6	0.2	0.5	1.9
T3-A	26/06/2017	35.2	<3	3	5	16	120	3.1	0.1	0.6	1.6
T3-B	26/06/2017	35.3	3	3	4	17	140	2.6	<0.1	0.5	1.9
T3-C	26/06/2017	35.3	4	3	5	16	130	2.4	0.2	0.4	2.2
T4-A	26/06/2017	35.3	6	3	6	17	130	3.0	0.2	0.6	3.9
T4-B	26/06/2017	35.3	5	3	5	17	120	2.6	0.1	0.5	2.1
T4-C	26/06/2017	35.3	5	3	5	16	130	2.6	0.2	0.4	1.6
T5-A	26/06/2017	35.3	9	4	6	18	140	2.4	0.1	0.5	2.5
T5-B	26/06/2017	35.3	15	4	6	16	130	2.0	0.1	0.4	3.8
T5-C	26/06/2017	35.3	12	4	7	18	140	2.3	0.1	0.4	3.5
QC-1	26/06/2017	35.3	12	4	5	18	130	2.2	0.1	0.4	3.1
QC-2	26/06/2017	35.2	4	3	4	16	120	2.6	0.1	0.4	2.1

Signatory: Jamie Woodward
Date: 4/07/2017

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WATER QUALITY DATA

Contact: Lemuel Cabahug
Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 4/07/2017
Date Received: 27/06/2017
Our Reference: GHD17-4
Your Reference: 61-34786-04

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	ICP006
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L	Hg mg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1	<0.0001
File		17062801	17062801	17062801	17062801	17062801	17062801	17062801	17062801	17062801	17062801	17063001
T1-A	26/06/2017	6	<0.2	3.0	<1	0.3	1.0	2	1.5	<0.1	<0.1	<0.0001
T1-B	26/06/2017	<5	<0.2	3.0	<1	0.4	0.9	3	1.5	<0.1	<0.1	<0.0001
T1-C	26/06/2017	<5	<0.2	3.2	<1	0.7	1.4	3	1.5	<0.1	0.2	<0.0001
T2-A	26/06/2017	<5	<0.2	3.2	<1	<0.3	0.4	1	1.5	<0.1	0.2	<0.0001
T2-B	26/06/2017	<5	<0.2	2.4	<1	<0.3	0.6	2	1.6	<0.1	0.2	<0.0001
T2-C	26/06/2017	<5	<0.2	3.0	<1	0.5	0.5	2	1.6	<0.1	0.1	<0.0001
T3-A	26/06/2017	<5	<0.2	2.2	<1	0.3	0.6	1	1.5	<0.1	0.2	<0.0001
T3-B	26/06/2017	<5	<0.2	2.1	<1	<0.3	0.4	1	1.6	<0.1	0.3	<0.0001
T3-C	26/06/2017	<5	<0.2	2.4	<1	0.3	0.5	3	1.5	<0.1	0.1	<0.0001
T4-A	26/06/2017	<5	<0.2	1.9	<1	<0.3	0.4	<1	1.5	<0.1	0.1	<0.0001
T4-B	26/06/2017	<5	<0.2	2.0	<1	<0.3	0.4	1	1.5	<0.1	0.3	<0.0001
T4-C	26/06/2017	<5	<0.2	1.9	<1	<0.3	0.7	1	1.5	<0.1	0.2	<0.0001
T5-A	26/06/2017	<5	<0.2	2.3	<1	0.3	0.9	4	1.5	0.9	0.7	<0.0001
T5-B	26/06/2017	<5	<0.2	2.3	<1	0.3	0.6	2	1.6	<0.1	0.5	<0.0001
T5-C	26/06/2017	<5	<0.2	2.1	<1	<0.3	0.3	1	1.6	<0.1	<0.1	<0.0001
QC-1	26/06/2017	<5	<0.2	2.1	<1	<0.3	0.3	<1	1.6	<0.1	0.2	<0.0001
QC-2	26/06/2017	<5	<0.2	2.2	<1	<0.3	0.3	1	1.6	<0.1	<0.1	<0.0001

Signatory: Jamie Woodward
Date: 4/07/2017

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Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Lemuel Cabahug
Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 29/08/2017
Date Received: 4/08/2017
Our Reference: GHD17-5
Your Reference: 613478604

METHOD	Sampling	5060	2000	4100	2100	4700	2700	3020	3020	3020	2540D
SAMPLE CODE	Date	Turbidity NTU	AMMONIA µg.N/L	ORTHO-P µg.P/L	NO3+NO2 µg.N/L	TOTAL-P µg.P/L	TOTAL-N µg.N/L	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit		<0.1	<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<1
Analysis Date		5/08/2017	10/08/2017			18/08/2017			16/08/2017		5/08/2017
File		170805	17081001,17081701			17081802			17081601		170805
T1-A	4/08/2017	15	18	4	24	37	320	3.0	0.1	0.4	23
T1-B	4/08/2017	5.1	20	4	23	19	210	1.6	<0.1	0.2	5
T1-C	4/08/2017	8.0	22	4	20	25	240	2.3	0.1	0.3	10
T2-A	4/08/2017	17	17	4	36	38	340	3.9	0.1	0.7	24
T2-B	4/08/2017	8.8	16	4	38	26	310	2.5	<0.1	0.4	11
T2-C	4/08/2017	15	16	4	19	36	330	3.9	0.1	0.6	20
T3-A	4/08/2017	18	16	4	25	34	320	3.9	0.1	0.6	19
T3-B	4/08/2017	9.6	15	3	20	26	250	3.2	<0.1	0.4	12
T3-C	4/08/2017	7.5	13	3	15	21	200	2.4	<0.1	0.4	8
T4-A	4/08/2017	5.4	14	3	20	20	200	2.1	0.1	0.3	7
T4-B	4/08/2017	7.9	16	2	14	22	220	2.8	<0.1	0.5	7
T4-C	4/08/2017	8.1	13	<2	12	24	240	3.1	<0.1	0.5	9
T5-A	4/08/2017	5.7	17	4	14	23	220	2.4	<0.1	0.3	8
T5-B	4/08/2017	6.5	12	<2	11	24	220	3.1	0.1	0.5	10
T5-C	4/08/2017	6.3	10	2	10	23	210	2.8	<0.1	0.4	8
QC-1	4/08/2017	10	13	3	17	23	220	2.6	<0.1	0.3	9
QC-2	4/08/2017	17	16	3	19	36	310	4.3	0.2	0.7	22

Signatory: Jamie Woodward
Date: 29/08/2017

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WATER QUALITY DATA

Contact: Lemuel Cabahug
Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 29/08/2017
Date Received: 4/08/2017
Our Reference: GHD17-5
Your Reference: 613478604

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	ICP006
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L	Hg mg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1	<0.0001
Analysis Date		11/08/2017	11/08/2017	11/08/2017	11/08/2017	11/08/2017	11/08/2017	11/08/2017	11/08/2017	11/08/2017	11/08/2017	18/08/2017
File		17081101	17081101	17081101	17081101	17081101	17081101	17081101	17081101	17081101	17081101	17081801
T1-A	4/08/2017	<5	<0.2	2.6	1	<0.3	0.7	2	1.4	<0.1	0.1	<0.0001
T1-B	4/08/2017	<5	<0.2	2.5	1	<0.3	1.0	2	1.4	<0.1	0.3	<0.0001
T1-C	4/08/2017	<5	<0.2	2.7	1	<0.3	0.7	2	1.4	<0.1	0.4	<0.0001
T2-A	4/08/2017	<5	<0.2	2.5	1	0.3	0.7	2	1.5	<0.1	0.5	<0.0001
T2-B	4/08/2017	<5	<0.2	3.1	1	<0.3	0.5	1	1.4	<0.1	0.5	<0.0001
T2-C	4/08/2017	<5	<0.2	1.5	1	<0.3	0.4	1	1.4	<0.1	0.1	<0.0001
T3-A	4/08/2017	<5	<0.2	1.5	1	0.3	0.7	2	1.4	<0.1	0.4	<0.0001
T3-B	4/08/2017	<5	<0.2	1.5	1	0.3	0.5	1	1.4	<0.1	0.2	<0.0001
T3-C	4/08/2017	<5	<0.2	1.5	<1	<0.3	0.4	2	1.5	<0.1	0.7	<0.0001
T4-A	4/08/2017	<5	<0.2	1.9	1	<0.3	0.4	<1	1.6	<0.1	1.6	<0.0001
T4-B	4/08/2017	<5	<0.2	1.3	<1	<0.3	0.4	2	1.5	<0.1	0.7	<0.0001
T4-C	4/08/2017	<5	<0.2	1.2	<1	0.6	0.5	3	1.5	<0.1	0.5	<0.0001
T5-A	4/08/2017	<5	<0.2	2.0	<1	<0.3	0.5	4	1.6	<0.1	5.1	<0.0001
T5-B	4/08/2017	<5	<0.2	1.2	<1	<0.3	0.4	3	1.6	<0.1	7.4	<0.0001
T5-C	4/08/2017	<5	<0.2	0.9	<1	<0.3	0.3	2	1.6	<0.1	0.9	<0.0001
QC-1	4/08/2017	<5	<0.2	1.5	<1	0.3	0.4	2	1.5	<0.1	1.1	<0.0001
QC-2	4/08/2017	<5	<0.2	1.5	<1	<0.3	0.3	<1	1.5	<0.1	0.2	<0.0001

Signatory: Jamie Woodward
Date: 29/08/2017

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Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Lemuel Cabahug
Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 21/09/2017
Date Received: 01/09/2017
Our Reference: GHD17-8
Your Reference: 61-34786-04

METHOD	Sampling	5060	2000	4100	2100	4700	2700	3020	3020	3020	2540D
SAMPLE CODE	Date	Turbidity NTU	AMMONIA µg.N/L	ORTHO-P µg.P/L	NO3+NO2 µg.N/L	TOTAL-P µg.P/L	TOTAL-N µg.N/L	CHLORO 'a' µg/L	CHLORO 'b' µg/L	CHLORO 'c' µg/L	TSS mg/L
Reporting Limit		<0.1	<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<1
Analysis Date		1/09/2017		4/09/2017		6/09/2017			13/09/2017		1/09/2017
File		170901		17090402,1101		17090602			17091301		170901
T1-A	31/08/2017	5.1	6	3	2	27	190	2.5	0.2	0.4	8
T1-B	31/08/2017	7.0	10	4	3	34	220	2.7	0.2	0.4	14
T1-C	31/08/2017	2.9	7	4	2	22	160	1.7	0.1	0.4	6
T2-A	31/08/2017	5.0	<3	2	<2	30	220	3.8	0.3	0.5	9
T2-B	31/08/2017	8.9	<3	<2	<2	33	260	3.9	0.2	0.5	14
T2-C	31/08/2017	2.5	<3	4	<2	18	150	1.9	0.3	0.3	5
T3-A	31/08/2017	3.4	<3	4	<2	21	150	2.0	0.3	0.3	6
T3-B	31/08/2017	5.3	4	3	<2	21	160	1.9	0.2	0.3	8
T3-C	31/08/2017	1.8	<3	3	<2	16	130	1.0	0.2	0.1	4
T4-A	31/08/2017	2.4	<3	3	<2	20	140	1.8	0.2	0.3	7
T4-B	31/08/2017	1.4	<3	3	<2	16	120	1.5	0.3	0.2	3
T4-C	31/08/2017	1.3	<3	3	<2	15	120	1.6	0.3	0.2	3
T5-A	31/08/2017	2.2	7	4	3	20	150	1.6	0.3	0.2	4
T5-B	31/08/2017	1.6	<3	4	<2	17	150	1.1	0.2	<0.1	3
T5-C	31/08/2017	1.6	<3	4	<2	17	140	1.4	0.3	0.2	3
QC-1	31/08/2017	1.7	<3	3	<2	16	130	1.4	0.3	0.2	3
QC-2	31/08/2017	1.6	<3	<2	<2	16	130	1.6	0.3	0.3	3

Signatory: Jamie Woodward
Date: 21/09/2017

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WATER QUALITY DATA

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Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 21/09/2017
Date Received: 01/09/2017
Our Reference: GHD17-8
Your Reference: 61-34786-04

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	ICP006
SAMPLE CODE	Date	Filtered Al µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Ni µg/L	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Cd µg/L	Filtered Pb µg/L	Hg mg/L
Reporting Limit		<5	<0.2	<0.5	<1	<0.3	<0.2	<1	<0.5	<0.1	<0.1	<0.0001
Analysis Date		20/09/2017	20/09/2017	20/09/2017	20/09/2017	20/09/2017	20/09/2017	20/09/2017	20/09/2017	20/09/2017	20/09/2017	13/09/2017
File		17092001	17092001	17092001	17092001	17092001	17092001	17092001	17092001	17092001	17092001	17091302
T1-A	31/08/2017	<5	<0.2	4.1	1	0.8	0.8	3	1.6	<0.1	<0.1	<0.0001
T1-B	31/08/2017	<5	<0.2	3.7	2	<0.3	0.6	4	1.7	<0.1	<0.1	<0.0001
T1-C	31/08/2017	<5	<0.2	4.3	1	<0.3	0.9	3	1.8	<0.1	<0.1	<0.0001
T2-A	31/08/2017	<5	<0.2	3.3	<1	<0.3	0.5	3	1.5	<0.1	<0.1	<0.0001
T2-B	31/08/2017	<5	<0.2	3.3	<1	0.7	1.1	5	1.5	<0.1	<0.1	<0.0001
T2-C	31/08/2017	<5	<0.2	3.3	<1	0.4	0.4	5	1.5	<0.1	<0.1	<0.0001
T3-A	31/08/2017	<5	<0.2	2.2	<1	<0.3	0.5	6	1.7	<0.1	<0.1	<0.0001
T3-B	31/08/2017	<5	<0.2	2.4	<1	<0.3	0.4	3	1.5	<0.1	<0.1	<0.0001
T3-C	31/08/2017	<5	<0.2	3.1	<1	0.3	0.5	3	1.6	<0.1	<0.1	<0.0001
T4-A	31/08/2017	6	<0.2	2.3	<1	0.5	0.6	17	1.5	<0.1	0.2	<0.0001
T4-B	31/08/2017	<5	<0.2	3.2	<1	0.4	0.8	4	1.6	<0.1	0.1	<0.0001
T4-C	31/08/2017	<5	<0.2	3.0	<1	0.4	0.4	2	1.5	<0.1	0.1	<0.0001
T5-A	31/08/2017	8	<0.2	3.7	<1	<0.3	0.5	2	1.6	<0.1	0.4	<0.0001
T5-B	31/08/2017	5	<0.2	2.4	<1	<0.3	0.5	1	1.6	<0.1	0.3	<0.0001
T5-C	31/08/2017	<5	<0.2	2.6	<1	<0.3	0.4	1	1.7	<0.1	0.2	<0.0001
QC-1	31/08/2017	<5	<0.2	3.0	<1	<0.3	0.3	2	1.5	<0.1	<0.1	<0.0001
QC-2	31/08/2017	<5	<0.2	3.1	<1	0.5	0.5	4	1.5	<0.1	0.1	<0.0001

Signatory: Jamie Woodward
Date: 21/09/2017

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

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: Lemuel Cabahug
Customer: GHD
Address: 10 Victora Street, Bunbury WA 6230

Date of Issue: 13/10/2017
Date Received: 28/09/2017
Our Reference: GHD17-10
Your Reference: 61-34789-04

METHOD SAMPLE CODE	Sampling Date	5060 Turbidity NTU	2000 AMMONIA µg.N/L	4100 ORTHO-P µg.P/L	2100 NO3+NO2 µg.N/L	4700 TOTAL-P µg.P/L	2700 TOTAL-N µg.N/L	3020 CHLORO 'a' µg/L	3020 CHLORO 'b' µg/L	3020 CHLORO 'c' µg/L	2540D TSS mg/L
Reporting Limit		<0.1	<3	<2	<2	<5	<50	<0.1	<0.1	<0.1	<0.5
Analysis Date		29/09/2017		29/09/2017		3/10/2017			3/10/2017		29/09/2017
File		170929		17092902		17100301,101201			17100301		170929
T1-A	28/09/2017	3.3	9	3	9	18	160	1.5	0.1	0.2	4.3
T1-B	28/09/2017	3.9	9	3	10	19	170	2.1	0.2	0.3	4.5
T1-C	28/09/2017	4.7	8	4	10	21	180	2.0	0.1	0.3	5.9
T2-A	28/09/2017	3.7	8	3	13	18	190	2.2	0.1	0.3	5.7
T2-B	28/09/2017	3.0	10	3	14	17	190	2.1	0.2	0.3	4.3
T2-C	28/09/2017	5.3	9	3	10	19	180	1.8	0.1	0.3	7.6
T3-A	28/09/2017	2.5	7	3	11	16	250	1.3	<0.1	0.2	4.1
T3-B	28/09/2017	4.0	6	3	10	15	170	1.5	<0.1	0.3	3.9
T3-C	28/09/2017	2.8	10	3	9	18	180	2.1	0.1	0.3	5.4
T4-A	28/09/2017	2.9	7	3	12	16	190	1.4	0.1	0.2	4.2
T4-B	28/09/2017	3.2	9	3	9	17	190	2.0	0.1	0.3	4.2
T4-C	28/09/2017	3.2	10	4	8	17	180	2.0	<0.1	0.3	4.6
T5-A	28/09/2017	3.2	8	3	9	17	200	1.8	0.1	0.3	4.4
T5-B	28/09/2017	3.1	10	3	9	17	190	2.3	0.2	0.4	4.2
T5-C	28/09/2017	3.4	11	3	9	19	180	2.1	0.1	0.3	4.4
QC-1	28/09/2017	4.9	8	3	9	22	180	2.4	0.1	0.4	6.1
QC-2	28/09/2017	3.7	8	4	9	18	150	2.3	<0.1	0.4	4.8

Signatory: Jamie Woodward
Date: 13/10/2017

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

Appendix C

QA/QC Table for 2016-2017 Water Quality Samples

Table C.1 RPDs of QA/QC water quality replicate analytes

QA/QC ID	Date	Station	NHx	FRP	NOx	TP	TN	Chla	Chlb	Chlc	TSS	Al	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Pb	Hg
QA-1	26/10/2016	T2-C	0%	0%	0%	5%	21%	15%	0%	0%	0%	No Metals & Metalloid Analyses										
QA-2	26/10/2016	T1-C	15%	40%	0%	21%	20%	5%	0%	40%	27%											
T5-C REP	14/12/2016	T5-C	0%	0%	0%	6%	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%	0%	67%	5%	0%	0%	0%
T3-C REP	14/12/2016	T3-C	0%	50%	0%	0%	0%	51%	120%	67%	7%	0%	0%	2%	67%	0%	0%	67%	0%	0%	0%	0%
T5-C REP	17/01/2017	T5-C	0%	67%	0%	0%	7%	6%	67%	40%	13%	0%	0%	6%	0%	67%	18%	29%	0%	0%	13%	0%
T3-C REP	17/01/2017	T3-C	0%	0%	0%	6%	0%	6%	67%	0%	17%	0%	0%	0%	0%	91%	0%	0%	11%	0%	0%	0%
QC-1	22/02/2017	T5-C	22%	100%	0%	16%	7%	20%	0%	67%	26%	46%	0%	3%	0%	0%	0%	67%	5%	0%	0%	0%
QC-2	22/02/2017	T3-C	0%	40%	0%	0%	0%	32%	0%	40%	4%	82%	0%	4%	0%	0%	55%	67%	0%	0%	67%	0%
QC-1	30/03/2017	T4-C	18%	0%	0%	5%	0%	11%	0%	29%	29%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
QC-2	30/03/2017	T3-C	108%	0%	67%	5%	0%	22%	0%	0%	40%	67%	0%	0%	0%	0%	22%	0%	5%	0%	0%	0%
QC-1	26/06/2017	T5-C	0%	0%	33%	0%	7%	4%	0%	0%	12%	0%	0%	0%	0%	0%	0%	67%	0%	0%	120%	0%
QC-2	26/06/2017	T3-C	0%	0%	22%	0%	8%	8%	67%	0%	5%	0%	0%	9%	0%	67%	50%	100%	6%	0%	67%	0%
QC-1	4/08/2017	T3-C	0%	0%	13%	9%	10%	8%	0%	29%	12%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44%	0%
QC-2	4/08/2017	T2-C	0%	29%	0%	0%	6%	10%	67%	15%	10%	0%	0%	0%	67%	0%	29%	67%	7%	0%	67%	0%
QC-1	31/08/2017	T4-C	0%	0%	0%	6%	8%	13%	0%	0%	0%	0%	0%	0%	0%	91%	29%	0%	0%	0%	67%	0%
QC-2	31/08/2017	T3-C	0%	100%	0%	0%	0%	46%	40%	100%	29%	0%	0%	0%	0%	50%	0%	29%	6%	0%	67%	0%
QC-1	28/09/2017	T1-C	0%	29%	11%	5%	0%	18%	0%	29%	3%	No Metals & Metalloid Analyses										
QC-2	28/09/2017	T1-B	12%	29%	11%	5%	13%	9%	120%	29%	6%											

LEGEND	
	Both values LoR
	1 value LoR
	Both values <5x LoR

Appendix D

Chain of Custody Documentation for 2016 Sediment Samples

CHAIN OF CUSTODY

Marine and Freshwater Research Laboratory Environmental Science

Murdoch UNIVERSITY

Phone: 93602907

To: Marine and Freshwater Research Laboratory	From: Kristina Downey
Address: Murdoch University, Loading Zone 1,	Address: 999 Hay Street
Phys Sc Room 3.026, 90 South St, Murdoch 6150	
Phone: 08 93602907	Phone: 6222 8181 Fax:
Email:	Email: Kristina.downey@gnd.com
Courier Details:	Job Number: 61-3478G PO/ Account #:

Sample Preservation: None / Warm / Cool / On Ice / Frozen / Acidified / Filtered / Other: _____

Sample Type: Water / Bore / Fresh / Estuarine / Marine / Brine / Plant / Sediment / Soil / Other: _____

No	Sample Code	Sampling Date	Analysis Required							
			PSD Laser Diffraction	Wet weight Dry weight	LOI 550° 1000°					
1	SS-1	6 Sept 2016	✓	✓	✓					
2	SS-2	↓	✓	✓	✓					
3	SS-3		✓	✓	✓					
4	SS-4		✓	✓	✓					
5	SS-5		✓	✓	✓					
6	SS-6		✓	✓	✓					
7	SS-7		✓	✓	✓					
8	SS-8	↓	✓	✓	✓					
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Relinquished by:	Date:	Time:	Received by:	Date:	Time	Job Number:
Kristina Downey	7 Sept 2016	09:40	VG	7/9/16	9:45	GH016-2

Sample Condition:

Please acknowledge receipt of samples by signing where appropriate, quoting job number and returning to the sender by fax.

Appendix E

Laboratory Certificates of Analysis of 2016 Sediment Samples

Marine and Freshwater
Research Laboratory
Environmental Science
Telephone: +61 8 93602907 Facsimile: +61 8 93606613

Accreditation Number: 10603
This document is issued in accordance with
NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.

Murdoch UNIVERSITY

SEDIMENT DATA

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 20/09/2016
Date Received: 07/09/2016
Our Reference: GHD16-2
Your Reference: 61-34786

METHOD SAMPLE CODE	DATE	5400 % LOSS ON IGNITION AT 550°C	5400 % LOSS ON IGNITION AT 1000°C	Moisture % <0.1
File		160919	160919	160907
SS-1	6/09/2016	12.1	12.7	57%
SS-2	6/09/2016	16.0	14.2	59%
SS-3	6/09/2016	13.5	17.2	59%
SS-4	6/09/2016	16.8	16.5	64%
SS-5	6/09/2016	14.0	18.1	61%
SS-6	6/09/2016	8.5	21.0	48%
SS-7	6/09/2016	17.7	12.4	66%
SS-8	6/09/2016	9.8	15.2	50%

Note : Loss on ignition is outside the terms of NATA accreditation

Signatory: Lirong Han
Date: 20/09/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: +61 8 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

PARTICLE SIZE ANALYSIS REPORT

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 19/09/2016
Date Received: 6/09/2016
Our Reference: GHD16-2

Sample Name:	SS-1
Sampling Date:	6/09/2016
Sample Type:	Sediment
MAFRL Job Code:	GHD16-2
Client Reference:	61-34786
Analysis Date	14/09/2016

Wentworth Size Classifications	
Total Clay % (0-4µm)	**5.80**
Very Fine Silt % (4-8µm)	6.35
Fine Silt % (8-16µm)	11.15
Medium Silt % (16-31µm)	16.74
Course Silt % (31-63µm)	23.63
Total Silt (4-63µm)	**57.86**
Very Fine sand % (63-125µm)	19.77
Fine sand % (125-250µm)	7.97
Medium sand % (250-500µm)	3.43
Coarse sand % (500-1000µm)	4.40
Very Coarse sand % (1000-2000µm)	0.53
Total Sand (63-2000µm)	**36.10**
Total Gravels (>2000µm)	**0.24**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	4.40
1000	0.53
2000	0.24
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)	42.49
Minimum settling velocity of 50% of particles (mm s^1)	1.49
Time for 50% of particles to settle over 1 m (hours)	0.187
D10 (µm)	6.58
Minimum settling velocity of 90% of particles (mm s^1)	0.04
Time for 90% of particles to settle over 1 m (hours)	7.772

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

Watery mud with shell, sand and plant material present.

Signatory: Jamie Woodward
Date: 19/09/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: +61 8 93602907 Address: 90 South St, Murdoch, WA, 6150

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Murdoch UNIVERSITY

PARTICLE SIZE ANALYSIS REPORT

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 19/09/2016
Date Received: 6/09/2016
Our Reference: GHD16-2

Sample Name:	SS-2
Sampling Date:	6/09/2016
Sample Type:	Sediment
MAFRL Job Code:	GHD16-2
Client Reference:	61-34786
Analysis Date	14/09/2016

Wentworth Size Classifications	
Total Clay % (0-4µm)	**5.90**
Very Fine Silt % (4-8µm)	6.73
Fine Silt % (8-16µm)	11.81
Medium Silt % (16-31µm)	17.31
Course Silt % (31-63µm)	22.07
Total Silt (4-63µm)	**57.94**
Very Fine sand % (63-125µm)	17.66
Fine sand % (125-250µm)	8.49
Medium sand % (250-500µm)	3.66
Coarse sand % (500-1000µm)	2.33
Very Coarse sand % (1000-2000µm)	0.90
Total Sand (63-2000µm)	**33.05**
Total Gravels (>2000µm)	**3.12**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	2.33
1000	0.90
2000	0.45
4000	2.67
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)	40.60
Minimum settling velocity of 50% of particles (mm s^1)	1.36
Time for 50% of particles to settle over 1 m (hours)	0.204
D10 (µm)	6.37
Minimum settling velocity of 90% of particles (mm s^1)	0.03
Time for 90% of particles to settle over 1 m (hours)	8.299

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

Watery mud with shell, sand and plant material present.

Signatory: Jamie Woodward
Date: 19/09/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: +61 8 93602907 Address: 90 South St, Murdoch, WA, 6150

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Accredited for compliance with ISO/IEC 17025.
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PARTICLE SIZE ANALYSIS REPORT

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 19/09/2016
Date Received: 6/09/2016
Our Reference: GHD16-2

Sample Name:	SS-3
Sampling Date:	6/09/2016
Sample Type:	Sediment
MAFRL Job Code:	GHD16-2
Client Reference:	61-34786
Analysis Date	14/09/2016

Wentworth Size Classifications	
Total Clay % (0-4µm)	**5.50**
Very Fine Silt % (4-8µm)	6.28
Fine Silt % (8-16µm)	11.12
Medium Silt % (16-31µm)	16.52
Course Silt % (31-63µm)	20.75
Total Silt (4-63µm)	**54.67**
Very Fine sand % (63-125µm)	17.58
Fine sand % (125-250µm)	11.21
Medium sand % (250-500µm)	5.10
Coarse sand % (500-1000µm)	3.52
Very Coarse sand % (1000-2000µm)	0.60
Total Sand (63-2000µm)	**38.01**
Total Gravels (>2000µm)	**1.82**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	3.52
1000	0.60
2000	0.77
4000	0.34
8000	0.00
16000	0.71

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)	44.59
Minimum settling velocity of 50% of particles (mm s^1)	1.64
Time for 50% of particles to settle over 1 m (hours)	0.169
D10 (µm)	6.81
Minimum settling velocity of 90% of particles (mm s^1)	0.04
Time for 90% of particles to settle over 1 m (hours)	7.258

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

Watery mud with shell, sand and plant material present.

Signatory: Jamie Woodward
Date: 19/09/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: +61 8 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025.
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PARTICLE SIZE ANALYSIS REPORT

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 19/09/2016
Date Received: 6/09/2016
Our Reference: GHD16-2

Sample Name:	SS-4
Sampling Date:	6/09/2016
Sample Type:	Sediment
MAFRL Job Code:	GHD16-2
Client Reference:	61-34786
Analysis Date	15/09/2016

Wentworth Size Classifications	
Total Clay % (0-4µm)	**6.21**
Very Fine Silt % (4-8µm)	7.22
Fine Silt % (8-16µm)	13.01
Medium Silt % (16-31µm)	19.43
Course Silt % (31-63µm)	24.17
Total Silt (4-63µm)	**63.83**
Very Fine sand % (63-125µm)	17.93
Fine sand % (125-250µm)	8.27
Medium sand % (250-500µm)	3.14
Coarse sand % (500-1000µm)	0.35
Very Coarse sand % (1000-2000µm)	0.13
Total Sand (63-2000µm)	**29.82**
Total Gravels (>2000µm)	**0.14**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	0.35
1000	0.13
2000	0.14
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)	35.05
Minimum settling velocity of 50% of particles (mm s^1)	1.01
Time for 50% of particles to settle over 1 m (hours)	0.274
D10 (µm)	6.05
Minimum settling velocity of 90% of particles (mm s^1)	0.03
Time for 90% of particles to settle over 1 m (hours)	9.212

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

Watery mud with shell, sand and plant material present.

Signatory: Jamie Woodward
Date: 19/09/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: +61 8 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

PARTICLE SIZE ANALYSIS REPORT

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 19/09/2016
Date Received: 6/09/2016
Our Reference: GHD16-2

Sample Name:	SS-5
Sampling Date:	6/09/2016
Sample Type:	Sediment
MAFRL Job Code:	GHD16-2
Client Reference:	61-34786
Analysis Date	15/09/2016

Wentworth Size Classifications	
Total Clay % (0-4µm)	**6.45**
Very Fine Silt % (4-8µm)	7.50
Fine Silt % (8-16µm)	13.28
Medium Silt % (16-31µm)	18.76
Course Silt % (31-63µm)	21.50
Total Silt (4-63µm)	**61.05**
Very Fine sand % (63-125µm)	16.63
Fine sand % (125-250µm)	9.56
Medium sand % (250-500µm)	3.83
Coarse sand % (500-1000µm)	1.13
Very Coarse sand % (1000-2000µm)	0.17
Total Sand (63-2000µm)	**31.32**
Total Gravels (>2000µm)	**1.18**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.13
1000	0.17
2000	1.18
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)	35.28
Minimum settling velocity of 50% of particles (mm s^1)	1.03
Time for 50% of particles to settle over 1 m (hours)	0.271
D10 (µm)	5.83
Minimum settling velocity of 90% of particles (mm s^1)	0.03
Time for 90% of particles to settle over 1 m (hours)	9.901

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
Watery mud with rock, sand and plant material present.

Signatory: Jamie Woodward
Date: 19/07/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: +61 8 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025.
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: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 19/09/2016
Date Received: 6/09/2016
Our Reference: GHD16-2

Sample Name:	SS-6
Sampling Date:	6/09/2016
Sample Type:	Sediment
MAFRL Job Code:	GHD16-2
Client Reference:	61-34786
Analysis Date	15/09/2016

Wentworth Size Classifications	
Total Clay % (0-4µm)	**4.51**
Very Fine Silt % (4-8µm)	4.75
Fine Silt % (8-16µm)	8.26
Medium Silt % (16-31µm)	12.30
Course Silt % (31-63µm)	18.50
Total Silt (4-63µm)	**43.81**
Very Fine sand % (63-125µm)	25.67
Fine sand % (125-250µm)	19.48
Medium sand % (250-500µm)	5.49
Coarse sand % (500-1000µm)	0.52
Very Coarse sand % (1000-2000µm)	0.22
Total Sand (63-2000µm)	**51.37**
Total Gravels (>2000µm)	**0.32**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	0.52
1000	0.22
2000	0.00
4000	0.00
8000	0.32
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)	66.35
Minimum settling velocity of 50% of particles (mm s^1)	3.63
Time for 50% of particles to settle over 1 m (hours)	0.077
D10 (µm)	8.69
Minimum settling velocity of 90% of particles (mm s^1)	0.06
Time for 90% of particles to settle over 1 m (hours)	4.466

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

Watery mud with sand and plant material present.

Signatory: Jamie Woodward
Date: 19/09/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

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PARTICLE SIZE ANALYSIS REPORT

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 19/09/2016
Date Received: 6/09/2016
Our Reference: GHD16-2

Sample Name:	SS-7
Sampling Date:	6/09/2016
Sample Type:	Sediment
MAFRL Job Code:	GHD16-2
Client Reference:	61-34786
Analysis Date	15/09/2016

Wentworth Size Classifications	
Total Clay % (0-4µm)	**6.95**
Very Fine Silt % (4-8µm)	7.80
Fine Silt % (8-16µm)	13.45
Medium Silt % (16-31µm)	19.46
Course Silt % (31-63µm)	23.78
Total Silt (4-63µm)	**64.50**
Very Fine sand % (63-125µm)	17.24
Fine sand % (125-250µm)	7.07
Medium sand % (250-500µm)	2.82
Coarse sand % (500-1000µm)	1.04
Very Coarse sand % (1000-2000µm)	0.27
Total Sand (63-2000µm)	**28.43**
Total Gravels (>2000µm)	**0.12**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.04
1000	0.27
2000	0.12
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)	33.31
Minimum settling velocity of 50% of particles (mm s^1)	0.92
Time for 50% of particles to settle over 1 m (hours)	0.304
D10 (µm)	5.49
Minimum settling velocity of 90% of particles (mm s^1)	0.02
Time for 90% of particles to settle over 1 m (hours)	11.184

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

Watery mud with sand and plant material present.

Signatory: Jamie Woodward
Date: 19/09/2016

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PARTICLE SIZE ANALYSIS REPORT

Contact: Kristina Downey
Customer: GHD
Address: 999 Hay Street, Perth WA 6000

Date of Issue: 19/09/2016
Date Received: 6/09/2016
Our Reference: GHD16-2

Sample Name:	SS-8
Sampling Date:	6/09/2016
Sample Type:	Sediment
MAFRL Job Code:	GHD16-2
Client Reference:	61-34786
Analysis Date	15/09/2016

Wentworth Size Classifications	
Total Clay % (0-4µm)	**4.90**
Very Fine Silt % (4-8µm)	5.14
Fine Silt % (8-16µm)	8.89
Medium Silt % (16-31µm)	12.77
Course Silt % (31-63µm)	19.43
Total Silt (4-63µm)	**46.23**
Very Fine sand % (63-125µm)	24.95
Fine sand % (125-250µm)	16.80
Medium sand % (250-500µm)	5.72
Coarse sand % (500-1000µm)	1.09
Very Coarse sand % (1000-2000µm)	0.18
Total Sand (63-2000µm)	**48.75**
Total Gravels (>2000µm)	**0.13**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.09
1000	0.18
2000	0.13
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)	60.95
Minimum settling velocity of 50% of particles (mm s^1)	3.06
Time for 50% of particles to settle over 1 m (hours)	0.091
D10 (µm)	7.97
Minimum settling velocity of 90% of particles (mm s^1)	0.05
Time for 90% of particles to settle over 1 m (hours)	5.307

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

Watery mud with shell, sand and plant material present.

Signatory: Jamie Woodward
Date: 19/09/2016

All test items tested as received. Spare test items will be held for two months unless otherwise requested.

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The Power of Commitment