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ICHTHYS ONSHORE LNG FACILITIES

JKC AUSTRALIA LNG PTY LTD

Darwin, Australia

Subcontractor ISSUE PURPOSE	☐ FA ☐FR ☐FI X FC ☐AB ☐CA		
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EPA7 Annual Report 2019
Environmental Impact Monitoring Program

Ichthys On-Shore LNG Facilities

Bladin Point

Prepared for:
JKC Australia LNG Pty Ltd

Date: 16 July 2019

COMMUNITY FEEDBACK 1800 705 010

Prepared by:

GREENCAP
Going Further in Managing Risk

GREENCAP LTD

11 Winnellie Central, 14 Winnellie Road, Winnellie, NT 0820, P O BOX 39546, Winnellie NT 0820

Ph: 08 7906 1300 Fax: 08 8984 3105 Email: darwin@greencap.com.au Web: www.greencap.com.au

EPA7 Annual Report 2019 – Environmental Impact Monitoring Program

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ABBREVIATIONS

Abbreviation	Description
AEMR	Annual Environmental Monitoring Report
AOC	Accidentally Oil Contaminated
ASS	Acid Sulphate Soil
BOM	Bureau of Meteorology
BTEXN	Benzene, toluene, ethylbenzene, xylene and naphthalene
CEMP	Construction Environmental Management Plan (INPEX document L092-AH-PLN-10001)
COC	Continuously Oil-Contaminated
Cth	Commonwealth
dB(A)	A-weighted Decibel
DO	Dissolved Oxygen
EC	Electrical Conductivity
E. coli	*Escherichia coli*
EIMP	Environmental Impact Monitoring Program (Rev 10)
EIS	Environmental Impact Statement
EPA7	Environment Protection Approval 7 (as amended)
ERR	Environmental Risk Register
FRP	Filterable Reactive Phosphorus
g/L	Grams per litre
GEP	Gas Export Pipeline
ha	Hectare
HAT	Highest Astronomical Tide
ISQG	Interim Sediment Quality Guideline
Jetty	Product Loading Jetty
km	Kilometre
L	Litre
LNG	Liquefied Natural Gas
LOR	Limit of Reporting
NCW	Non-Contaminated Water
mg	Milligram
mm	Millimetre
MOF	Module Offloading Facility
m/s	Metres per second
NATA	National Association of Testing Authorities
NEPM	National Environment Protection Measure

Abbreviation	Description
NRETAS	Department of Natural Resources, Environment, the Arts and Sport
NSW	New South Wales
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
NTU	Nephelometric Turbidity Units
ORP	Oxidation reduction potential
Palmerston	City of Palmerston
PASS	Potential acid sulphate soils
pH	Acid/alkaline value
PM_{10}	Particulate matter of 10 micrometres or less in size
Site	The boundary of Contractor's scope of work as defined in Figure 1.2 of CEMP
TDS	Total Dissolved Solids
TPWC Act	*Territory Parks and Wildlife Conservation Act* (NT)
TRH	Total Recoverable Hydrocarbons
TSS	Total Suspended Solids
µg/L	Micrograms per litre
WONS	Weeds of National Significance
WQOs	Water Quality Objectives

1. INTRODUCTION

1.1 Background

INPEX Operations Australia Pty Ltd (INPEX), on behalf of Ichthys LNG Pty Ltd and the upstream Ichthys joint venture participants, is developing the Ichthys gas and condensate field (Ichthys Field) in the Browse Basin, around 450 kilometres (km) north north-east of Broome in Western Australia (**Figure 1-1**). JKC Australia LNG Pty Ltd (Contractor), the joint venture between JGC Corporation, Kellogg Brown and Root and Chiyoda Corporation, has been appointed by INPEX as the engineering, procurement and construction Contractor for development of the Ichthys Onshore Liquefied Natural Gas (LNG) Facilities and its supporting infrastructure at Bladin Point and Manigurr-ma Village at Howard Springs.

This document is the *EPA7 Annual Report 2019 – Environmental Impact Monitoring Program* (EPA7 Report [2019]), which reflects the environmental monitoring carried out from 1 May 2018 to 30 April 2019 (the monitoring period).

For the purposes of this document, the Project is defined to include the onshore facilities located at Bladin Point ('the Site'), including the product loading jetty (Jetty), module offloading facility (MOF) and the Gas Export Pipeline (GEP) terminating at the beach valve enclosure but excludes the Manigurr-ma Village and offshore infrastructure (**Figure 1-2**).

1.2 Purpose

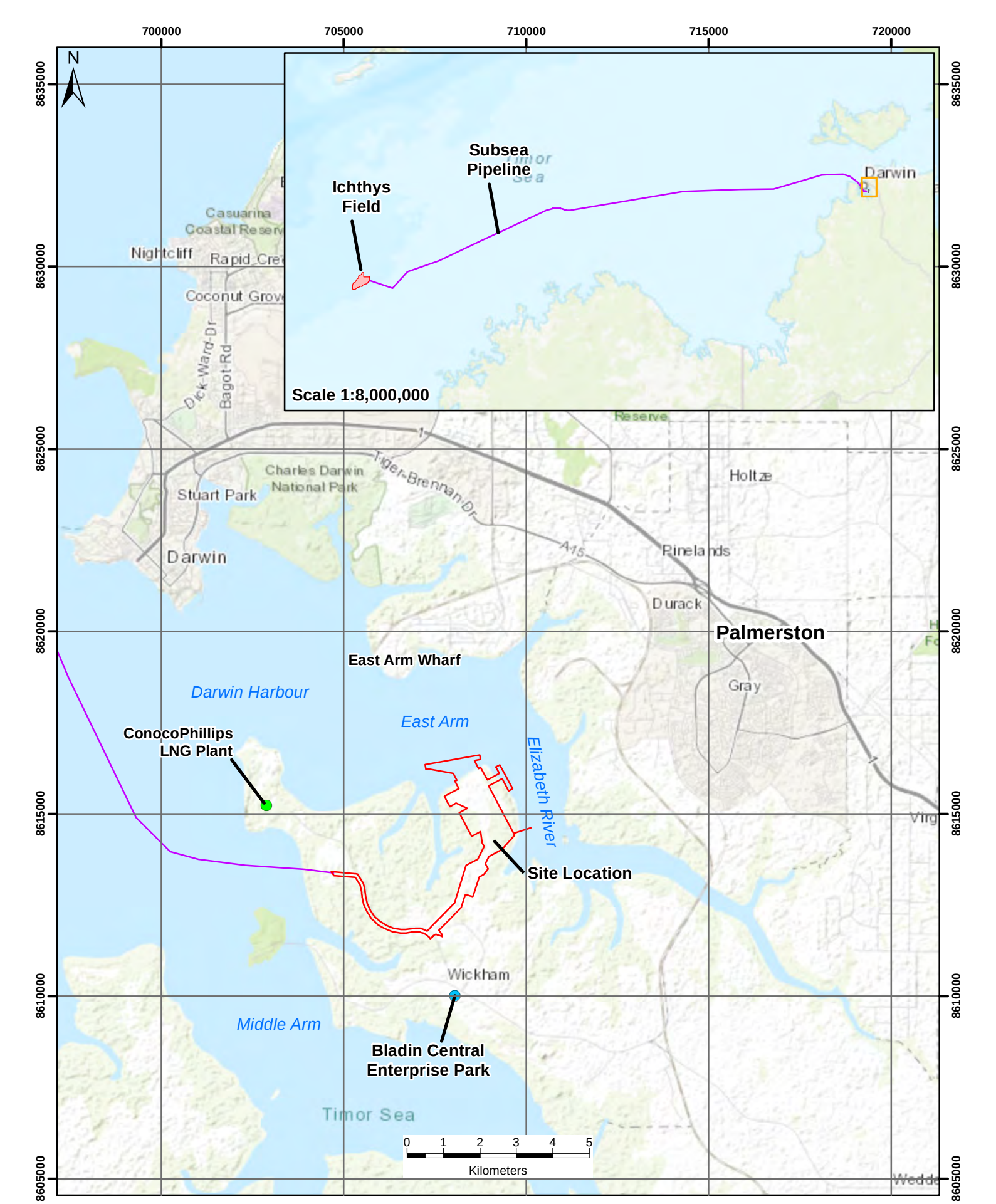
This EPA7 Report has been prepared to comply with Condition 28 of the Environment Protection Approval (EPA7 [as amended]) for the Project and provides a synopsis of the monitoring undertaken during the monitoring period.

This report excludes monitoring specifically associated with WDL192 and WDL211 discharges and the Extractive Minerals Area (EMA) which are subject to separate licence conditions. Any discussions or results from the monitoring of outfall discharges and EMA assets that are included in this report are only included to contextualise results associated with the EIMP.

The Project entered the closing stages of construction and commissioning in October 2018 and large portions of Site transitioned to the operations phase under Environment Protection Licence 228 (EPL 228), which became active on 14 September 2018. As a result, the risk sources, pathways and the potential for environmental harm reduced, and the monitoring scope was reviewed to remove surplus components whilst still maintaining the objectives of the EIMP (Rev 10).

Changes that were made were subject to the evaluation of risk sources, source-pathway-receptor relationships, evaluation of the monitoring dataset and a comprehensive multiple lines of evidence assessment. The revised monitoring focused on the on-going potential environmental risks associated with the remaining construction, pre-commissioning and commissioning within Site Areas B200 and E600. These changes were implemented on 1 February 2019. At the end of April 2019, the majority of the Site had transitioned to the operations phase under EPL 228. Construction activities were completed and only general CCPP commissioning activities remained. As a result, all construction risk sources with the potential for environmental harm were removed.

The remaining commissioning discharges are managed under separate approvals and following completion of a comprehensive multiple lines of evidence assessment undertaken in the 2019 Annual Environmental Monitoring Report (AEMR 2019), the environmental monitoring scopes under the EIMP of surface water, groundwater, mangrove health, sediments, bioindicators, noise, dust, weeds, and flora and fauna ceased on 30 April 2019.



Site Boundary
Subsea Pipeline
Ichthys Field
ConocoPhillips LNG Plant
Bladin Central Enterprise Park

Project Location

Figure 1-1	INPEX Bladin Point	GREENCAP
Date: 24/06/2019	**Author:** Diego.Correa	
	Map Scale: 1:130,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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Site Boundary

Gas Export Pipeline

Bladin Point Site

Figure 1-2	INPEX Bladin Point	GREENCAP
Date: 24/06/2019	Author: Diego.Correa	
	Map Scale (@A4): 1:35,000	
Revision: A	Coordinate System: GDA 1994 MGA Zone 52	

Image date: 10 October 2018

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2. ENVIRONMENTAL STRATEGY

2.1 Construction Environmental Management Plan

The *Ichthys Onshore LNG Facilities - Construction Environmental Management Plan* (INPEX Operations Australia Pty Ltd, 2017) (L092-AH-PLN-10001) (CEMP) was prepared for the Site following development approval (Northern Territory [NT] Government Development Permit DP12/0065B) to address the site-specific environmental risks associated with the Project. The CEMP details the environmental protection management measures and controls necessary to avoid, reduce or mitigate environmental impacts during the construction, pre-commissioning, commissioning and demobilisation phases of the Project.

2.2 Environmental Impact Monitoring Program

An *Environmental Impact Monitoring Program* (Greencap Pty Ltd, 2017) (L290-AH-PLN-10013) (EIMP [Rev 10]) for the Project, which was prepared in order to meet Condition 21 of the Environment Protection Approval for the Project (EPA7) (as amended). The EIMP establishes the monitoring framework for the detection of potential impacts associated with the construction of the Project.

The monitoring programs for the following aspects were undertaken as part of EIMP (Rev 10):

- Surface water monitoring;
- Groundwater quality monitoring;
- Mangrove community health, sediments and bio-indicator monitoring;
- Air quality (dust) monitoring;
- Airborne noise monitoring;
- Weed monitoring; and
- Adaptive response monitoring.

In addition to the results of the monitoring programs listed above, flora and fauna reporting was included in EIMP (Rev 10).

Table 2-1 summarises the aims and objectives of each monitoring strategy.

Table 2-1 CEMP Objectives and Targets Relevant to EIMP (Rev 10)

Management Strategy	Objectives	Performance Criteria
Surface Water Management	To protect surface water quality from Project-related activities	No detectable changes in surface water quality in the receiving environment above relevant water quality parameters listed in Table 6-14 of the CEMP and in excess of 10% of concurrently measured background concentrations (defined as the 80th percentile of the reference site database).
		Stormwater actively discharged from Site does not exceed the relevant discharge trigger values listed in Table 6-14 of the CEMP.
		Construction water discharged from Site does not exceed the relevant discharge trigger values listed in Table 6-14 of the CEMP.
		Treated effluent discharged from Site does not exceed the water quality criteria listed in the MOF Outfall monitoring program.
		Surface water reused on Site is compliant with the criteria for reuse in Table 6-14.
		Spent hydrotest water discharged from Site via the regulating drain is compliant with the MOF Outfall monitoring program.

Management Strategy	Objectives	Performance Criteria
Surface Water Management	To protect surface water quality from Project-related activities	Spent hydrotest water discharged via the MOF outfall.
		Treated effluent discharged from the permanent Jetty Outfall does not exceed water quality criteria as specified in EPA7 (as amended).
Groundwater Management	To minimise changes in groundwater levels and/or quality resulting from construction and commissioning activities	No statistically significant trend showing a deterioration of groundwater levels outside of historical background seasonal fluctuations and that is attributable to construction and commissioning activities.
	To minimise changes in groundwater levels and/or quality resulting from construction and commissioning activities	No statistically significant trend showing a deterioration of groundwater quality listed in Table 6-29 of the CEMP and in excess of 10% of seasonal background concentrations and no plume trend that is attributable to construction and commissioning activities.
ASS Management	To minimise the impacts of ASS resulting from construction and commissioning activities on sediments and bio-indicators	Zero incidents of exceedances in the intertidal sediment quality criteria listed in Table 6-22 of the CEMP attributed to Project activities.
		Zero incidents of exceedances in the bioavailability of heavy metals in bio-indicators criteria in Table 6-23 attributed to Project activities.
Erosion and Sedimentation Management	To minimise transport of sediment from the Site into immediate surroundings including adjacent land, intertidal areas and receiving surface waters	Stormwater actively discharged from a controlled sediment basin to receiving waters complies with the water quality criteria in Table 6-14 of the CEMP.
Dust and Air Quality Management	To minimise impacts of dust generation on the nearby receptors (mangroves and adjacent communities) during construction	No significant visible dust attributable to the Project outside the Site.
		Compliance with the air quality criteria listed in Table 6-37 of the CEMP.
		No deterioration of greater than 30% in mangrove community health.
		No increase beyond 5 cm in ground level, averaged over 1 m^2 and a 12 month period attributed to sediment (veneer deposition in comparison to reference sites).
Noise and Vibration Management	To minimise the impacts of construction noise, including from commissioning, and vibration on local communities (nearest sensitive receptors).	No environmental nuisance infringements as a result of construction and commissioning activities.
		No exceedance of the noise limits defined in Table 6-43 of the CEMP which correlate with noise complaints.
Flora and Fauna Management	To minimise disturbance to flora and alteration of mangrove communities outside the Site boundary due to Project activity.	Vegetation clearing within the approved clearing boundary.
		No detected impact to mangroves outside the Site boundary attributable to the works (acceptable change in mangrove canopy cover is <30% reduction in canopy cover and in tree condition, including pneumatophores).
	To avoid injury or death to native terrestrial fauna related to Project activities.	Zero incidents of death or injury to native fauna attributable to Project activities.

Management Strategy	Objectives	Performance Criteria
Weed and Pest Management	To prevent the introduction of new weed species to the Site and the spread of 'declared' weed species and Weeds of National Significance (WONS) within the Site	Zero introduction and spread of new weeds to Site.
		Effective and strategic control of weeds.

3. SITE INFORMATION

3.1 Site Identification

The Site is located at Bladin Point on Middle Arm Peninsula in Darwin Harbour approximately 16 km south-east of the City of Darwin and occupies an area of 348 hectares (ha) (excluding the EMA) (**Figure 1-1**). The Site is located at NT Portion 07002, 144 Wickham Point Road, Wickham NT 0822; Section 1901 and Section 1896, Hundred of Ayers, Wickham NT 0822; and 1000 Channel Island Road, Wickham NT 0822. The Site is surrounded by the following land uses:

- North – Darwin Harbour and East Arm Peninsula (approximately 2.5 km to the north-west);
- East – Elizabeth River;
- West – Lightning Creek and Wickham Point beyond; and
- South – Bladin Central Enterprise Park (approximately 2 km to the south).

The City of Palmerston (Palmerston) is located approximately 4 km to the north-east and the existing Darwin Liquefied Natural Gas Plant is located approximately 2 km to the west of the Site.

3.2 Surrounding Environment

Bladin Point is a low-lying peninsula which is separated from the mainland by a mudflat dominated by deeply weathered lateritic regolith formed on labile Cretaceous marine sediments. The dominant soils covering over half the area on the undulating terrain are shallow to moderately deep, very gravely massive earth (surface lateritic gravel). The residual soils are typically lateritic clay, silts and sand with ferricrete layers often close to the surface or outcropping.

Bladin Point is surrounded on three sides by water: to the east is the Elizabeth River, to the north the East Arm of Darwin Harbour and to the west is Lightning Creek. Rainfall during the wet season forms ephemeral overland streams that discharge into the surrounding water bodies. Surface water historically flowed from the high point along the centre of the Peninsula to the east, north and west. Construction works have modified the topography of the Site but have maintained the general discharge to the north, east and south through specifically constructed discharge points. The main access road for the Site has been constructed through a salt flat located at the isthmus between Bladin Point and the mainland.

Bladin Point is located in the upper estuary area of Darwin Harbour. The water quality of Darwin Harbour is regarded as '*slightly modified*' in accordance with the *Water Quality Objectives for the Darwin Harbour Region – Background Document* (Darwin Harbour Water Quality Objectives [WQOs]) (NRETAS, 2010a), which states the following:

> *Hydrodynamic modelling, supported by water quality studies, indicate that significant tidal movement in the Harbour does not, on a time scale of weeks or even months, transport diffuse and point source nutrients out of the Harbour, but rather assists in their dispersal within the Harbour precinct.*

From the above it is considered that the impacts of urban and point source discharges are likely to be localised and remain within the confines of Darwin Harbour.

Bladin Point is considered to be part of the Darwin Coastal Bioregion. The flora of Bladin Point, prior to clearing, was dominated by woodland and monsoon vine forest with fringing patches of mixed low woodland species and *Melaleuca* forest. The woodland community mostly consisted of *Eucalyptus miniata* (Darwin woollybutt) and *E. tetrodonta* (Darwin stringybark) with mixed mid-storey species including *Cycas armstrongii* (NRETAS, 2011) which is listed as vulnerable under the *Territory Parks and Wildlife Conservation Act* (NT) (TPWC Act). Clearing was undertaken as part of the approved development permit.

Bladin Point is fringed by an extensive mangrove community, typical of the majority of the shoreline of Darwin Harbour. The intertidal areas of Darwin Harbour contain over 27,000 ha of mangroves, which constitutes 44% of the mangrove community in the Darwin Coastal Bioregion (NRETAS, 2011). Darwin Harbour contains 36 mangrove species, six of which are common: *Rhizophora stylosa*, *Ceriops tagal*, *Sonneratia alba*, *Bruguiera exaristata*, *Avicennia marina* and *Camptostemon schultzii* (Brocklehurst *et al.*, 1996).

3.3 Geology and Hydrogeology

Aquifers within the Site occur within the Cretaceous and Proterozoic sediments and rocks (URS, 2009 and Appendix 18, *Ichthys Project Environmental Impact Statement* [INPEX Browse, Ltd, 2010] [EIS]). The uppermost aquifer at Bladin Point occurs in the clayey sand/gravel horizons of the Cretaceous Darwin Formation. The Darwin Formation is underlain by weathered Proterozoic rocks represented by a cemented gravel horizon. Cretaceous sediments covering the gravel horizon comprise sand, clay and silt.

Groundwater quality assessments have previously been undertaken on the aquifers in the Darwin rural area. Regionally, the aquifer is included in the Cretaceous rock/sediments, which are present beneath the Site as part of the Cretaceous Darwin Member of the Bathurst Island formation. The formations are reported to have acidic conditions, i.e. groundwater within this aquifer is typically of low pH, as presented in Radke *et. al.* (1998), which states:

"*Darwin rural groundwater have a wide range of pH (4.1 to 7.6), within which acidity is the main problem. The overlying Cretaceous sediments are also utilised for groundwater supplies, but only out of necessity because of lower yields and higher acidity. Water quality from areas of immediate recharge through Cretaceous sediments can be summarised as low hardness (usually <10 mg/L), acidic (approximately pH 5 at the borehead) and very corrosive (Jolly, 1983).*"

Within the Darwin Region, the regional groundwater are known to contain arsenic and other metals. NRETAS (2008) refers to the following:

"*On the basis of geological formation, three main zones were defined with two zones of elevated risk of bores producing groundwater with arsenic concentrations above the Australian Drinking Water Guidelines. Zones with high risk consists of four formations (Burrell Creek Formation, Mount Bonnie Formation, Acacia Gap Member, Wildman Siltstone) with a high possibility of mineralization as the source of elevated arsenic concentrations in groundwater.*"

The Burrell Creek Formation is one of the key formations which underlays the Site. The report indicates that arsenic concentrations may vary seasonally as a result of groundwater level fluctuations. Also noted is the increase in arsenic concentrations by the oxidation of sulfidic minerals in the aquifer. A review of the NRETAS dataset has indicated that the groundwater from the Burrell Creek formation contained elevated levels of aluminium, cadmium, iron, manganese, lead and zinc. Baseline monitoring undertaken for the EIS (INPEX Browse Ltd, 2010) reported elevated concentrations of aluminium, cadmium, copper, manganese, nickel and zinc in groundwater at the Site before the commencement of the Project. This information indicates that naturally acidic groundwater with the presence of the above dissolved metals has a wide distribution in the Darwin Region and in the groundwater from the Burrell Creek Formation in particular.

3.4 Climate

The Site is located within tropical northern Australia and is subject to two distinct weather seasons, namely the wet and dry season. The wet season occurs from October to April and is characterised by warm and humid weather. The monsoonal rainfall period occurs between December and March and is characterised by higher than average rainfall and an increased potential for cyclone development. The dry season occurs between May and September and is typically characterised by dry days and cooler day-time temperatures.

Climatic data were recorded at the onsite weather station since October 2012 and this collected data on rainfall, temperature, humidity, wind speed and wind direction. From September 2018 onwards, only rainfall data were collected on Site. As such, from September 2018 to April 2019, the remaining climatic parameters were sourced from the BOM Darwin Airport station (014015).

During the monitoring period, the Site received 1,117.2 mm of rainfall, with rain falling on 78 days. March recorded the highest average daily temperature range during the monitoring period, with a temperature range of 21.7°C minimum to 35.2°C maximum. A summary of the climatic data collected during the monitoring period is presented in **Figure 3-1**.

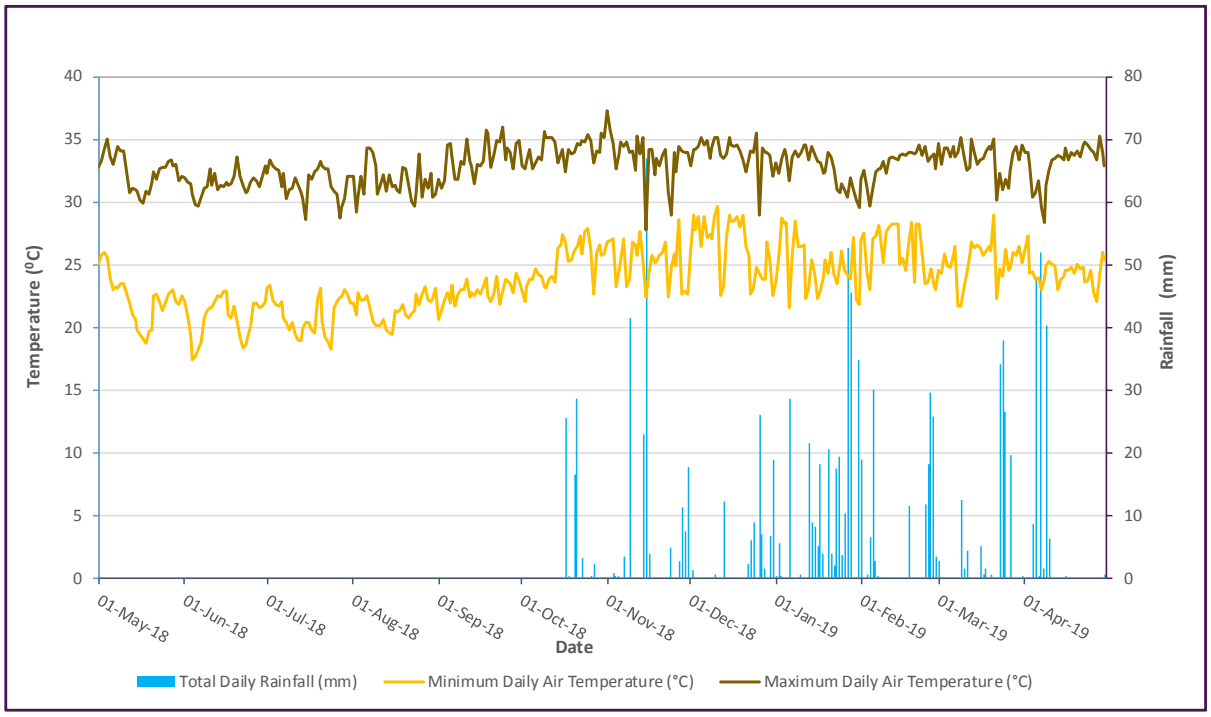

Figure 3-1 Summary of Climatic Data, May 2018 to April 2019

The rainfall recorded during the monitoring period (1,117.2 mm) was significantly lower than the historical mean for Darwin (1,726.2 mm) and was the lowest rainfall recorded since monitoring began on the Project in 2013. The average rainfall for previous monitoring periods was 2,212.3 mm which was just under double the rainfall recorded in this monitoring period.

In the 2018/19 wet season, the monthly rainfall steadily increased (except December 2018), to reach a maximum of 311.4 mm during January 2019, which was also considerably lower that the historical mean for the month of January of 429.4 mm.

During the dry season, the prevailing wind direction was easterly to south-easterly while in the wet season the prevailing wind direction was westerly. Average wind speeds during the monitoring period ranged from 1 to 10 metres per second (m/s) and the average maximum wind speed was 7.3 m/s.

4. RESULTS AND DISCUSSION

4.1 Surface Water

4.1.1 Monitoring Methodology

The surface water management objectives for the Site seek to minimise changes in receiving water quality resulting from the disturbance or dewatering of acid sulphate soils (ASS) and discharges offsite of water containing nutrients, dissolved metals, hydrocarbons or any other contaminants. Results from the following monitoring programs were used to assess potential impacts on the marine receiving environment during the monitoring period:

- Sampling at up to 17 offshore marine surface water monitoring locations (13 impact sites and four reference sites) in Darwin Harbour (a key sensitive receptor);
- Sampling of wastewaters discharged to Darwin Harbour via the Jetty Outfall as per EPA7 (as amended);
- Results from the MOF Outfall, temporary WWTP Outfall monitoring and adaptive response monitoring as required for spatial context during the EIMP monitoring dataset assessment.

Figure 4-1 and **Figure 4-2** presents the surface water monitoring locations.

The following analytes were recorded in situ:

- Electrical conductivity (EC);
- Dissolved oxygen (DO);
- Oxidation reduction potential (ORP);
- pH;
- Temperature;
- Salinity; and
- Turbidity.

Each of the surface water samples collected at onsite and offsite locations were analysed for:

- Total and dissolved metals;
- Total dissolved solids (TDS) and suspended solids (TSS);
- Alkalinity;
- Nutrients (ammonia, oxides of nitrogen, total kjeldahl nitrogen, total nitrogen, filterable reactive phosphorus [FRP] and total phosphorus); and
- Major ions and hardness.

Surface water locations were also analysed for the following additional parameters, as required:

- Total recoverable hydrocarbons (TRH);
- Benzene, toluene, ethylbenzene, xylenes, and naphthalene (BTEXN); and
- Biological indicators (*E. coli,* Enterococci, and chlorophyll-a).

Site Boundary

Gas Export Pipeline

Surface Water Monitoring Locations

Offsite Marine Sampling Locations

Reference Sites

Image date: 10 October 2018

Offsite Surface Water Monitoring Locations

Figure 4-1	INPEX Bladin Point	GREENCAP
Date: 24/06/2019	**Author:** Diego.Correa	
	Map Scale (@A4): 1:50,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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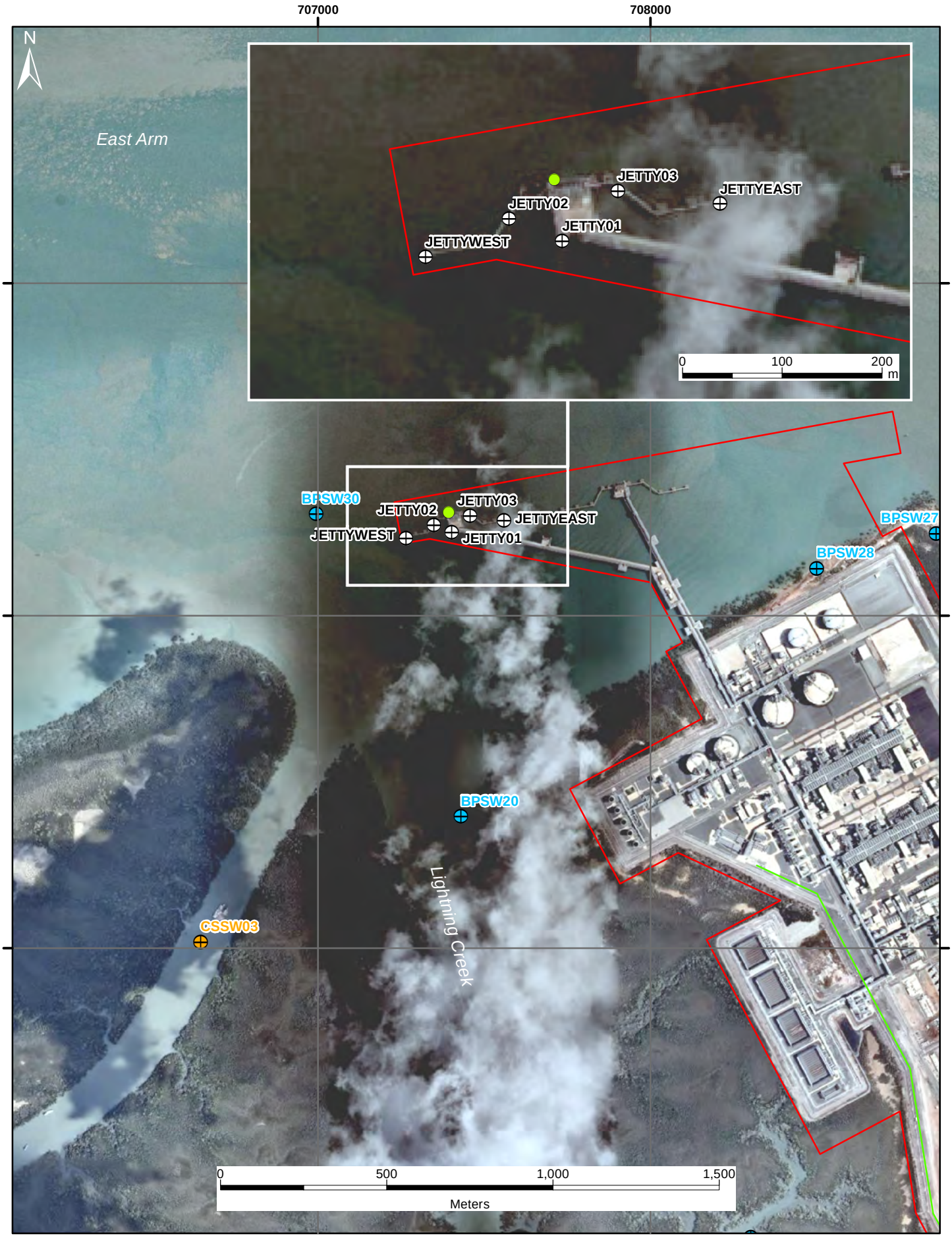

Site Boundary

Gas Export Pipeline

Surface Water Monitoring Locations

Jetty Outfall Monitoring Location

Jetty Outfall Diffuser

Offsite Marine Sampling Locations

Reference Sites

Image date: 10 October 2018

Jetty Outfall Monitoring Locations

Figure 4-2	INPEX Bladin Point	GREENCAP
Date: 24/06/2019	**Author:** Diego.Correa	
	Map Scale (@A4): 1:15,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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4.1.2 Field and Analytical Results

4.1.2.1 Marine Surface Water Quality

Salinity

The salinity recorded at the marine surface water locations ranged from 29.28 to 37.94 g/L with a median of 34.80 g/L during the monitoring period. Further analysis of salinity data revealed the following:

- During the dry season, salinity values ranged between 33.21 g/L and 37.28 g/L with a median of 35.15 g/L;
- During the wet season, salinity values ranged between 29.28 g/L and 37.94 with a median of 34.56 g/L;
- The highest median salinity was recorded in October 2018 with a value of 37.31 g/L;
- The lowest median salinity was recorded in April 2019 with a value of 31.33 g/L;
- Median salinity during the 2018 dry season was comparable to salinities during the 2016 and 2017 dry seasons (medians of 35.83 and 35.82 g/L, respectively), was lower than the salinity during the 2015 dry season (37.6 g/L) and was higher than the salinity during the 2014 dry season (33.90 g/L);
- Median salinity during the 2018/19 wet season was higher than the salinities during the 2016/17 and 2017/18 wet seasons (medians of 32.37 and 33.43 g/L, respectively) and comparable to the salinity during the 2015/16 wet season (34.00 g/L); and
- A noticeable decrease in salinity was observed in the wet season compared to the dry season as a result of increased rainfall and freshwater inputs.

Dissolved Oxygen

The DO at marine surface water locations ranged from 49.8 to 95.6% saturation with a median of 85.6% saturation during the monitoring period. Results for DO were lowest in March with a median of 71.6% saturation and the highest values were recorded in December with a median of 89.4% saturation.

Dissolved oxygen exceedances were recorded in June, November and March at impact sites and reference sites and were therefore not a result of Site activities and discharges.

Exceedances were recorded at impact sites as follows: two exceedances at BPSW22 and 29 in May 2018; one in July 2018 (BPSW29); one in December 2018 (BPSW22); and, one in February 2019 (BPSW33). There were no DO exceedances in outfall monitoring in these months and no environmental incidents (spills, leaks or unregulated wastewater discharges) were recorded. There was no rainfall recorded during May and July and therefore there was no pathway (i.e. passive discharges) for the DO exceedances at these locations in May and July 2018. There was no rainfall recorded for the four days preceding the December 2018 sampling event, and for five days preceding the February 2019 sampling event and therefore it is unlikely that passive discharges from Site contributed to the DO exceedances recorded at impact sites in December 2018 and February 2019. It was therefore concluded that these exceedances were not related to Site activities and discharges.

pH

The pH at the marine surface water locations ranged from 7.09 to 8.24 pH units with a median of 7.92 pH units during the monitoring period. Further analysis of pH data revealed the following:

- The pH remained relatively stable between the wet season and dry season;
- During the dry season, the pH ranged from 7.61 to 8.04 pH units with a median of 7.94 pH units, while in the wet season, the pH ranged from 7.09 to 8.24 pH units with a median of 7.90 pH units;
- The highest pH was observed in April 2019 with a median of 8.05 pH units; and
- The lowest pH was observed in January 2019 with a median of 7.87 pH units.

There were no pH exceedances in the marine receiving environment in the monitoring period. The monitoring results for pH remained stable over the monitoring period and were consistent across impact sites and reference sites, which indicated the results were indicative of ambient conditions within the East Arm area of Darwin Harbour.

Turbidity

Turbidity at the marine surface water locations ranged from 0.81 to 71.60 NTU with a median of 4.07 NTU in the monitoring period (**Figure 4-3**).

Four exceedances were recorded in the monitoring period as follows: in November (21.5 NTU at BPSW22 and 71.6 NTU at BPSW29), December (23.3 NTU at BPSW22) and March 2019 (37.4 NTU at BPSW25).

Median turbidity results recorded at impact sites and reference sites were relatively similar in the monitoring period and this was indicative of background conditions in Darwin Harbour. The four exceedances were all recorded at impact sites but a review of construction activities did not identify a source(s) for these exceedances and they were not attributed to Site activities and discharges.

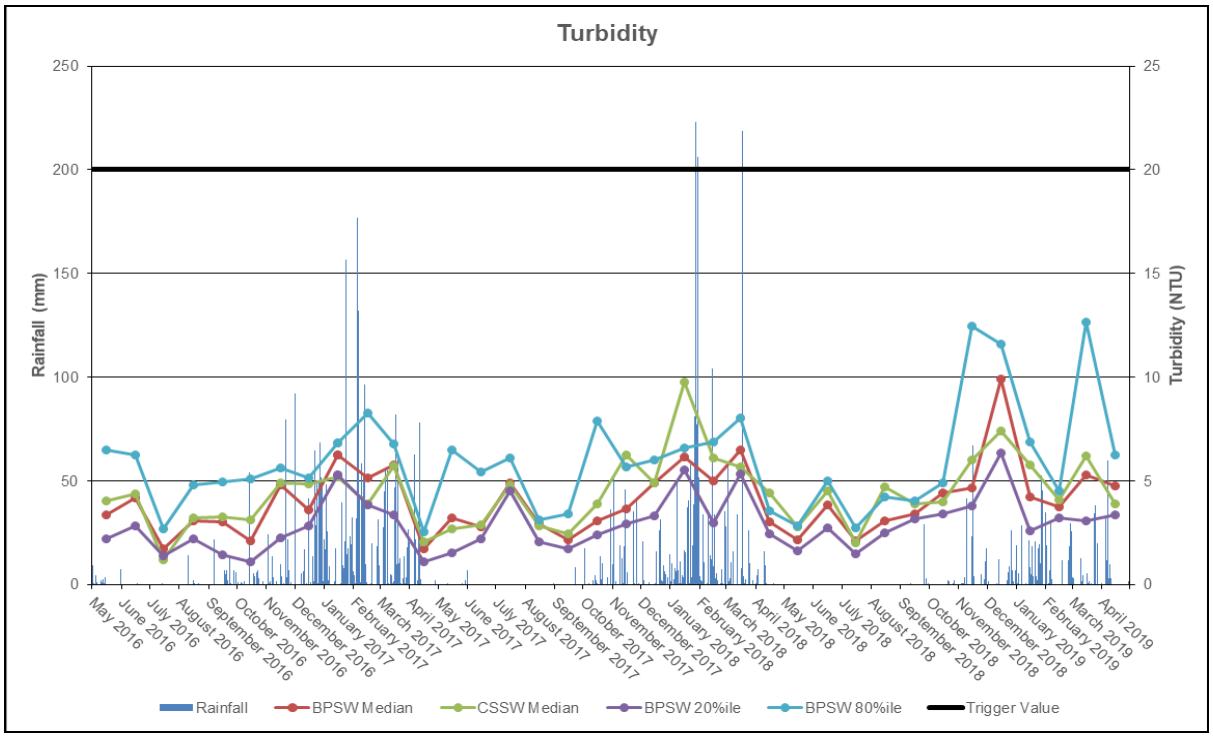

Figure 4-3 Marine Surface Water Turbidity vs Daily Rainfall, May 2016 – April 2019

Total Suspended Solids

The TSS concentrations at marine surface water locations ranged from 2.1 to 130.0 mg/L with a median of 17.0 mg/L during the monitoring period (**Figure 4-4**). The TSS concentrations recorded at impact sites ranged from 2.1 to 130.0 mg/L with a median of 18.0 mg/L, while reference sites ranged from 2.3 to 120.0 mg/L, with a median of 14.0 mg/L. Further analysis revealed the following:

- During the dry season, TSS ranged between 2.1 and 130.0 mg/L with a median of 21.0 mg/L;
- During the wet season, TSS ranged between 2.7 and 94.0 mg/L with a median of 14.0 mg/L;
- During the dry season, the highest concentration was in August (130 mg/L) with a median value of 33.0 mg/L, the lowest was in May (2.1 mg/L) with a median of 1.2 mg/L; and
- During the wet season, the highest concentration was recorded in January (94.0 mg/L) with a median of 42.0 mg/L, the lowest was in October (2.7 mg/L) with a median of 1.3 mg/L.

Total suspended solid exceedances were recorded at impact sites and reference sites in every month of the monitoring period, except April 2019. Given that the exceedances were recorded at both impact sites and reference sites it was assessed that they were not attributable to Site activities and discharges.

The TSS exceedances in April were recorded at four impact sites (BPSW25, 29, 32, 33). There were no exceedances recorded in outfall monitoring in April and a review of construction activities did not identify a source for these exceedances. As such, the exceedances were not a result of Site activities and discharges.

There were two occasions where TSS exceedances were recorded in outfall monitoring, namely December 2018 in WWTP monitoring and March 2019 in MOF Outfall monitoring. Median TSS concentrations at the impact sites were of 24.5 and 42.0 mg/L, respectively and the end of pipe concentrations were 1.8 and 4.8 mg/L, respectively. In both instances, the end of pipe concentrations were insufficient to have caused the exceedances at the impact sites at the edge of the mixing zones. Therefore, it was assessed that these TSS exceedances were a result of seasonal variation. Furthermore, the potential for environmental harm as a result of these exceedances was assessed to be low.

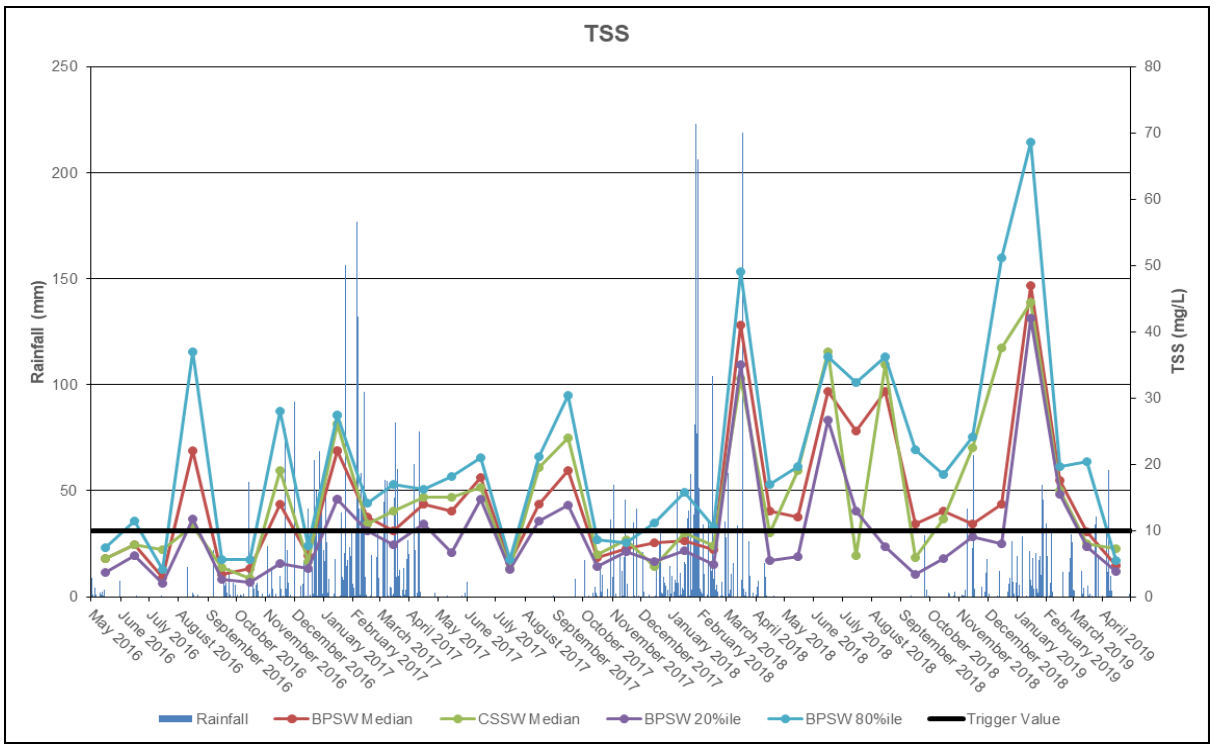

Figure 4-4 Marine Surface Water TSS vs Daily Rainfall, May 2016 – April 2019

Nutrients

Ammonia

Ammonia results recorded at marine surface water monitoring locations ranged from <5 to 38 µg/L, with a median of <5 µg/L during the monitoring period. Further analysis of the ammonia results revealed the following:

- The median was <5 µg/L in the dry season and 7 µg/L in the wet season;
- During the dry season, concentrations ranged from <5 µg/L to 36 µg/L;
- During the wet season, concentration ranged from <5 µg/L to 38 µg/L;
- The lowest concentrations were recorded in May, with 14 out of the 17 results below the laboratory limit of reporting and with a median of <5 µg/L; and
- The highest concentrations were recorded in December with a median of 19 µg/L.

Previous studies consider that ammonia concentrations in the Harbour do not vary remarkably from 10 µg/L (Butler *et al.*, 2013), which was higher than the median reported in the monitoring period. These authors do concede that ammonia concentrations may be higher in creek arms due to mineralisation, presumably through the lower oxygen environments that exist in the dry season. Alternatively, increased water input through the wet season may reduce ammonia by flushing and/or advection through the same environments.

In January and March 2019, ammonia exceedances were recorded at impact and reference sites and were therefore were not related to Site activities and discharges.

Ammonia exceedances that were recorded at impact sites only were as follows: BPSW23 in July 2018; BPSW29 in October 2018; and BPSW22 and 25 to 31 in December 2018.

The single exceedances in July and October occurred within the mouth of two shallow tidal creeks to the south-east of the Site (in July 2018) and up an arm of Lightning Creek to the west of the Site (in October 2018). There was no rainfall in July and the first wet season rainfall recorded in the monitoring period (in October) occurred after the October sampling event and therefore there was no pathway (i.e. passive discharges) for Site activities to have caused the ammonia exceedances at these impact sites in July and October.

The December exceedances were widely distributed to the north and east of the Site and up the arms of Lighting Creek to the west of the Site. There was no rainfall for four days preceding the December sampling event and therefore it is unlikely that passive discharges from Site contributed to the ammonia exceedances at impact sites in December.

There were no ammonia exceedances recorded in outfall monitoring and no environmental incidents (spills, leaks or unregulated wastewater discharges) were recorded in these months.

Based on these factors, Site activities and discharges were eliminated as a source for these exceedances.

Oxides of Nitrogen

Oxides of nitrogen results ranged from <5 to 48.0 µg/L, with a median of <5 µg/L during the monitoring period. Further analysis of the oxides of nitrogen data revealed the following:

- The median was <5 µg/L in both the dry and the wet seasons;
- During the dry season, concentrations ranged from <5 µg/L to 15 µg/L;
- During the wet season, concentrations ranged from <5 µg/L to 48 µg/L;
- The highest concentrations were recorded November with a median of 7 µg/L; and
- The lowest concentrations were recorded in February and March with all values below LOR.

The two oxides of nitrogen exceedances that were recorded in November at impact sites (BPSW22 and 29) were located in the arms of Lightning creek to the south-west of the Site. There was no rainfall for four days preceding the November sampling event and therefore it is unlikely that passive discharges from Site contributed to the oxides of nitrogen exceedances at these impact sites in November.

There were no oxides of nitrogen exceedances in outfall monitoring in November and no environmental incidents (spills, leaks or unregulated wastewater discharges) were recorded.

Furthermore, a review of construction and commissioning activities in these months did not identify a source(s) for these exceedances. Based on these factors, Site activities and discharges were eliminated as a source for these exceedances.

Total Nitrogen

Total nitrogen results ranged from <50 to 3,400 µg/L, with a median of 170 µg/L during the monitoring period. The maximum value occurred at both an impact site and a reference site, with the next highest value of 730 ug/L occurring at an impact site. Further analysis of the total nitrogen data revealed the following:

- The median was 150 µg/L in the dry season and 190 µg/L in the wet season;
- Concentrations ranged from <50 µg/L to 3,400 µg/L in both the dry and wet seasons;
- The highest concentrations were recorded in July with a median of 110 µg/L; and
- The lowest concentrations were recorded in January with 11 out of the 17 results below the limit of reporting and a median of <50 µg/L.

Total nitrogen mostly comprises of organic nitrogen, either attached to sediment or (more commonly) as part of the natural degradation processes of organic material. Its generation is therefore independent of wet and dry season cycles (Butler *et al*., 2013) and thus, unlike dissolved forms such as ammonia or oxides of nitrogen, it may not have as strong a signal due to runoff associated with the wet season.

In July, September and December 2018 and January, February and March 2019, the total nitrogen exceedances were recorded at both impact sites and reference sites and were therefore not related to Site activities.

Total nitrogen exceedances recorded at impact sites only were as follows: BPSW20, 22, 23, 25 to 27, 31 in May; BPSW20 in October; BPSW26 to 29, 31 and 32 in November; and BPSW24 and 25 in April.

The May exceedances were distributed and spatially separated to the east of the Site, within the mouth of two shallow tidal creeks to the south-east of the Site and at the mouth and up an arm of Lightning Creek to the west of the Site. The single exceedance in October occurred at the mouth of Lightning Creek to the west of the Site. There was no rainfall recorded in May and the first wet season rainfall recorded in the monitoring period (in October) occurred after the October sampling event and therefore there was no pathway (i.e. passive discharges) for Site activities to have caused the total nitrogen exceedances at impact sites in May and October.

The November exceedances were distributed to the north, east and south-east of the Site, and the April exceedances to the east of the Site. There was no rainfall for four days preceding the November sampling event, and no rainfall for 14 days preceding the April sampling event and therefore it is unlikely that passive discharges from Site contributed to the total nitrogen exceedances at impact sites in November and April.

There were no total nitrogen exceedances in outfall monitoring in the monitoring period and no environmental incidents (spills, leaks or unregulated wastewater discharges) were recorded in these months.

Furthermore, a review of construction and commissioning activities did not identify a source(s) for these exceedances. Based on these factors, Site activities and discharges were eliminated as a source for these exceedances.

Total Phosphorus

Total phosphorus results ranged from <5 to 1,700 µg/L with a median of 26 µg/L during the monitoring period. Further analysis of the total phosphorus data revealed the following:

- The median was 20 µg/L in the dry season and 29 µg/L in the wet season;
- During the dry season, concentrations ranged from <5 µg/L to 79 µg/L;
- During the wet season, concentrations ranged from <5 µg/L to 1,700 µg/L;
- The highest concentrations were recorded in December with a median of 38 µg/L; and
- The lowest concentrations were recorded in June, with 15 out of the 17 results less than LOR and a median of <5 µg/L.

Exceedances recorded in July, September, November and December 2018, and in January, February and April 2019 occurred at impact and reference sites and were therefore not related to Site activities and discharges.

Total phosphorus exceedances recorded at impact sites only were as follows: BPSW20, 22 to 25 and 28 in May; BPSW23 and 24 in August; and BPSW25, 27, 29, 32 and 33 in March.

The May exceedances were distributed and spatially separated to the south-east of the Site within the mouth of two shallow tidal creeks to the south-east of the Site and at the mouth and up an arm of Lightning Creek to the west of the Site. The August exceedances occurred within the mouth of two shallow tidal creeks to the south-east of the Site. There was no rainfall recorded in May and August and therefore there was no pathway (i.e. passive discharges) for Site activities to have caused the total phosphorus exceedances at impact sites in May and October.

The March exceedances were widely distributed in two spatially separated areas, one comprising the mouth of the East Arm tributary and Lightning Creek to the west of the Site, and the second from the east of Site to the middle reaches of Elizabeth River to the south-east of the Site. There was limited rainfall (7.4 mm) in the eight days preceding the March sampling event and therefore it is unlikely that passive discharges from Site contributed to the total phosphorus exceedances at impact sites in March.

There were no total phosphorus exceedances in outfall monitoring and no environmental incidents (spills, leaks or unregulated wastewater discharges) recorded in these areas.

Furthermore, a review of construction and commissioning activities in these months did not identify a source(s) for these exceedances. Based on these factors, Site activities and discharges were eliminated as a source for these exceedances.

Filterable Reactive Phosphorus

Filterable reactive phosphorus results during the monitoring period ranged from <1 to 120 µg/L with a median value of 5 µg/L. Further analysis of the FRP data revealed the following:

- The median was 3 µg/L during the dry season and 13 µg/L during the wet season;
- During the dry season, concentrations ranged from <1 µg/L to 7 µg/L;
- During the wet season, concentrations ranged from <1 µg/L to 120 µg/L;
- The highest concentrations were recorded in February with a median of 20.5 µg/L; and
- The lowest concentrations were recorded in June, with 15 out of the 17 results less than LOR and a median of <1 µg/L.

Filterable reactive phosphorus is the reactive form of this nutrient and is readily available for uptake by plants. Its generation would occur from degradation processes acting on the organic phosphorus (a major component of total phosphorus) in Darwin Harbour which would have been delivered from the upstream Elizabeth River catchment.

All FRP exceedances were recorded at impact sites and reference sites in the monitoring period and were therefore not related to Site activities and discharges.

Metals and Metalloids

Marine field and analytical metal and metalloid results obtained during the monitoring period were reflective of seasonal trends and historical values based on the extended dataset collected for the Project. During the monitoring period, (all filtered) aluminium, arsenic, copper, mercury and zinc were the only metals to record exceedances in the receiving environment.

Filtered Aluminium

The results for filtered aluminium ranged from <10 to 30 µg/L with the majority of results below LOR during the monitoring period.

Only one trigger value exceedance for filtered aluminium was recorded during the monitoring period, at impact site BPSW30 located to the north-west of the Site in November.

There were no filtered aluminium exceedances in outfall monitoring and no environmental incidents (spills, leaks or unregulated wastewater discharges) this area.

Furthermore, a review of construction and commissioning activities did not identify a source(s) for this exceedance. Based on these factors, it was assessed that this single exceedance was not related to Site activities and discharges.

Filtered Arsenic

The results for filtered arsenic ranged from <0.2 to 5.0 µg/L with a median of 2.1 µg/L during the monitoring period.

Filtered arsenic exceedances that occurred in May, June, August, October and November 2018 and January to March 2019 were recorded at impact sites and reference sites and were therefore not related to Site activities and discharges.

Exceedances that were recorded at impact sites only were as follows: BPSW25 in July; BPSW22 in September; BPSW30, 32 and 33 in December; and BPSW24, 25 and 27 in April 2019.

The single exceedances in July and September occurred to the east of the Site and in the arm of Lightning Creek to the south-west of the site, respectively. There was no rainfall recorded in July and September and therefore there was no pathway (i.e. passive discharges) for Site activities to have caused these filtered arsenic exceedances.

The December exceedances were distributed in two spatially separated areas, one at the mouth of the East Arm tributary to the west of the Site, and the second at the middle reaches of Elizabeth River to the south-east of the Site. Both areas are spatially separated from Site with monitoring locations between these areas and Site recording filtered arsenic below the trigger value. Further, there was no rainfall for four days preceding the December monitoring event and therefore it is unlikely that passive discharges from Site contributed to the filtered arsenic exceedances at impact sites in this month.

The April exceedances were distributed in two spatially separated areas, one to the north and one to the east of the Site. There was no rainfall for 14 days preceding the April sampling event and therefore it is unlikely that passive discharges from Site contributed to the exceedances at impact sites in this month.

There were no filtered arsenic exceedances in outfall monitoring and no environmental incidents (spills, leaks or unregulated wastewater discharges) were recorded in these months.

Furthermore, a review of construction and commissioning activities did not identify a source(s) for these exceedances. Based on these factors, it was assessed that this these exceedances were not related to Site activities and discharges.

Filtered Copper

The results for filtered copper ranged from <1 to 3 µg/L with the majority of the results less than the LOR during the monitoring period).

There were eight filtered copper exceedances recorded during the monitoring period, all of which occurred in May 2018. The exceedances were recorded at impact sites and a reference and were therefore not related to Site activities and discharges.

Filtered Mercury

The results for filtered mercury ranged from <0.1 to 0.2 µg/L with the majority of the results less than the LOR during the monitoring period.

There were three filtered mercury exceedances recorded during the monitoring period, all of which occurred in March 2019. The exceedances were recorded at impact sites and a reference and were therefore not related to Site activities and discharges.

Filtered Zinc

The results for filtered zinc ranged from <5 to 76 µg/L with most results less than the LOR during the monitoring period.

There were four filtered zinc exceedances recorded during the monitoring period, all of which occurred at impact sites in November. The exceedances at impact sites were distributed to the east and south-east of the Site and up an arm of Lightning Creek to the west of the Site. There was no rainfall for four days preceding the November sampling event and therefore it is unlikely that passive discharges from Site contributed to the exceedances at impact sites in November.

There were no filtered zinc exceedances in outfall monitoring and no environmental incidents (spills, leaks or unregulated wastewater discharges) were recorded in this month.

Furthermore, a review of construction and commissioning activities did not identify a source(s) for these exceedances. Based on these factors, it was assessed that these exceedances to be unrelated to Site activities and discharges.

Other Parameters

Total Recoverable Hydrocarbons

Total recoverable hydrocarbon results were less than the limit of reporting during the monitoring period with the exception of eight detections at impact sites BPSW23, 24, 25, 26, 27, 28, 31 and 32 and reference site CSSW04 in June; and, one detection at BPSW25 in July. Following silica gel clean-up only three sites (BPSW23, 24 and 31) exceeded the trigger value in June.

The exceedances that were recorded at BPSW23, 24 and 31 occurred in the Elizabeth River to the east of the Site. Impact sites BPSW26 and 27 are positioned just to the north and south of the MOF and all are downstream of the non-contaminated water (NCW) system discharge point, which drains to the perimeter regulating drain on the north-eastern boundary of Site. If the TRH exceedances that were recorded at BPSW23, 24 and 31 in June were a result of the release of TRH impacted waters from Site, via either active discharges from the MOF or passive discharges via the NCW, it would be expected that the TRH detections would be spatially connected and would also have been recorded at nearby sites BPSW25, 26 and 27. However, this was not the case and exceedances were not recorded at these sites after silica gel clean-up. Furthermore, there were seven monitoring events in the MOF monitoring in June and there were no TRH detections recorded within the source water or the receiving environment during this period.

In addition, within the monitoring period, there were 30 surface water monitoring events associated with the ongoing attenuation monitoring for the MOF diesel spill. Monitoring was undertaken during June immediately downstream of the spill site during periods of greatest risk i.e. spring high tide cycles, with all reported results less than the laboratory LORs.

Based on the above evidence, and a review of the construction and commissioning activities in June, a potential source(s) for these TRH exceedances could not be identified and it was therefore concluded that they were not attributable to Site activities and discharges.

Chlorophyll-a

Chlorophyll-a results were less than the limit of reporting in the monitoring period.

E. coli

E. coli results were below the trigger value during the monitoring period.

Enterococci

All enterococci results were below the trigger value during the monitoring period with the exception of two exceedances at impact sites BPSW22 and 29 in November. A review of construction and commissioning activities did not identify a source for the exceedances and there were no exceedances in the outfall monitoring programs in November when the exceedances were recorded at the impact sites. It was therefore concluded that these exceedances were not related to Site discharges and activities.

Chloride/Sulphate Ratio

Chloride/sulphate ratios can be used to determine whether there has been discharge from ASS-impacted streams into marine receptors. Chloride/sulphate ratios are often <3 in ASS-impacted streams, whereas ratios between ~5 and 7 are expected in estuarine streams (Sammut et al., 1996). A chloride/sulphate ratio of less than four and certainly a ratio less than two, is a strong indication of an extra source of sulphate from previous sulphide oxidation (Mulvey, 1993).

Salinity results from the surface water monitoring program remained consistent with seawater with a number of exceptions that were indicative of slightly fresher water (**Figure 4-5**). It was concluded that there have not been discharges from ASS-impacted streams into the marine receiving environment during the monitoring period, which is consistent with previous monitoring periods.

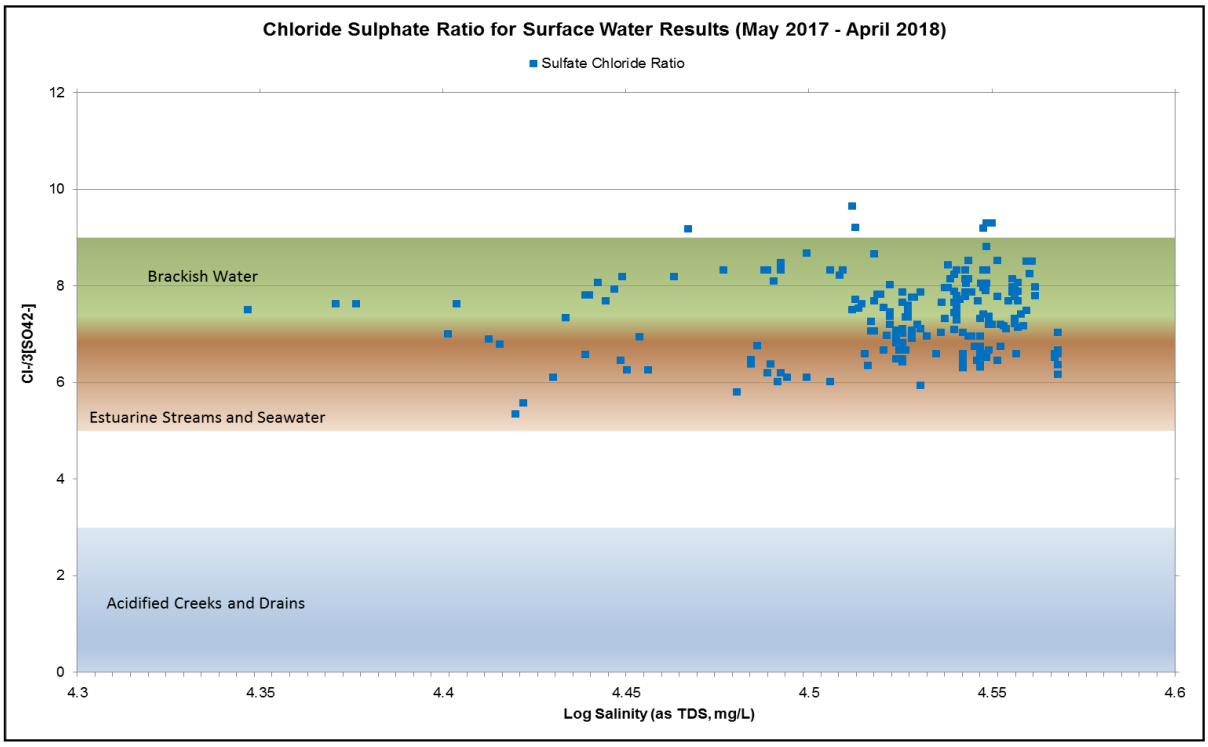

Figure 4-5 Surface Water Chloride/Sulphate Ratio

4.1.2.2 Jetty Outfall Water Quality

The authorisation to discharge wastewaters to Darwin Harbour via the permanent Jetty Outfall and the requirement for monitoring in the receiving environment was transferred to Environmental Protection Licence 228 (EPL288) on 14 September 2018, and therefore only monitoring results up to this date have been reported here. Three Jetty Outfall monitoring events triggered further assessment in the period between May and September 2018 and these assessments concluded that the exceedances were not attributable to the Jetty Outfall discharges.

4.2 Groundwater

4.2.1 Monitoring Methodology

The groundwater management objectives for the Site seek to minimise changes in groundwater levels and quality which may be arising from construction activities. This includes impacts associated with the possible oxidation of ASS, which may lead to disturbance of the mangrove communities fringing the Site where groundwater may discharge. Monitoring also aims to assess potential impacts resulting from onsite spills and leaks at the nominated higher risk locations as identified via environmental incident reporting. Sampling locations are provided in **Figure 4-6**.

Site Boundary

Gas Export Pipeline

EIMP Groundwater Sampling Location

Non-EIMP Groundwater Sampling Location[1]

Groundwater Sampling Locations

Figure 4-6	INPEX Bladin Point	GREENCAP
Date: 25/06/2019	**Author:** Diego.Correa	
	Map Scale: 1:30,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

Image date: 10 October 2018

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Samples were collected from the monitoring bores on a monthly basis. The following analytes were recorded in situ:

- Temperature;
- Electrical conductivity;
- pH;
- Turbidity;
- Total dissolved solids;
- Dissolved oxygen;
- Oxidation reduction potential; and
- Salinity.

Each of the collected groundwater samples were analysed for:

- Total and dissolved metals;
- Total suspended solids;
- Alkalinity;
- Nutrients (ammonia, oxides of nitrogen, total kjeldahl nitrogen, total nitrogen, FRP and total phosphorus); and
- Major ions and hardness.

Specifically identified groundwater monitoring bores were also analysed for the following additional parameters:

- Total recoverable hydrocarbons and BTEXN.

4.2.2 Field and Analytical Results

4.2.2.1 Groundwater Elevation

Groundwater bores have been grouped within two main zones, namely: areas above the high water mark i.e. above the highest astronomical tide (HAT) and those below the HAT which are periodically inundated by tidal waters.

Bores above the HAT exhibit seasonal variation in water levels and are more influenced by rainfall recharge while bores below the HAT are influenced by tidal movements. Groundwater levels may also be influenced by the amount of hard stand areas on Site limiting recharge during the wet season.

Groundwater level patterns on Site for the period 2013 to 2019 have indicated the following:

- Groundwater level increases were generally not proportional to the amount of rain recorded each year, potentially driven by the capacity of the uppermost aquifer to absorb seasonal recharge volumes, both south and north of the isthmus; and
- The decrease in groundwater levels during the dry season were noted to be relatively proportional to the amount of rain that occurred during the preceding wet seasons to the south of the isthmus.

Based on the data collected between 2013 and 2019 there have been no observed long term increasing or decreasing trends in groundwater levels on Site. Therefore, it has been assessed that Site activities and discharges have not adversely impacted seasonal groundwater level fluctuations on Site.

4.2.2.2 Salinity

The overall field measured salinity ranged from 0.05 g/L to 93.21 g/L and seasonal variation was evident over the monitoring period and showed consistency with previous years. Groundwater salinity on Site varied depending on proximity to the coastal margins and showed a typical seasonal pattern i.e. increased in the dry season as a result of a lack of rainfall and recharge and decreased in the wet season as a result of increased rainfall and recharge and subsequent groundwater dilution.

Areas of hypersalinity were located in the proximity to the isthmus, the Flare Pad and along the north-western boundary of the Site. A freshwater node was centred around BPGW36 and seasonally around bores BPGW08A, 13A and 14A.

4.2.2.3 pH

Data from the EIS (INPEX Browse, Ltd, 2010) indicated that groundwater pH levels were substantially below the lower limit of the trigger value range (pH 6) prior to the commencement of the Project and were representative of the natural background quality of the groundwater on Site.

During the monitoring period, 77% of the recorded pH values were below the lower limit of the pH trigger value range (pH 6.0). Low pH values were typically recorded in areas with fresh to saline groundwater (not hypersaline) that interacts with natural soils (uppermost aquifer material) that are known to be naturally low in pH.

There was a node of low pH on Site centred around bores BPGW11, 23, 29A, 32 and 34 during this monitoring period, which was also present historically. The size of this node was generally consistent between the dry season and wet season. This was likely due to the lower than normal rainfall recorded in the wet season and the drier than normal dry season that preceded the 2018/19 wet season. This had the effect of concentrating the groundwater at a time when in previous years increased rainfall and recharge was diluting groundwater and reducing the size of the low pH nodes on Site.

There were four primary zones of near-neutral pH that were observed on Site in October, as follows:

- The isthmus and the southern area;
- The central western area at BPGW14A;
- The north-western area at BPGW28; and
- The north-eastern area around BPGW26, 27A, 40, 38A and 41.

Groundwater acidity is naturally occurring because background data have indicated it was present prior to the commencement of construction, it is a known characteristic of the saline aquifer and it is the result of natural processes historically occurring in the area. Acid sulphate soils management has been completed and validated, all major earthworks packages have finished, no groundwater extraction has taken place and all analytical testing undertaken to date has not identified any ASS-related geochemical changes in the groundwater.

Based on the historical background data and results from the current monitoring period, it has been assessed that low pH levels in the groundwater on Site are a result of the natural processes historically occurring in these areas.

4.2.2.4 Groundwater Acidification

There were no new excavations or treatments of ASS in the monitoring period. In order to assess potential groundwater acidification arising from previous ASS disturbance an analysis of the sulphate/chloride ratios was carried out. The *Acid Sulphate Soils Assessment Guidelines* (Acid Sulphate Soil Management Committee NSW, 1998) (ASS Guidelines) states the following:

> *The potential influence from ASS on groundwater quality was assessed using sulphate/chloride ratios. A typical sulphate-chloride ratio for seawater is 0.14 (19,400 mg/L chloride and 2,700 mg/L of sulphate). As the ratios of the dominant ions in saline water remains approximately the same when diluted with rainwater, estuaries, coastal saline creeks and associated groundwater can be expected to have similar ratios to the dominant ions in seawater (Mulvey, 1993). Where the analysis indicates that there is an elevated level of sulphate ions relative to the chloride ions, these results provide a good indication of the presence of acid sulphate soils in the landscape. A Cl-:$SO4_{2-}$ ratio of less than four* [i.e. a sulphate/chloride of ≥ 0.25] *and certainly a ratio less than two* [i.e. a sulphate/chloride ratio of ≥ 0.5]*, is a strong indication of an extra source of sulphate from previous sulphide oxidation (Mulvey, 1993).*

High sulphate/chloride ratios would indicate a potential influence from a sulphate-containing source e.g. ASS oxidation. Lower ratios would indicate a sulphate salt precipitation or dilution with water with minor sulphate content e.g. rainwater. The majority of the results indicated that groundwater on Site had a ratio ≤ 0.25 (**Figure 4-7**), suggesting a negligible influence from sulphate generation sources and some influence from dilution. A few results were noted to exceed the ratio of 0.5 (a strong indicator of a sulphate source). All but one of these results were recorded at BPGW36 and these occurrences were attributed to calcium sulphate (gypsum) which is used in the production of concrete. Localised concrete works were carried out historically near this bore and consistent with previous monitoring periods, these elevated ratios were attributed to this localised source, and not ASS impacts. A similar signal was present in BPGW36 in previous years. A result 0.7 for the SO_4/Cl ratio was calculated for BPGW38A in April 2019. The SO_4/Cl ratio for BPGW38A was calculated for the period dating back to October 2014 (**Figure 4-8**). Elevated ratios in this bore were fairly common towards the end of previous wet seasons but no trends were noted. This was assessed to be result of localised dilution associated with wet season conditions in this area.

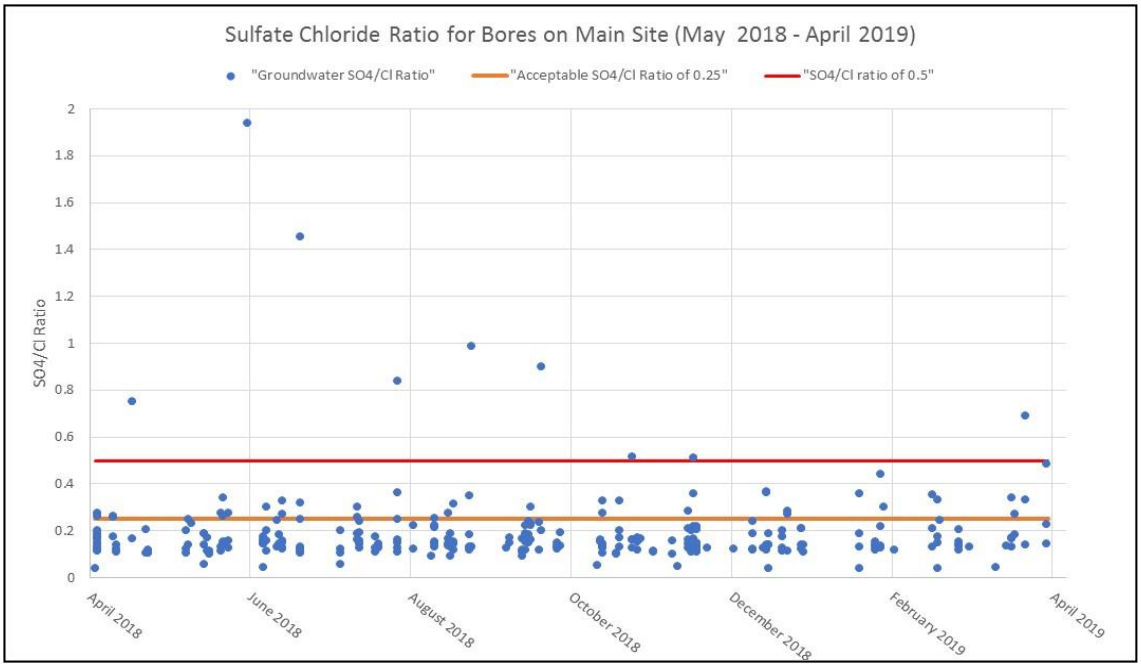

Figure 4-7 Sulphate/Chloride Ratio for Site Bores

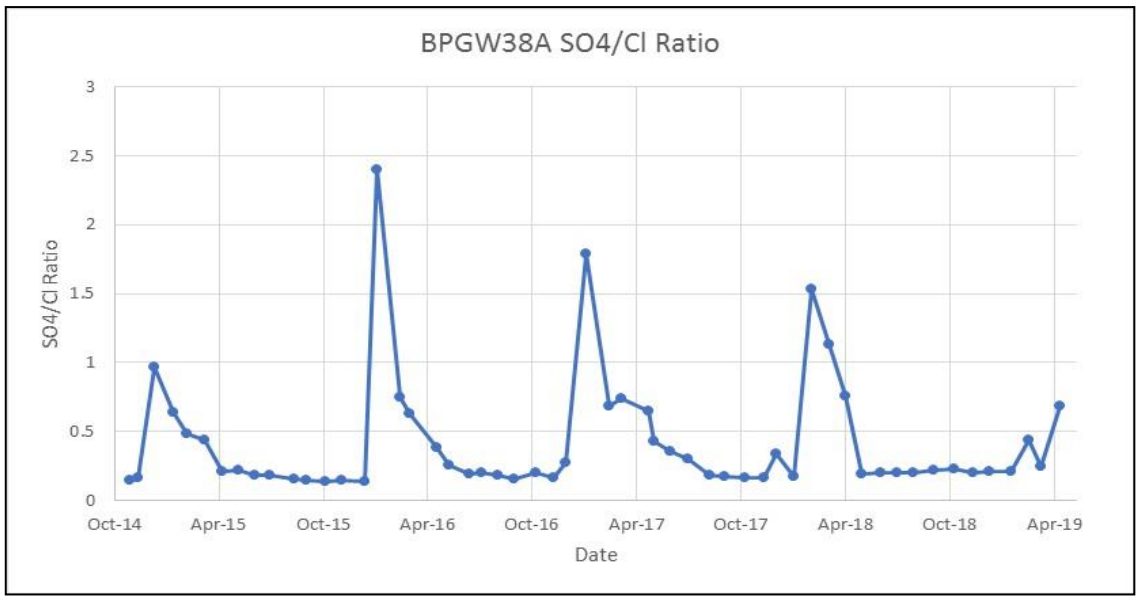

Figure 4-8 Sulphate/Chloride Ratio for BPGW38A

Mann-Kendall statistical trend analysis was also conducted to determine whether there were any statistically significant, increasing trends in sulphate/chloride ratios (indicating potential ASS impacts) and decreasing trends in pH (indicating groundwater acidification) in the bores on Site. The analysis was run with XLSTAT software using both the classic trend analysis and seasonal (12-month period) trend analysis to test for increasing trends as a two-tailed test with a 5% significance level.

As Darwin is located within tropical northern Australia where there are two distinct seasons, the wet and dry, it is appropriate to use the seasonal trend analysis technique.

No watch-list bores on Site displayed a statistically significant, decreasing pH trend and an increasing sulphate/chloride ratio in the monitoring period. This was also true for BPGW36, which exhibited an elevated SO_4/Cl ratio but not a decreasing pH trend over the monitoring period. A comparison of Mann-Kendall classic trend analysis against the seasonal trend technique indicated that the majority of the bores displayed a strong seasonal influence in the sulphate/chloride ratios associated with the wet and dry seasons and in response to groundwater recharge rates. The only exceptions to this included some of the bores located near the coastal margins, where the variations are more influenced by tidal movement than rainfall recharge.

4.2.2.5 Metals

A review of the available baseline data indicated that the metal species exceeding the trigger values in the EIS (INPEX Browse, Ltd, 2010) were similar to those identified in this monitoring period. Also, the observed lateral distribution of metals did not identify any plume-like extents indicative of metal contamination sources on Site. Based on the information reported in the EIS (Appendix 17) the natural onsite soils contain metals which can be mobilised into solution under acidic conditions. Groundwater beneath the Site may contain metals resulting from natural processes involving groundwater interaction with acidic soils which contain acid-extractable metals (Radke *et. al.*, 1998; URS, 2009; NRETAS, 2008).

Metals reported to exceed the adopted trigger levels in the bores on Site during the monitoring period were (all filtered) aluminium, arsenic, cadmium, cobalt, copper, lead, manganese, nickel, silver and zinc. Mercury only exceeded the trigger value once in February 2019.

The following observations were made in regard to metals exceedances:

- Metal exceedances tend to peak towards the end of the dry season and decrease towards the end of the wet season, depending on the proximity to direct rainfall infiltration areas for example direct infiltration would be reduced in sealed areas like roads etc.; and
- The number of metals exceedances generally remained stable or decreased slightly in the wet season in this monitoring period. This was a slightly different pattern to previous, corresponding monitoring periods in that the decreases in metals exceedances in previous wet seasons were much more pronounced. This was attributed to the lower rainfall in both the 2018/19 wet season and the 2018 dry season, but particularly in the wet season which recorded the lowest rainfall since monitoring commenced on the Project in 2013. The effect of this atypical rainfall pattern was that it reduced recharge and groundwater dilution, which led to higher metals concentrations.

An additional observation from the metals results were that elevated concentrations of filtered aluminium, cobalt, cadmium, copper, nickel, and zinc typically correlated with nodes of lower pH on Site. In contrast elevated filtered, total arsenic and manganese concentrations were usually correlated with areas of near neutral pH.

As indicated in previous AEMRs metal concentrations generally followed typical seasonal patterns by increasing in the dry season and decreasing in the wet season and were largely influenced by resulting changes in pH and salinity levels. As outlined above, this pattern was slightly different in this monitoring period in that metals concentrations did not decrease in the wet season to the same degree as previous years and this was attributed to the lower rainfall in the 2018/19 wet season and the preceding 2018 dry season, which led to higher metals concentrations.

A review of the 80th percentile statistical analysis tool (which provides a temporal assessment of metal exceedances), indicated exceedances of the 80th percentile during the monitoring period for aluminium, arsenic, cadmium, cobalt, copper, lead, manganese, nickel, silver and zinc. These results were then compared with isopleths to provide a spatial assessment of metal concentrations. A comparison of the temporal and spatial tools indicated that the 80th percentile exceedances generally correlated with areas of lower pH and did not correspond with known spills.

Based on statistical analysis of the dataset, historical and baseline data, and the results from the monitoring period, it was assessed that elevated metal concentrations detected in the groundwater on Site are naturally occurring and are reflective of seasonal variation.

4.2.2.6 Nutrients

Nutrients that exceeded the adopted trigger values during the monitoring period were ammonia, oxides of nitrogen, total nitrogen, total phosphorus and FRP.

The following observations were made in regard to nutrient exceedances:

- Higher ammonia and lower oxides of nitrogen concentrations correlated with areas with higher salinities and higher pH levels;
- Total phosphorus generally correlated with nodes of low pH on Site; and
- Total nitrogen showed some correlation with low groundwater salinity areas.

Additional observations from the metals results indicated the following:

- The area of elevated ammonia concentrations on Site was smaller in April 2019 compared to October 2018, as a result of increased rainfall and recharge (and dilution) associated with wet season conditions;
  The areas of elevated total nitrogen and oxides of nitrogen concentrations were larger in April 2019 compared to October 2018. This was attributed to increased recharge and infiltration of freshwater passing through organic-rich soils in these areas. In addition, some of the increase in oxides of nitrogen concentrations may have been a result of the conversion of ammonia to oxides of nitrogen as a result of an increase in ORP; and
- There were very fewer FRP exceedances in the dry season compared to the wet season (these increased significantly from November 2018 onwards). This was the opposite trend to total phosphorus, which was consistent with typical seasonal patterns. The increase in FRP exceedances in the wet season may be attributable re-vegetation works in these areas.

A review of the 80th percentile statistical analysis tool indicated some exceedances of the 80th percentile for all analysed nutrient parameters. A comparison of the temporal (80th percentile) and spatial (isopleths) tools indicated that the 80th percentile exceedances corresponded with areas where these exceedances were observed throughout the entire monitoring period since 2012.

Based on statistical analysis of the dataset, historical and baseline data, and the results from the monitoring period, it was assessed that elevated nutrient concentrations detected in the groundwater on Site are naturally occurring and are reflective of seasonal variation.

4.2.2.7 Metals and Nutrients on Watch List

In AEMR (2019), certain bores that recorded increasing trends in metal and nutrient concentrations were placed on a watch-list for further assessment. Part of this assessment included analysis of the sulphate/chloride ratios and pH, in order to determine whether any groundwater acidification and/or ASS impacts were occurring that could be influencing metal and nutrient concentrations.

The process outlined below was followed to develop and assess the AEMR (2019) watch-list for bores, metals and nutrients and to assess the most likely source of any observed trends:

1. The specific metal or nutrient was assessed against the adopted trigger value during the monitoring period and the 80th percentile in January (for those bores removed on 1 February) and April 2019 (for the remaining bores). If the concentration of the metal or nutrient did not exceed either value then it was considered to be reflective of natural, seasonal variation and was not subjected to further statistical analysis.
2. Where the concentrations did not return to within normal seasonal variation (i.e. exceeded the 80th percentile), further assessment using Mann-Kendall trend analysis was carried out.
3. Metal or nutrient concentrations that were found to display a statistically significant, increasing trend, after accounting for seasonal variation, were assessed against the sulphate/chloride ratio and pH Mann-Kendall trend results for the monitoring location. If a location did not display an increasing trend in the sulphate/chloride ratio then the metal/nutrient trend was not attributed to ASS impacts. Similarly, if the location did not show a decreasing trend in pH then no groundwater acidification was considered to have taken place at that location.
4. If a location displayed a decreasing pH trend but no increasing trend in the sulphate/chloride ratio, the increasing acidity (and potential mobilisation of metals) was not attributed to construction and commissioning activities (subject to a review of the environmental incidents register which would confirm whether any leaks and/or spills may have occurred in the vicinity of the specific monitoring location).

The 80th percentile statistical analysis tracks the concentration of analytes over time. It utilises cumulative data to establish if observed concentrations are within acceptable limits i.e. within the 80th percentile of the reported concentrations. As cumulative data are used to establish the 80th percentile and assess if an analyte exceeds seasonal variations, it is appropriate to use the most recent and up-to-date data available. As such, the January/April 2019 80th percentile analysis was the most appropriate dataset to use to determine which parameters required further statistical trend analysis as per the above method. The watch-list was updated with data from the monitoring period and the results are presented below in the AEMR (2019) watch-list (**Table 4-1**).

Table 4-1 AEMR (2019) Watch-list

Bore ID	Analyte	pH Decreasing Trend	SO_4/CL Ratio Increasing Trend
BH602	Ammonia	No	No
BPGW11	Aluminium	Yes	No
	Copper	Yes	No
BPGW18	Total Phosphorus	No	No
BPGW20	Total Phosphorus	No	No
BPGW24	Ammonia	No	Yes
BPGW25	FRP	No	No
BPGW26	Oxides of nitrogen	No	No
BPGW27A	Ammonia	No	No
BPGW28	Copper	Yes	No
BPGW32	Ammonia	No	No
	Total Nitrogen	No	No
BPGW40	Total Phosphorus	Yes	No
	Manganese	Yes	No
ONBH03	Ammonia	No	No
	Total Phosphorus	No	No
VWP341	Ammonia	No	No

Based on the results in **Table 4-1**, no watch-list bores on Site recorded increasing trends for metal and/or nutrient concentrations, and statistically significant, decreasing pH trends and increasing trends in the sulphate/chloride ratio. This confirmed that any source of low pH levels and elevated metals and nutrients in the watch-list bores were not associated with the oxidation of ASS.

A review of environmental incidents during the monitoring period was undertaken to determine whether any spills or leaks had occurred in the vicinity of these bores that could have been a source of the observed trends. The outcome of this review was that there were no incidents that could explain these trends and therefore, spills and leaks were discounted as a potential source. Therefore, any increasing trends in metal and/or nutrient concentrations or decreases in pH were reflective of seasonal influences on the local groundwater quality.

4.3 Mangrove Community Health, Sediments and Bio-Indicators

4.3.1 Monitoring Methodology

Monitoring of mangrove community health, sediments and bio-indicators was undertaken to assess potential impacts from the Site activities on mangrove communities fringing the Site.

Mangrove monitoring occurred at the locations identified on **Figure 4-9**.

The parameters used to monitor mangrove community health were seedling density and species composition, canopy cover, tree condition and benthic community health. These were monitored on a quarterly basis. To complement the collection of this data, photographs were taken of mangroves within the monitoring plots from standard reference points. To monitor for potential sedimentation and erosion effects, surveying of ground level profiles (annually) through tidal flat and mangroves areas and the monitoring of relative sediment heights (quarterly) from within the monitoring plots using fixed marker stakes were used.

Within each mangrove monitoring plot, a sample of sediment from the surface was collected for metal and hydrocarbon analysis within an area of 1 x 1 m. Using a sterile wooden spatula, the sediment surface (top 1 to 5 cm) was scraped and the material directly transferred into a Whirlpak™ bag.

High concentrations of metals and hydrocarbons are potentially toxic to benthic macro-fauna that live within the sediment or at the sediment-water interface (Clark, 2001). Additionally, many organisms that live in or on the sediment are known to accumulate metals and hydrocarbons in their tissue (bioaccumulation) which may cause a threat to human health if consumed. The measurement of metals and hydrocarbons in the tissue of organisms can therefore be used as an indicator for bioavailability of contaminants in the environment (Gay *et al*., 2003). For this particular assessment, a large snail, the mud whelk (*Telescopium telescopium*), was selected as an indicator of bioaccumulation. These bio-indicators were sampled on a quarterly basis to account for seasonal variation.

4.3.2 Results

4.3.2.1 Mangrove Community Health

There were no exceedances of the 30% trigger value for canopy cover during the monitoring period which increased in the majority of survey plots. Impact sites (+5% ± 4 SE) recorded a greater increase compared to reference sites (0% ± 1 SE), which was consistent with previous monitoring periods. Mean canopy cover results were similar at impact sites (91% ± 1 SE) and reference sites (89% ± 2 SE). Across both impact and reference locations the total canopy cover increased in comparison to the background data by 2% (± 2 SE).

Tree condition decreased slightly compared to background data which was consistent with previous monitoring periods. Five exceedances of the 30% trigger value were recorded in the monitoring period, as follows; two reference sites in June 2018 and one reference site (CSMC01-1) in each of September and December 2018 and March 2019. Tree condition remained high with the average percentage of healthy trees marginally higher at reference sites compared to impact sites.

The majority of the impact and reference sites contained seedlings (77% and 92% respectively in December 2018 and 100% of impact and reference sites in March 2019), and regeneration capacity remained high at the majority of survey plots.

Exceedances of the 30% trigger value for pneumatophore and crab burrow density were recorded during the monitoring period at both impact and reference sites. Overall, there was a decline in mean crab burrow density and pneumatophore density at impact and reference sites, and these were assessed to be related to natural, seasonal variation.

Dust was not evident on the leaves of mangrove trees at impact and reference sites during the monitoring period. This was consistent with AEMR (2017) and AEMR (2018) and represented a decrease in dust levels in comparison to AEMR (2016), which recorded light dust levels in June 2015 and light to medium dust levels in September 2015.

The mangrove community health results recorded in this monitoring period were consistent with previous AEMRs and no ecologically significant decline in mangrove community health was detected at the impact sites surveyed during the monitoring period. Where changes were observed these were at impact and reference sites and were assessed to represent natural variation. The results indicated that the mangrove communities located close to the Site have remained in a healthy condition.

4.3.2.2 Sedimentation and Erosion

Relative mean sediment height was surveyed at monitoring plots on a quarterly basis and increases and decreases of more than 5 cm at impact and reference sites were not recorded during the monitoring period. Overall, sediment height decreased very slightly at reference sites but the results were variable with no distinct trend and remained consistent with all previous monitoring periods.

On an annual basis (May 2012, June 2013, June 2014, June 2015, June 2016, June 2017 and June 2018), ground level measurements at monitoring transects are recorded by a surveyor. A review of the annual ground level variation data indicated the following:

- The overall ground level results were consistent with previous monitoring periods;
- Survey point 22006 recorded the largest increase of +8.5 cm, however nearby survey points 22005 and 22004 recorded small variations of +3.6 cm and -2.1 cm, respectively. This result indicated a ground level increase in the Tidal Creek assemblage, however mangrove community health parameters (regeneration, canopy cover and tree condition) remained consistent with background data, indicating that adverse impacts were not recorded in this area; and
- Survey point 17002 (along BPMC17) recorded the largest decrease of -34.6 cm, however nearby survey point 17003 recorded a minor decrease of -1.8 cm. Additionally, mangrove community health parameters recorded at BPMC17 remained consistent with background data, indicating that adverse impacts were not recorded in this area.

The data indicated that there had not been any broad-scale sediment accumulation or erosion during the monitoring period that had impacted mangroves fringing the Site. Within the mangrove environment, there is a dynamic relationship between erosion and sediment deposition resulting from tidal, surface and stormwater runoff including cyclones. Furthermore, most mangroves are tolerant of moderate (i.e. up to 10 mm per year) rates of sediment accretion (Ellison, 1998). Small scale changes in sediment deposition or erosion are not necessarily deleterious to the mangrove environment and should be seen as part of long-term processes driving mangrove habitat development.

Site Boundary

Gas Export Pipeline

Mangrove Transects

Mangrove Transects (Reference Sites)

Mangrove Monitoring Locations

Figure 4-9	INPEX Bladin Point	GREENCAP
Date: 25/06/2019	**Author:** Diego.Correa	
	Map Scale: 1:35,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

Image date: 10 October 2018

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4.3.2.3 Sediment Quality

Exceedances of total metals in sediments were recorded for total arsenic, total antimony and total chromium in the monitoring period. Acid soluble (bio-available) metals in sediments were all below the adopted trigger values during the monitoring period.

The observed bio-available mercury exceedances in September 2017 had returned to below the limit of reporting in the subsequent December 2017, March, June and September and December 2018, and March 2019 monitoring rounds. Similarly, the majority of total mercury concentrations in sediments were below the limit of reporting in the monitoring period.

A more detailed assessment of the potential source(s) of those metals that recorded exceedances in the mangrove sediments in the monitoring period is outlined in **Section 4.3.2.5** below.

The presence of veneers at impacts sites and reference sites indicated that terrestrial sediment deposition was not related to Site activities or discharges. Sediment grain size and moisture content analysis did not show any trend towards increasing or decreasing grain size or composition across the impact and reference sites.

There were no TRH detections in mangrove sediments after silica gel clean-up, with the exception of TRH (C_{15}-C_{28}, C_{16}-C_{34} and C_{10}-C_{36}) at BPMC23 in December 2018, which indicated an anthropogenic source. Assessment of the multiple lines of evidence found the following:

- There were no TRH exceedances recorded at nearby surface water locations (BPSW23 and 24) or in the outfall monitoring in December 2018; and
- A review of construction and commissioning activities did not identify any potential source(s) for this TRH detection.

4.3.2.4 Bio-indicators

Metals and semi-metals in mud whelk tissue were within the adopted trigger values during the monitoring period with the exception of copper and mercury, which were recorded at both impact sites and reference sites in the monitoring period.

Mean mercury concentrations increased in the monitoring period at impact sites and reference sites in comparison to the June 2012 background results and all previous monitoring periods with the exception of AEMR (2016) at impact sites.

Mean copper concentrations increased in comparison to all previous AEMRs and the June 2012 background levels at impact sites and increased at reference sites in comparison to AEMR (2015), AEMR (2017), AEMR (2018) and the June 2012 background levels, and decreased in comparison to AEMR (2014) and AEMR (2016).

There were no hydrocarbons detected in mud whelk tissues during the monitoring period.

A more detailed assessment of the potential source(s) of those metals that recorded exceedances in the bio-indicators in the monitoring period is outlined in **Section 4.3.2.5** below.

Since June 2014, when the frequency of bio-indicator monitoring was revised to quarterly, there has been substantial variability in the data between monitoring periods and between impact sites and reference sites. Some of this variability may be attributed to sample size variation, location, tides, and climatic and seasonal changes.

4.3.2.5 Metals in Sediments and Bio-indicators

Total Arsenic in Sediments

Trigger value (low) exceedances for total arsenic in sediments were recorded at: two impact sites and four reference sites in June 2018; six impact sites and five reference sites in September 2018; four impact sites and three reference sites in December 2018; and, one impact site and three reference sites in March 2019. There was a trigger value (high) exceedance of total arsenic at one impact site in September 2018 and one in March 2019.

Assessment of the multiple lines of evidence found the following:

- The arsenic exceedances were recorded at both impact sites and reference sites;
- There were no corresponding elevated, bio-available arsenic concentrations in the mangrove sediments in the monitoring period;
- Total arsenic exceedances in sediments were typically recorded close to and south of the isthmus, at impact sites BPMC01, 17, 20, 21, 22, 23 and 24. Sites BPMC01, 20, 21, 22 and 24 are located in close proximity to the isthmus and groundwater bores BPGW09, 10, 13A and MW20b which have historically recorded elevated arsenic concentrations. It was assessed that the consistently elevated arsenic concentrations at these locations are related to their close proximity to the isthmus, an area of known groundwater expression. Groundwater is known to historically egress at the isthmus during periods of higher groundwater elevation as a result of recharge following rain events; and
- With the exception of BPMC17, 20 and 24, there were no exceedances north of the isthmus where the major portion of the construction works were occurring in the monitoring period.

Given that the above exceedances were recorded at both impact sites and reference sites in the monitoring period they were not related to Site activities and discharges.

Mann-Kendall statistical analysis indicated there were no increasing trends for arsenic in mangrove sediments (and bio-indicators) and there was no decline in mangrove community health parameters).

Total Antimony and Total Chromium in Sediments

An exceedance for total antimony in sediments was recorded at one reference site in June 2018, two reference sites in December 2018 and at one impact and one reference site in March 2019.

One total chromium exceedance was recorded at a reference site in each of June and September, two impact sites and one reference site in December 2018 and at two impact sites and one reference site in March 2019.

Given that these exceedances were recorded at both impact sites and reference sites or reference sites only, they were not related to Site activities and discharges.

Mann-Kendall statistical analysis indicated there were no increasing trends for total antimony and total chromium in mangrove sediments and bio-indicators.

Mercury in Bio-indicators

Exceedances for mercury in bio-indicators were recorded at: one reference site in June 2018; one impact site and one reference site in September 2018; one impact site and three reference sites in December 2018; and, two reference sites in March 2019.

Assessment of the multiple lines of evidence found the following:

- The mercury exceedances were recorded at both impact sites and reference sites or reference sites only;
- There were no corresponding elevated, total or bio-available mercury concentrations in the mangrove sediments in the monitoring period; and
- Filtered mercury did not exceed the trigger value in groundwater wells during the monitoring period, with the exception of one exceedance at BPGW29A in February 2019, however this location is not upstream of the impact site detection at BPMC26. Furthermore, there were no increasing mercury concentrations in groundwater wells upstream of the mangrove sampling locations, with mercury concentration remaining less than the limit of reporting on all but one occasion.

Given that the above exceedances were recorded at both impact sites and reference sites in the monitoring period they were not related to Site activities and discharges.

Mann-Kendall statistical analysis indicated there were no increasing trends for mercury in bio-indicators or mangrove sediments during the monitoring period, with the exception of an increasing trend in bio-indicators at one reference site in March 2019. Furthermore, there was no decline in mangrove community health parameters during the monitoring period.

Copper in Bio-indicators

Exceedances for copper in bio-indicators were recorded at one impact site and one reference site in June, and one impact site and two reference sites in September 2018. Assessment of the multiple lines of evidence found the following:

- The copper exceedances were recorded at both impact sites and reference sites;
- There were no corresponding elevated, total or bio-available copper concentrations in the mangrove sediments in June and September 2018; and
- Filtered copper did not exceed the trigger value in nearby groundwater wells in June and September 2018, and there were no increasing copper concentrations in groundwater wells nearby and upstream of the mangrove sampling locations, with copper concentrations remaining less than the limit of reporting.

Given that the above exceedances were recorded at both impact sites and reference sites in the monitoring period they were not related to Site activities and discharges.

Mann-Kendall statistical analysis indicated there were no increasing trends for copper in bio-indicators (or mangrove sediments) and there was no decline in mangrove community health parameters during the monitoring period.

Trends for Aluminium, Iron and Manganese in Sediments and Bio-indicators

Mann-Kendall statistical analysis of metals in sediments and bio-indicators indicated that there were no increasing trends for aluminium and iron at impact sites and reference sites.

An increasing trend for manganese concentrations in sediments (total and bio-available) was observed at one impact site (BPMC22), which was consistent with AEMR (2018). There were no reported environmental incidents during the monitoring period in the vicinity of BPMC22 during the monitoring period and there were no corresponding increasing trends in manganese concentrations in bio-indicators. Based on this evidence, it was assessed that the increasing trend for manganese in the sediments at BPMC22 was not a result of Site activities and discharges.

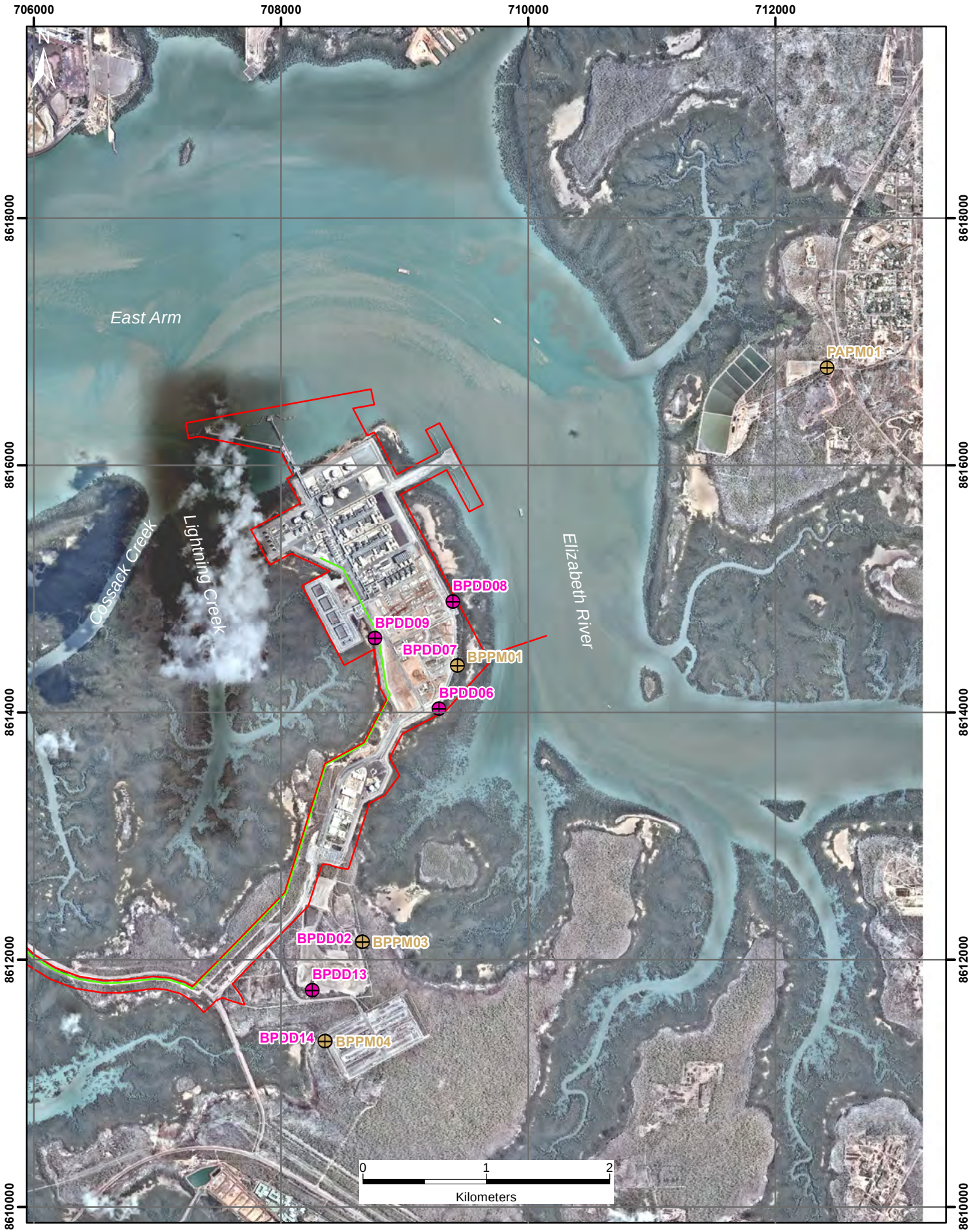
4.4 Air Quality (Dust)

4.4.1 Monitoring Methodology

The objective of the dust monitoring program is to assess whether Site dust is giving rise to exceedances of the approved trigger values at identified sensitive receptors.

The dust monitoring program comprised the collection of particulate matter of 10 micrometres or less in size (PM_{10}) near residential sensitive receptor locations in Palmerston (PAPM01) and Bladin Central Enterprise Park (BPPM04), and dust deposition rates at the Site to monitor dust impacts in mangrove communities fringing the Site.

During the monitoring period, air quality monitoring occurred at the locations set out in **Figure 4-10**.



Site Boundary

Gas Export Pipeline

Dust Monitoring Location (Dust Deposition Sample)

Dust Monitoring Location (Particulate Matter Sample)

Image date: 10 October 2018

Dust Monitoring Locations

Figure 4-10	INPEX Bladin Point	GREENCAP
Date: 25/06/2019	**Author:** Diego.Correa	
	Map Scale: 1:40,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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4.4.2 Results

4.4.2.1 PM_{10}

During the monitoring period, there were 33 PM_{10} exceedances at PAPM01. There were no exceedances of the trigger value for 24-hour averaged dust levels recorded during vector-averaged south-westerly winds, which are the winds that blow along the impact pathway from Site towards Palmerston.

There were 155 PM_{10} exceedances at BPPM04 during the monitoring period and 25 of these exceedances were recorded during vector-averaged northerly winds, which are winds that blow along the impact pathway from Site towards the Bladin Central Enterprise Park. However, there were no construction-related dust complaints in the monitoring period.

4.4.2.2 Dust Deposition

There were no exceedances of the trigger value recorded at PADD01 and BPDD14 during the monitoring period. There were no construction-related dust complaints during the monitoring period.

Dust deposition gauges on Site provided data on potential impacts on the mangrove communities fringing the Site. The trigger value was exceeded 5% of the time on Site during the monitoring period. Mangrove communities fringing the Site remained in a healthy condition during the monitoring period and were not affected by dust deposition.

4.5 Airborne Noise

4.5.1 Monitoring Methodology

The objective of the airborne noise monitoring program is to assess whether Site noise is giving rise to exceedances of the adopted noise trigger values at identified sensitive receptors

Monitoring occurred at three locations during the monitoring period (**Figure 4-11**).

4.5.2 Results

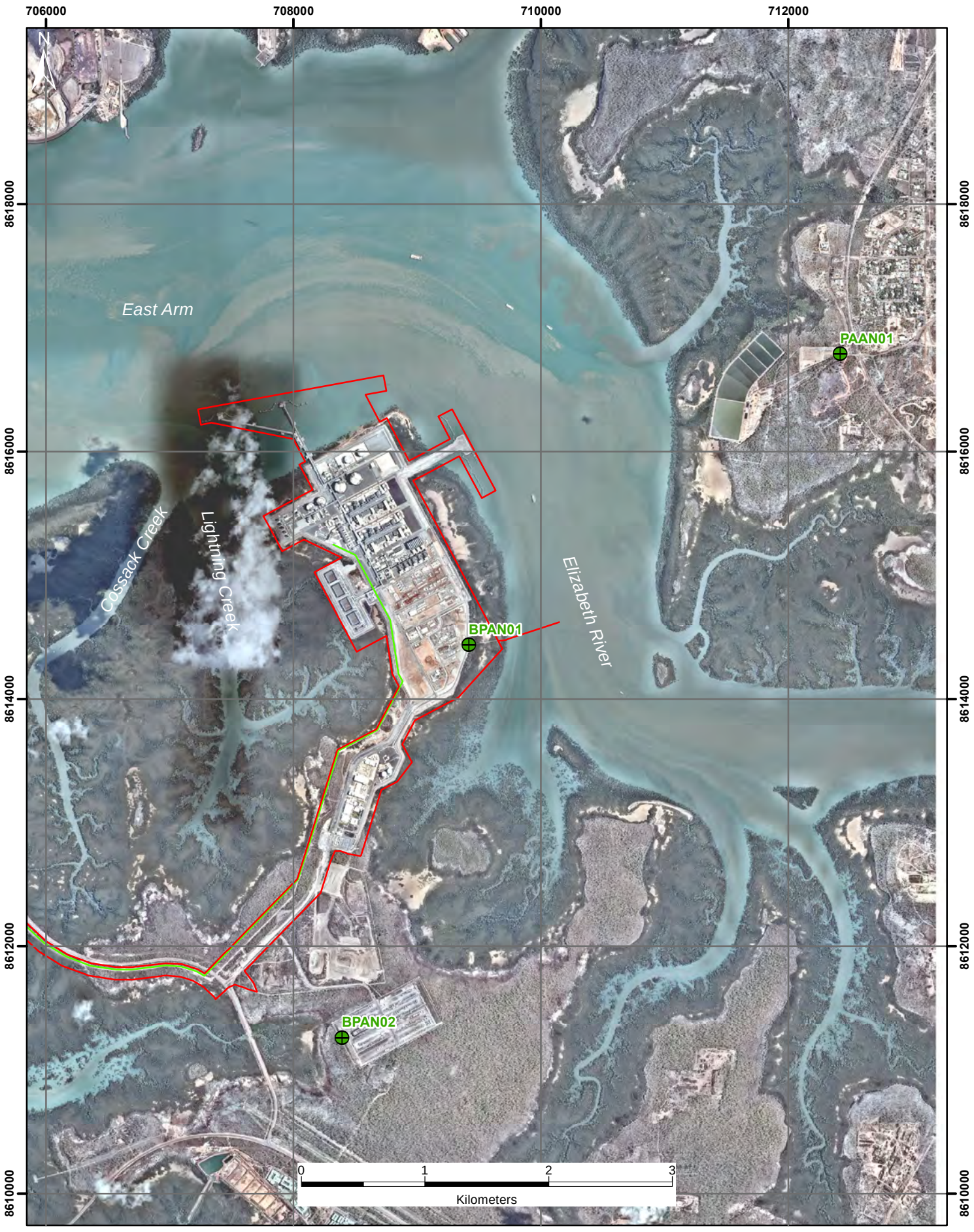
Results from BPAN01 remained relatively consistent over the monitoring period, ranging from 38.7 to 67.6 dB(A) during the day and 41.6 to 65.4 dB(A) at night. The noise-generating activities included Site activities such as traffic, machinery, general construction activities, steam blowing and gas flaring activities.

Following audio file analysis, it was assessed that the noise exceedances recorded at PAAN01 during the monitoring period were mainly caused local activities (e.g. motor vehicles, passing trains, airplanes, farm activity) and natural noise sources (e.g. birdsong, frogs, insects and rain). In addition, flaring, steam blowing and alarm system testing activities were audible at PAAN01 in the monitoring period.

The majority of day-time and night-time exceedances at BPAN02 were caused by natural noise sources such as weather, insects and bird song. Those exceedances not caused by natural sources were caused by Site activities such as traffic, machinery and general construction noise within the laydown area. In addition, steam blowing, alarm system testing and non-construction related activities (e.g. flaring) were audible at BPAN02 in the monitoring period.

Based on noise attenuation monitoring undertaken previously, in order for there to be an exceedance of the trigger value at Bladin Central Enterprise Park there would need to be a noise level of 109 dB(A) in the day-time and 99 dB(A) in the night-time at noise monitoring location (BPAN02). The data collected during the monitoring period indicated that there were no noise levels of this magnitude at BPAN02.

No construction-related noise complaints were received during the monitoring period.



Site Boundary

Gas Export Pipeline

Noise Monitoring Locations

Noise Monitoring Locations

Figure 4-11	INPEX Bladin Point	GREENCAP
Date: 25/06/2019	**Author:** Diego.Correa	
	Map Scale: 1:40,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

Image date: 10 October 2018

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4.6 Flora and Fauna

The flora management objectives identified in the CEMP were to minimise disturbance to flora and alteration of mangrove communities outside the Site boundary due to Site activities. The fauna management objective was to avoid injury or death to native terrestrial fauna as a result of Site activities or discharges from Site.

No vegetation clearing or ponding occurred during the monitoring period.

The majority of fauna interactions reported related to observations of fauna that were active on Site. A variety of fauna sightings/encounters were recorded in a fauna register, including birds, snakes and wallabies. The following reported environmental incidents relating to fauna were recorded during the monitoring period:

- A deceased Golden Tree Snake due to a suspected vehicle interaction;
- An injured falcon found in a Contractor office car park due to a suspected vehicle interaction;
- Three instances of wallaby mortality due to vehicle interactions;
- Two instances of injured bats, including one found within the CCPP crib area and another located within the CCPP mixing bay; and
- Three juvenile birds that were found on the office access stairs.

4.7 Weeds

The objective identified in the CEMP is to prevent the introduction of new weed species to the Site and the spread of declared weed species and WONS within the Site.

The Site has mostly been cleared of vegetation and is heavily compacted and stabilised to allow for construction operations. The northern portion of Site is predominantly sealed in impermeable surface or covered with rock chip thus minimising the opportunity and potential for weed species to become established. The drains are lined and are a barrier to weed growth. Additionally, the northern section of the Site is completely surrounded by intertidal mangrove habitats and associated salt flats which has historically acted as a barrier to weed invasion.

Two Class B declared species were recorded during the monitoring period, namely Horehound and Gamba Grass. Both of these species were recorded in the EIS (2008), indicating that they did occur on Site prior to the commencement of the Project.

Results from weed surveys undertaken in the monitoring period identified that the occurrence of declared weeds was mainly centred around the north-eastern Site perimeter and the Site access road verge. The majority of Horehound and Gamba Grass infestations along the Site access road had been recorded during previous surveys.

No new declared weed species were recorded during the monitoring period.

5. RISK ASSESSMENT

The risk assessment used in this report is aligned with the environmental risk identification process contained in the CEMP and the risk ratings contained in the Environmental Risk Register (ERR) (Appendix C of the CEMP). The Risk Register is a collation of the Projects risks generated from the various Environmental Risk Assessments that have been undertaken.

A detailed Conceptual Site Model was prepared for Site which outlines the sources, pathways and receptors that the EIMP is designed to monitor and provides data to assess the relevant lines of evidence. Impacts are assessed using spatial, temporal and statistical assessment of data points and are investigated using the key inter-relationships between the environmental parameters and the source-pathway-receptor linkages. The AEMR assessed multiple lines of evidence to determine if the signal detected is attributable to Site activities and/or discharges, or to a source not related to the Project.

The data collected were also used to inform management plans and tools that included the CEMP and the ERR to support the mitigation of the major environmental risks posed by Site activities and discharges. The risk assessment has been updated to reflect Project staging and emerging risks as identified from updates to the Risk Register and monitoring data collected.

5.1 National Environmental Protection Measure Requirement

In accordance with the NEPM (2013), environmental risk assessment is based on identifying plausible source-pathway-receptor linkages and then assessing the magnitude of the risk of an adverse effect. If there is no linkage between a source and a receptor (i.e. no pathway), then there is no inherent risk.

The estimate of risk used in this report is qualitative (e.g. low, moderate, high and critical) and is based on the potential for exposure (likelihood) and the potential magnitude of environmental impacts (consequences) which results in changes in the risk profile. These risk factors are described further in Table 5-1 of CEMP.

This risk assessment makes a qualitative assessment of risk via comparison with environmental criteria for potential source-pathway-receptor linkages in the CEMP and the ERR. The best application of these criteria for beneficial use is specific to surface water and groundwater, as opposed to other environmental parameters considered in accordance with the Darwin Harbour WQOs. However, the groundwater and surface water beneficial use criteria apply to the broader environment including ecotoxicology, flora and fauna protection, commercial use relating to primary and secondary use of waters and agricultural purposes for marine and surface activities (DLRM, 2010a; DLRM, 2010b). It should be noted that a beneficial use assessment was undertaken in the AEMR (2014) that is still applicable and assessed that the only applicable beneficial use at the present time for groundwater at the Site was for environmental purposes. Other potential future uses not applicable to the Site included agriculture, public water supply, rural stock and domestic supply.

5.2 Surface Water Monitoring

5.2.1 Qualitative Risk Assessment

According to the risk assessment approach the potential sources of impacts were noted as construction and commissioning activities influencing surface water quality from the Site into the immediate surroundings including adjacent land, intertidal areas and receiving surface waters. The impact pathways include surface water discharges into the receiving environment.

Receptors include: the landward mangrove habitat; seaward mangrove habitat; intertidal and soft bottom benthic habitats and ecosystem; the water column; and, the aquatic megafauna in Darwin Harbour.

5.2.2 Surface Water Quality Assessment

Surface water physico-chemical parameters (pH, ORP, temperature, salinity, DO, EC, turbidity and TSS) displayed similar patterns to previous monitoring periods (e.g. water temperature, salinity and EC varied seasonally depending on changes in air temperature and rainfall).

The metals and nutrients that exceeded the trigger values in the monitoring period included (all filtered) aluminium, arsenic, copper, mercury, zinc, ammonia, total nitrogen, oxides of nitrogen, total phosphorus and FRP.

In June, three impact sites (BPSW23, 24 and 31) located in the Elizabeth River to the east of the Site recorded hydrocarbon exceedances after silica clean-up. However, there was no consistent spatial pattern observed with three adjacent sites that did not exceed for hydrocarbons and a review of construction activities did not identify a Site-based source for these exceedances.

There were three instances (two in June and one in July) where TSS exceedances were recorded in the Jetty Outfall monitoring. Investigations concluded that these exceedances were not recorded in the source characterisation sampling, and elevated concentrations were also present in the upstream reference site or were typical of the ambient concentrations in the receiving environment at the time of the EIMP monitoring. It was concluded that these exceedances were a result of seasonal variation and the potential for environmental harm in the receiving environment receptors (e.g. water column, soft bottom benthic) was low based on the low chlorophyll-a concentrations in the marine receiving environment at the time.

The majority of the physico-chemical, nutrient, metal and hydrocarbon exceedances that occurred in the monitoring period were recorded at impact sites and reference sites. Where exceedances were recorded at impact sites only, data from outfall monitoring, rainfall patterns (to determine if there was a passive discharge pathway) and environmental incidents during the monitoring period (e.g. spills, leaks) were assessed to determine the source for these exceedances. These assessments concluded that Site activities and discharges were not the source of the exceedances that were recorded at impact sites only in the monitoring period.

5.3 Groundwater Monitoring

5.3.1 Qualitative Risk Assessment

According to the risk assessment approach, the potential sources of impact to groundwater were earthworks, ground improvement works, ASS and spills. The impact pathway is ingress/inflow of contaminated water into groundwater and migration offsite. Receptors include the mangrove habitats and other ecosystems in Darwin Harbour.

5.3.2 Groundwater Levels and Quality

The objectives of the groundwater monitoring were to minimise changes in groundwater levels and quality resulting from construction and commissioning activities.

Groundwater level fluctuations in bores located above the HAT (mostly in the centre of the Site) were a result of seasonal rainfall and recharge, while bores located below the HAT (mostly along the perimeter of the Site) were more influenced by tides.

Based on the historical background data and results from the groundwater monitoring that was undertaken during the monitoring period, there were no observed increasing or decreasing trends in groundwater levels outside of normal seasonal variation.

The groundwater pH data recorded in the monitoring period were broadly consistent with previous monitoring periods i.e. pH decreased as a result of a lack of rainfall and recharge in the dry season and increased in the wet season as a result of increased rainfall, recharge and dilution of the groundwater on Site.

Metals reported to exceed the adopted trigger levels during the monitoring period were (all filtered) aluminium, arsenic, cadmium, cobalt, copper, lead, manganese, nickel, silver and zinc. Mercury exceeded the trigger value on one occasion in February 2019.

Overall, the percentage of bores with metals exceedances either remained stable or decreased slightly towards the end of the 2018/19 wet season. The decrease in metals exceedances during the wet season was not nearly as pronounced as previous monitoring periods and this was attributed to the lower rainfall (and recharge) that was recorded in the monitoring period (both the dry season and wet season). The monsoons also arrived late this monitoring period and significant rainfall events only started in mid-to-late January 2019 as opposed to mid-December in previous years.

A review of the 80th percentile statistical analysis tool (which provides a temporal assessment of metal exceedances), indicated exceedances of the 80th percentile during the monitoring period for aluminium, arsenic, cadmium, cobalt, copper, lead, manganese, nickel, silver and zinc. These results were then compared with isopleths to provide a spatial assessment of metal concentrations. A comparison of the temporal and spatial tools indicated that the 80th percentile exceedances generally correlated with areas of lower pH.

The nutrients that exceeded the adopted trigger values were ammonia, oxides of nitrogen, total nitrogen, total phosphorus and FRP. A similar pattern to metals was observed for nutrients in that any increases or decreases in concentrations in the wet season were not as pronounced as previous monitoring periods.

A review of the 80th percentile statistical analysis tool indicated some exceedances of the 80th percentile for all analysed nutrient parameters. A comparison of the temporal (80th percentile) and spatial (isopleths) tools indicated that the 80th percentile exceedances corresponded with areas of underlying mangrove muds and did not correspond with known spills. Based on statistical analysis of the dataset, baseline data and the results from the monitoring period, it was assessed that elevated nutrient concentrations detected in the groundwater were naturally occurring and were related to natural nutrient cycling.

Mann-Kendall statistical analysis was conducted to determine whether there were any statistically significant, increasing trends in metal and nutrient concentrations (indicating mobilisation), decreasing pH trends (an indicator of groundwater acidification) and increasing trends in sulphate/chloride ratios (an indicator of ASS impacts) in the watch-list bores on Site. No watch-list bores on Site that recorded increasing trends for metal and/or nutrient concentrations displayed a statistically significant, increasing trend in the sulphate/chloride ratio and a decreasing trend in pH. This confirmed that any source of low pH levels and elevated metals and nutrients in the watch-list bores were not associated with the oxidation of ASS.

A review of environmental incidents during the monitoring period that occurred in the monitoring period was undertaken to determine whether any spills or leaks had occurred in the vicinity of these bores that could have been a source of the observed trends. The outcome of this review was that there were no incidents that could explain these trends and therefore, spills and leaks were discounted as a potential source. Therefore, any increasing trends in metal and/or nutrient concentrations or decreases in pH were reflective of seasonal influences on the local groundwater quality.

Based on multiple lines of evidence including temporal, spatial, statistical, geochemical and historical evidence it has been determined that any changes in groundwater quality, including pH, metals and nutrients on Site were a result of seasonal variation.

5.3.3 Mangrove Community Impacts

The mangrove objective for the groundwater monitoring was to minimise the disturbance to, and alteration of, mangrove communities as a result of changes to groundwater levels and quality arising from construction and commissioning activities. No ASS impacts on mangroves were observed during the monitoring period and the mangrove systems adjacent to the Site were in a healthy condition. The data collected were consistent with previous monitoring periods.

5.4 Mangrove, Sediments and Bio-indicator Monitoring

5.4.1 Qualitative Risk Assessment

Objectives of the mangrove community health, sediment and bio-indicator monitoring include minimising the disturbance to, and alteration of, mangrove communities outside the Site boundary due to Project activities.

5.4.2 Mangrove Community Health

Mangrove community health exceeded the 30% trigger value for the following parameters during the monitoring period: tree condition on five occasions at reference sites; pneumatophore density on nine occasions at reference sites; and, crab burrow density on 11 occasions at impact sites and 13 occasions at reference sites. Although change was recorded for tree condition, pneumatophore and crab burrow densities, these exceedances were recorded at impact sites and reference sites or reference sites only and were a result of natural heterogeneity.

Although change was recorded for tree condition, pneumatophore and crab burrow densities, these exceedances were recorded at both impact sites and reference sites or reference sites only and were therefore not attributed to Site activities and discharges.

Seedling counts decreased at impact sites and at reference sites during the monitoring period compared to background data. The majority of impact and reference sites contained seedlings in the monitoring period and regeneration capacity remained high at the majority of the sites.

Changes in pneumatophore and crab burrow density between the background data and results from the March 2019 survey were minimal, recording an overall decrease in density at impact sites and at reference sites. It was assessed that these changes were a result of seasonal variation.

Canopy cover increased at all sites in comparison to background data and results showed minimal change with the patterns observed representing minor ecological variation. Dust was not evident on the leaves of mangrove trees at both impact and reference sites during the monitoring period. Tree condition recorded a slight decline at impact sites and reference sites which was consistent with previous monitoring periods. Overall, the mangrove communities fringing the Site have remained in a healthy condition and have not diminished since the pre-construction period.

Overall, the mangrove communities fringing the Site have remained in healthy condition and have not diminished since the pre-construction period.

5.4.3 Sedimentation and Erosion

The quarterly relative sediment height results indicated that there were no exceedances of the sedimentation and erosion trigger values and relative sediment heights remained stable in the monitoring period.

The annual ground level survey results indicated that overall ground level variations were consistent with previous monitoring periods. The largest increase was recorded at BPMC22 (+8.5 cm) and the largest decrease was at BPMC17 (-34.6 cm), in the Hinterland Margin and Tidal Creek assemblages respectively. However, the majority of nearby survey points to these locations recorded minor ground level variations and there were no ecologically significant declines in mangrove community health parameters recorded at these two locations in comparison to background data. All other ground level variations were minor in nature.

5.4.4 Sediment Quality and Bio-Indicators

Total metals in sediments were within the adopted trigger values with the exception of total arsenic, total antimony and total chromium. Acid soluble (bio-available) metals in sediments were all below the adopted trigger values during the monitoring period.

Total metals in mud whelk tissue were within the adopted trigger values with the exception of copper and mercury.

Given that the metal exceedances in mangrove sediments and bio-indicators were recorded at impact sites and reference sites or reference sites only they were not related to Site activities or discharges.

Mann-Kendall statistical analysis indicated that there were no statistically significant, increasing trends for metals in mangrove sediments and bio-indicators, except for total manganese in sediments at one impact site, which was assessed to be unrelated to Site activities and discharges, and an increasing trend for mercury in bio-indicators at one reference site.

Total recoverable hydrocarbons in mangrove sediments were detected on 11 occasions at impact sites and 15 occasions at reference sites in the monitoring period. No detections were recorded after silica gel clean-up, indicating that these detections were from natural sources, with the exception of TRH (C_{15}-C_{28}, C_{16}-C_{34} and C_{10}-C_{36}) at one impact site in December 2018. There were no TRH exceedances recorded at nearby EIMP surface water locations or in outfall monitoring in this month. There was no consistent spatial pattern observed and a review of construction activities did not identify a Sie-based source for these exceedances. There were no TRH detections in mud whelk tissues during the monitoring period.

5.5 Dust Monitoring

5.5.1 Qualitative Risk Assessment

According to the risk assessment approach the potential sources of impact were earthworks and general construction and commissioning activities, the impact pathway is winds blowing from Site and the receptors were mangroves fringing the Site and community sensitive receptors located in Palmerston and Bladin Central Enterprise Park.

5.5.2 Dust Impacts on the Environment

No PM_{10} exceedances were recorded at PAPM01 during 24-hour vector-averaged south-westerly winds (i.e. along the impact pathway) and therefore, it was assessed that Site activities had not resulted in dust impacts at sensitive receptors located in Palmerston.

Twenty-five PM_{10} exceedances were recorded at BPPM04 during 24-hour vector-averaged northerly winds (i.e. along the impact pathway), however there were no construction-related dust complaints during the monitoring period.

There were no exceedances of the dust deposition trigger value recorded at PADD01 (Palmerston) and BPDD14 (Bladin Central Enterprise Park) during the monitoring period.

Dust deposition gauges on Site provided data on potential impacts on the mangrove and hinterland vegetation communities fringing the Site. The trigger value was exceeded 14% of the time on Site during the monitoring period, however mangrove monitoring determined that the mangrove communities fringing the Site remained in a healthy condition and were not affected by dust deposition.

5.6 Airborne Noise Monitoring

5.6.1 Qualitative Risk Assessment

According to the risk assessment approach the potential source of impact was general construction and commissioning activities, the impact pathway was sound propagation through air (as a longitudinal wave) and sensitive receptors are in Palmerston and Bladin Central Enterprise Park.

5.6.2 Noise Impacts to Local Community

No construction-related noise complaints were received during the monitoring period.

The day-time and night-time noise levels recorded at PAAN01 were evaluated with reference to available audio files and were a result of local activities (e.g. motor vehicles, passing trains), animal sounds (e.g. frogs and insects) and non-construction related activities (e.g. flaring).

Assessment of available audio files collected from BPAN02 indicated that the noise levels were a result of vehicle reversing alarms, heavy vehicle movements that were operating in the laydown area, natural noise sources (e.g. insects and birds) and non-construction related activities (e.g. flaring). However, noise attenuation analysis indicated that these events would not have caused an exceedance of the residential trigger values at the Bladin Central Enterprise Park.

Noise levels at BPAN01 remained relatively consistent over the monitoring period and ranged from 38.7 to 67.6 dB(A) during the day and 41.6 to 65.4 dB(A) at night.

5.7 Flora and Fauna Monitoring

5.7.1 Qualitative Risk Assessment

According to the risk assessment approach, the potential sources of impact were vegetation clearing and ponding water (specific to mangroves) and Project activities causing injury or death to native terrestrial fauna. The receptors were mangrove flora and terrestrial flora on Site.

5.7.2 Flora and Fauna

No vegetation clearing or ponding occurred during the monitoring period.

A variety of fauna sightings/encounters were recorded in a fauna register, including birds, snakes and wallabies. There were eight reported environmental incidents relating to fauna during the monitoring period, which comprised vehicle interactions with wallabies, a bird and a snake, two injured bats and three juvenile birds found on the office access stairs.

5.8 Weed Monitoring

5.8.1 Qualitative Risk Assessment

According to the risk assessment approach the potential sources of impact were general Site activities, vehicles and clearing activities. The pathway is the movement of weed/pest species and the receptors were natural vegetation communities surrounding the Site.

5.8.2 Weed Management

The Site has mostly been cleared of vegetation and is heavily compacted and stabilised to allow for construction operations. The compaction of the soil minimises the opportunity and potential for weed species to become established. Additionally, the northern section of the Site is completely surrounded by intertidal mangrove habitats and associated salt flats which has historically acted as a barrier to weed invasion.

Two Class B declared species were recorded during the monitoring period, namely Horehound and Gamba Grass. Both of these species were recorded in the EIS (2008), indicating that they did occur on Site prior to the commencement of the Project.

The declared weed species with the highest recorded abundance in the monitoring period was Horehound followed by Gamba Grass. Declared weeds occurred in previously recorded areas and the majority were isolated and sporadic occurrences in low densities (median densities <1% ground cover or 1 or 2 plants).

Weed control measures undertaken between November 2018 and April 2019 were relatively effective in controlling weed growth during the peak active growth period in the 2018/19 wet season.

5.9 Adaptive Response Monitoring

5.9.1 MOF Diesel Spill

On 14 November 2017, a diesel spill was identified at the rear of crib room facilities located on the MOF causeway. The origin of the spill was a portable generator with a fuel cell that was providing power to the crib room and ablution facilities. The volume of diesel lost to ground was estimated to be approximately 1,800 L.

Within the monitoring period, on-going attenuation sampling was completed with samples collected from the downstream surface waters and MOF sumps.

Surface water monitoring was undertaken during June immediately downstream of the spill site during periods of greatest risk i.e. spring high tide cycles, with all reported results less than the laboratory LORs. The sump water monitoring that was undertaken during the monitoring period demonstrated a significant reduction in hydrocarbon concentrations in groundwater since the commencement of monitoring and did not detect any hydrocarbons (following silica gel clean-up) exceeding the remediation goal criteria in either sump since 30 July 2018. The remediation objectives were met and monitoring concluded in December 2018.

5.9.2 Environmental Demobilisation Plan

As construction activities have progressively concluded, demobilisation of temporary construction facilities and rehabilitation has been undertaken to bring the Site to the final configuration for the operations phase of the facility.

The CEMP outlines that demobilisation of the temporary Site facilities will be consistent with the *Bladin Point Environmental Demobilisation Plan* (JKC Australia LNG Pty Ltd, 2018) (L290-AB-PLN-10561). The plan provides the environmental assessment requirements applicable to demobilisation for package construction activities and temporary structures at Site.

Site Areas have been assessed and areas of low, moderate and high risk have been identified based on land use (i.e. potentially contaminating activity) and any spills from the environmental incidents register that require further attention, were identified. A Suitably Qualified Person (SQP) has reviewed the low and moderate risk sites through review of the spill register, loss prevention inspections (LPI's) and any assessment or validation sampling completed. The review outcome recommended further assessment relating to a number of Site Areas and incidents. These assessments have been progressively completed through Loss Prevention Inspections and with some Site Areas subject to Detailed Site Investigations (DSIs).

Detailed Site Assessments (DSIs) were undertaken for high-risk Site Areas and DSIs were completed in accordance with NEPM (2013) and were reviewed and endorsed by the SQP. The findings validate that the remaining in-situ soils, following the reinstatement of ground levels during the demobilisation process, are free of contaminants of potential concern associated with the historical use and that the areas are suitable for on-going commercial/industrial land use with no requirement for future assessment or remediation. On-going environmental monitoring to date has not detected any Project-related impacts to groundwater and mangrove sediments.

5.10 Changes to the Monitoring Scope

In accordance with the approved adaptive management process in EIMP (Rev 10) changes were made to the applicable monitoring scope. The changes were detailed following an evaluation of the risk source(s) and source-pathway-receptor relationships, evaluation of the available monitoring dataset and a comprehensive assessment of multiple lines of evidence.

Applicable changes made on 1 February are outlined in **Chapter 6** while the applicable changes made on 30 April 2019 are outlined in **Chapter 7**. Based on the approved EIMP adaptive management process and the information outlined in AEMR (2019), environmental monitoring ceased on 30 April 2019.

6. RISK RATINGS AND CHANGES TO MONITORING SCOPE (FEBRUARY 2019)

6.1 Risk Ratings

Based on the consideration of construction and commissioning activities in the monitoring period and a comprehensive assessment of potential environmental impacts outlined in **Chapters 4** to **11** of AEMR (2019), residual risk ratings were assigned to those activities and impacts relevant to the period between 1 May 2018 and 31 January 2019 (**Table 6-1**).

These ratings are based on the risk assessment methodology outlined in Section 5.1 'Environmental Risk Assessment Framework' and Appendix C 'Environmental Risk Register' in the CEMP.

6.2 Changes to Monitoring Scope (1 February 2019)

Once construction and commissioning activities ceased the risk sources related to those activities were removed. As a result, there was a reduction in the scale of relevant activities and redundancy in specific monitoring scopes.

Based on the adaptive management process in EIMP (Rev 10) and the detailed assessment of monitoring results outlined in AEMR (2019), a number of changes to the monitoring scope were made on 1 February 2019. Assets that were removed are outlined in **Table 6-2** and the revised monitoring scope implemented on 1 February 2019 is outlined in **Table 6-3**. The monitoring focussed on on-going potential environmental risks associated with remaining construction, pre-commissioning, commissioning and demobilisation of temporary facilities with Site Areas B200 and E600.

Table 6-1 Risk Ratings (1 May 2018 to 31 January 2019)

Activity[1,2]	Potential Environmental Impact[3]	Residual Risk						Comments
		CEMP Revision 2			2019 AEMR			
		Severity	Likelihood	Risk Rating	Severity	Likelihood	Risk Rating	
Earthworks and ground improvement works (ID #7)	The deep soil mixing may change the soil profile to impermeable causing the following potential impacts: - Increased surface runoff. - Alteration to surface water drainage. - Reduced surface water infiltration to groundwater. - Isolated groundwater system from freshwater recharge. - Lowering of groundwater table and potential for seawater intrusion and potential for PASS to oxidise if not in an anaerobic state in surrounding areas. - Reduced health of mangrove communities, or mortality due to reduced flow through of fresh groundwater.	E-Minor	4-Unlikely	Moderate	E-Minor	5-Highly Unlikely	Low	- Surface water drainage system completed on Site as per final design. Non-contaminated stormwater channelled into the NCW system and discharged through the regulating drain in a controlled manner. - No changes to groundwater elevations (outside of seasonal variation) have been detected on Site to date and hence surface water infiltration to groundwater appears to be unaffected. - The extensive EIMP bore network established on Site has not detected any ASS-related impacts to date. - Based on these factors, the risk rating of low is now justified.
Onshore clearing, earthworks and construction activities (including in intertidal zone); storage, handling, transfer of cement, fuel, oils, greases, chemicals and other dangerous goods and hazardous substances (ID #21)	Uncontrolled release of dangerous goods or hazardous substances resulting in: - Atmospheric contamination. - Soil, surface water and groundwater pollution. - Effects on flora and fauna. - Potential eventual migration of contaminants to Darwin Harbour.	E-Minor	4-Unlikely	Moderate	E-Minor	5-Highly Unlikely	Low	- The volumes of hazardous materials and dangerous goods that are transported, stored and handled on Site have decreased significantly. - All activities in the intertidal zone have been completed. - Based on these factors, the risk rating of low is now justified.
Onshore refuelling and vehicle movement including in intertidal zones (ID #23)	Uncontrolled release of dangerous goods or hazardous substances from refuelling (e.g. truck rollover; interaction of vehicles with the tidal flow) leading to - Soil, surface water and groundwater pollution. - Potential eventual migration of contaminants to Darwin Harbour.	D-Moderate	5-Highly Unlikely	Moderate	E-Minor	5-Highly Unlikely	Low	- Only one refuelling location remains. - Activities in the intertidal zone have been completed. - Based on these factors, the risk rating of low is now justified.

Activity[1,2]	Potential Environmental Impact[3]	Residual Risk						Comments
		CEMP Revision 2			2019 AEMR			
		Severity	Likelihood	Risk Rating	Severity	Likelihood	Risk Rating	
General construction including the construction of access roads, soil stockpiling and earthworks (ID #28)	Introduction of contaminated fill, leading to contamination of soil, surface water and groundwater	F-Insignificant	4-Unlikely	Low	F-Insignificant	4-Unlikely	Low	Risk rating remains low.
General construction activities (ID #34)	Uncontrolled release of construction materials (i.e. grout, bentonite), welding, grinding, drilling, facing and cutting particulates etc. in drainage to surrounding environment resulting in: - Soil, surface-water and groundwater pollution. - Potential eventual migration of contaminants to Darwin Harbour. - Impacts to mangrove health. - Potential legal impacts due to classification as listed waste (waste resulting from surface preparation of metals and plastics).	E-Minor	5-Highly Unlikely	Low	F-Insignificant	5-Highly Unlikely	Low	Risk rating remains low but severity has changed to insignificant.
Exposure of soil to erosive forces during construction activities and modification of natural overland flow velocities/volumes as a result of site preparation, material removal from the EMA and infrastructure construction activities (ID #42)	Soil erosion and sediment transport during construction activities resulting in: - Increased nutrient, sediment, salt and other contaminant concentrations in receiving waters. - Deterioration of onshore and nearshore water quality and of aquatic environmental health. - An increase in sediment loads on the fringing vegetation community, smothering the vegetation and invertebrate fauna resulting in damage or death (e.g. of mangroves) - Deterioration of soil quality and fertility due to increased erosion.	F-Insignificant	3-Possible	Low	F-Insignificant	4-Unlikely	Low	Risk rating remains low.

Activity[1,2]	Potential Environmental Impact[3]	Residual Risk						Comments
		CEMP Revision 2			2019 AEMR			
		Severity	Likelihood	Risk Rating	Severity	Likelihood	Risk Rating	
General construction activities including earthworks, vehicle movements, abrasive blasting (ID #66)	Dust generation, resulting in: - Nuisance, amenity and health impacts on nearby communities. - Health impacts on the workforce (e.g. respiratory and impaired vision). - Decreased vegetation health.	F-Insignificant	4-Unlikely	Low	F-Insignificant	5-Highly Unlikely	Low	Risk rating remains low but likelihood has changed to highly unlikely.
Storage, handling or transport of dangerous goods (ID #69)	- Incorrect storage of dangerous goods leading to fire/explosion event.	F-Insignificant	4-Unlikely	Low	F-Insignificant	5-Highly Unlikely	Low	Risk rating remains low but likelihood has changed to highly unlikely.
General construction activities (including onshore pile driving, drilling, blasting, abrasive blasting, pipeline cleaning/pigging and equipment, vessel and pipeline drying (ID #76)	- Airborne noise or vibration causing nuisance, disturbance or health impacts to local community.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.
Transport of sediment from Site onto Site access and/or public roads beyond Site boundary by construction associated traffic (ID #100)	- Increased nutrient, sediment, salt and other contaminant concentrations in receiving waters. - Deterioration of aquatic environmental health.	F-Insignificant	3-Possible	Low	F-Insignificant	5-Highly Unlikely	Low	Risk rating remains low but likelihood has changed to highly unlikely.
Discharge of treated effluent from temporary STP to the nearshore development area (ID #102)	- Increased nutrient, salt and other contaminant concentrations in receiving waters. - Deterioration of aquatic environmental health including decline in water quality and seabed impacts.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.
Pre-commissioning activities other than hydrotesting (cleaning, testing, lubricant oil flushing, motor run tests, first fills of fuels and	- Uncontrolled release of dangerous goods or hazardous materials, hydrocarbons and other chemicals resulting in surface water contamination and impacts to Darwin Harbour and deterioration of aquatic environmental health.	F-Insignificant	4-Unlikely	Low	F-Insignificant	4-Unlikely	Low	Risk rating remains low.

Activity[1,2]	Potential Environmental Impact[3]	Residual Risk						Comments
		CEMP Revision 2			2019 AEMR			
		Severity	Likelihood	Risk Rating	Severity	Likelihood	Risk Rating	
lubricants, charging of catalysts, operational tests of emergency utilities including fire water pumps and emergency diesel generators (ID # 108 and 109).	- Inappropriate handling and disposal of chemicals and hydrocarbons resulting in soil, surface water and groundwater with potential migration to Darwin Harbour and deterioration of aquatic environmental health	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.
Hydrotesting activities (ID #111 and 112)	- Uncontrolled release of dangerous goods or hazardous materials, hydrocarbons and other chemicals resulting in surface water contamination and impacts to Darwin Harbour and deterioration of aquatic environmental health.	D-Moderate	5-Highly Unlikely	Moderate	E-Minor	5-Highly Unlikely	Low	- The volumes of hydrotest waters that will be discharged to the receiving environment will significantly reduce over the remainder of the construction and commissioning phase of the Project. - Based on this reduction in volumes, the risk rating of low is now justified.
	- Inappropriate handling and disposal of water resulting in soil, surface water and groundwater with potential migration to Darwin Harbour and deterioration of aquatic environmental health	D-Moderate	5-Highly Unlikely	Moderate	E-Minor	5-Highly Unlikely	Low	
Loading of new catalyst, desiccant and absorbent Tr-1/2, inlet, utilities/CCPP (air dryer) transfer and handling of product (ID #115)	- Spills resulting in a release of chemicals to environment. - Breach of CEMP criteria Unanticipated pollution event with regulatory reporting.	F-Insignificant	6-Remote	Low	F-Insignificant	6-Remote	Low	Risk rating remains low.
CCP water treatment - blow down water onsite and transfer/handling of caustic and acids (ID #133)	- Spills of caustic or acids resulting in a release of chemicals to environment. - Unanticipated pollution event with regulatory reporting. - Breach of CEMP criteria. - Progress of drainage and seasonality.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.
CCP water treatment - blow down water onsite storage (ID #134a)	- Loss of containment resulting in release of blow down water to environment. - Breach of CEMP criteria. - Unanticipated pollution event with reporting.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.

Activity[1,2]	Potential Environmental Impact[3]	Residual Risk						Comments
		CEMP Revision 2			2019 AEMR			
		Severity	Likelihood	Risk Rating	Severity	Likelihood	Risk Rating	
CCP water treatment - blow down water commissioning – blowdown water (ID #134b)	- Discharge of off spec water resulting in surface water pollution, water has added ammonia and potentially phosphate. - Breach of CEMP criteria. - Unanticipated pollution event with regulatory reporting.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.
CCPP start-up, onsite transfer and handling of fuels (ID #166)	- Loss of containment resulting in release of blow down water to environment. - Breach of CEMP criteria. - Unanticipated pollution event with regulatory reporting.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.
Commissioning and start-up of various systems which require storage, loading and transfer of chemicals, flushing and cleaning of equipment, wastewater management and discharge, stormwater runoff and discharge, commissioning and use of ship loading facilities over water, transfer and storage of chemicals (ID #185 and 186)	- Loss of containment resulting in contaminated water to environment. - Unanticipated pollution event with regulatory reporting. - Breach of CEMP criteria.	F-Insignificant	5-Highly Unlikely	Low	F-Insignificant	5-Highly Unlikely	Low	Risk rating remains low.

1 Activity descriptions (and ID #s) as per Appendix C in the CEMP.

2 Activities have been included on the basis that they are still applicable for the remainder of the construction, commissioning and demobilisation phases of the Project, activities no longer relevant have been omitted, hence why the ID# numbers are not sequential.

3 Impacts have been evaluated on the basis of being Site-wide impacts, as per the CEMP.

Table 6-2 Changes to the Monitoring Scope from 1 February 2019

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
Surface Water					
BPSW20, 22, 23, 28 and 30	Nutrients, metals, hydrocarbons and physico-chemical parameters	General construction and commissioning activities; vehicle movement; storage, handling and/or transfer of cement, fuels, oils, greases, chemicals and other dangerous goods and hazardous substances; excavation and/or displacement of ASS/PASS; reinstatement works. The above activities have the potential to result in: - Spills and active discharges of contaminated waters or chemicals. - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of construction and commissioning materials. - Uncontrolled release of sediments. - PASS oxidation, acidification and heavy metal mobilisation.	Surface water Groundwater expression	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	These marine surface water monitoring sites are located closest to the following construction and commissioning areas: C500, E600 (to the south of the isthmus) and B300. The monthly marine surface water monitoring commenced in June 2012 to assess the potential surface water impacts associated with the construction and commissioning of the Site. Construction and commissioning (ASS/PASS excavations, associated deep soil mixing and vegetation clearing, spills and active discharges) have the potential to result in the deterioration of aquatic environmental health including a decline in water quality through the introduction of nutrients, metals and hydrocarbons. **Sources** - All clearing, earthworks, general construction and commissioning activities and concrete works have been completed in Areas C500 and B300; - All deep soil mixing, excavation, dewatering and and/or displacement of ASS/PASS was completed in 2014 on Site. On the Main Site, disturbance of PASS or ASS is no longer likely as all Site excavations and ground preparation works into natural ground have been completed and the top 5 m has been confirmed as non-ASS during the major earthworks stage of the Project in 2013/14. The construction activities and reinstatement scopes have been completed and the risk source(s) have been removed. Groundwater monitoring has consistently concluded that no latent adverse impacts from ASS have been detected. - The Flare Pad Basin berm was flattened in June 2018 and reinstated to a natural inundation cycle. - The Site has been reinstated as per final design; and - Storage, handling and/or transfer of construction and commissioning related dangerous goods and hazardous chemicals has ceased. Construction and commissioning activities were completed in these parts of the Site in April 2018 and the completion of these activities has removed potential construction and commissioning related risk sources from these areas. **Pathways** The completion, commissioning and operation of the accidentally oil-contaminated system (AOC) and the continuously oil-contaminated system (COC) prevents contaminated and potentially contaminated surface waters from leaving Site via the non-contaminated water system.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
					These systems are designed to ensure that both potentially contaminated stormwater and stormwater likely to be contaminated with hydrocarbons do not comingle with non-contaminated stormwater runoff. The AOC and COC drain to holding basins and must meet specific criteria before they can discharge via the Jetty Outfall. The commissioning of these systems has removed the drainage and/or discharge pathways for impact sources to identified marine receiving environment receptors in these parts of the Site. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and the removal of the pathways to the marine receiving environment, monitoring at surface water locations BPSW20, 22, 23, 28 and 30 will cease on 31 January 2019. In-line with the above justification, as final construction and commissioning works are completed and sources removed, the associated monitoring scopes will be reviewed and redundant parts will be closed out. This will be rationalised based on any remaining risk source(s), source-pathway-receptor relationships, evaluation of the available monitoring dataset and a comprehensive multiple lines of evidence assessment.
Groundwater					
BPGW07, 08A, 09, 10, 18, 19A, 20, 26, 27A, 28, 40, 41, ONBH03	Nutrients, metals, hydrocarbons and physico-chemical parameters Groundwater elevation	Clearing; ground improvement works; earthworks; general construction and commissioning activities; vehicle movement; storage, handling and/or transfer of cement, fuels, oils, greases, chemicals and other dangerous goods and hazardous substances; deep soil mixing; excavation, dewatering and/or displacement of ASS/PASS; reinstatement works. The above activities have the potential to result in: - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of construction and commissioning materials. - PASS oxidation, acidification and heavy metal mobilisation.	Groundwater Surface water	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	These bores are located in, or adjacent to: Areas E400; B600; C100, 200, 300, 400, 500; and E200, 600. Construction and commissioning in these areas, and in particular vegetation clearing and ASS/PASS excavations had the potential to result in the deterioration of aquatic environmental health and aquatic ecosystems (e.g. through the groundwater expression pathway), and a decline in groundwater quality through the introduction of nutrients, metals, hydrocarbons and an altered physico-chemical environment. **Sources** - All clearing, ground improvement works, general construction and commissioning activities and concrete works have been completed in Areas E400, B600, C100-500 and E200; - All deep soil mixing, excavation, dewatering and and/or displacement of ASS/PASS was completed in 2014 on Site; - The catchment areas are now reinstated as per final design; - Vehicle movement in these catchment areas have been restricted; and - Storage, handling and/or transfer of construction and commissioning related dangerous goods and hazardous chemicals has ceased.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
		- Reducing soil permeability and lowering of the groundwater table.			Construction and commissioning activities in these parts of the Site were completed in May 2017 and the completion of these activities has removed potential construction and commissioning related risk sources. An assessment of the groundwater levels within the bores during the monitoring period indicated that groundwater levels had not changed outside of natural, seasonal variation and followed a similar pattern observed at other bores on Site. A geochemical assessment indicated that, to date, there have been no discernible changes in groundwater geochemistry in these bores. The bores that recorded increasing metals concentrations in AEMR (2018), namely BPGW09 and BPGW26 (both arsenic), did not display both a statistically significant, increasing trend in the sulphate/chloride ratio and a decreasing trend in pH. These results indicated that the source of low pH levels (and subsequent metals mobilisation) in these bores was not associated with the oxidation of ASS and construction and commissioning activities. The remaining bores did not record statistically significant, increasing trends in metals concentrations. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and with continued monitoring confirming no latent impacts, monitoring at groundwater bores BPGW07, 08A, 09, 10, 18, 19A, 20, 26, 27A, 28, 40, 41 and ONBH03 will cease on 31 January 2019. In-line with the above justification, as final construction and commissioning works are completed and sources removed, the associated monitoring scopes will be reviewed and redundant parts will be closed out. This will be rationalised based on any remaining risk source(s), source-pathway-receptor relationships, evaluation of the available monitoring dataset and a comprehensive multiple lines of evidence assessment.
Mangroves					
BPMC01, 11, 21, 22, 23 and CSMC02	Nutrients, metals, hydrocarbons, physico-chemical parameters and sediment loads	Clearing; earthworks; general construction and commissioning activities; vehicle movement; storage, handling and/or transfer of cement, fuels, oils, greases, chemicals and other dangerous goods and hazardous substances; deep soil mixing; excavation, dewatering and/or displacement of ASS/PASS; reinstatement works.	Land Surface water Groundwater	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	The mangrove monitoring sites are located adjacent to Area C100 and E400. Construction and commissioning in these areas, ASS/PASS excavations, deep soil mixing and vegetation clearing had the potential to result in disturbance to, alteration and deterioration of, mangrove communities through sedimentation and erosion, the introduction of nutrients, metals, hydrocarbons and an altered physico-chemical environment. **Sources** - All clearing, earthworks, general construction and commissioning activities and concrete works have been completed in Areas C100 and E400;

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
		The above activities have the potential to result in: - Spills and active discharges of contaminated waters or chemicals - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of construction and commissioning materials. - Uncontrolled release of sediments. - PASS oxidation, acidification and heavy metal mobilisation. - Altered Site drainage, increased surface runoff with increased erosion and sedimentation in mangrove communities. - Altered offsite drainage and flow with reduced flow through mangrove communities.			- Construction and commissioning works associated with clearing, earthworks and potential displacement of ASS/PASS were completed on Site in 2014. Site reinstatement using clean soils was completed in April 2018. - The catchment areas are now sealed as per final design; - Vehicle movement in these catchment areas has been restricted; and - Storage, handling and/or transfer of construction and commissioning related dangerous goods and hazardous chemicals has ceased. Continued monitoring of these mangrove locations for other potential sources (e.g. uncontrolled releases) has shown there have been no latent impacts from clearing, earthworks and potential displacement of ASS/PASS. Further there has not been any uncontrolled releases of dangerous goods, hazardous substances, materials or sediment in the vicinity of these monitoring sites. As such, there is no potential for latent impacts associated with uncontrolled releases as construction and commissioning activities in this area were completed in April 2018. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and with continued monitoring confirming no latent impacts have been detected at these locations, monitoring at transects BPMC01, 11, 21, 22, 23 and CSMC02 will cease on 31 January 2019. In-line with the above justification, as final construction and commissioning works are completed and sources removed, the associated monitoring scopes will be reviewed and redundant parts will be closed out. This will be rationalised based on any remaining risk source(s), source-pathway-receptor relationships, evaluation of the available monitoring dataset and a comprehensive multiple lines of evidence assessment.
Air Quality (Dust)					
PM_{10} monitoring station BPPM03	PM_{10}	General construction and commissioning activities including earthworks and vehicle movements. The above activities have the potential to result in: - Nuisance, amenity and health impacts on nearby communities.	Air	Community sensitive receptors	This monitoring site is located along the eastern boundary of the EMA. **Sources** - Clearing and general construction and commissioning activities have been completed in this portion of the Site; - The re-vegetation and rehabilitation program is in progress in this area; and - Vehicle movement in this area has been restricted. The completion of the above activities has removed potential construction and commissioning related risk sources.
Dust deposition stations BPDD06 and 09	Dust			Mangrove vegetation	

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
					Monitoring at BPPM03 during the monitoring period confirmed that PM_{10} concentrations at this location exceeded the adopted trigger value on 79 occasions during the monitoring period (or 43% of the time), which was lower than BPPM04 (143) and BPPM01 (113). It was assessed that the risk of the PM_{10} dust concentrations recorded at BPPM03 impacting on sensitive receptors at Palmerston (to the north-east) and Bladin Central Enterprise Park (to the south) was low. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and with no identified impacts on sensitive receptors and mangroves during the monitoring period, monitoring of PM_{10} at BPPM03 and dust deposition at BPDD06 and 09 will cease on 31 January 2019. In-line with the above justification, as final construction and commissioning works are completed and sources removed, the associated monitoring scopes will be reviewed and redundant parts will be closed out. This will be rationalised based on any remaining risk source(s), source-pathway-receptor relationships, evaluation of the available monitoring dataset and a comprehensive multiple lines of evidence assessment.

Table 6-3 Revised Monitoring Scope (1 February 2019)

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors
Surface Water				
BPSW24, 25, 26, 27, 29, 31, 32, 33 and CSSW01 to 04	Nutrients, metals, hydrocarbons, physico-chemical parameters and sediment loads.	Clearing; ground improvement works; earthworks; general construction and commissioning activities; vehicle movement; storage, handling and/or transfer of cement, fuels, oils, greases, chemicals and other dangerous goods and hazardous substances; onshore refuelling; concrete batch plant, concrete works, and onsite cleaning of concrete. The above activities have the potential to result in: - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of construction and commissioning materials. - Uncontrolled release of sediments.	Surface water	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column
Groundwater				
BPGW11, 12A, 13A, 14A, 23, 24, 25, 29A, 32, 34, 36, 38A, VWP341, VWP328	Nutrients, metals, hydrocarbons and physico-chemical parameters Groundwater elevation	Clearing; ground improvement works; earthworks; general construction and commissioning activities; vehicle movement; storage, handling and/or transfer of cement, fuels, oils, greases, chemicals and other dangerous goods and hazardous substances; deep soil mixing; excavation, dewatering and/or displacement of ASS/PASS; reinstatement works. The above activities have the potential to result in: - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of construction and commissioning materials. - PASS oxidation, acidification and heavy metal mobilisation. - Reducing soil permeability and lowering of groundwater table.	Groundwater Surface water	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column
Mangroves				
BPMC16, 17, 20, 24, 26 and CSMC01, 03 and 04	Nutrients, metals, hydrocarbons, physico-chemical parameters and sediment loads	Clearing; earthworks; general construction and commissioning activities; vehicle movement; storage, handling and/or transfer of cement, fuels, oils, greases, chemicals and other dangerous goods and hazardous substances; deep soil mixing; excavation, dewatering and/or displacement of ASS/PASS; reinstatement works. These activities have the potential to result in: - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of construction and commissioning materials. - Uncontrolled release of sediments. - PASS oxidation, acidification and heavy metal mobilisation. - Altered Site drainage, increased surface runoff with increased erosion and sedimentation. - Altered offsite drainage and flow with reduced flow through communities. -	Land Surface water Groundwater	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors
Air Quality (Dust)				
PM_{10} monitoring stations BPPM01 and PAPM01	PM_{10}	General construction and commissioning activities including earthworks and vehicle movements. The above activities have the potential to result in: - Nuisance, amenity and health impacts on nearby communities.	Air	Community sensitive receptors
Dust deposition stations BPDD07, 08 and PADD01	Dust	General construction and commissioning activities including earthworks and vehicle movements. The above activities have the potential to result in: - Decreased vegetation health.	Air	Mangrove and hinterland vegetation communities
Noise				
BPAN01, BPAN02 and PAAN01	Sound levels	Noise from construction and commissioning activities	Air	Community sensitive receptors

7. RISK RATINGS AND CESSATION OF MONITORING SCOPE (APRIL 2019)

7.1 Risk Ratings

Based on the consideration of construction and commissioning activities in the monitoring period and a comprehensive assessment of potential environmental impacts, residual risk ratings were assigned to activities and impacts relevant to the period between 1 February and 30 April 2019 (**Table 7-1**).

These ratings are based on the risk assessment methodology outlined in Section 5.1 'Environmental Risk Assessment Framework' and Appendix C 'Environmental Risk Register' in the CEMP.

7.2 Cessation of Monitoring Scope

The Project is entering the closing stages of construction/commissioning and large portions of Site have transitioned to the operations phase under EPL228 which became active on 14 September 2018.

As at 30 April 2019, the construction phase of the Project has ended, with only commissioning activities in Site Area B200 and demobilisation activities within portions of E600 remaining active. The rest of the areas have been completed to final surfaces and/or handed over to Company operations which is subject to a separate approval (EPL 228). As a result, the risk sources, pathways and the potential for environmental harm have reduced, and the monitoring scope was reviewed to remove surplus components.

The remaining general commissioning and demobilisation phases of the Project currently include general commissioning activities of the CCPP.

The EIMP (Rev 10) allows for change to, and cessation of, the monitoring scope to occur as a result of the following change criteria:

1. Changes in the hazard classification of the Site (or parts of the Site) related to the use of live hydrocarbons or MHF status, resulting in restrictions on the types of equipment being used and safety considerations;
2. Cessation of specific Site activities in a given location, or altogether, resulting in the removal of an impact pathway and/or risk source;
3. Changes in regulatory requirements; or
4. Reduction in the scale of an activity, resulting in redundancy in monitoring locations.

Once construction and commissioning activities have ceased the risk sources related to these activities have been removed. As a result, there has been a reduction in the scale of relevant activities and redundancy in specific monitoring scopes.

Based on the above change criteria, and the detailed assessment of monitoring results outlined in AEMR (2019), environmental monitoring under the EIMP ceased on 30 April 2019. The assets that were removed are outlined in **Table 7-2** below. In accordance with the approved EIMP adaptive management process. the cessation of the monitoring scope was based on an evaluation of the risk source(s), source-pathway-receptor relationship, evaluation of the available monitoring dataset and a comprehensive multiple lines of evidence assessment.

Table 7-1 Risk Ratings (1 February to 30 April 2019)

Activity[1,2]	Potential Environmental Impact	Residual Risk						Comments
		CEMP Revision 2			2019 AEMR			
		Severity	Likelihood	Risk Rating	Severity	Likelihood	Risk Rating[3]	
Storage, handling or transport of dangerous goods (ID #69)	- Incorrect storage of dangerous goods leading to fire/explosion event.	F-Insignificant	4-Unlikely	Low	F-Insignificant	5-Highly Unlikely	Low	Risk rating remains low but likelihood has changed to highly unlikely.
Discharge of treated effluent from temporary STP to the nearshore development area (ID #102)	- Increased nutrient, salt and other contaminant concentrations in receiving waters. - Deterioration of aquatic environmental health including decline in water quality and seabed impacts.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	- The monitoring and reporting of WWTP discharges are addressed under separate and discharge-specific Licences and approvals, in this case WDL192. - The risk rating remains low. - Any monitoring that might be undertaken during the pipeline/diffuser removal works would be in accordance with a task-specific risk assessment and will not fall within the scope of the EIMP.
CCPP water treatment - blow down water onsite and transfer/handling of caustic and acids (ID #133)	- Spills of caustic or acids resulting in a release of chemicals to environment. - Unanticipated pollution event with regulatory reporting. - Breach of CEMP criteria. - Progress of drainage and seasonality.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.
CCPP water treatment - blow down water onsite storage (ID #134a)	- Loss of containment resulting in release of blow down water to environment. - Breach of CEMP criteria. - Unanticipated pollution event with reporting.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	Risk rating remains low.
CCPP water treatment - blow down water commissioning – blowdown water (ID #134b)	- Discharge of off spec water resulting in surface water pollution, water has added ammonia and potentially phosphate. - Breach of CEMP criteria. - Unanticipated pollution event with regulatory reporting.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	- The monitoring and reporting of MOF Outfall discharges are addressed under separate and discharge-specific Licences and approvals, in this case WDL211. - Risk rating remains low.

Activity[1,2]	Potential Environmental Impact	Residual Risk						Comments
		CEMP Revision 2			2019 AEMR			
		Severity	Likelihood	Risk Rating	Severity	Likelihood	Risk Rating[3]	
Steam blowing onsite commissioning (ID #155)	- Noise emission results in community complaints - Assumes silencers and modelled cumulative noise for Project.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	- Key mitigation measures are in place (e.g. silencers, sound enclosures) to control the noise to comply with health criteria of 82 dBA at 1 m away from unit. - Noise attenuates by more than 20 dBA across the river before it reaches community sensitive receptors, so distance provides a level of natural noise attenuation. - Based on these factors, the risk rating of low is justified.
Steam blowing onsite commissioning (ID #156 and 157)	- Ammonia fumes released results in community complaints. - Visual impact from steam blowers and HRSG result in community complaints.	F-Insignificant	3-Possible	Low	F-Insignificant	3-Possible	Low	Risk rating remains low.
CCPP Start-up combustion tuning HRSGs (ID #163)	- Potential visible plume from the heat haze from stacks.	F-Insignificant	3-Possible	Low	F-Insignificant	3-Possible	Low	Risk rating remains low.
CCPP Start-up combustion tuning HRSGs (ID #164)	- Greenhouse gas emissions (NOx) arising from combustion of fossil fuel energy source. - Air quality impacts through turbine stacks.	F-Insignificant	3-Possible	Low	F-Insignificant	3-Possible	Low	Risk rating remains low.
CCPP Start-up combustion tuning HRSGs (ID #165)	- Noise from operating turbines resulting in community complaints.	F-Insignificant	3-Possible	Low	F-Insignificant	3-Possible	Low	See comments on activity ID #155 because they are relevant to this activity as well.
CCPP start-up, onsite transfer and handling of fuels (ID #166)	- Loss of containment resulting in release of chemicals to environment. - Breach of CEMP criteria. - Unanticipated pollution event with regulatory reporting.	E-Minor	5-Highly Unlikely	Low	E-Minor	5-Highly Unlikely	Low	- Only one refuelling location remains. - Fuel volumes and scale of activity has significantly reduced. - Key mitigation measures in place to prevent impacts e.g. design and monitoring to include containment of contamination in the environmental controls (e.g. bunding, booms, sediment retention areas). - Based on these factors, the risk rating of low is justified.

Activity[1,2]	Potential Environmental Impact	Residual Risk						Comments
		CEMP Revision 2			2019 AEMR			
		Severity	Likelihood	Risk Rating	Severity	Likelihood	Risk Rating[3]	
Commissioning and start-up of various systems which require storage, loading and transfer of chemicals, flushing and cleaning of equipment, wastewater management and discharge, stormwater runoff and discharge, commissioning and use of ship loading facilities over water, transfer and storage of chemicals (ID #185 and 186)	- Loss of containment resulting in contaminated water to environment. - Unanticipated pollution event with regulatory reporting. - Breach of CEMP criteria.	F-Insignificant	5-Highly Unlikely	Low	F-Insignificant	5-Highly Unlikely	Low	Risk rating remains low.

1 Activity descriptions (and ID #s) as per Appendix C in the CEMP.

2 Activities were included on the basis that they were applicable during the monitoring period.

3 Impacts were evaluated on the basis of being Site-wide impacts, as per the CEMP.

Table 7-2 Cessation of the Monitoring Scope

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Assessment	Conclusions
Surface Water						
BPSW20, 22 to 29, 30 to 33 and CSSW01 to 04	Nutrients, metals, hydrocarbons and physico-chemical parameters	General commissioning activities at the CCPP, including; vehicle movement; storage, handling and/or transfer of fuels, oils, greases, chemicals and other dangerous goods and hazardous substances. The above activities have the potential to result in: - Spills and active discharges of contaminated waters or chemicals. - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of commissioning materials.	Surface water Groundwater expression	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	Construction activities were completed at the CCPP by 30 April 2019 and only general commissioning activities remain. Therefore, all construction-related risk sources and/or impacts have been removed from these areas. The completion, commissioning and operation of the AOC and COC prevents contaminated and potentially contaminated surface waters from leaving Site via the non-contaminated water system. The AOC and COC drain to holding basins and must meet specific criteria before they can discharge via the Jetty Outfall. The commissioning of these systems has removed the drainage and/or discharge pathways for impact sources to identified marine receiving environment receptors in these parts of the Site. All remaining discharges required during remaining commissioning activities (and WWTP if still ongoing) will be addressed under the separate and discharge-specific Licences and approvals e.g. EPL228, WDL192 and WDL211). Any monitoring that might be undertaken during the WWTP pipeline/diffuser removal works would be in accordance with a task-specific risk assessment and will not fall within the scope of the EIMP. Any monitoring associated with temporary structure demobilisation and rehabilitation will be undertaken in accordance with the Environmental Demobilisation Plan [L290-AB-PLN-10561] and will not fall within the scope of the EIMP.	Monitoring at all surface water monitoring locations ceased on 30 April 2019.
Groundwater						
BH602, BPGW07, 08A, 09, 10, 11, 12A, 13A, 14A, 18, 19A, 20, 23, 24, 25, 26, 27A, 28, 29A, 32, 34,	Nutrients, metals, hydrocarbons and physico-chemical parameters Groundwater elevation	General commissioning activities at the CCPP, including; vehicle movement; storage, handling and/or transfer of fuels, oils, greases, chemicals and other dangerous goods and hazardous substances. These activities have the potential to result in: - Spills and active discharges of contaminated waters or chemicals.	Groundwater Surface water	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic	Construction activities were completed at the CCPP by 30 April 2019 and only general commissioning activities remain. Therefore, all construction-related risk sources and/or impacts have been removed from these areas.	Monitoring at all groundwater monitoring locations ceased on 30 April 2019.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Assessment	Conclusions
36, 38A, 40, 41, ONBH03, VWP341 and, VWP328		- Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of commissioning materials.		Water column	An assessment of the groundwater levels within the bores during the monitoring period indicated that groundwater levels had not changed outside of natural, seasonal variation and followed a similar pattern observed at other bores on Site. A geochemical assessment indicated that, to date, there have been no discernible changes in groundwater geochemistry in these bores. These results from the monitoring period indicated that the source of low pH levels (and subsequent metals mobilisation) in the bores on Site were not associated with construction and commissioning activities. No watch-list bores on Site that recorded statistically significant increasing trends in metal concentrations displayed decreasing trends in pH levels and increasing trends in the sulphate/chloride ratios. It was assessed that elevated nutrient concentrations detected in the groundwater were naturally occurring and were related to natural nutrient cycling involved nitrification and denitrification processes driven by seasonal variations in ORP levels. Based on multiple lines of evidence including temporal, spatial, statistical, geochemical and historical evidence it has been determined that any changes in groundwater quality, including pH, metals and nutrients on Site were a result of natural seasonal variation.	
Mangroves						
BPMC01, 11, 16, 17, 20, 21, 22, 23, 24, 26 and CSMC01 to 04	Nutrients, metals, hydrocarbons, physico-chemical parameters and sediment loads	General commissioning activities at the CCPP, including; vehicle movement; storage, handling and/or transfer of fuels, oils, greases, chemicals and other dangerous goods and hazardous substances. The above activities have the potential to result in: - Spills and active discharges of contaminated waters or chemicals. - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of commissioning materials.	Land Surface water Groundwater	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	Construction activities were completed at the CCPP by 30 April 2019 and only general commissioning activities remain. All construction-related risk sources and/or impacts have been removed from these areas. Construction and commissioning activities had the potential to result in disturbance to, alteration and deterioration of, mangrove communities through sedimentation and erosion, the introduction of nutrients, metals, hydrocarbons and an altered physico-chemical environment. Continued monitoring of these mangrove locations has shown there have been no latent impacts from construction and commissioning activities to date and mangroves fringing the Site have remained in a healthy condition.	Monitoring at all mangrove monitoring locations ceased on 30 April 2019.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Assessment	Conclusions
					Further there has not been any uncontrolled releases of dangerous goods, hazardous substances, materials or sediment in the vicinity of these monitoring sites. All remaining discharges required during remaining commissioning activities (and WWTP if still ongoing) will be addressed under the separate and discharge-specific Licences and approvals (e.g. EPL228, WDL192 & WDL211).	
Air Quality (Dust)						
PM_{10} monitoring stations BPPM01, 03, 04 and PAPM01	PM_{10}	General commissioning activities e.g. steam blowing, CCPP start-up combustion tuning. These activities have the potential to result in nuisance, amenity and health impacts on nearby communities.	Air	Community sensitive receptors	Construction activities were completed at the CCPP by 30 April 2019 and only general commissioning activities remain. Therefore, all construction-related risk sources and/or impacts have been removed from these areas. No PM_{10} exceedances were recorded at PAPM01 during 24-hour vector-averaged south-westerly winds (i.e. along the impact pathway) and therefore, it was assessed that Site activities had not resulted in dust impacts at sensitive receptors located in Palmerston. Twenty-five PM_{10} exceedances were recorded at BPPM04 during 24-hour vector-averaged northerly winds (i.e. along the impact pathway), however there were no construction-related dust complaints during the monitoring period. There were no exceedances of the dust deposition trigger value recorded at PADD01 (Palmerston) and BPDD14 (Bladin Central Enterprise Park) during the monitoring period. Mangrove monitoring did not detect dust on mangrove leaves during the monitoring period.	Monitoring at all PM_{10} and dust deposition stations ceased on 30 April 2019.
Dust deposition stations BPDD06, 07, 08, 09 and PADD01	Dust			Mangrove vegetation		
Noise						
BPAN01, BPAN02 and PAAN01	Sound levels	General commissioning activities e.g. steam blowing, CCPP start-up combustion tuning. These activities have the potential to result in nuisance and amenity impacts on nearby communities.	Air	Community sensitive receptors	Construction activities were completed at the CCPP by 30 April 2019 and only general commissioning activities remain. Therefore, all construction-related risk sources and/or impacts have been removed from these areas. Audio file analysis of PAAN01 indicated the main contributing factors to the day-time and night-time noise levels at PAAN01 were local activities (e.g. motor vehicles, passing trains), animal sounds (e.g. frogs and insects) and gas flaring.	Monitoring at all noise monitoring locations ceased on 30 April 2019.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Assessment	Conclusions
					Audio analysis of sound files from BPAN02 confirmed that the predominant noise sources were vehicle reversing alarms, heavy vehicle movements that were operating in the laydown area and gas flaring. Exceedances also occurred as a result of natural noise sources, such as insects and birds. Based on noise attenuation monitoring undertaken previously, in order for there to be an exceedance of the trigger value at Bladin Central Enterprise Park there would need to be a noise level of 109 dB(A) in the day-time and 99 dB(A) in the night-time at BPAN02. The data collected during the monitoring period indicated that there were no noise levels of this magnitude at BPAN02.	

8. CONCLUSIONS

In conclusion, the EPA7 Report provides a clear assessment of the Project's potential impacts on the adjacent receiving environment. While there were exceedances across a small range of the total number of parameters measured during the monitoring period, it was assessed that the majority of the exceedances were not attributable to Site activities and discharges and did not result in environmental harm in the receiving environment.

The environmental impacts and risks associated with the Project are adequately managed through the provisions, procedures and mitigation measures in EIMP (Rev 10) and the performance criteria in the CEMP.

Following the EIMP adaptive management process and multiple lines of evidence assessment the applicable EIMP monitoring scope was reduced on 1 February and ceased on 30 April 2019.

9. REFERENCES

Acid Sulphate Soil Management Committee NSW. (1998). *Acid Sulphate Soils Assessment Guidelines*. Sydney, NSW: Author.

AEC Environmental Pty Ltd. (2013). *Annual Environmental Monitoring Report 2013 – Environmental Impact Monitoring Program*. Darwin, NT: Author.

AEC Environmental Pty Ltd. (2014). *Annual Environmental Monitoring Report 2014 – Environmental Impact Monitoring Program*. Darwin, NT: Author.

AEC Environmental Pty Ltd. (2015). *Annual Environmental Monitoring Report 2015 – Environmental Impact Monitoring Program*. Darwin, NT: Author.

Brocklehurst, P.S. & Edmeades, B.F. (1996). *Mangrove Survey of Darwin Harbour, Northern Territory, Australia*. Darwin, NT: Land Conservation Unit, Conservation Commission of the Northern Territory.

Butler, E.C.V., Streten-Joyce, C., Tsang, J.J., Williams, D.K., Alongi, D.M., Furnas, M.J. & McKinnon, A.D. (2013). *A procedure for evaluating the nutrient assimilative capacity of Darwin Harbour*. Darwin, NT: Aquatic Health Unit, Department of Land Resource Management.

Clark, R. (2001). *Marine Pollution* (5th ed.) Oxford, UK: Oxford University Press.

Department of Land Resource Management. (2010a). *Declaration of Beneficial Uses and Objectives – Elizabeth-Howard Rivers Region Groundwater*. Darwin, NT: Author.

Department of Land Resource Management. (2010b). *Declaration of Beneficial Uses and Objectives – Darwin Harbour Region*. Darwin, NT: Author.

Department of Natural Resources, Environment, the Arts and Sport. (2011). *Assessment Report 65: Environmental Assessment Report and Recommendations*. Darwin, NT: Author.

Department of Natural Resources, Environment, the Arts and Sports. (2008). *Groundwater Arsenic Concentrations in the Darwin Region. Reference Report 19/2008D*. Darwin, NT: Author.

Department of Natural Resources, Environment, the Arts and Sports. (2010a). *Water Quality Objectives for the Darwin Harbour Region – Background document.* Darwin, NT: Author.

Department of Natural Resources, Environment, the Arts and Sports. (2010b). *Guidelines for Weed Data Collection in the Northern Territory*. Darwin, NT: Author.

Dyrhman, S., Ammerman, J. and Van Mooy, B. Microbes and the Marine Phosphorus Cycle. *Oceanography, Vol 20, No.2: 110-116*.

Ellison JC. 1998. Impacts of sediment burial on mangroves. *Marine Pollution Bulletin 37:420-26.*

Gay, D. & Maher, W. (2003). Natural variation of copper, zinc, cadmium and selenium concentrations in *Bembiciumnanum* and their potential use as a biomonitor of trace metals. *Water Research, 37, 2173-2185*.

Greencap Pty Ltd. (2017). *Annual Environmental Monitoring Report 2017 – Environmental Impact Monitoring Program*. Darwin, NT: Author.

Greencap Pty Ltd. (2018). *Annual Environmental Monitoring Report 2018 - Environmental Impact Monitoring Program*. Darwin, NT: Author.

Greencap Pty Ltd. (2019). *Annual Environmental Monitoring Report 2019 - Environmental Impact Monitoring Program*. Darwin, NT: Author.

Greencap-NAA Pty Ltd. (2015). *Environmental Impact Monitoring Program*. Revision 6. Darwin, NT: Author.

Greencap-NAA Pty Ltd. (2016). *Annual Environmental Monitoring Report 2016 – Environmental Impact Monitoring Program*. Darwin, NT: Author.

INPEX Browse, Ltd. (2010). *Ichthys Gas Field Development Project: Draft Environment Impact Statement* and the *Supplement to the Draft Environmental Impact Statement*. Perth, WA: Author.

INPEX Operations Australia Pty Ltd. (2017). *Ichthys Onshore LNG Facilities Construction Environmental Management Plan.* Revision 2. Darwin, NT.

JKC Australia LNG Pty Ltd. (2018). *Bladin Point Environmental Demobilisation Plan (L290-AB-PLN-10561)*, Darwin. NT.

Jolly, P. (1983). McMinns-Benham Lagoon Borefield Investigation 1981-82, Report No. 17/83D, Department of Transport and Works, Darwin, NT.

Mulvey P (1993) Pollution, prevention and management of sulfidic clays and sands. In 'Proceedings 1 st national conference on acid sulfate soils'. (Ed. RT Bush). (CSIRO, NSW Agriculture, Tweed Shire Council: Australia).

National Environmental Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013.

Radke, B., Watkins, K.L. & Bauld, J. (1998). A Groundwater Quality Assessment of Shallow Aquifers in the Darwin Rural Area, Northern Territory – Volume 1: Text. In Australian Geological Survey Organisation and Department of Primary Industries and Energy, *Australian Groundwater Quality Assessment Project Report No. 4*. Canberra, ACT: Australian Geological Survey Organisation.

Sammut, J., White, I. & Melville, M.D. (1996). Acidification of an estuarine tributary in eastern Australia due to drainage of acid sulphate soils. *Marine and Freshwater Research*, *47, 669 – 684*.

Territory Parks and Wildlife Conservation Act (NT) (TPWC Act).

URS Australia Pty Ltd. (2009). *Ichthys Gas Field Development Project: onshore topography, geology, geomorphology and soils study*. (C036-AH-REP-0029 Rev 2). Perth, WA: Author.

10. STATEMENT OF LIMITATIONS

This report was prepared for Contractor and INPEX in accordance with industry recognised standards and procedures recognised at the time of the work.

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