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DOCUMENT TITLE:	EPA7 ANNUAL REPORT 2018 - ENVIRONMENTAL IMPACT MONITORING PROGRAM
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ICHTHYS ONSHORE LNG FACILITIES

JKC AUSTRALIA LNG PTY LTD

INPEX

Darwin, Australia

Subcontractor ISSUE PURPOSE	☐FA ☐FR ☐FI X FC ☐AB ☐CA						
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Approval or review hereunder shall not be construed to relieve Vendor / Subcontractor of his responsibilities and liability under the Contract.							
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EPA7 Annual Report 2018
Environmental Impact Monitoring Program

Ichthys On-Shore LNG Facilities

Bladin Point

Prepared for:
JKC Australia LNG Pty Ltd

Date: 30th July 2018

COMMUNITY FEEDBACK 1300 724 795

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EPA7 Annual Report 2018 – 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 following:

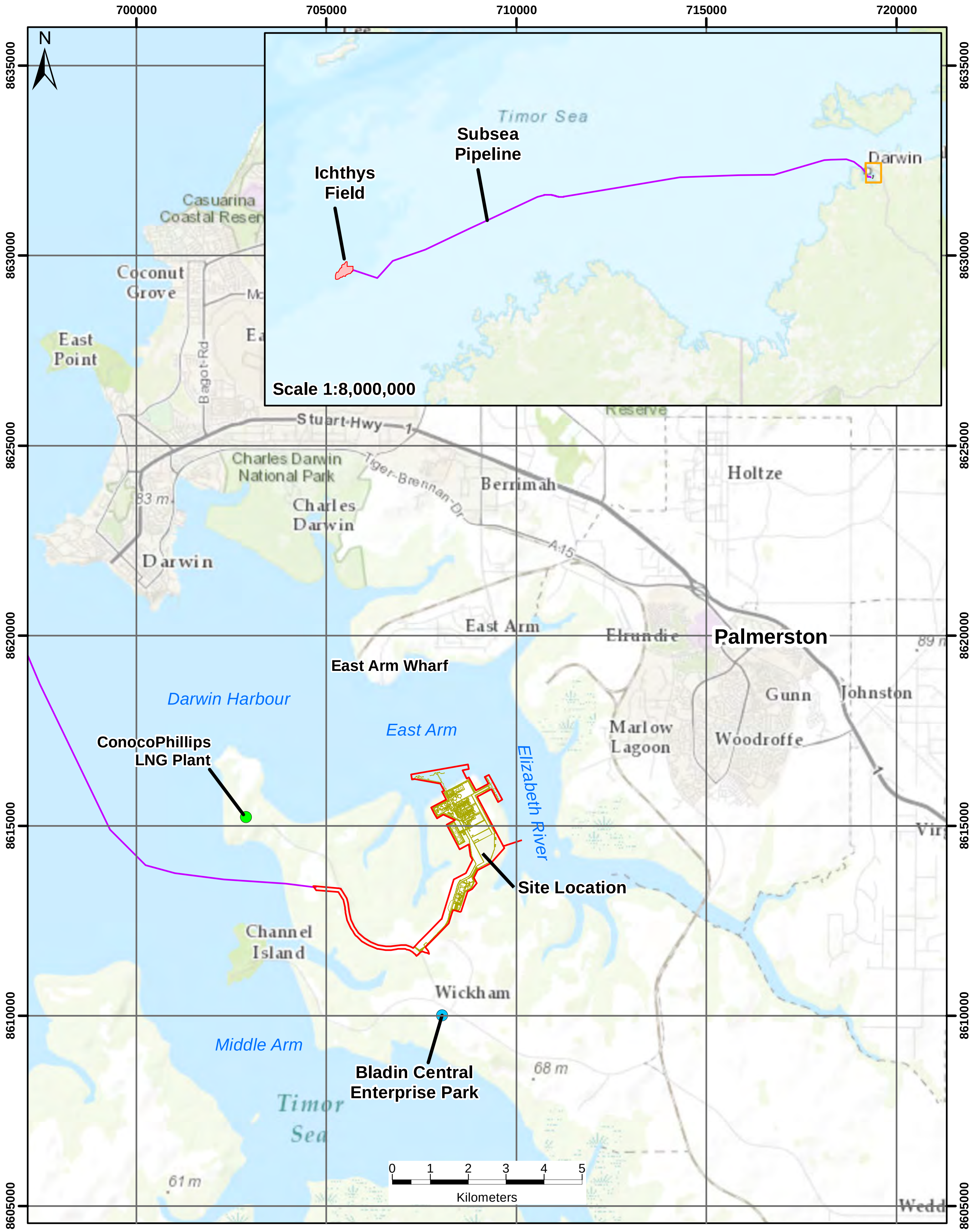
- Ichthys Onshore Liquefied Natural Gas (LNG) Facilities and its supporting infrastructure at Bladin Point; and
- Manigurr-ma Village at Howard Springs.

This document is the *EPA7 Annual Report 2018 – Environmental Impact Monitoring Program* (EPA7 Report [2018]), which reflects the environmental monitoring carried out from 1 May 2017 to 30 April 2018 (the annual 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 (see **Figure 1-2**). This EPA7 Report excludes monitoring specifically associated with discharges from the outfalls 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 from the EIMP.

1.2 Purpose

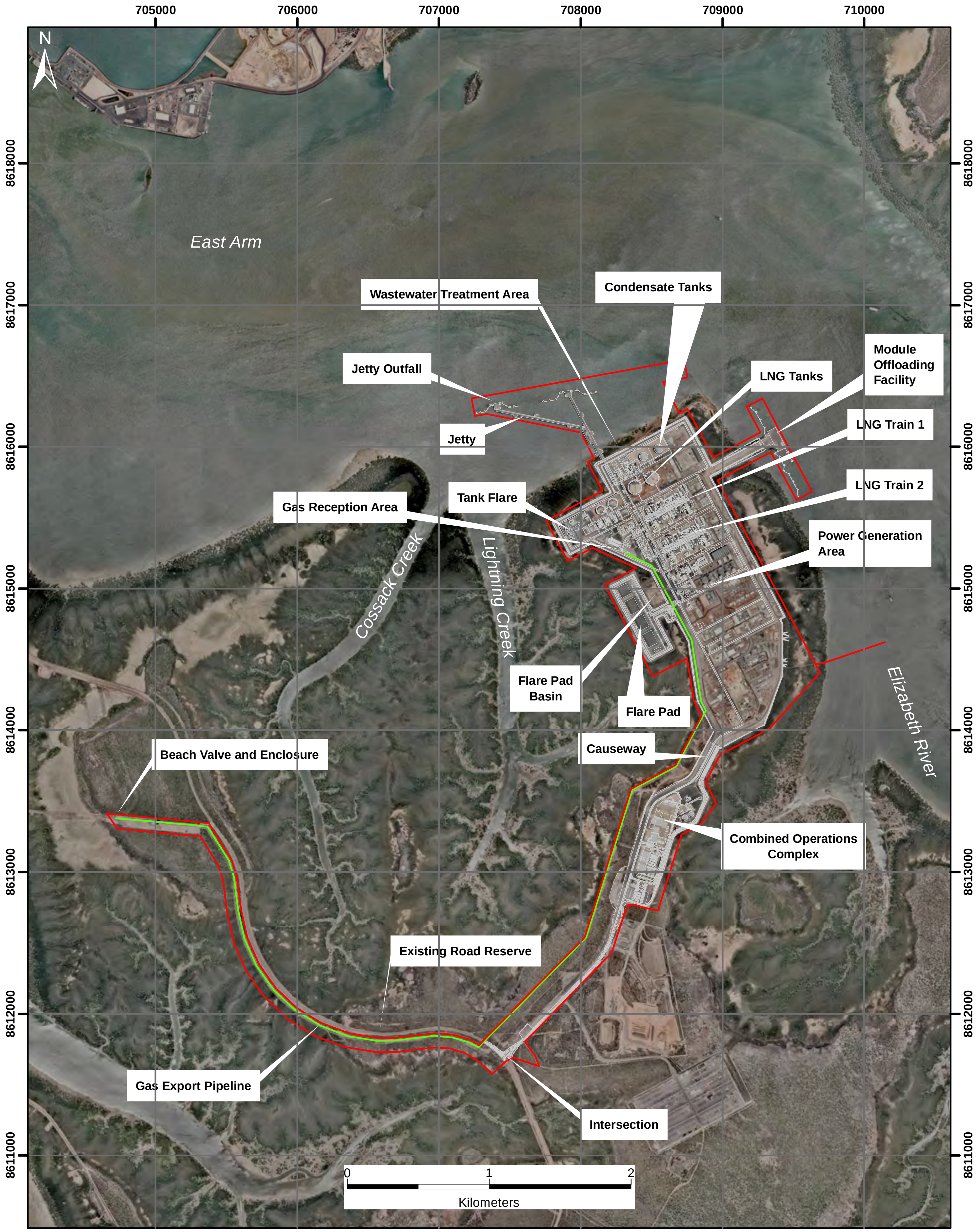
This EPA7 Report has been prepared to comply with Condition 28 of the Environment Protection Approval (EPA7 [as amended]) for the Project and provides a synopsis of the monitoring undertaken during the annual monitoring period.



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

Project Location

Figure 1-1	INPEX Bladin Point	GREENCAP
Date: *3/05/2018*	**Author:** malcolm.nunn	
	Map Scale: 1:130,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	



Site Boundary

Construction Footprint

Gas Export Pipeline

Bladin Point Site		
Figure 1-2	INPEX Bladin Point	GREENCAP
Date: 18/07/2018	**Author:** malcolm.nunn **Map Scale (@A4):** 1:35,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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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).
Flora and Fauna Management	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 has been recorded at the onsite weather station since October 2012 and collects data on rainfall, temperature, humidity, wind speed and wind direction.

During the annual monitoring period, the Site received 2,350.4 mm of rainfall, with rain falling on 111 days, mainly in the wet season. September was the hottest month with a temperature range of 21.3°C minimum to 36.9°C maximum. A summary of the climatic data collected during the annual monitoring period is presented in **Figure 3-1**.

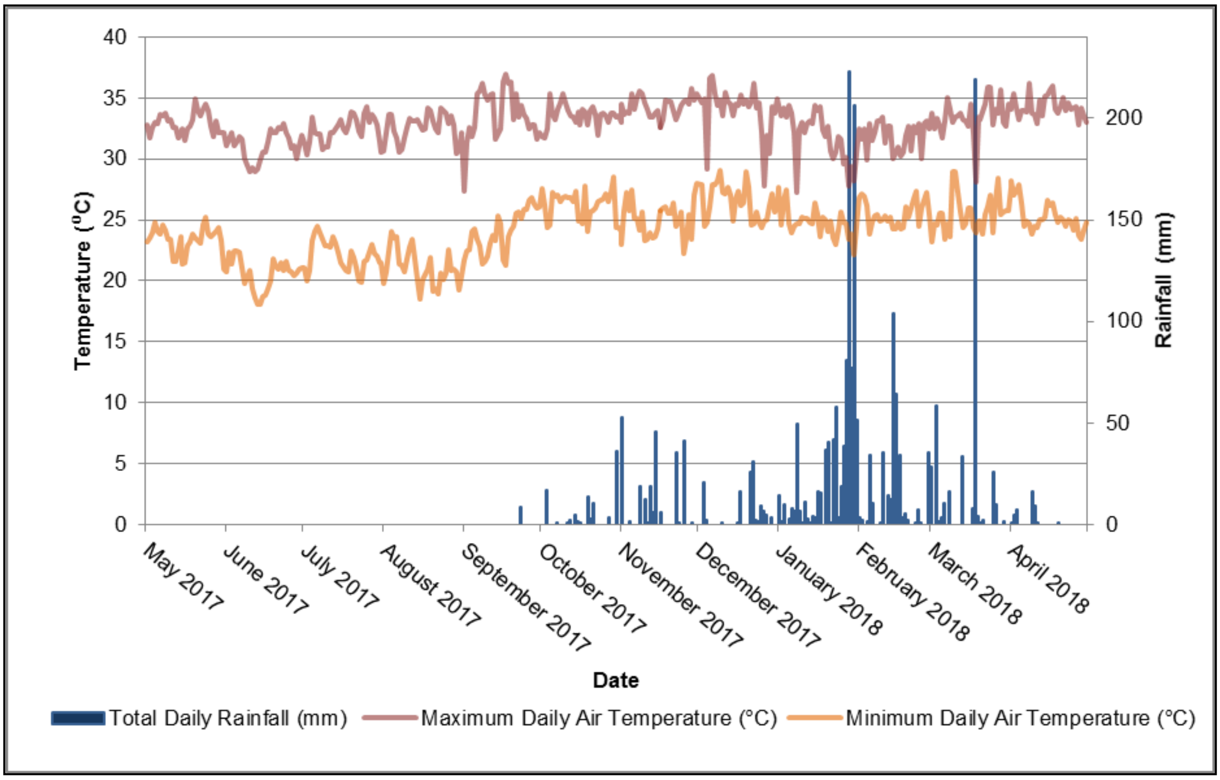

Figure 3-1 Summary of Climatic Data, May 2017 – April 2018

The rainfall recorded during the annual monitoring period (2,350.4 mm) was higher than the historical average for Darwin (1,728.9 mm) and was the second highest recorded since the monitoring program began (3,024.0 mm was recorded in the 2016/17 monitoring period). The average rainfall for all previous annual monitoring periods was 2,057.5 mm. In the 2017/18 wet season the monthly rainfall steadily increased (the exception being December 2017), to reach a maximum of 1,020.8 mm in January 2018. Rainfall in January 2018 was substantially higher than corresponding periods in previous annual monitoring periods, indicating a late onset of the monsoon season.

During the dry season, the prevailing wind direction was easterly to south-easterly while in the wet season the prevailing wind direction was westerly to north-westerly.

Wind speeds during the annual monitoring period ranged between 2 and 10 metres per second (m/s) and the average maximum wind speed was 8.1 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 annual monitoring period:

- Sampling of 19 offshore marine surface water monitoring locations (15 impact sites and four reference sites) in Darwin Harbour (a key sensitive receptor);
- Sampling of surface water from four auto-sampler units located at drainage outfalls at strategic locations in the drainage structures to monitor over-topping events;
- Sampling of wastewaters discharged to Darwin Harbour via the Jetty Outfall as per the EPA7 (as amended);
- Results from the MOF Outfall and temporary WWTP Outfall monitoring programs, insofar as they contextualise the results from the EIMP monitoring.

Figure 4-1, Figure 4-2 and **Figure 4-3** present 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;
- Turbidity; and
- Total dissolved solids (TDS).

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

- Total and dissolved metals;
- Total 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

Auto-Sampler

Onsite Basin

Onsite Surface Water Monitoring Locations

Figure 4-1	INPEX Bladin Point	GREENCAP
Date: *3/05/2018*	**Author:** malcolm.nunn	
	Map Scale (@A4): 1:20,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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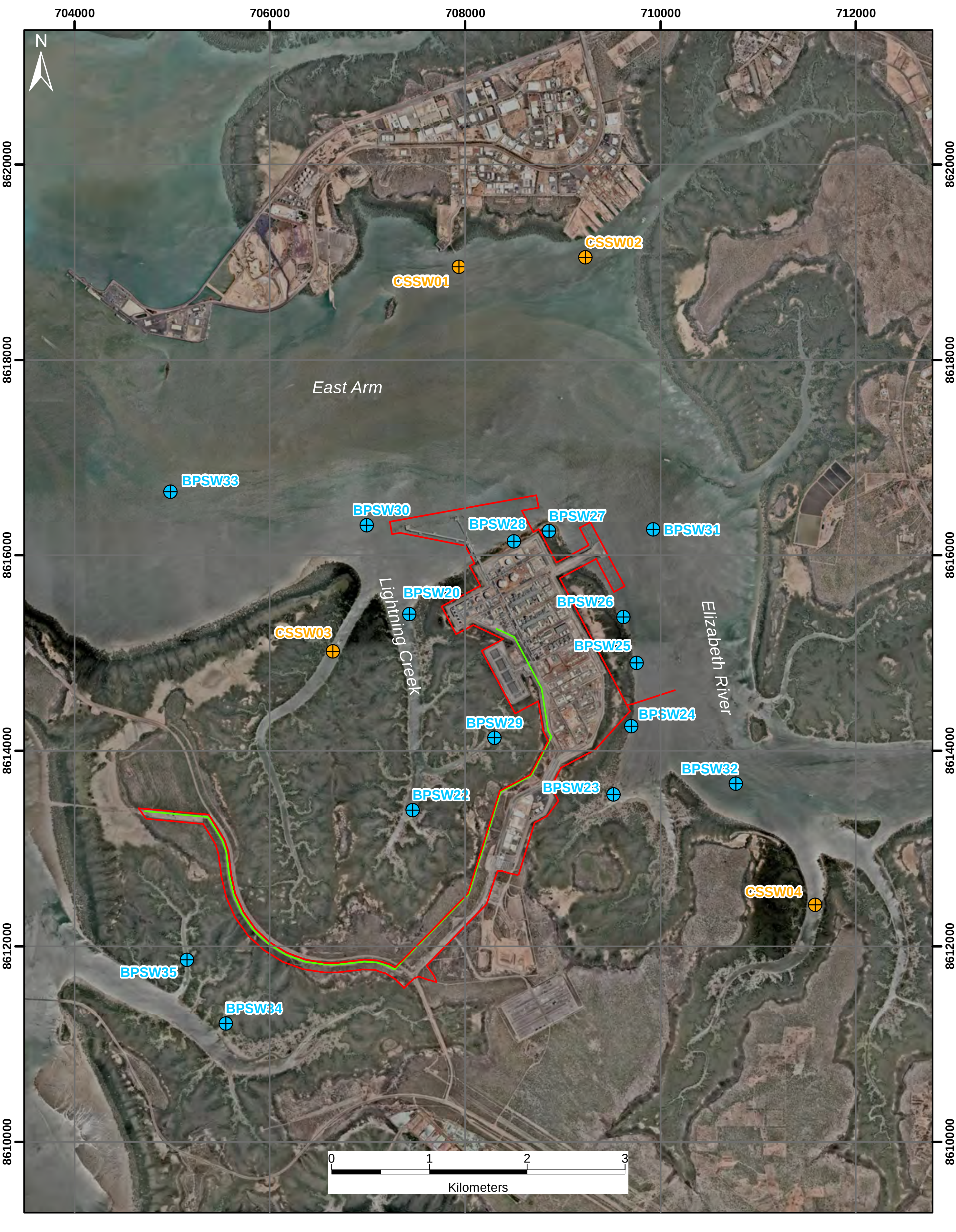


Site Boundary

Gas Export Pipeline

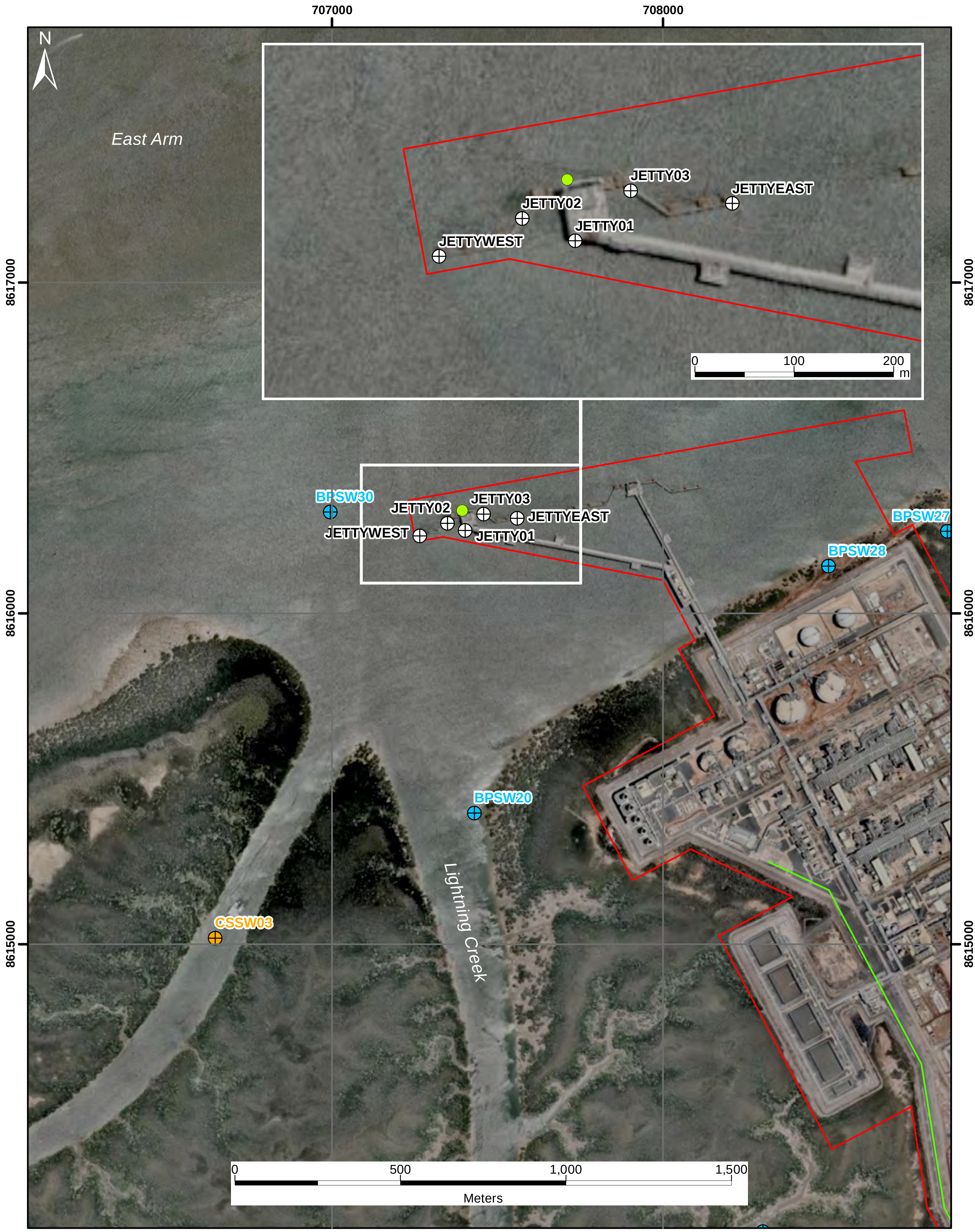
Surface Water Monitoring Locations

Offsite Marine Sampling Locations

Reference Sites

Offsite Surface Water Monitoring Locations

Figure 4-2	INPEX Bladin Point	GREENCAP
Date: *3/05/2018*	**Author:** malcolm.nunn	
	Map Scale (@A4): 1:50,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	



Site Boundary

Gas Export Pipeline

Surface Water Monitoring Locations

Jetty Outfall Monitoring Location

Jetty Outfall Diffuser

Offsite Marine Sampling Locations

Reference Sites

EPA7 Jetty Outfall Monitoring Locations

Figure 4-3	**INPEX Bladin Point**	GREENCAP
Date: *18/07/2018*	**Author:** malcolm.nunn **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 20.81 to 37.92 g/L with a median of 34.72 g/L during the annual monitoring period.

Further analysis of the salinity data revealed the following:

- During the dry season, salinity values ranged between 32.74 and 37.92 g/L with a median of 35.82 g/L;
- During the wet season, salinity values ranged between 20.81 and 36.20 g/L with a median of 33.43 g/L;
- Median salinity was highest in September 2017 with a value of 36.48 g/L;
- From October 2017 to February 2018, salinity decreased as a result of dilution associated with increased rainfall;
- Median wet season salinity was marginally lower than the 2015/16 (median of 34.00 g/L) and 2016/17 wet seasons (median of 33.60 g/L) but was higher than the 2014/15 wet season (median of 24.30 g/L); and
- Median salinity during the dry season was comparable to the salinity during the 2016 dry season (median of 35.83 g/L) and was higher than the salinity during the 2014 and 2015 dry seasons (33.00 and 33.10 g/L respectively).

Figure 4-4 presents the salinity data trends from May 2015 to April 2018.

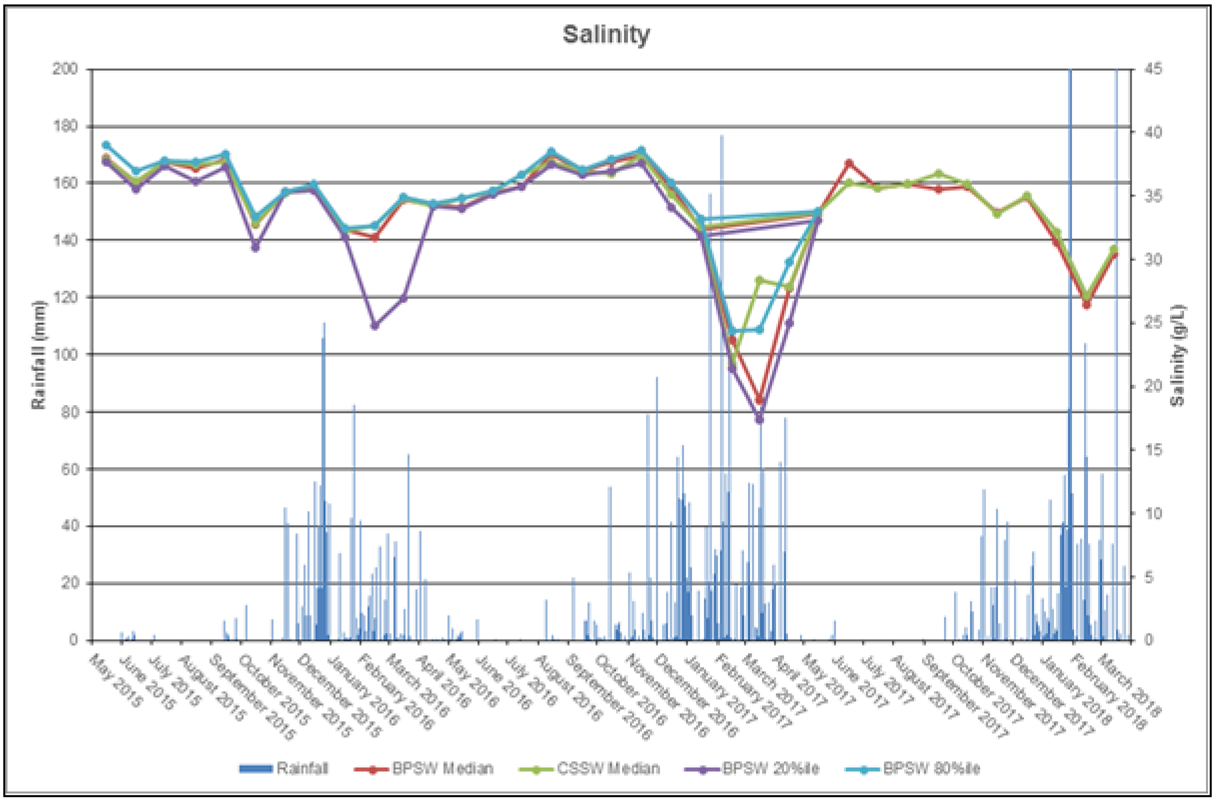


Figure 4-4 Marine Surface Water Salinity vs Daily Rainfall, May 2015 to April 2018

Dissolved Oxygen

The DO at marine surface water locations ranged from 52.9 to 103.1% saturation with a median of 82.2% saturation during the annual monitoring period. Results for DO were lowest in December 2017 with a median of 69.4% saturation and the highest values were recorded in August 2017 with a median of 93.9% saturation.

Forty one DO exceedances were recorded at impact sites during the 2017/18 wet season, compared to 39 in 2014/15, 54 in 2015/16 and 37 in 2016/17. Twelve exceedances were recorded at impact sites during the 2017 dry season, compared to 38 in 2014, 16 in 2015 and 11 in 2016.

The dry season isopleth for DO saturation indicated there were two exceedances of the trigger value, one at an impact site (BPSW29) and one at a reference site (CSSW04), while the wet season isopleth indicated a total of 11 exceedances, nine at impact sites and two at reference sites.

The abovementioned DO exceedances were assessed as being unrelated to Site activities and discharges.

pH

The pH at the marine surface water locations ranged from 7.07 to 8.23 pH units with a median of 7.88 pH units during the annual monitoring period. Further analysis of the pH data revealed the following:

- The pH remained relatively stable between the wet season and the dry season. During the dry season, the pH ranged from 7.56 to 8.23 pH units with a median of 7.99 pH units, while in the wet season, the pH ranged from 7.07 to 8.04 pH units with a median of 7.80 pH units;
- The highest pH reading was observed in September 2017 with a median of 8.10 pH units; and
- The lowest pH reading was observed in January 2018 with a median of 7.43 pH units.

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

Turbidity

Turbidity at the marine surface water locations ranged from 0.29 to 15.50 NTU with a median of 4.27 NTU during the monitoring period. During the dry season, turbidity ranged from 0.42 to 12.62 NTU with a median of 2.98 NTU and during the wet season, turbidity ranged from 0.29 to 15.50 NTU with a median of 5.16 NTU.

The data collected to date indicates that turbidity in Darwin Harbour is primarily driven by tides, however, there is some influence from rainfall, particularly high rainfall events and the subsequent sediment runoff from the upstream catchment areas.

There were no turbidity exceedances recorded during the annual monitoring period which is the first time this has occurred since monitoring began in 2012/2013. Turbidity results were consistent across impact sites and reference sites and this was indicative of background conditions in Darwin Harbour.

Total Suspended Solids

The TSS concentrations at marine surface water locations ranged from <1 to 74.0 mg/L with a median of 11.0 mg/L during the annual monitoring period. Further analysis of the data revealed the following:

- During the dry season, TSS ranged from 1.2 to 63.0 mg/L, with a median of 15.0 mg/L;
- During the wet season, TSS ranged from <1 to 74.0 mg/L, with a median of 8.4 mg/L;
- During the dry season, TSS was highest in September 2017 with a median of 19.0 mg/L;
- During the wet season, TSS was lowest in October with a median value of 5.9 mg/L and was highest in March 2018, with a median of 40.0 mg/L; and
- During the monitoring period, TSS was lowest in July 2017, with a median of 5.1 mg/L.

This annual monitoring period presented a different trend to that reported in AEMR (2013), AEMR (2014) and AEMR (2017) with fewer exceedances recorded during the wet season and more exceedances during the dry season. However, these results were more consistent with those recorded in AEMR (2015) and AEMR (2016). The maximum TSS concentration within this annual monitoring period was 74.0 mg/L compared to the historical maximum concentration of 1,207 mg/L that was reported in AEMR (2014). The monitoring results for TSS were consistent across impact sites and reference sites, which indicated that TSS patterns in the marine receiving environment were not impacted by Site activities or discharges.

Total suspended solid exceedances were recorded at impact sites in every month of the annual monitoring period. There were only three occasions where TSS exceedances were recorded in the MOF Outfall monitoring program (September 2017 and March 2018) and WWTP monitoring program (July 2017). These exceedances were not a contributing factor in the TSS exceedances recorded in the EIMP in these months because on all occasions, the end of pipe concentrations were less than the concentrations at the edge of the mixing zones.

During the course of the Jetty Outfall monitoring in the annual monitoring period there were five TSS exceedances, as follows:

- In May, July and September 2017, and March 2018 the median TSS concentrations at the impact sites were 26, 42, 28 and 48 mg/L, respectively. The end of pipe concentrations were 6.5, 2.8, 1.9 and <1 mg/L, respectively. In all instances, the end of pipe concentrations were insufficient to have caused the exceedances at the impact sites at the edge of the mixing zone. In addition, the concentrations at the upstream reference sites (based on tidal movement) were all similar to the impact site concentrations. Therefore, it was assessed that these TSS exceedances were not attributable to Site activities or discharges; and
- In June 2017, the median TSS concentration at the impact sites was 23 mg/L while the end of pipe concentration was 20 mg/L. The median concentration at the upstream reference site (30 mg/L) was higher than that recorded at the impact site, and exceedances were recorded at 15 monitoring locations (including three reference sites) in the EIMP monitoring program in the month of June. Therefore, it was concluded that this TSS exceedance was not attributable to Site activities or discharges.

Nutrients

Ammonia

Ammonia results recorded at marine surface water monitoring locations ranged from <5 to 68 µg/L, with a median of <5 µg/L during the annual monitoring period.

Further analysis of the ammonia data revealed the following:

- The highest concentrations were recorded in August 2017 with a median of 12 µg/L;
- The lowest concentrations were recorded in January 2018, with all results <LOR;
- The median was 7 µg/L during the dry season and <5 µg/L during the wet season; and
- There was no apparent correlation between rainfall and ammonia concentrations in the annual monitoring period.

Previous studies consider that ammonia concentrations in the Harbour do not vary remarkably from 10 µg/L (Butler *et al.*, 2013), which was comparable to the median reported in the annual 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.

The dry season isopleth for ammonia indicated there were two exceedances of the trigger value in October 2017, both of which occurred at impact sites, and no exceedances were recorded in the wet season isopleth in March 2018.

Ammonia exceedances were only recorded at EIMP impact sites in the annual monitoring period, as follows: BPSW27 and BPSW32 in May 2017; BPSW24 and BPSW32 in August 2017; BPSW26 and BPSW31 in October 2017; BPSW26 in December 2017; and, BPSW22 in February 2018. A review of construction and commissioning activities in these months did not identify a source(s) for these exceedances and there were no ammonia exceedances in any of the outfall monitoring programs in the months in which exceedances were recorded at the EIMP monitoring locations. Therefore, the ammonia exceedances recorded at the EIMP impact sites were not attributable to Site activities and discharges.

Oxides of Nitrogen

Oxides of nitrogen results ranged from <5 to 50.0 µg/L, with a median of <5 µg/L during the annual monitoring period.

Further analysis of the oxides of nitrogen data revealed the following:

- The median concentration was <5 µg/L during the dry season and the wet season;
- The median decreased from 16.0 µg/L in May 2017 to <5 µg/L in June 2017;
- Median concentrations increased from December 2017 (<5 µg/L) to January 2018 (18.0 µg/L), and decreased in February (<5 µg/L) and March 2018 (<5 µg/L);
- Concentrations were highest in January 2018 with a median of 18.0 µg/L;
- Concentrations were lowest in November 2017 with all values <LOR; and
- Results did not correlate with the rainfall recorded during each month.

The dry season isopleth showed oxides of nitrogen exceedances at two impact sites (BPSW26, BPSW32) and one reference site (CSSW04) in October 2017, while the wet season isopleth showed no exceedances in March 2018.

Overall, fewer exceedances were recorded in this annual monitoring period compared to the previous monitoring period. This was particularly evident during the wet season which had substantially fewer exceedances compared to all other annual monitoring periods.

Exceedances that were recorded in May, June and October 2017, and January 2018 all occurred at EIMP impact sites and reference sites and were therefore not related to Site activities and discharges.

A single oxides of nitrogen exceedance was recorded at an impact site (BPSW22) that is located in a creek to the south-west of the Site in February 2018. A review of construction and commissioning activities in this month did not identify a source for this exceedance and it was therefore not attributed to Site activities and discharges.

During the course of the Jetty Outfall monitoring, there were two oxides of nitrogen exceedances at the edge of the mixing zone, as follows:

- In January 2018, the median concentration at the impact sites was 54 µg/L while the end of pipe concentration was 190 µg/L, which is below the end of pipe criteria. The median concentration at the upstream reference site (59 µg/L) was higher than that recorded at the impact sites, and exceedances were recorded at eight monitoring locations (including three reference sites) in the EIMP monitoring program in January. Therefore, it was concluded that this exceedance was not attributable to Site activities or discharges;
- In February 2018, the median concentration at the impact sites was 73 µg/L while the end of pipe concentration was 230 µg/L, which is below the end of pipe criteria. The median concentration at the upstream reference site was 18 µg/L. There was only one exceedance that was recorded in the EIMP monitoring program at BPSW22 which was located in a creek to the south-west of the Site and is geographically separated from the Jetty Outfall. A more detailed review of the 80th percentile statistical analysis of surface water oxides of nitrogen data showed that the reported concentration at the edge of the mixing zone was similar to those reported at reference locations in January and February. Therefore, it was concluded that the exceedance was not attributable to Site activities or discharges.

Total Nitrogen

Total nitrogen results ranged from <50 to 2,400 µg/L, with a median of 165 µg/L during the annual monitoring period.

Further analysis of the total nitrogen data revealed the following:

- The median was 170 µg/L in the dry season and 160 µg/L in the wet season;
- During the dry season, concentrations ranged from <50 µg/L to 740 µg/L;
- During the wet season, concentrations ranged from <50 µg/L to 2,400 µg/L;
- The lowest concentrations were recorded in December 2017 and April 2018, both with a median of <50 µg/L; and
- The highest concentrations were recorded in September 2017 with a median of 430 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 a stronger signal due to runoff associated with the wet season.

The dry season isopleth showed no total nitrogen exceedances in October 2017, while the wet season isopleth showed a single exceedance in March 2018 at impact site BPSW35 (2,400 µg/L) which is located at the head of a creek to the south-west of the GEP corridor.

There were fewer exceedances during this annual monitoring period compared to the previous monitoring period.

Exceedances that were recorded in September and November 2017, and February 2018 occurred at EIMP impact sites and reference sites and were therefore not related to Site activities and discharges.

With the exception of April 2018, the exceedances that were recorded at impact sites only (BPSW22, 28 to 31, 33 to 35 in May 2017; BPSW20 in January 2018, BPSW35 in March 2018, and BPSW27 and BPSW28 in April 2018) were either single exceedances or were spatially separated around the creeks to the south-west of the Site and the GEP, to the north-west of the Site and to the north-east of the Site. A review of construction and commissioning activities in these months did not identify a source(s) for these exceedances, and there were no total nitrogen exceedances recorded in any of the outfall monitoring programs in the annual monitoring period. It was therefore, concluded that these exceedances were not attributable to Site activities and discharges.

Total Phosphorus

Total phosphorus results during the monitoring period ranged from <5 to 140 µg/L, with a median of 24 µg/L during the annual monitoring period.

Further analysis of the total phosphorus data revealed the following:

- The median concentration was 23 µg/L during the dry season and 24 µg/L during the wet season;
- Median concentrations were relatively consistent throughout the monitoring period;
- Concentrations were lowest in March 2018 (median of <5 µg/L) and highest in January 2018 (median of 43 µg/L);
- Concentrations decreased in September (median of 31 µg/L) and October 2017 (median of 23 µg/L) before increasing again in November 2017 (median of 26 µg/L); and
- Results across the annual monitoring period could not be correlated with rainfall.

During the annual reporting period, the highest total phosphorus concentrations were generally associated with more saline water and were not significantly influenced by wet season runoff. In addition, the total phosphorus concentrations were not significantly influenced by TSS concentrations which confirmed that seasonal rainfall events were not the primary load for total phosphorus.

Like the nitrogen cycle the phosphorus cycle is strongly regulated by the activity of micro-organisms (Dyhrman *et al*. 2007) but it differs from nitrogen in also being highly particle-reactive (Butler *et al.* 2013). Given that total phosphorus exceedances were also observed at reference sites during the dry season it was assessed that they are related to harbour-wide effects of the phosphorus cycle and the resuspension of marine sediments.

The dry season isopleth showed exceedances of total phosphorus at three impact sites (BPSW20, BPSW31 and BPSW33) and two references sites (CSSW02 and CSSW03) in October 2017. The wet season isopleth showed exceedances at three impact sites (BPSW27, BPSW30 and BPSW33) in March 2018.

There were fewer exceedances during this annual monitoring period compared to the previous monitoring period.

Exceedances that were recorded between August 2017 and January 2018 all occurred at EIMP impact sites and reference sites and were therefore not related to Site activities and discharges.

The exceedances that were recorded at impact sites only (BPSW23 in July 2017; BPSW20, 22 and 29 to 31 in February 2018; BPSW27, 30 and 33 in March 2018 and BPSW20, 22, 27 and 30 in April 2018) were either single exceedances or were spatially separated around the creeks to the south-west of the Site and to the north-east of the Site. A review of construction and commissioning activities in these months did not identify a source(s) for these exceedances, and there were no exceedances in any of the outfall monitoring programs in the months in which exceedances were also recorded at EIMP monitoring locations. The exception was October 2017 but these exceedances were recorded at both EIMP impact sites and reference sites. Therefore, these exceedances were not attributed to Site activities and discharges.

<u>Filterable Reactive Phosphorus</u>

Filterable reactive phosphorus results during the monitoring period ranged from <1 to 38 µg/L with a median value of 3 µg/L during the annual monitoring period (**Figure SW4-35, Appendix SW4**).

Further analysis of the FRP data revealed the following:

- Elevated FRP concentrations were recorded in May and July 2017 (medians of 5 µg/L). These elevated results did not correlate with any rainfall events; and
- Results were consistent throughout the remainder of the annual monitoring period with medians ranging from <1 to 4 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.

The dry season and wet season isopleths for FRP indicated there were no exceedances in these months.

Filterable reactive phosphorus exceedances were only recorded at impact sites in the annual monitoring period. A review of construction and commissioning activities in these months did not identify a source(s) for these exceedances, and there were no FRP exceedances in any of the outfall monitoring programs in the months in which exceedances were recorded at EIMP monitoring locations. Therefore, these exceedances were not attributed to Site activities and discharges.

<u>Nutrient Summary</u>

The results at the majority of the surface water monitoring locations did not exceed the adopted trigger values for nutrients and overall the number of exceedances deceased in comparison to previous annual monitoring period, with the exception of FRP, where there was a slight increase.

Results from the reference sites were similar to impact sites during the annual monitoring period. Where nutrient exceedances were recorded in the marine receiving environment, these were either single exceedances or they were recorded at both impact sites and reference sites in the monitoring period.

Where exceedances were recorded at impact sites only a review of construction activities did not identify potential sources for these exceedances and it was concluded that these were not attributable to Site activities and discharges.

There were instances where exceedances were recorded in the outfall monitoring programs in the annual monitoring period. Investigations concluded that these exceedances were either single exceedances, were not recorded in source characterisation sampling, were also present in the upstream reference site or were typical of the ambient concentrations in the receiving environment based on the monitoring. The mixing zone exceedances that were recorded in the monitoring period were considered to be representative of conditions in Darwin Harbour and were not attributable to Site activities and discharges. It was assessed that the potential for environmental harm to the receiving environment receptors (e.g. water column, soft bottom benthic) was low.

Metals and Metalloids

Marine field and analytical metal and metalloid results obtained during the annual monitoring period were generally reflective of seasonal trends and historical values based on the extended dataset now collected for the Project. During the monitoring period, filtered aluminium and filtered arsenic were the only metal parameters to record exceedances at EIMP monitoring locations in the receiving environment.

<u>Filtered Aluminium</u>

The results for filtered aluminium ranged from <10 to 30 µg/L with the majority of results below the LOR during the annual monitoring period. Only three trigger value exceedances for filtered aluminium were recorded during the monitoring period, one at reference site CSSW03 in September 2017 and two at impact sites BPSW24 and BPSW32 in February 2018.

There were three filtered aluminium exceedances recorded in the annual monitoring period compared to nine in AEMR (2017).

The September 2017 exceedance occurred at a reference site only and was not related to Site activities and discharges. A review of construction and commissioning activities in February 2018 did not identify a source for the filtered aluminium exceedances at the two impact sites and they were assessed to be unrelated to Site activities and discharges.

<u>Filtered Arsenic</u>

The results for filtered arsenic ranged from <0.2 to 5.3 µg/L with a median of 1.7 µg/L during the annual monitoring period.

Trigger value exceedances for filtered, total arsenic were recorded at impact sites BPSW25 and 29 in July 2017; impact sites BPSW23, 25, 26 and 31 in August 2017; impact sites BPSW23 to 28, 31 and 32 and reference site CSSW04 in August 2017; impact site BPSW22 in October 2017; impact sites BPSW23 to 27, 31, 32 and reference site CSSW04 in November 2017; impact sites BPSW20 and 29 in December 2017; impact sites BPSW23, 27 to 30, 33 and reference sites CSSW01 to 03 in January 2018; impact sites BPSW28, 30 and reference site CSSW03 in February 2018; impact sites BPSW28, 33 to 35 and reference sites CSSW01 and 03 in March 2018; and impact sites BPSW27, 28, 30 and 33 and reference sites CSSW01 to 03 in April 2018.

The filtered arsenic exceedances in September and November 2017, and January, February, March and April 2018 were recorded at EIMP impact sites and reference sites but not at outfall monitoring locations, which indicated these exceedances were not attributable to Site activities and discharges.

The exceedances in July, August, October and December 2017 occurred at impact sites only. A review of construction and commissioning activities in these months did not identify a source(s) for these exceedances, and there were no exceedances in the outfall monitoring programs in the months where exceedances were recorded at EIMP monitoring locations. Therefore, these exceedances were not attributed to Site activities and discharges.

Other Parameters

Total Recoverable Hydrocarbons

All TRH values were <LOR during the annual monitoring period with the exception of one exceedance in June 2017 at impact site BPSW29, one exceedance in November 2017 at reference site CSSW03, and six exceedances recorded at impact sites BPSW20, 26, 29, 30, 33 and 34 in December 2017.

Following silica gel clean-up there were no TRH detections in June and this indicated that the hydrocarbon was from a natural source. The exceedance in November 2017 occurred at a reference site and was not attributable to Site activities or discharges.

In regard to the December 2017 exceedances, the majority of the hydrocarbons were in the lighter hydrocarbon chain range of C_6 – C_{10} where silica gel clean-up could not be performed. However, a review of construction and commissioning activities did not identify a source(s) for these exceedances and there were no exceedances in the outfall monitoring programs in this month. The impact sites where the exceedances occurred are mostly separated spatially (e.g. BPSW29 and BPSW34) and are located some distance away from each other. Therefore it was concluded that these exceedances were not attributable to Site activities and discharges.

Chlorophyll-a

Chlorophyll-a results ranged from <5 to 9 µg/L, with a median value of <5 µg/L during the annual monitoring period.

Isopleths were prepared that identify chlorophyll-a distribution during the annual monitoring period. One exceedance was recorded at impact site BPSW30 in May 2017; one exceedance was recorded at impact site BPSW32 in November 2017; and, two exceedances were recorded in February 2018 at impact sites BPSW22 and 29. A review of construction and commissioning activities in these months did not identify a source(s) for these exceedances. There were no exceedances in any of the outfall monitoring programs in the months in which exceedances were recorded at the EIMP monitoring locations, with the exception of November 2017 but the EIMP location is ~3 km away from the outfall and the chlorophyll-a concentrations at locations in between the two points were all <LOR. Therefore, these exceedances were not attributed to Site activities and discharges.

Biological Parameters

All *E. coli* results were below the trigger value during the annual monitoring period with the exception of one exceedance at impact site BSW24 in January 2018. A review of construction and commissioning activities did not identify a source for the exceedance. It was therefore concluded that this exceedance was not related to Site discharges and activities.

All enterococci results were below the trigger value during the annual monitoring period with the exception of three exceedances at impact sites BPSW24, 25 and 32 in October 2017). 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 October. It was therefore concluded that these exceedances were not related to Site activities and discharges.

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, while slightly higher than previous annual monitoring period, 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 annual monitoring period, which is consistent with previous annual monitoring periods.

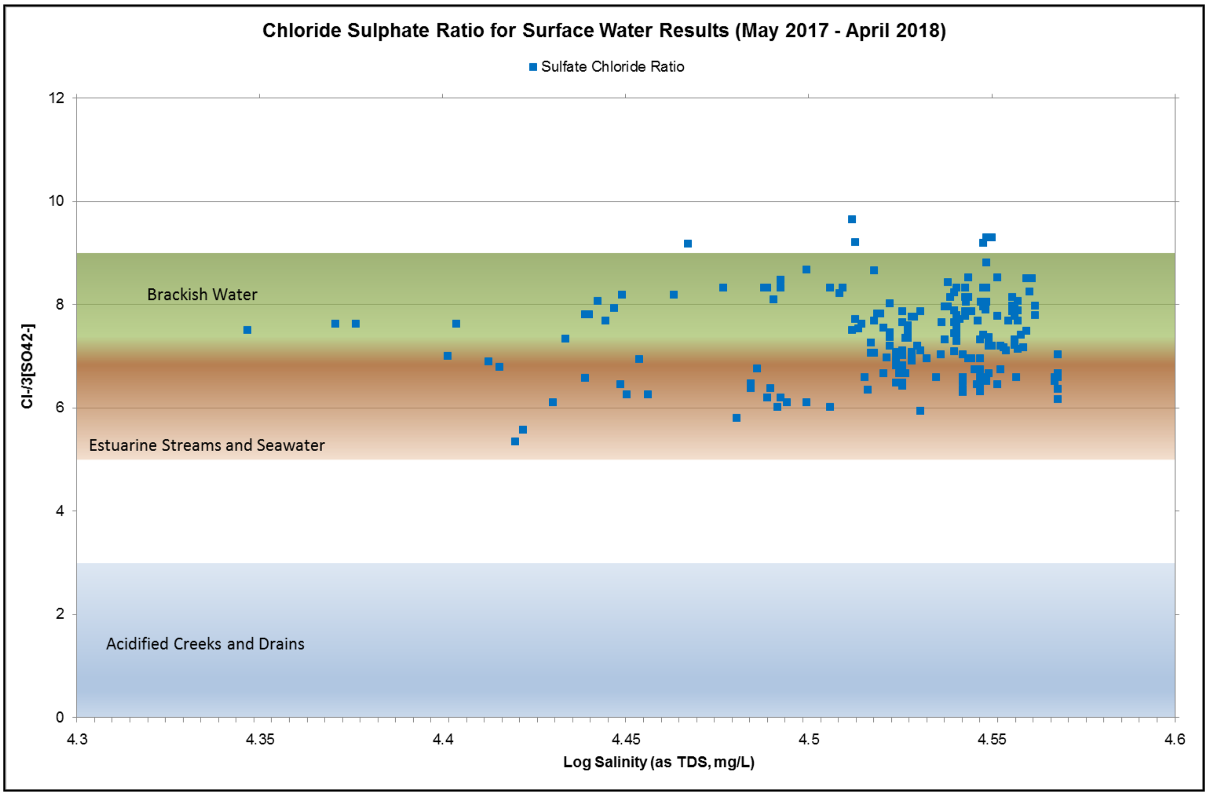


Figure 4-5 Surface Water Chloride/Sulphate Ratio

4.1.2.2 Terrestrial Surface Water Quality

The auto-sampler results were representative of terrestrial surface waters passively discharging from Site. The auto-samplers were installed in outfall locations, including basin outfalls previously used as part of the Site erosion and sedimentation controls. These basins are not free flowing. Auto-samplers are not compliance points for stormwater discharge.

The proportion of auto-sampler samples that recorded turbidity and metals exceedances are summarised below. The percentages are out of a total of 66 samples collected in the annual monitoring period while the AEMR (2017) results are provided in parentheses:

- Turbidity - 91% (93%);
- Aluminium - 98% (87%);
- Total arsenic - 56% (As [III] was 4% and As [V] was 15%);
- Copper - 58% (26%); and
- Zinc - 29% (13%).

Fewer metals exceeded the trigger values in the auto-sampler samples in this annual monitoring period compared to AEMR (2017). Cobalt, lead, manganese, mercury and nickel exceeded the trigger values in AEMR (2017) but not in this annual monitoring period.

Samples collected from the auto-samplers correlated with rain events. Turbidity results were representative of surface flow and sediment loads from unsealed areas, gravel sheeting and hardstand areas as the Site progressed to its final design. It has been assessed that the source of the elevated concentrations of the metals (i.e. aluminium, arsenic, copper and zinc) is the soils that wash-off the auto-sampler catchment areas during rain events and passively discharge from Site.

Results for auto-samplers were compared with mangrove sediments and bio-indicators to determine if analytes in the passive Site discharges were accumulating in the downstream sediments or receptors in the mangrove environment fringing the Site (see **Section 4.3.2.5**).

4.1.2.3 Jetty Outfall Water Quality

Twelve Jetty Outfall monitoring events were undertaken during the annual monitoring period and eight triggered further assessments that concluded the exceedances recorded at the edge of the mixing zone 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.

The current bore network comprises 41 monitoring locations[1], identified on **Figure 4-6**. 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 levels were highest south of the isthmus where typically the underlying soils are less compacted and covered in a more permeable layer allowing increased recharge compared to the north of the isthmus were the soils are typically more compacted and covered in more impermeable surface materials. 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.

[1] The 41 bores in the network include five bores that are located in the EMA. EIMP (Rev 10) excludes monitoring in the EMA and this area is subject to a different licence. Bores in the EMA are only included in this EPA7 Report to provide context for the groundwater monitoring results in the EIMP.

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 between 2013 and 2018 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;
- 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; and
- The dry season water level decreases to the north of isthmus were noted to be consistent every year irrespective of the seasonal rainfall pattern.

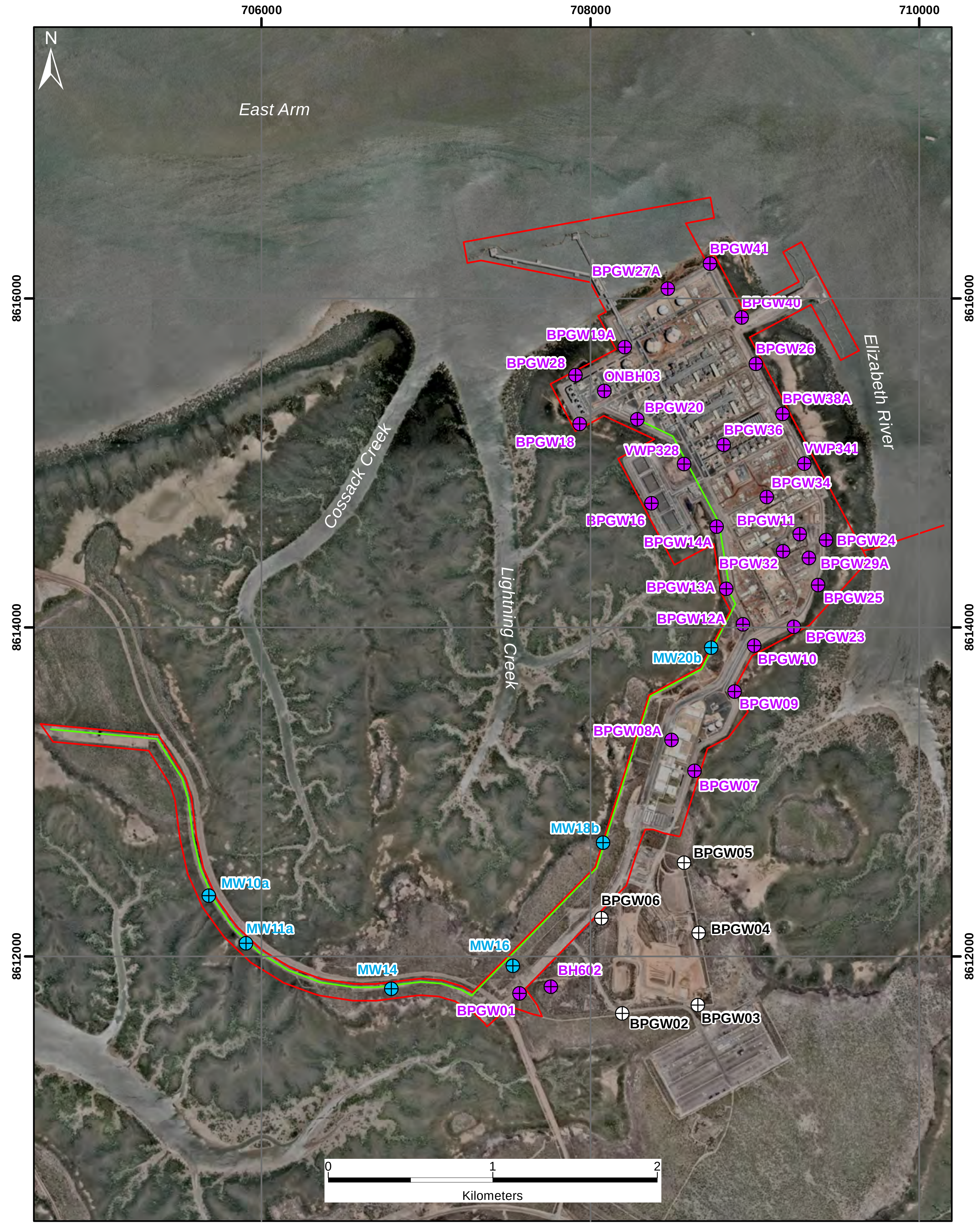
Based on the data collected between 2013 and 2018 there have been no observed long term increasing or decreasing trends in groundwater levels on Site and along the GEP corridor. Therefore, it has been assessed that Site activities and discharges have not adversely impacted seasonal groundwater level fluctuations on Site.

4.2.2.2 Salinity

Field measured salinity ranged from 0.06 g/L to 98.73 g/L. The results confirmed that groundwater salinity varies seasonally and increases depending on proximity to the coastal margins, with varying degrees of rainfall or tidal influence on the groundwater at each bore location.

Results confirmed that salinity varies seasonally and increases depending on proximity to the coastal margins, varying degrees of rainfall and tidal influence on the groundwater at each bore location. Areas of hypersalinity were located around the isthmus, the Flare Pad and along the GEP around MW10a and MW11a. Freshwater areas were centred around BPGW36, BPGW04 and BPGW06.

Groundwater salinity along the GEP corridor followed a similar pattern where salinity varied seasonally in bores installed above the HAT and was generally consistent in the bores installed below the HAT. Areas of hypersalinity occurred at the bores located below the HAT along the coastal margins of the GEP and in the areas dominated by mangrove forests. Comparison of the collected data with baseline monitoring data indicated that the groundwater salinity values along the GEP corridor were not notably modified by the Site activities or discharges.



Site Boundary

Gas Export Pipeline

EIMP Groundwater Sampling Location

GEP Groundwater Sampling Location

Non-EIMP Groundwater Sampling Location[1]

Groundwater Sampling Locations		
Figure 4-6	**INPEX Bladin Point**	GREENCAP
Date: *19/07/2018*	**Author:** malcolm.nunn **Map Scale:** 1:30,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

[1]EIMP (Rev 10) excludes monitoring in the EMA because this area is subject to a different licence. Bores in the EMA are only included in this AEMR to provide context for the groundwater monitoring results in the EIMP.

No warranty is given in relation to the data (including accuracy, reliability, completeness or suitability) and accept no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of or reliance upon the data. Data must not be used for direct marketing or be used in breach of privacy laws. Imagery (7th October 2017) © Nearmap (2017).
R:_Projects\C110042_Inpex\GIS\Maps\BP_Annual_Report\2017_2018\EPA7\FIG_4_06_GroundWater_180719.mxd

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 annual monitoring period, 70% 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 groundwater that interacts with soils known to be naturally low in pH and with high metals concentrations.

There were two large nodes of low pH on Site during the dry and wet season (see **Figure 4-7** and **Figure 4-8**). In the dry season these nodes occurred in the southern portion of the Site (centred around MW16, BPGW06 and BH602) and to the north of isthmus (centred around bores BPGW11, BPGW29A, BPGW32 and BPGW34). In the wet season the node to the north of the isthmus remained similar to that in the dry season and the southern node expanded towards the east. This kind of wet season pattern (i.e. expansion of low pH node in the southern portion of the Site) was observed in previous annual monitoring periods namely AEMR (2015) and AEMR (2016).

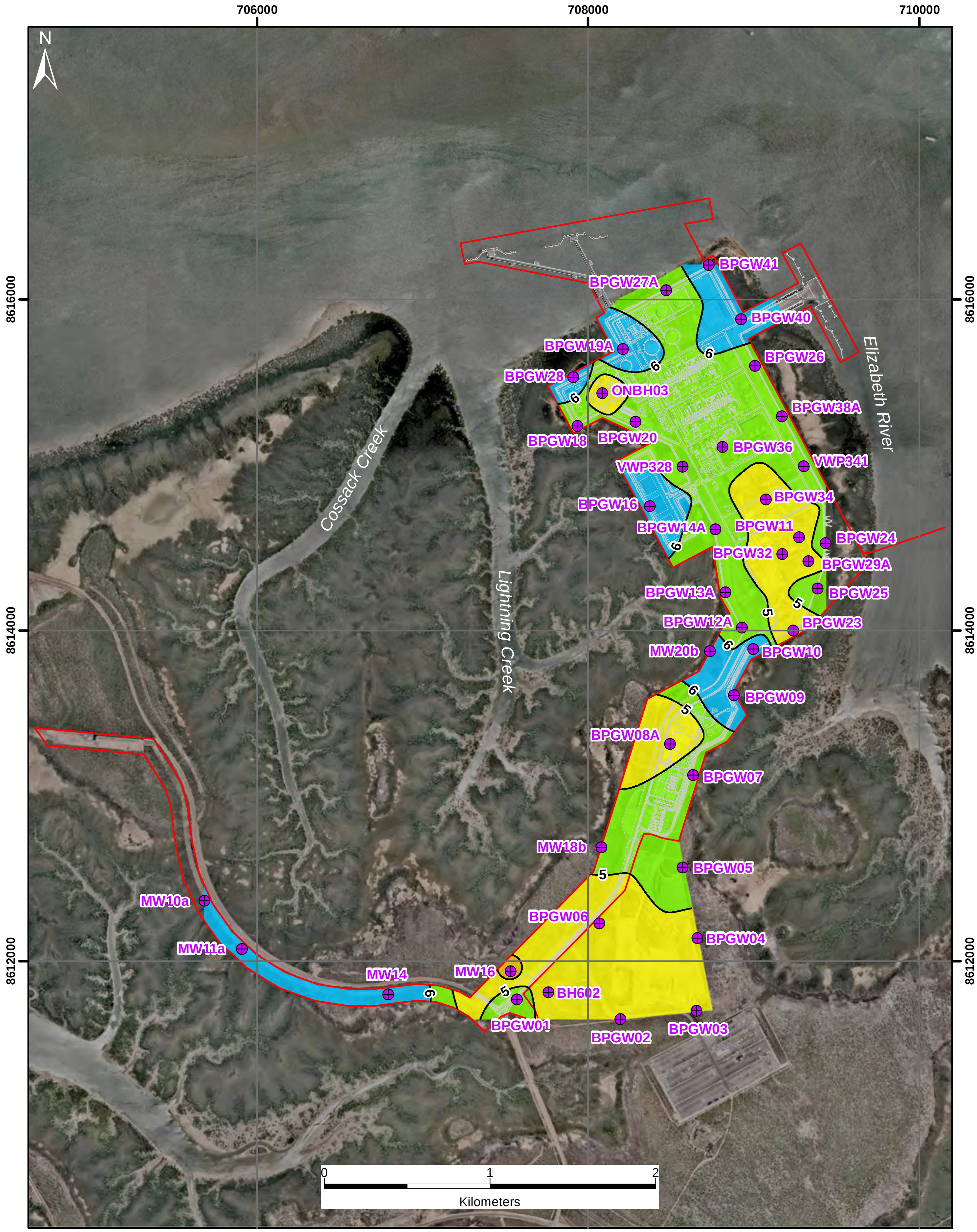
The near neutral pH areas were generally associated with the high salinity groundwater zones along the coastal fringes of the Site. There were five primary zones of near-neutral pH that were observed on Site, as follows:

- The isthmus area;
- The central western area around BPGW16;
- The north-western areas around bores BPGW18, BPGW19A and BPGW28;
- The north-eastern area around BPGW40 and BPGW41;
- Bore BPGW38A; and
- Along parts of the GEP corridor.

Groundwater acidity was assessed to be unrelated to Site activities or discharges because background data 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. The 2017/18 wet season recharge of the groundwater occurred and the pH and groundwater levels were within seasonal ranges.

Given that the baseline and current pH values along the GEP are within similar ranges, the low pH groundwater along the GEP was assessed to be attributable to natural, background conditions resulting from groundwater interaction with acidic soils that also causes metal mobilisation from the soil matrix.

Based on the historical background data and results from the annual monitoring period, it has been inferred that the most likely cause of the low pH levels in the groundwater on Site and along the GEP is the natural processes historically occurring in these areas.



- Site Boundary
- Construction Footprint
- Groundwater Sampling Locations
- pH Level Contours

pH

- <4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 8.5
- >8.5

pH Level Contours, October 2017

Figure 4-7

INPEX Bladin Point

GREENCAP

Date: *8/05/2018*

Author: malcolm.nunn

Map Scale: 1:30,000

Revision: A

Coordinate System: GDA 1994 MGA Zone 52

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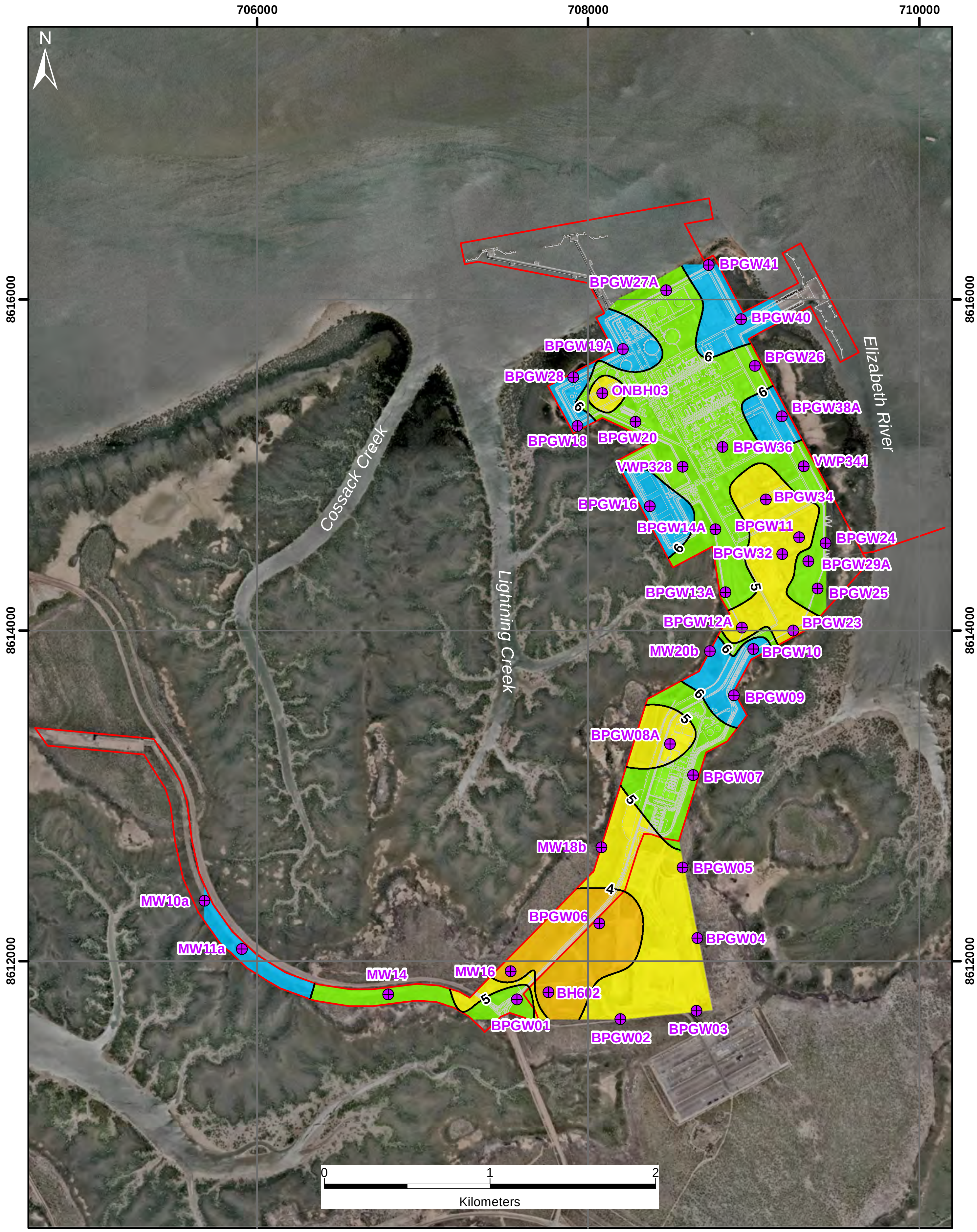

- Site Boundary
- Construction Footprint
- Groundwater Sampling Locations
- pH Level Contours

pH

- <4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 8.5
- >8.5

pH Level Contours, March 2018

Figure 4-8	INPEX Bladin Point	GREENCAP
Date: 8/05/2018	**Author:** malcolm.nunn **Map Scale:** 1:30,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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4.2.2.4 Groundwater Acidification

There were no new excavations or treatments of ASS in the annual monitoring period. In order to assess potential groundwater acidification arising from previous ASS disturbance an analysis of the sulphate/chloride ratios has been 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 and certainly a ratio less than two, is a strong indication of an extra source of sulphate from previous sulphide oxidation (Mulvey, 1993).*

A high sulphate/chloride ratio would indicate a potential influence from a sulphate-containing source e.g. ASS oxidation. A lower ratio would indicate a sulphate salt precipitation or dilution with water with minor sulphate content e.g. rainwater. The groundwater on Site and along the GEP was below the typical seawater ratio (0.14; **Figure 4-9**), indicating a negligible influence from sulphate generation sources and some influence from dilution. During the annual monitoring period, there were 14 occasions when the sulphate/chloride ratio in groundwater was above the typical seawater ratio and of these 12 were recorded at BPGW36 and two at BPGW38A. The occurrences at BPGW36 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 the elevated ratios were are attributed to this localised source, and not ASS impacts. The remaining two occurrences at BPGW38A were considered outliers and were not indicative of increasing sulphate/chloride ratios or ASS impacts.

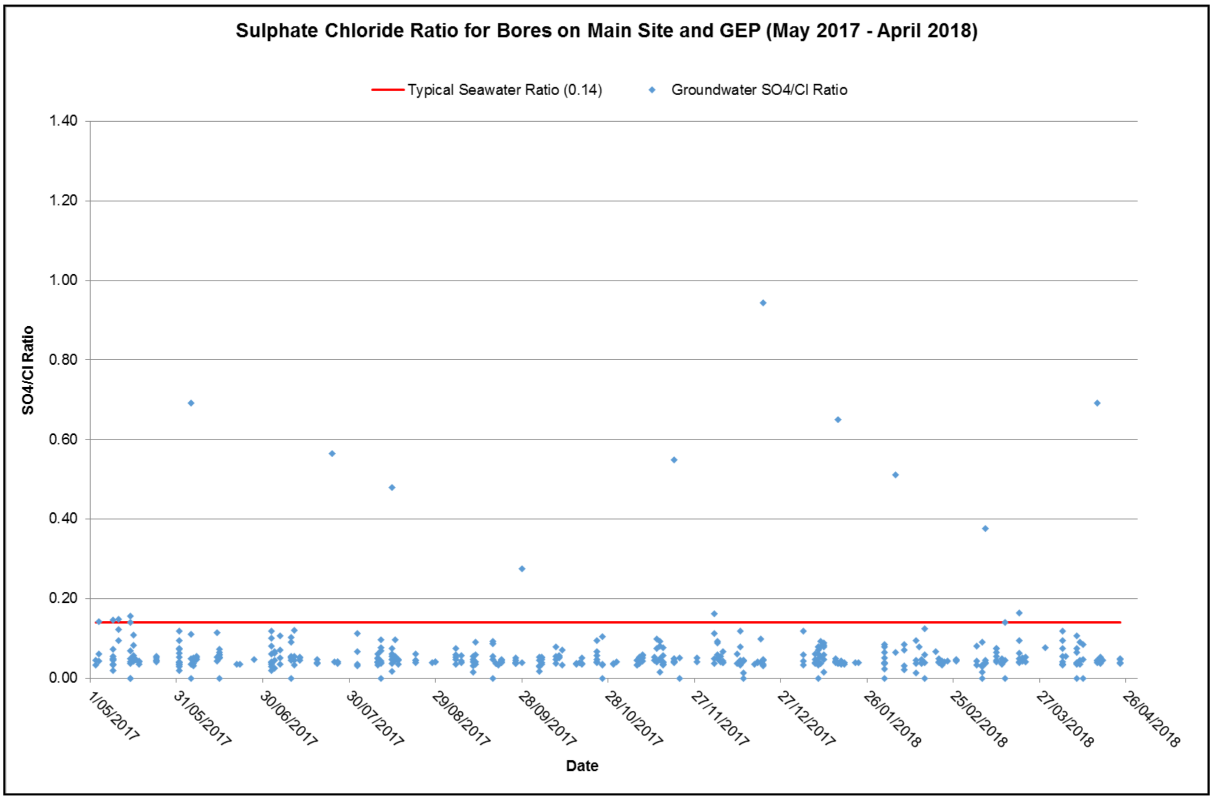


Figure 4-9 Sulphate/Chloride Ratio for Site and GEP Bores

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 and along the GEP corridor). 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 bores on Site displayed a statistically significant, increasing trend in the sulphate/chloride ratio and a decreasing trend in pH. A comparison of the Mann-Kendall classic trend 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, which 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 annual 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 and along the GEP corridor during the annual monitoring period were (all filtered) aluminium, arsenic, cadmium, cobalt, copper, lead, manganese, nickel, silver, and zinc. Mercury only exceeded the trigger value on two occasions, in December 2017 and February 2018.

The following observations were made in regard to metals exceedances:

- The number of arsenic exceedances[2] was consistent with previous annual monitoring periods;
- There were fewer aluminium, cobalt and copper exceedances during the 2017 dry season compared to 2016. However, there was a similar number of exceedances compared to all other annual monitoring periods. The number of exceedances during the wet season showed the opposite pattern;
- There were fewer cadmium exceedances compared to previous annual monitoring periods;
- Lead exceedances were similar to previous years and there were fewer exceedances during the wet season compared to the dry season;
- The number of manganese and nickel exceedances decreased compared to all previous monitoring periods; and
- The number of zinc exceedances was slightly higher compared to the 2016/2017 annual monitoring period but was similar to all previous monitoring periods.

Additional observations from the metals results were as follows:

- Elevated concentrations of filtered aluminium, cobalt, cadmium, copper, nickel, and zinc typically correlated with nodes of low pH on Site. In contrast elevated filtered, total arsenic and manganese concentrations were usually correlated with areas of near neutral pH;
- Metal concentrations tended to decrease during the wet season when freshwater infiltration reduced the groundwater salinity and diluted the concentrations of these metals;

[2] Although filtered arsenic was not monitored in previous periods, the sum of speciated arsenic (arsenic [III] and arsenic [V]) was used to compare total filtered arsenic between the annual monitoring periods.

- The reduction in metal concentrations during the wet season also indicated that no additional metals infiltrated groundwater from the surface. This supports the hypothesis that the source of the metals in the groundwater is the in situ soils that are naturally found on Site, rather than a release and subsequent plume associated with ASS, spills or leaks; and
- There were no increasing trends in metals concentrations in the bores on Site and along the GEP, with the exception of those metals/bores outlined in **Section 4.2.2.7** below.

Metal concentrations followed typical seasonal patterns during the annual monitoring period by increasing in the dry season and decreasing in the wet season, and were largely influenced by resulting changes in pH and salinity levels. After a number of high rainfall events from November onwards, metals concentrations decreased quite rapidly as a result of the rainfall and recharge.

A review of the 80th percentile statistical analysis tool (which provides a temporal assessment of metal exceedances), indicated some exceedances of the 80th percentile during the monitoring period for aluminium, arsenic, cadmium, cobalt, copper, lead, manganese, mercury (on two occasions), 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.

Both the total number of the metal exceedances and metals concentrations decreased with the onset and progression of the wet season, which was indicative of the influence of increased rainfall and subsequent recharge on groundwater quality. Based on statistical analysis of the dataset, baseline data and the results from the annual monitoring period at construction activity locations, it was assessed that those elevated metal concentrations detected in the groundwater on Site and along the GEP corridor were not related to Site activities or discharges.

4.2.2.6 Nutrients

The nutrients that exceeded the adopted trigger values on Site and along the GEP corridor during the annual monitoring period were ammonia, oxides of nitrogen, total nitrogen, total phosphorus and occasionally FRP.

The following observations were made in regard to nutrient exceedances:

- There were more total phosphorus exceedances recorded in this annual monitoring period compared to previous monitoring periods;
- There were a similar number of oxides of nitrogen, ammonia and total nitrogen exceedances compared to previous monitoring periods;
- Low ammonia and oxides of nitrogen concentrations in bores to the south of the isthmus and to some extent total phosphorus in bores to the north of the isthmus, correlated with nodes of low pH on Site;
- Total nitrogen showed some correlation with low groundwater salinity areas;
- There were no increasing trends in nutrient concentrations with the exception of those outlined in **Section 4.2.2.7** below;
- Elevated ammonia concentrations were noted in saline and hypersaline groundwater (with the exception of BH602). Concentrations varied seasonally and the following patterns were observed:
  - Slight seasonal variations in the bores below the HAT where groundwater levels were not heavily influenced by rainwater infiltration; and
  - Decreases in concentrations in the bores above the HAT during the wet season as a result of freshwater recharge and subsequent dilution.
- Filterable reactive phosphorus concentrations occasionally exceeded the trigger levels during the wet season in the areas where rainwater infiltrated through natural soils; and
- A seasonal increase in oxides of nitrogen concentrations was noted mainly during the wet season in areas where groundwater had high ORP levels, which supported conversion of natural ammonia into nitrite and nitrate.

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 mangrove muds and did not correspond with known spills. The number of exceedances and nutrient concentrations generally decreased with the onset and progression of the wet season which indicated the influence of increased rainfall and subsequent recharge on groundwater quality.

Based on statistical analysis of the dataset, baseline data and the results from the annual monitoring period at construction activity locations, it was assessed that those elevated nutrient concentrations detected in the groundwater on Site and along the GEP corridor were not related to Site activities and discharges.

4.2.2.7 Metals and Nutrients on Watch List

In AEMR (2017), a small number of bores recorded potentially increasing trends in metal and nutrient concentrations and these bores 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 an AEMR (2018) 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 annual monitoring period and the 80th percentile in April 2018. 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 Site activities or discharges (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 April 2018 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 metals and nutrients presented in **Table 4-1** are those from the AEMR (2018) watch-list that showed a statistically significant, increasing trend in annual monitoring period.

Table 4-1 AEMR (2018) Watch-list

Bore ID	Analyte (Increasing Trend)	pH Decreasing Trend	SO4/CL Ratio Increasing Trend
BPGW09	Arsenic	Yes	No
BPGW11	Aluminium	Yes	No
BPGW11	Arsenic	Yes	No
BPGW11	Cadmium	Yes	No
BPGW11	Cobalt	Yes	No
BPGW11	Lead	Yes	No
BPGW11	Nickel	Yes	No
BPGW11	Zinc	Yes	No
BPGW16	Total nitrogen	No	No
BPGW23	Aluminium	Yes	No
BPGW24	Oxides of Nitrogen	Yes	No
BPGW26	Arsenic	No	No
BPGW32	Nitrogen	No	No
BPGW34	Arsenic	Yes	No
BPGW34	Cobalt	Yes	No
BPGW34	Nickel	Yes	No
BPGW34	Zinc	Yes	No

The bores displaying increasing trends in metal or nutrient concentrations either displayed no increasing trend in sulphate/chloride ratios and no decreasing trend in pH or a decreasing trend in pH but no accompanying increasing trend in the sulphate/chloride ratio.

A review of environmental incidents was undertaken to determine whether any spills or leaks had occurred in the vicinity of bores listed in **Table 4-1** and whether these could have been 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 nutrient concentrations or decreases in pH were not attributed to Site activities.

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.

During the annual monitoring period, mangrove monitoring occurred at the locations identified on **Figure 4-11**.

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 annual monitoring period and canopy cover increased in the majority of survey plots. The largest overall increase in canopy cover was recorded at impact sites (+8.1% ± 2.1 SE) compared to reference sites (+3.4% ± 1.9 SE), which was consistent with previous annual monitoring periods. Mean canopy cover was only slightly higher at impact sites (85.1% ± 1.4 SE) compared to reference sites (86.1% ± 2.0 SE) during the annual monitoring period.

Canopy cover data has been summarised in **Figure 4-10** by comparing mean canopy cover for the three mangrove assemblages monitored, namely:

- *Rhizophora* forest zone;
- *Ceriops* dominated tidal flat zone; and
- Hinterland margin zone.

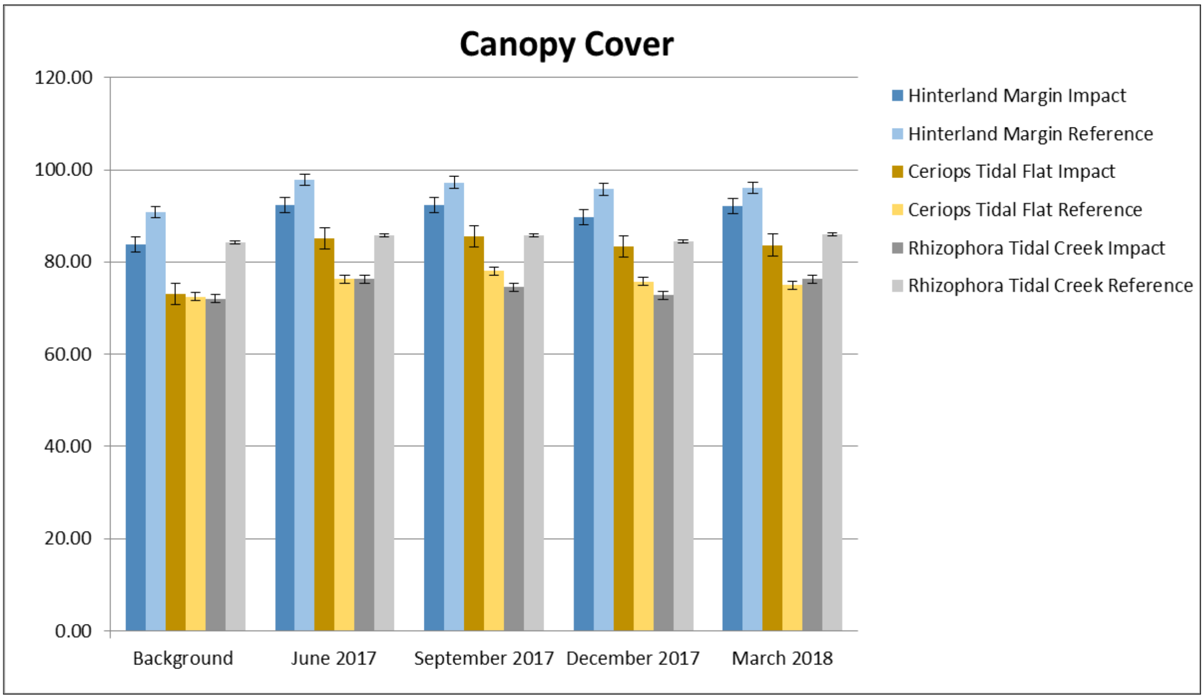


Figure 4-10 Mean Canopy Cover Summarised for each Mangrove Assemblage

Tree condition decreased slightly at all sites in comparison to background data which was consistent with previous annual monitoring periods. With the exception of two reference sites, tree condition did not exceed the 30% trigger value. Tree condition remained high with the average percentage of healthy trees marginally higher at reference sites compared to impact sites.

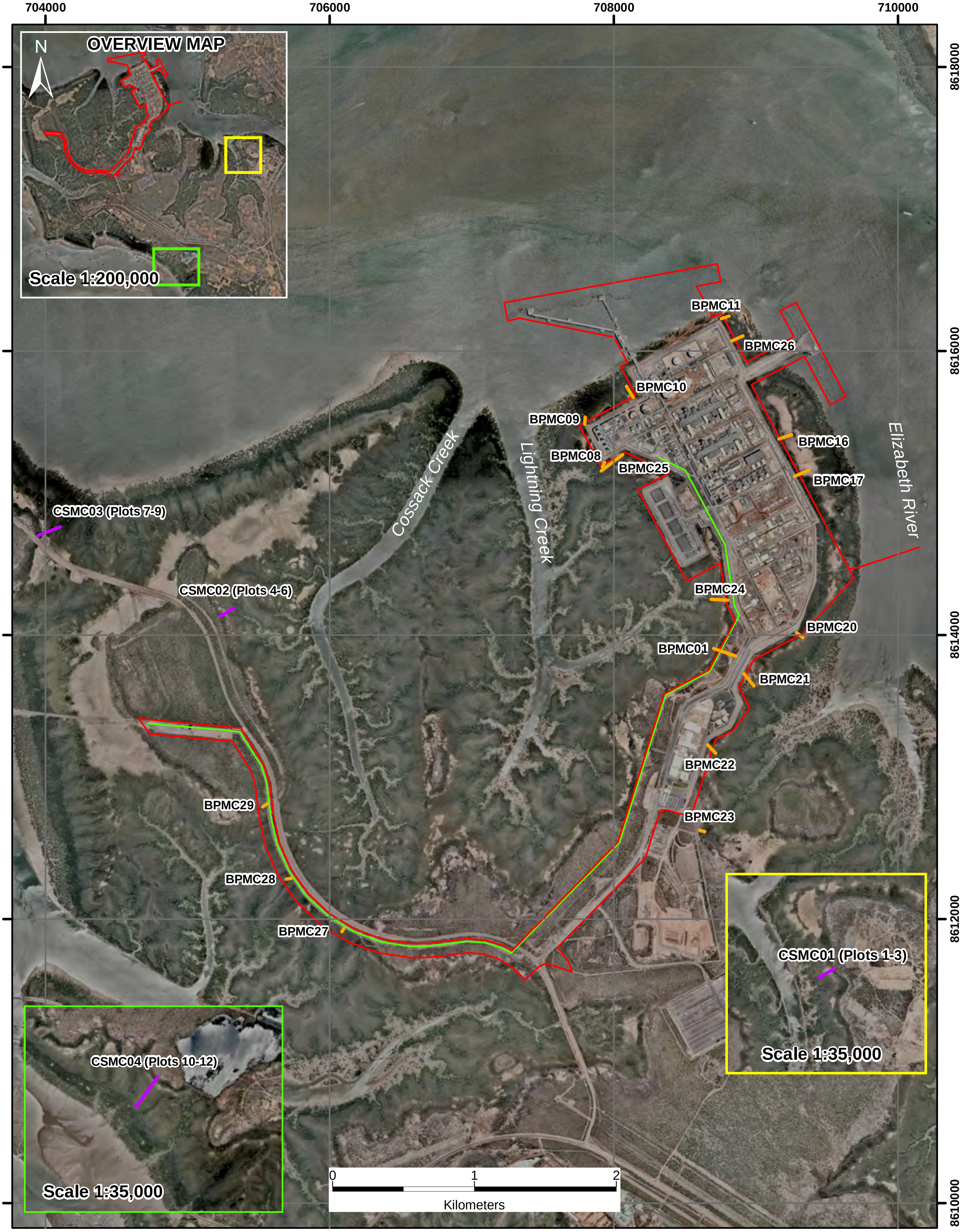
Impact and reference sites contained seedlings (77% and 92% respectively) during the annual monitoring period. Overall, there was a mean increase of seedlings observed at impact sites and a mean decrease at reference sites compared to AEMR (2017), with regeneration rates remaining high.

Exceedances of the 30% trigger value for pneumatophore and crab burrow density were recorded during the annual 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 annual monitoring period. This was consistent with AEMR (2017) 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 annual monitoring period were consistent with the June 2012 survey (AEMR [2013]) and background data collected in March 2015, June 2015, September 2015, December 2015 and June 2016.

No ecologically significant decline in mangrove community health was detected at the 17 impact sites surveyed during the annual 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.



Site Boundary

Gas Export Pipeline

Mangrove Transects

Mangrove Transects (Reference Sites)

Mangrove Monitoring Locations

Figure 4-11	INPEX Bladin Point	GREENCAP

Date: 8/05/2018

Author: malcolm.nunn

Map Scale: 1:35,000

Revision: A

Coordinate System: GDA 1994 MGA Zone 52

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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 annual monitoring period. Sediment height increased slightly at impact and reference sites but the results were variable with no distinct trend and remained consistent with all previous annual monitoring periods.

On an annual basis (May 2012, June 2013, June 2014, June 2015, June 2016 and June 2017), 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 the findings in all previous annual monitoring periods; and
- Survey point 17002 (along BPMC17) recorded the largest increase of +39.8 cm, however, nearby survey point 17003 recorded a minor decrease of -3.9 cm. Survey point 24002 (along BPMC24) recorded the largest decrease of -23.1 cm, however nearby survey point 24003 recorded a minor decrease of -1.2 cm. Additionally, mangrove community health parameters recorded at BPMC17 and BPMC24 remained consistent with background data, indicating that adverse impacts were not recorded in these areas.

The mangrove sediment data collected during the annual monitoring period indicated that there had not been any broad-scale sediment accumulation or erosion that had impacted mangrove communities 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). Hence, 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.

4.3.2.3 Sediment Quality

Exceedances of total metals in sediments were below the ISQG-High trigger values with the exception of:

- Total arsenic at two impact sites, namely BPMC22 and BPMC24 in June 2017 and at one impact site (BPMC24) in September 2017; and
- Total mercury at three impact sites (BPMC20, BPMC27 and BPMC28) in September 2017.

Acid soluble (bio-available) metals in sediments were all below the adopted trigger values, with the exception of trigger value (low) exceedances of mercury at six impact sites in September 2017.

The observed bio-available mercury exceedances in September 2017 had returned to <LOR in the subsequent December 2017 and March 2018 monitoring rounds. Similarly, with the exception of one detection at reference location CSMC04-11, total mercury concentrations in sediments returned to <LOR at all sites in December 2017 and March 2018.

A more detailed assessment of the potential source(s) of those metals that recorded exceedances in the mangrove sediments in the annual 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.

Total recoverable hydrocarbons were detected in sediments at impact sites and reference sites in the annual monitoring period. However, no detections were recorded after silica gel clean-up, indicating that these detections were from natural sources.

4.3.2.4 Bio-indicators

Metals and semi-metals in mud whelk tissue were within the adopted trigger values during the annual monitoring period with the exception of mercury. However, the percentage of impact sites and references sites that exceeded the adopted trigger values for mercury during the annual monitoring period decreased in comparison to the June 2012 background and all previous annual monitoring periods (with the exception of references sites in AEMR (2014) and June 2012 background).

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

A more detailed assessment of the potential source(s) of those metals that recorded exceedances in the bio-indicators in the annual 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

During the annual monitoring period, total arsenic, total chromium, total mercury and bio-available mercury exceedances were detected in mangrove sediments, while mercury exceedances were detected in bio-indicators. Mann-Kendall statistical analysis was also undertaken on the following metals in mangrove sediments and bio-indicators: aluminium, arsenic, cadmium, cobalt, copper, manganese, mercury, nickel and zinc to determine the significance of any potential trends.

Terrestrial surface water quality results (from auto-samplers, denoted with the prefix SWAS) were compared to mangrove sediment and bio-indicator results because terrestrial surface waters passively discharging from Site are a potential, cumulative source of sediments (and metals) in the mangrove environment fringing the Site. Results from auto-samplers were compared to results at nearby mangrove monitoring sites as follows:

- BPMC08 and BPMC09 were compared to SWAS01 (250 m and 75 m away, respectively);
- BPMC26 was compared to SWAS02 (125 m away);
- BPMC17 and BPMC20 were compared to SWAS03 (500 m and 750 m away, respectively);
- BPMC22 was compared to SWAS04 (125 m away).

Total Arsenic in Sediments

Exceedances for total arsenic in sediments were recorded at six impact sites and four reference sites in June 2017. These exceedances were not related to Site activities or discharges because they were recorded at both impact sites and reference sites.

Exceedances for total arsenic in sediments were recorded at seven impact sites in September 2017 and at two impact sites in December 2017. An assessment of the multiple lines of evidence found:

- Total arsenic exceedances were recorded at BPMC17 (near auto-sampler SWAS03) and BPMC01 (which is not located close to auto-sampler locations) in December 2017. Auto-sampler SWAS03 recorded a filtered arsenic exceedance in December 2017, which corresponds to the total arsenic exceedance at BPMC17, however, BPMC20 which is also located in close proximity to SWAS03 did not record elevated filtered arsenic concentrations during the annual monitoring period;
- There were no triggers for auto-sampler sample collection in September 2017 to enable comparison with total arsenic concentrations in sediments;
- There were no corresponding elevated, bio-available sediment or bio-indicator tissue arsenic concentrations in the mangrove sediments in September and December 2017;
- There were no reportable arsenic exceedances recorded in any of the outfall monitoring programs during the annual monitoring period;

- Total arsenic exceedances in sediments were typically present at, and south of the isthmus, at impact sites BPMC01, BPMC22, BPMC23 and at GEP site, BPMC27. Sites BPMC01, BPMC22, and BPMC24 are located in close proximity to the isthmus and groundwater bores BPGW09, BPGW10, BPGW12A, BPGW13A and MW20b. The most likely reason for the consistently elevated arsenic concentrations at these locations may be their 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;
- With the exception of BPMC11, BPMC17 and BPMC24, there were no exceedances north of the isthmus where the major portion of the construction works were occurring; and
- A review of construction and commissioning activities and environmental incidents did not identify a source for the elevated arsenic concentrations in the sediments.

Mann-Kendall statistical analysis indicated there were no increasing trends for arsenic in mangrove sediments (and bio-indicators) during the annual monitoring period and there was no decline in mangrove community health parameters during the annual monitoring period). Therefore, after the assessment of multiple lines of evidence, it was concluded that the arsenic exceedances recorded in sediments in June, September and December 2017 were not related to Site activities or discharges.

Total and Bioavailable Mercury in Sediments

Exceedances for total mercury in sediments were recorded at 16 impact sites and bio-available mercury in sediments at six impact sites in September 2017. An assessment of the multiple lines of evidence found:

- Mercury did not exceed the trigger value in any groundwater wells during September 2017, and there were no elevated mercury concentrations in groundwater wells upstream of the mangrove sediment sampling locations, with mercury concentrations remaining <LOR;
- There were no filtered mercury exceedances detected at any of the auto-sampler locations, no detections of mercury in marine surface water sampling (all concentrations remaining below the LOR) and no reportable mercury exceedances were recorded in any of the outfall monitoring programs in the annual monitoring period; and
- A review of construction and commissioning activities and environmental incidents did not identify a source for the elevated mercury concentrations in the sediments at the abovementioned impact sites.

The observed bio-available mercury exceedances in September 2017 returned to <LOR in the subsequent December 2017 and March 2018 monitoring rounds. Similarly, with the exception of one detection at reference location CSMC11, total mercury concentrations in sediments were <LOR in both the December 2017 and March 2018 monitoring rounds.

Mann-Kendall statistical analysis of all available data (June 2012 to March 2018) indicated there were no increasing trends for mercury in mangrove sediments (total and bio-available) and bio-indicators during the annual monitoring period.

Based on the assessment of multiple lines of evidence, a Site source and pathway for the mercury exceedances in the sediments could not be identified. Therefore, it was concluded that the mercury exceedances were unrelated to Site activities. In addition, there was no decline in mangrove community health parameters during the annual monitoring period.

Mercury in Bio-indicators

Exceedances for mercury in bio-indicators were recorded at two impact sites in June 2017. An assessment of multiple lines of evidence found:

- There were no corresponding elevated, total or bio-available mercury concentrations in the mangrove sediments in June 2017;
- Mercury did not exceed the trigger value in any groundwater wells during June 2017, and there were no increasing mercury concentrations in groundwater wells upstream of the mangrove sampling locations, with mercury concentrations remaining <LOR;
- There were no filtered mercury exceedances detected at any of the auto-sampler locations, no detections of mercury in marine surface water sampling (all concentrations remaining below the LOR) and no reportable mercury exceedances were recorded in any of the outfall monitoring programs in the annual monitoring period; and
- A review of construction activities and environmental incidents did not identify a source for the elevated mercury concentrations in bio-indicators at the abovementioned impact sites.

Exceedances for mercury in bio-indicators were recorded at two impact sites and three reference sites in March 2018. As they were recorded at both impact sites and reference sites these exceedances were considered to be unrelated to Site activities or discharges. Furthermore, there were no filtered mercury exceedances recorded at nearby auto-sampler location SWAS02 in March 2018. Of the eight impact sites where bio-indicators were collected in March 2018, only two (25%) of these sites also recorded mercury exceedances in total sediment and none of these recorded mercury exceedances in bio-available sediment in the preceding September 2017 survey. Therefore, this does not suggest that there was a link between the sites which recorded total and bio-available mercury exceedances in sediment in September 2017 and the subsequent mercury exceedances in bio-indicators in March 2018.

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

Based on the assessment of multiple lines of evidence, a Site source and pathway for the mercury exceedances in the bio-indicators could not be identified, therefore, it was concluded that the mercury exceedances were unrelated to Site activities.

Total Chromium in Sediments

Total chromium in the sediments exceeded the trigger value at BPMC17 and BPMC24 in June 2017. There were no filtered chromium exceedances detected at any of the auto-sampler locations during the annual monitoring period and all bio-indicator chromium results were <LOR. Mann-Kendall statistical analysis indicated there were no increasing trends for chromium in the mangrove sediments (and bio-indicators) during the annual monitoring period.

Based on the assessment of multiple lines of evidence, a Site source and pathway for the total chromium exceedances in sediments could not be identified, therefore, it was concluded that the exceedances were unrelated to Site activities.

Trends for Aluminium, Arsenic, Chromium, Copper, Iron, Manganese and Mercury in Sediments and Bio-indicators

Mann-Kendall statistical analysis of metals in sediments and bio-indicators indicated that there were no statistically significant, increasing trends for arsenic, chromium, copper, iron and mercury (including bio-available mercury) in the annual monitoring period. However, increasing trends for total and bio-available manganese in sediments was observed at impact site BPMC22 and an increasing trend for aluminium in bio-indicators was observed at reference site CSMC01-2.

The increasing trend for aluminium in bio-indicators at reference site CSMC01-2 was not attributed to Site activities and discharges because it occurred at a reference site.

There were no reported environmental incidents in the vicinity of BPMC22, and no manganese exceedances were recorded at the corresponding auto-sampler SWAS04 during the annual monitoring period. There were also no increasing trends for manganese concentrations observed in bio-indicators in the same sampling period. Based on these multiple lines of evidence, it was assessed that the increasing trend for total and bio-available manganese in the sediments at impact site BPMC22 was not a result of Site activities and discharges.

Summary

There was no evidence of a direct link between the metals exceedances in the mangrove sediments and bio-indicators and the stormwater passively discharging from Site. There was also no evidence of increasing metals trends in the mangrove sediments and bio-indicators that were related to Site activities and discharges.

Based on the above analysis, the risk of passive Site discharges resulting in the accumulation of metals in mangrove sediments or bio-indicators was assessed to be low.

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 comprises 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 annual monitoring period, air quality monitoring occurred at the locations set out in **Figure 4-12**.

Fifteen dust deposition locations (BPDD01 to BPDD14 and PADD01) have been installed. Sample bottles were retrieved from the dust deposition gauges on a monthly basis and submitted to the laboratory for analysis.

Five E-Samplers (BPPM01 to BPPM04 and PAPM01) have been installed to monitor PM_{10}.

4.4.2 Results

4.4.2.1 PM_{10}

During the annual monitoring period, there was one PM_{10} exceedance 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 96 PM_{10} exceedances at BPPM04 during the annual monitoring period. One PM_{10} exceedance was recorded at BPPM04 during 24-hour vector-averaged northerly winds (i.e. along the impact pathway). Further assessment identified that on 11 October 2017, dust was blowing from Site towards the Bladin Central Enterprise Park, which was potentially impacted by dust levels exceeding the air quality criteria. However, there were no dust complaints during the annual monitoring period.

4.4.2.2 Dust Deposition

There was one exceedance of the trigger value recorded at PADD01 and one exceedance recorded at BPDD14 during the annual monitoring period. There were no reports of complaints in relation to dust impacts in Palmerston or at the Bladin Central Enterprise Park.

Dust deposition gauges on Site provided data on potential impacts on the mangrove communities fringing the Site. The trigger value was exceeded 17% of the time on Site during the monitoring period. Mangrove communities fringing the Site remained in a healthy condition during the annual 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 annual monitoring period (BPAN01, BPAN02 and PAAN01) (**Figure 4-13**).

4.5.2 Results

No noise complaints were received during the annual monitoring period.

The day-time and night-time exceedances recorded at PAAN01 were evaluated with reference to available audio files and were confirmed to be related to insects, frogs, birdsong, motor vehicles and passing trains.

Audio analysis of sound files from BPAN02 confirmed that the predominant causes of exceedances were vehicle reversing alarms and heavy vehicle movements that were operating in the laydown area. Exceedances also occurred during the wet season as a result of thunder storms passing over Site. 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 annual monitoring period indicated that there were no noise levels of this magnitude at BPAN02.

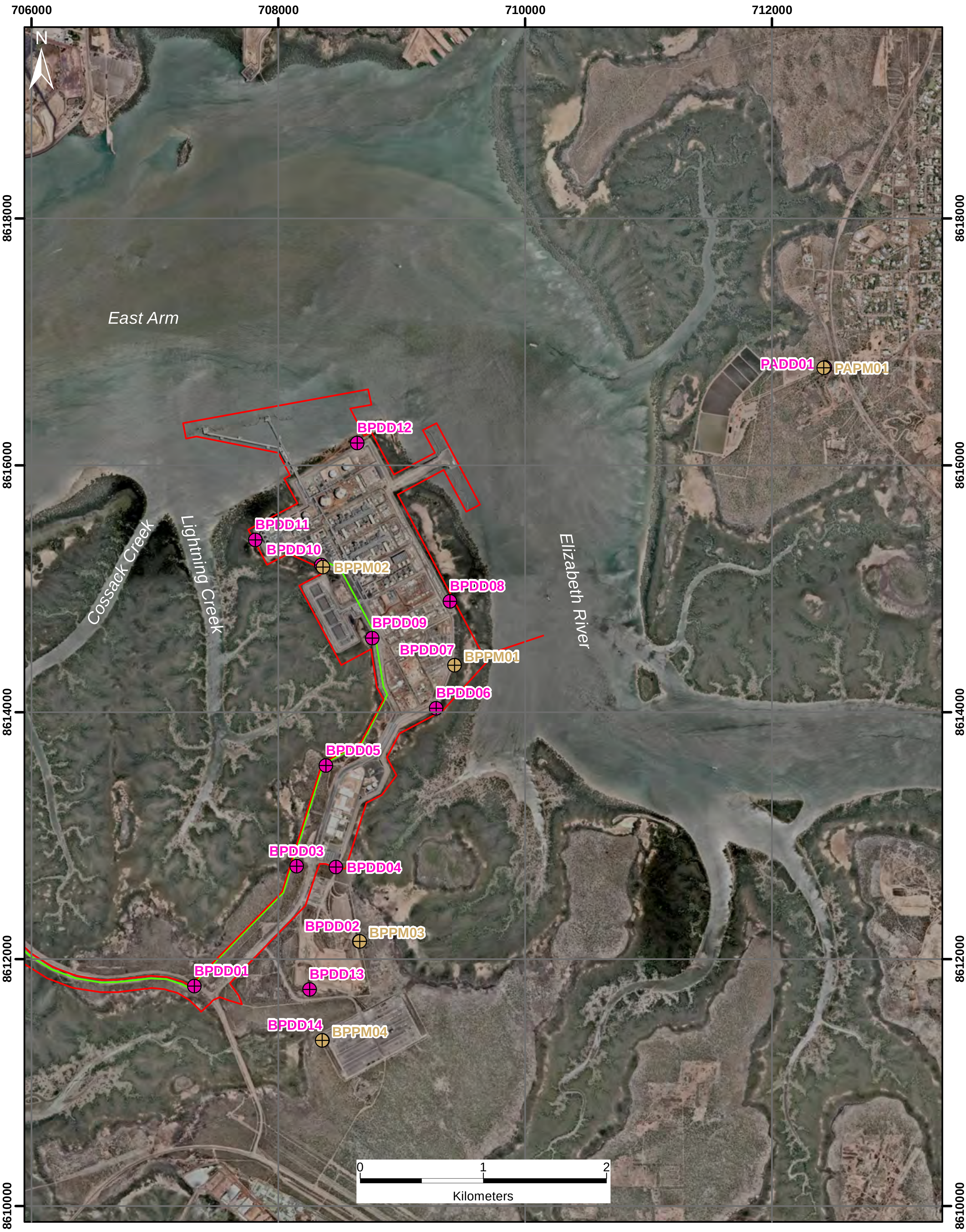
4.6 Flora and Fauna

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 was cleared during the annual monitoring period.

Any fauna deaths that occurred on Site triggered internal incident reporting and fauna relocation activities were recorded in the fauna registers held on Site. Registers relating to fauna injuries and deaths were maintained. Review of incidents, corrective actions and trends occurred on a quarterly basis as part of normal operations.

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 mammals such as flying foxes and wallabies. There were six reported environmental incidents relating to fauna during the annual monitoring period, with the most common being fauna interactions with vehicles, which accounted for five of the incidents. Speed restrictions were implemented at the Site entrance road to minimise the potential for further incidents, which reduced the number of incidents.



Site Boundary

Gas Export Pipeline

Dust Monitoring Location (Dust Deposition Sample)

Dust Monitoring Location (Particulate Matter Sample)

Dust Monitoring Locations		
Figure 4-12	INPEX Bladin Point	GREENCAP
Date: *8/05/2018*	**Author:** malcolm.nunn	
	Map Scale: 1:40,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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Site Boundary
Noise Monitoring Locations
Gas Export Pipeline

Noise Monitoring Locations

Figure 4-13	INPEX Bladin Point	GREENCAP
Date: 8/05/2018	**Author:** malcolm.nunn	
	Map Scale: 1:40,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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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 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.

Five Class B declared species were recorded during the annual monitoring period and two of these (Sicklepod and Neem) were not recorded during the EIS. One new species, a single Neem sapling, was first recorded on Site in December.

The declared weed species with the highest recorded abundance in the annual monitoring period was Perennial Mission Grass (including *Cenchrus spp.*) followed by Horehound and Gamba Grass. Sicklepod and Neem were recorded in small, isolated patches.

Weed control measures were undertaken from November to April, which was an increase compared to the previous annual monitoring period and resulted in an overall decrease in weed abundance of 7% during the peak growth period between December and March.

Although declared weed total area increased in comparison to AEMR (2017) (1.2 ha), the total area of declared weed patches recorded (1.5 ha) in March remained small (~0.4%) compared to the total area occupied by the Site.

It is recommended that the targeted and strategic weed control program is continued to prevent the spread of weeds, particularly along the GEP corridor and along highly trafficked areas adjacent to the Site access road and near storm water outlets. Implementing control measures at an early stage, while densities of declared species are still relatively low will help prevent further infestation and spread. It is recommended that in order to achieve full Site coverage of weeds during each weed control event, spraying events should include foot-based spraying in areas where vehicular access is restricted during times of seasonal inundation (the peak weed growth and treatment period).

The success of future weed control on Site will depend on timing of control measures, which must aim to treat all target weed occurrences during the active growing stage and before viable seed formation.

To continue to ensure that the control of all weeds is carried out before seed set, the ideal timing of the weed control program is as follows:

- Round 1: Early wet season (December): to control all early germinations;
- Round 2: Mid wet season (February): the major control program. 90% of the annual control will occur in this period; and
- Round 3: Late wet season (April): to control all the germinations and any weeds that may have been missed in earlier controls as well as areas previously inaccessible in the wet season.

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 rankings 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 EIMP assess 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 in this report 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.

5.1 Surface Water Monitoring Program

5.1.1 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 and the transport of sediment from the Site into the immediate surroundings including adjacent land, intertidal areas and receiving surface waters. The impact pathways include surface water and the discharge of sediments 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.

5.1.2 Surface Water Contamination

The results at the majority of the marine receiving environment monitoring locations did not exceed the adopted trigger values for nutrients and the overall number of exceedances deceased in comparison to the previous annual monitoring period. There were fewer ammonia, oxides of nitrogen, total nitrogen and total phosphorus exceedances, but slightly more FRP exceedances in the annual monitoring period compared to the previous monitoring period.

The only metals to exceed the adopted trigger values in the marine receiving environment were aluminium and arsenic. There were fewer aluminium exceedances, the same number of copper exceedances and more arsenic exceedances, recorded in the annual monitoring period compared to the previous annual monitoring period.

Samples collected from the auto-samplers correlated with rain events. Turbidity results were representative of surface flow and sediment loads from unsealed areas, gravel sheeting and hardstand areas as the Site progressed to its final design. It has been assessed that the source of the elevated concentrations of the metals (i.e. aluminium, arsenic, copper and zinc) is the soils that wash-off the auto-sampler catchment areas during rain events and passively discharge from Site.

There were instances where exceedances were recorded in the outfall monitoring programs in the annual monitoring period. Investigations concluded that these exceedances were either single exceedances, were not recorded in source characterisation sampling, were also present in the upstream reference site or were typical of the ambient concentrations in the receiving environment based on the monitoring. The risk of environmental harm from these exceedances was assessed to be low.

Where physico-chemical, nutrient and metals exceedances were recorded in the marine receiving environment, these were mostly recorded at both impact sites and reference sites and were therefore unrelated to Site activities and discharges. Where exceedances were recorded at impact sites only a review of construction and commissioning activities did not identify potential source(s) for these exceedances. A multiple lines of evidence assessment was undertaken that support these findings.

The risk ranking remained moderate for surface water contamination and the monitoring program objectives were achieved.

5.1.3 Sediment Transport

The objective of the erosion and sediment controls was to minimise the transport of sediment from the Site into the immediate surroundings including adjacent land, intertidal areas and receiving surface waters.

Terrestrial surface water results from auto-samplers were compared to mangrove sediment results because terrestrial surface waters passively discharging from Site are a potential, cumulative source of sediments in the mangrove environment fringing the Site. The results of this analysis indicated that stormwater passively discharging from the Site did not result in sedimentation or erosion and did not exceed the trigger values during the annual monitoring period.

The risk ranking remained low and the monitoring program objectives were achieved.

5.2 Groundwater Monitoring Program

5.2.1 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.

5.2.2 Groundwater Levels and Quality

The objectives of the groundwater monitoring program 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 attributed to 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 program that was undertaken during the annual monitoring period, there were no observed increasing or decreasing trends in groundwater levels outside normal seasonal variations along the GEP corridor and on Site. Therefore, it has been assessed that Site activities and discharges have not adversely impacted seasonal groundwater level fluctuations on Site.

Metals reported to exceed the adopted trigger levels in the bores on Site and along the GEP corridor during the annual monitoring period were (all filtered) aluminium, arsenic, cadmium, cobalt, copper, lead, manganese, nickel, silver, and zinc. Mercury only exceeded the trigger value on two occasions, in December 2017 and February 2018. The nutrients that exceeded the adopted trigger values on Site and along the GEP corridor during the annual monitoring period were ammonia, oxides of nitrogen, total nitrogen, total phosphorus and occasionally FRP.

The data on groundwater metal and nutrient concentrations and exceedances recorded in the annual monitoring period was generally consistent with previous monitoring periods. These parameters followed typical seasonal trends where concentrations decreased in the wet season in response to increased rainfall and subsequent recharge, and gradually increased over the dry season as the groundwater became more concentrated due a lack of rainfall and recharge.

Mann-Kendall statistical analysis was conducted to determine whether there were any statistically significant, increasing trends in metal/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 bores on Site and along the GEP corridor.

The bores displaying increasing trends in metal or nutrient concentrations either displayed no increasing trend in sulphate/chloride ratios and no decreasing trend in pH or a decreasing trend in pH but no accompanying increasing trend in the sulphate/chloride ratio. A review of environmental incidents was undertaken to determine whether any spills or leaks had occurred in the vicinity of these bores whether these could have been 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 nutrient concentrations or decreases in pH were not attributed to Site activities.

Based on multiple lines of evidence including temporal, spatial, statistical, geochemical and historical evidence it has been inferred that the changes in groundwater quality, including pH, metals and nutrients on Site and along the GEP corridor were not related to Site activities.

The risk ranking has remained moderate for concentrations of metals and nutrients in soils and groundwater and the monitoring program objectives were achieved.

5.2.3 Mangrove Community Impacts

The mangrove objective for the groundwater monitoring program 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 annual monitoring period. The mangrove systems adjacent to the Site were in a healthy condition and relatively undisturbed by Site activities and discharges. The data collected were consistent with data collected during previous annual monitoring periods.

The risk ranking remained moderate for ASS impacts on mangroves surrounding the Site and the monitoring program objectives were achieved.

5.3 Mangrove, Sediments and Bio-indicator Monitoring Program

5.3.1 Qualitative Risk Assessment

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

5.3.2 Mangrove Community Health

Mangrove community health exceeded the 30% trigger value for the following parameters during the annual monitoring period: tree condition on two occasions at reference sites; pneumatophore density on three occasions at impact sites and eight occasions at reference sites; and, crab burrow density on 14 occasions at impact sites and eight occasions at reference sites. Although change was recorded for tree condition, pneumatophore and crab burrow densities, these exceedances were recorded at impact and reference sites, or reference sites only, and therefore were attributed to natural heterogeneity and not Site activities or discharges. These changes did not cause deleterious impacts on mangroves fringing the Site during the annual monitoring period.

Seedling counts increased at impact sites and decreased at reference sites compared to background data, and the majority of impact and reference sites contained seedlings (77% and 92% respectively). The seedling regeneration capacity remained high at the majority of the monitoring sites.

Changes in pneumatophore and crab burrow density compared to background data were minimal, recording an overall slight decrease in pneumatophore density at impact sites and reference sites.

Canopy cover increased at all sites in comparison to background data and results showed minimal change, and the observed patterns were representative of minor ecological variation. Dust was not evident on the leaves of mangrove trees at impact and reference sites during the quarterly mangrove monitoring periods. 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 relatively healthy condition and have not diminished since the pre-construction period.

The risk ranking for loss of mangrove habitat and loss of biodiversity around the Site remained moderate and the monitoring program objectives were achieved.

5.3.3 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 annual monitoring period.

The annual ground level survey results indicated that overall ground level variations were consistent with previous annual monitoring periods. The largest increase was recorded at BPMC17 (+39.8 cm) and the largest decrease was at BPMC24 (-23.1 cm), both in the Hinterland Margin assemblage. However, 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.

The risk ranking for sedimentation and erosion remained low and the monitoring program objectives were achieved.

5.3.4 Sediment Quality

Total metals in sediments were within the adopted trigger values with the exception of total arsenic, total chromium and total mercury in the annual monitoring period. Acid soluble (bio-available) metals in sediments were all below the adopted trigger values, with the exception of trigger value (low) exceedances of mercury at six impact sites in September 2017.

The observed bio-available mercury exceedances in September 2017 had returned to <LOR in the subsequent December 2017 and March 2018 monitoring rounds. Similarly, with the exception of one detection at reference location CSMC04-11, total mercury concentrations in sediments returned to <LOR at all sites in December 2017 and March 2018.

Based on the assessment of multiple lines of evidence, a Site source and pathway for the mercury concentrations in the sediments could not be identified, therefore, it was concluded that the mercury exceedances recorded in sediments in September 2017 were not a result of Site activities and discharges.

Mann-Kendall statistical analysis of metals in mangrove sediments indicated that there were no statistically significant, increasing trends for arsenic, chromium, copper, iron and mercury (including bio-available mercury) in the annual monitoring period. Based on the analysis, the risk of passive Site discharges resulting in the accumulation of metals in mangrove sediments was assessed to be low.

Increasing trends for total and bio-available manganese in sediments was observed at impact site BPMC22 in the monitoring period. There were no reported environmental incidents in the vicinity of BPMC22, and no manganese exceedances were recorded at the corresponding auto-sampler SWAS04 during the annual monitoring period. There were also no increasing trends for manganese concentrations observed in bio-indicators in the same sampling period. Based on this evidence, it was assessed that the increasing trend for total and bio-available manganese at BPMC22 was not a result of Site activities and discharges.

Total recoverable hydrocarbons were detected in sediments at impact sites and reference sites in the annual monitoring period. However, no detections were recorded after silica gel clean-up, indicating that these detections were from natural sources.

The risk ranking for sediment quality remained low and the monitoring program objectives were achieved.

5.3.5 Bio-indicators

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.

Metals in mud whelk tissue were within the adopted trigger values with the exception of mercury. Exceedances were recorded at two impact sites in June 2017, and two impact sites and three reference sites in March 2018. The March exceedances were recorded at both impact sites and reference sites and were therefore not a result of Site activities or discharges. Based on the assessment of multiple lines of evidence, a Site source and pathway for the mercury exceedances in June 2017 could not be identified, therefore, it was concluded that these mercury exceedances were not a result of Site activities and discharges.

Mann-Kendall statistical analysis of metals in bio-indicators revealed that there were no statistically significant, increasing trends for arsenic, chromium, copper, iron and mercury (including bio-available mercury) in the annual monitoring period. Based on the analysis, the risk of passive Site discharges resulting in the accumulation of metals in bio-indicators was assessed to be low.

There were no TRH detections in mud whelk tissues during the annual monitoring period.

The risk ranking for bio-indicator impacts remained low and the monitoring program objectives were achieved.

5.4 Dust Monitoring Program

5.4.1 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.

5.4.2 Dust Impacts on the Environment

No PM_{10} exceedances were recorded at Palmerston (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.

One PM_{10} exceedance was recorded at BPPM04 during 24-hour vector-averaged northerly winds (i.e. along the impact pathway). Further assessment indicated that the Bladin Central Enterprise Park was potentially impacted by dust levels exceeding the air quality criteria on this particular occasion (11 October 2017), however no dust complaints were received.

There was one exceedance of the dust deposition trigger value recorded at PADD01 and one exceedance recorded at BPDD14 during the annual monitoring period. Dust deposition gauges on Site provided data on potential impacts on the mangrove communities fringing the Site. The trigger value was exceeded 17% of the time on Site during the annual monitoring period and mangrove communities fringing the Site remained in a healthy condition and were not affected by dust deposition.

The risk ranking for dust impacts on community sensitive receptors remained low and the monitoring program objectives were achieved.

5.5 Airborne Noise Monitoring Program

5.5.1 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.

5.5.2 Noise Impacts to Local Community

No noise complaints were received during the annual monitoring period.

Noise audio file analysis of the day-time and night-time exceedances recorded at PAAN01 indicated that noise exceedances at this monitor were caused by local activities (e.g. motor vehicles, passing trains and aircraft) and natural noise sources (e.g. insects, frogs and birdsong).

Assessment of available audio files collected from BPAN02 indicated that the vast majority of exceedances at this noise monitoring location were caused by Site activities within the Area 1888 Laydown Area, however, noise attenuation analysis undertaken previously indicated that these events would not have caused an exceedance of the residential trigger values at the Bladin Central Enterprise Park. The remaining exceedances were caused by natural noise sources like insect and bird sounds.

The risk ranking for noise impacts (nuisance and health impacts) remained low and the monitoring program objectives were achieved.

5.6 Flora and Fauna Monitoring Program

5.6.1 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.

5.6.2 Flora and Fauna

No vegetation clearing occurred during the annual 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 mammals such as flying foxes and wallabies.

There were six reported environmental incidents relating to fauna during the annual monitoring period, with the most common being fauna interactions with vehicles, which accounted for five of the incidents. Speed restrictions were implemented at the Site entrance road to minimise the potential for further incidents, which reduced the number of incidents.

The risk ranking related to terrestrial fauna and mangrove flora impacts was low and any effects on the surrounding environment were localised and minor.

5.7 Weed Monitoring Program

5.7.1 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.

5.7.2 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.

Five Class B declared species were recorded during the annual monitoring period and two of these (Sicklepod and Neem) were not recorded during the EIS, indicating that these species did not occur on Site prior to the commencement of the Project.

The declared weed species with the highest recorded abundance in the annual monitoring period was Perennial Mission Grass (including *Cenchrus spp.*) followed by Horehound and Gamba Grass. The majority of these infestations were within the known locations of existing infestations along the Site access road and the GEP corridor.

Results from weed monitoring undertaken in the annual monitoring period identified that the occurrence of weeds was mainly centred around the GEP corridor, the southern portions of the Site and the Site access roads in areas where top soil has been reinstated for rehabilitation or unsealed ground surfaces such as roadsides.

Although the total area of declared weeds (1.5 ha) increased compared to the previous annual monitoring period (1.2 ha), it remained small (~0.4%) in relation to the total area occupied by the Site.

Weed control measures were undertaken from November to April, which was an increase compared to the previous annual monitoring period. This was evident in the overall decrease in weed abundance of 7% during the peak growth period between December and March.

The success of future weed control on Site will depend on the timing of control measures, which must aim to target weed occurrences during the active growth stage and before viable seed formation.

The weed monitoring program was implemented as planned but the objective of no new declared weed species was not met, however, it was not clear whether this was due to a pre-existing seed bank in the soils or construction and commissioning activities.

5.8 Adaptive Response Monitoring

5.8.1 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.

Surface Water

In order to assess potential impacts and to ensure the effectiveness of the constructed controls and subsequent remediation works, routine downstream marine surface water monitoring was conducted. In total, 20 downstream surface water samples were collected and all samples returned results that were <LOR. The monitoring results confirmed that the initial response, constructed control measures, remedial works and ongoing interception and pumping from the sumps had been effective in containing the spill. Based on these results, the risk of environmental harm to marine surface waters arising from the spill was assessed to be low.

Seep Water – interception sumps

Eight seep water samples were collected from the interception sumps between 7 December 2017 and 21 March 2018. These samples showed a gradual reduction in TRH concentrations over time.

The risk ranking related to the MOF spill was moderate and results monitoring results will be utilised to determine any potential impacts on the receiving environment.

6. CHANGES TO MONITORING PROGRAM

The Project is entering the closing stages of construction/commissioning and is approaching the operations phase. As a result, the risk sources, pathways and the potential for environmental harm have changed, and the monitoring program can be reviewed to remove surplus components.

The remaining phases of the Project currently include:

- Final construction activities;
- Pre-commissioning and commissioning; and
- Removal of temporary facilities and demobilisation.

As the Project progresses into the commissioning and operation phases, the Site will be classified as a Major Hazard Facility (MHF), as defined by Safe Work Australia as "locations such as oil refineries, chemical plants and large fuel and chemical storage sites where large quantities of hazardous materials are stored, handled or processed".

The EIMP (Rev 10) allow changes to the monitoring program 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; and
4. Reduction in the scale of an activity, resulting in redundancy in monitoring locations or programs.

Based on the above change criteria, and the detailed assessment of monitoring results outlined in AEMR (2018), a number of changes to the EIMP are proposed. These are outlined in **Table 6-1** below. Following this, the revised monitoring program is outlined in **Table 6-2**, **Figure 6-1** and **Figure 6-2** below.

The consideration of changes to the monitoring program has been based on whether the cessation of construction and commissioning activities has resulted in the risk source(s) being removed and/or the impact pathway ceasing. If these criteria are met, and it leads to a reduction in the scale of the risk source, this is sufficient justification for the removal of the specified monitoring requirement.

Table 6-1 Changes to the Monitoring Program

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
Surface Water					
Auto-samplers SWAS01, 02, 03, 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	Auto-samplers were installed to monitor the water quality of the catchment runoff discharged via the basin and drainage network during significant rainfall events from drop structures and culverts of the regulating drain. The sampling has provided an indication of the water quality of the runoff flowing across the main catchment areas on Site. Auto-samplers were not intended to report on the quality of all water leaving the Site for compliance purposes because this is covered by operational sampling prior to discharge, which demonstrates compliance with Project objectives. Auto-samplers SWAS01 and SWAS02 are located within SP2 (northern portion of Site) and have provided informative water quality data from passive surface water discharges from these catchment areas. Auto-sampler SWAS04 collects water quality samples from passive surface water discharges from the Operations Complex area while SWAS03 collects samples from the basin outfall in the south-eastern portion of the Site. **Sources** Construction and commissioning activities have been completed in the vicinity of SWAS01 and 04 therefore sources no longer exist. The majority of the construction and commissioning sources either no longer exist (e.g. clearing, ground improvement works concrete works) or are nearing completion (e.g. sealing of roads, storage, handling and/or transfer of dangerous goods and hazardous chemicals) in the vicinity of SWAS02 and 03. **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 (NCW). The systems are designed to ensure both potentially contaminated stormwater and stormwater likely to be contaminated with hydrocarbons does not comingle with non-contaminated stormwater runoff. Both the AOC and COC drain to holding basins and must meet specific criteria before it can be discharged via the Jetty Outfall. The commissioning of these systems has removed the pathway for impact sources to identified receptors. **Conclusions** As a result of the removal of the construction and commissioning related risk sources for SWAS01 and 04, and the removal of the impact pathways for all auto-samplers via the commissioning of the AOC and COC systems, SWAS01, 02, 03 and 04 will be removed. Further all areas north of the Operations Complex (i.e. SWAS 01, 02 and 03) are now classified as a MHF and electrical equipment must be intrinsically safe or require a permit (e.g. hot work permit) and controls. Given the auto-samplers were installed to provide supplementary informative information and are not intrinsically safe (i.e. potential ignition source), removal of auto-samplers is also justified for safety reasons.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
BPSW34, 35	Nutrients, metals, hydrocarbons and physico-chemical parameters	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. 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. - PASS oxidation, acidification and heavy metal mobilisation. - Nutrient leaching from mulch placement.	Surface water Groundwater expression	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	The monthly GEP marine surface water monitoring program commenced in August 2014 to assess the potential surface water impacts associated with the construction and commissioning of the GEP pipeline in the nearshore environment downstream of the GEP corridor. Construction and commissioning in these areas, and in particular ASS/PASS excavations, associated deep soil mixing and vegetation clearing had 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 along the GEP; - All deep soil mixing, excavation, dewatering and and/or displacement of ASS/PASS has been completed along the GEP; - The GEP has been reinstated as per final design; - Vehicle movement along the GEP is prohibited; and - Storage, handling and/or transfer of construction and commissioning related dangerous goods and hazardous chemicals has ceased. Construction and commissioning activities along the GEP were completed in August 2015 and reinstatement activities were completed in October 2016. The completion of these activities has removed all potential construction and commissioning related risk sources. In accordance with AEMR (2017), monitoring has continued at these surface water monitoring locations (albeit quarterly instead of monthly) through to the end of the 2017/18 wet season to provide further evidence of whether any construction and commissioning and reinstatement impacts (e.g. ASS mobilisation and nutrient leaching) could be detected. This assessment was based on the premise that if impacts along the GEP arose (e.g. ASS mobilisation through the groundwater expression pathway) these could start to manifest post the removal of the construction and commissioning related risk sources due to anticipated groundwater transit times in this area. Monitoring of surface water quality at BPSW34, 35 in this annual monitoring period has not detected any ASS mobilisation impacts or nutrient leaching. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and with continued monitoring through the 2017/18 wet season confirming no latent impacts, monitoring at surface water locations BPSW34 and 35 will cease.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
Groundwater					
GEP bores MW10a, 11a, 14, 16, 18b, 20b	Nutrients, metals, hydrocarbons and physico-chemical parameters Groundwater elevation	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. 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. - Nutrient leaching from mulch placement.	Groundwater Surface water	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	The monthly GEP groundwater monitoring program commenced in September 2014 to assess the potential groundwater impacts associated with the construction and commissioning of the GEP pipeline. Construction and commissioning in these areas, and in particular ASS/PASS excavations, associated deep soil mixing and vegetation clearing 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. **<u>Sources</u>** - All clearing, earthworks, general construction and commissioning activities and concrete works have been completed along the GEP; - All deep soil mixing, excavation, dewatering and and/or displacement of ASS/PASS has been completed along the GEP; - The GEP has been reinstated as per final design; - Vehicle movement along the GEP is prohibited; and - Storage, handling and transfer of dangerous goods/hazardous chemicals has ceased. Construction and commissioning activities along the GEP were completed in August 2015 and reinstatement activities were completed in October 2016. The completion of these activities has removed all potential construction and commissioning related risk sources. The velocity of any groundwater flow and potential plume migration was estimated using hydraulic conductivity of the uppermost aquifer material, hydraulic gradient and porosity. Based on observations made during the regular groundwater sampling program the distances between the GEP bores and the locations where deep soil mixing and ASS treatment took place, were on average 15-20 m. It was inferred that the actual migration of potentially impacted groundwater would be in order of 10 m/year or slower and that if any groundwater impacts (e.g. acidification) did occur during GEP construction and commissioning works, it would take approximately one year (i.e. August 2016) for any potentially impacted plume to be detected in the monitoring bores along the GEP. AEMR (2016) recommended that based on the inferred groundwater transit times in these areas, monitoring of bores MW10a, MW11 and MW14 should continue until the end of the 2016/17 wet season as this would provide sufficient time to detect any potential latent groundwater impacts. On the basis that no groundwater impacts were detected in the 2016/17 annual monitoring period, AEMR (2017) recommended that monitoring at bores MW10a, MW11a and MW14 could cease and these bores could be removed from the EIMP. However, monitoring continued at these bores through the 2017/18 annual monitoring period and this provided further evidence that construction and commissioning and reinstatement impacts (e.g. ASS mobilisation and nutrient leaching) had not been detected at these locations.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
					Similar to bores MW10a, MW11 and MW14, the monitoring of GEP bores MW16, MW18b and MW20b has continued for more than 18 months post reinstatement activities (October 2016), including the 2016/17 and 2017/18 wet seasons. Monitoring of these bores through the 2017/18 annual monitoring period provided further and sufficient evidence that construction and commissioning and reinstatement impacts had not been detected. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and with continued monitoring through the 2017/18 wet season confirming no latent impacts, monitoring at bores MW10a, 11a, 14, 16, 18b and 20b will cease.
BPGW16	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	BPGW16 is positioned approximately 50 m from the western boundary of the Flare Pad (Area B300), which is located within SP1. Construction and commissioning in this area, 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 this area; - All deep soil mixing, excavation, dewatering and and/or displacement of ASS/PASS has been completed; - The catchment area is now sealed as per final design; - Vehicle movement in this catchment area is restricted; and - Storage, handling and/or transfer of construction and commissioning related dangerous goods and hazardous chemicals has ceased. Construction and commissioning activities in this area were completed in May 2017. The completion of these activities has removed all potential construction and commissioning related risk sources. An assessment of the groundwater level results from BPGW16 in this annual 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, and no increasing trends in metal and nutrient concentrations resulting from acidification and/or ASS mobilisation in this area. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and with continued monitoring through the 2017/18 wet season confirming no latent impacts, monitoring at groundwater bore BPGW16 will cease.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
Mangroves					
BPMC27, 28 and 29	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. 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. - PASS oxidation, acidification and heavy metal mobilisation. - Reducing soil permeability and lowering of groundwater table. - Nutrient leaching from mulch placement.	Land Surface water Groundwater	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	The quarterly GEP mangrove community health, sediment and bio-indicator monitoring program commenced in March 2015 to assess the potential impacts associated with the construction and commissioning of the GEP pipeline. 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 along the GEP; - All deep soil mixing, excavation, dewatering and and/or displacement of ASS/PASS has been completed along the GEP; - The GEP has been reinstated as per final design; - Vehicle movement along the GEP is prohibited; and - Storage, handling and/or transfer of construction and commissioning related dangerous goods and hazardous chemicals has ceased. Construction and commissioning activities along the GEP were completed in August 2015 and reinstatement activities were completed in October 2016 and therefore the main risk source(s) were removed. EIMP (Rev 10) stated that mangrove monitoring would continue at these locations until the end of the 2017/18 wet season to provide further evidence of whether impacts from the construction and commissioning of the GEP had arisen. The projected date of their removal was May 2018. Monitoring of these transects through the 2017/18 annual monitoring period has provided further and sufficient evidence that construction and commissioning impacts have not been detected at these locations. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and with continued monitoring through the 2017/18 wet season confirming no latent impacts, monitoring at transects BPMC27, 28 and 29 will cease.
BPMC08, 09, 10 and 25	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	Land Surface water Groundwater	Landward mangrove habitat Seaward mangrove habitat Intertidal benthic Soft bottom benthic Water column	This monitoring location is positioned approximately 50 m from the south-western boundary of Area C500 within SP2. Construction and commissioning in this area, 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.

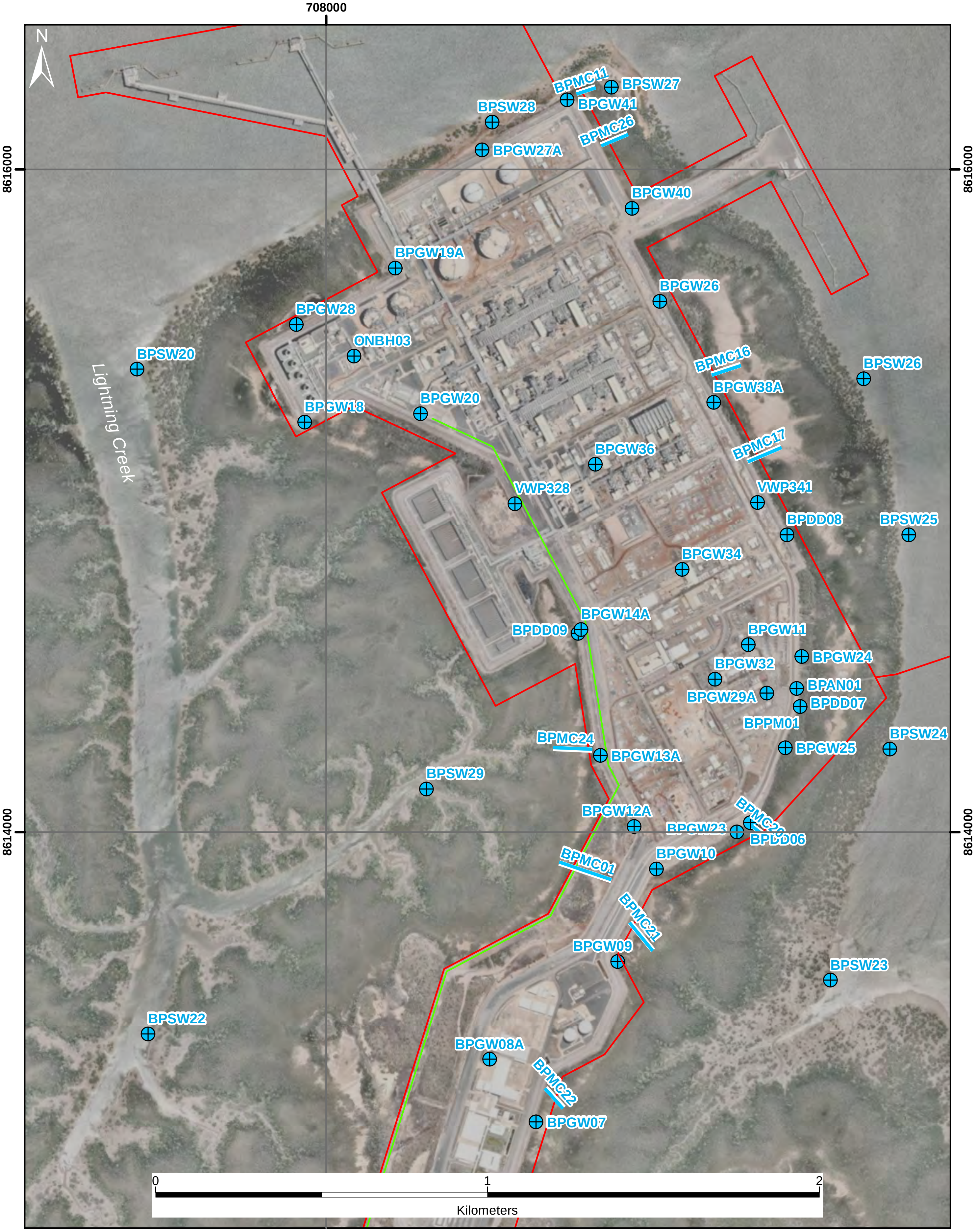
Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
		soil mixing; excavation, dewatering and/or displacement of ASS/PASS; reinstatement works. The above activities have the potential to result in: - Uncontrolled release of dangerous goods and hazardous substances. - Uncontrolled release of construction and commissioning materials. - 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.			**<u>Sources</u>** - All clearing, earthworks, general construction and commissioning activities and concrete works have been completed in this area; - All deep soil mixing, excavation, dewatering and and/or displacement of ASS/PASS has been completed; - The catchment area is now sealed as per final design; - Vehicle movement in this catchment area is restricted; and - Storage, handling and/or transfer of construction and commissioning related dangerous goods and hazardous chemicals has ceased. Construction and commissioning works associated with clearing, earthworks and potential displacement of ASS/PASS reinstatement works were completed in April 2018. Continued monitoring at this site 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 an uncontrolled release of dangerous goods, hazardous substance, material or sediment in the vicinity of BPMC08. 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. **<u>Conclusions</u>** As a result of the removal of the construction and commissioning related risk sources, and with continued monitoring through the annual monitoring period confirming no impacts have been detected at this location, monitoring at transect BPMC08 will cease.
Air Quality (Dust)					
PM_{10} monitoring station BPPM02	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 location is positioned on the southern boundary of A600 within SP2 and has provided data on PM_{10} concentrations at the Site boundary in this area of the Site. **<u>Sources</u>** - All clearing, ground improvement works and general construction and commissioning activities have been completed in this area; - The area is now sealed as per final design; and - Vehicle movement in this area is restricted. The completion of the above activities has removed all potential construction and commissioning related risk sources. Monitoring at BPPM02 during this annual monitoring period confirmed that PM_{10} concentrations at the Site boundary at this location only exceeded the adopted trigger values on six occasions. It was assessed that on all these occasions the risk of dust impacting on identified community sensitive receptors was low.

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors	Justification
					Conclusions As a result of the removal of the construction and commissioning related risk sources, and with no identified impacts during the annual monitoring period, monitoring of PM_{10} at BPPM02 will cease.
Dust deposition stations BPDD01, 03, 04, 05, 10, 11, 12	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	These monitoring locations are positioned at various locations on the boundary of the Site and provide data on potential impacts to hinterland margin and mangrove communities fringing the Site. **Sources** - All clearing, ground improvement works and general construction and commissioning activities have been completed in these areas; - The areas are now sealed as per final design; and - Vehicle movement in these areas is either restricted or prohibited. The completion of the above activities has removed all potential construction and commissioning related risk sources. Mangrove monitoring has confirmed that communities fringing the Site have remained in a healthy condition and were not affected by dust deposition during the annual monitoring period. **Conclusions** As a result of the removal of the construction and commissioning related risk sources, and with no identified impacts during the annual monitoring period, monitoring of dust deposition at BPDD01, 03, 04, 05, 10, 11 and 12 will cease.

Table 6-2 Revised Monitoring Program

Monitoring Asset	Contaminants of concern	Source	Pathway	Receptors
Surface Water				
BPSW20, 22 to 33, 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				
BH602, BPGW07, 08a, 09, 10, 11, 12A, 13A, 14A, 18, 19A, 20, 23, 24, 25, 26, 27A, 28, 29A, 32, 34, 36, 38A, 40, 41, VWP341, VWP328 and 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. - 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				
BPMC01, 11, 16, 17, 20, 21, 22, 23, 24, 26 and CSMC01 to 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. 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. - 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, 03, 04 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 BPDD02, 06, 07, 08, 09, 13, 14 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, 02, PAAN01	Sound levels	Noise from construction and commissioning activities	Air	Community sensitive receptors



Site Boundary | Monitoring Asset
Gas Export Pipeline | Mangrove Transect

EIMP Monitoring Program (north)		
Figure 6-1	INPEX Bladin Point	GREENCAP
Date: 30/07/2018	**Author:** malcolm.nunn	
	Map Scale (@A4): 1:15,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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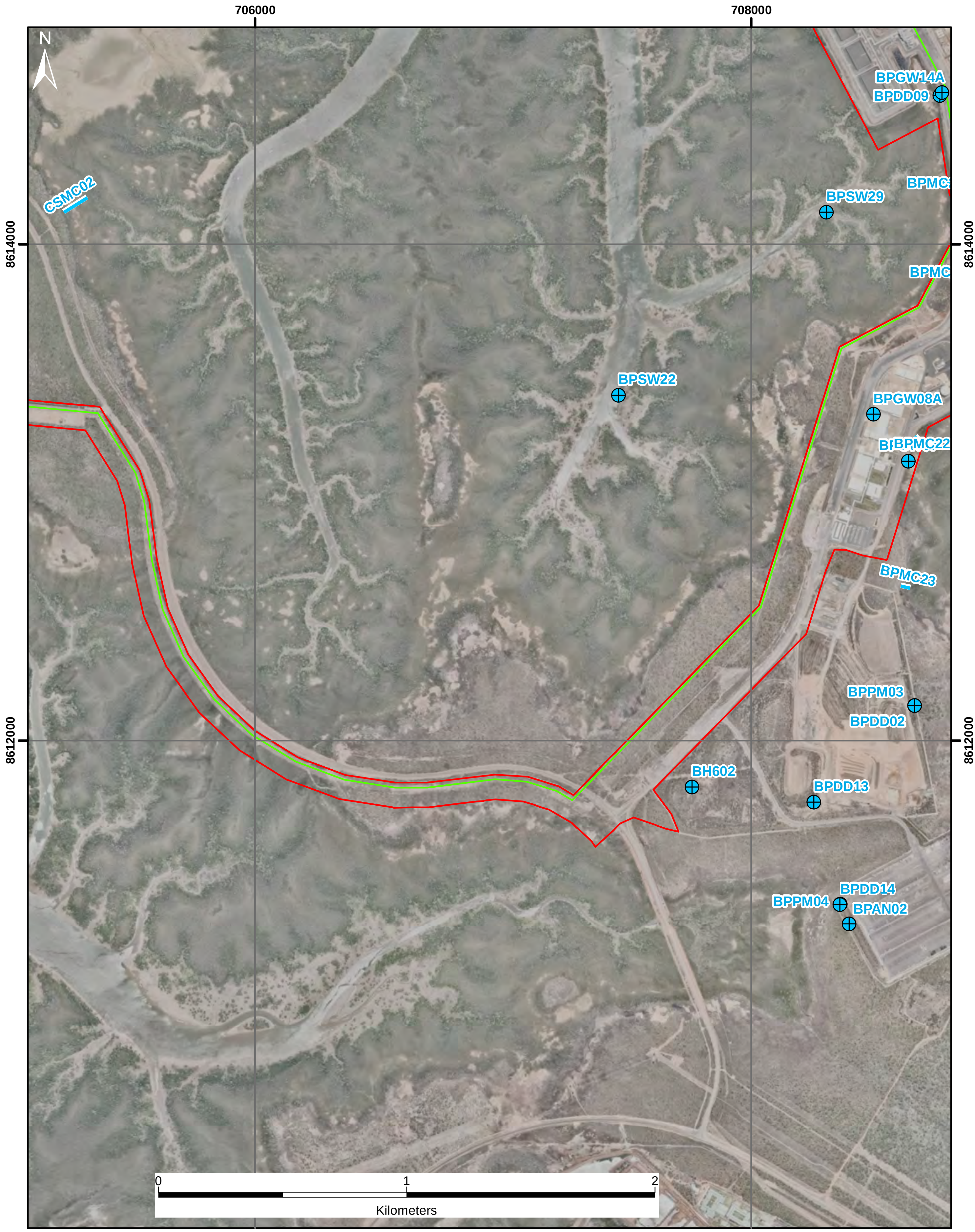

Site Boundary
Monitoring Asset
Gas Export Pipeline
Mangrove Transect

EIMP Monitoring Program (south)		
Figure 6-2	INPEX Bladin Point	GREENCAP
Date: *19/07/2018*	**Author:** malcolm.nunn	
	Map Scale (@A4): 1:20,000	
Revision: A	**Coordinate System:** GDA 1994 MGA Zone 52	

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7. CONCLUSIONS

In conclusion, this EPA7 Report provides a clear understanding of the Project's potential impacts on the adjacent receiving environment and broader Darwin Harbour. While there were exceedances across a small range of the total number of parameters measured during the annual monitoring period, it was assessed that these 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 outlined in the CEMP.

8. 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 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. (2010). *Water Quality Objectives for the Darwin Harbour Region – Background document.* Darwin, NT: Author.

Department of Natural Resources, Environment, the Arts and Sport. (2011). *Assessment Report 65: Environmental Assessment Report and Recommendations*. 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. 1999. 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-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.

Greencap Pty Ltd. (2017). *Annual Environmental Monitoring Report 2017 – 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.

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*.

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.

9. 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.

The report presents the results of the assessment based on the quoted Scope of Services (unless otherwise agreed in writing) for the specific purposes of the commission. No warranties expressed or implied are offered to any third parties and no liability will be accepted for use of this report by any third parties.

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