Community Feedback:
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Onshore Operations Environmental Management Plan

Plan

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RECORD OF AMENDMENT

Revision	Section	Amendment
3	Throughout OEMP	Updated to: • reflect the requirements of EPL228-03 • remove reference to start-up activities which have already been completed • remove specific references directly related to EPBC 2008/4208 Condition 8 (Liquid Discharges Management Plan), which is now a stand-alone document • provided further clarity of system processes • incorporate a new EPBC protected matters search • amend typographical errors.
4	Throughout OEMP	Updated to incorporate third-party qualified professionals review comments.
5	Throughout OEMP	Updated to reflect requirements of EPL228-04.
6	Throughout OEMP	• amend typographical errors • remove refence to condition 17 of Development Permit (DP) 12/0065, which has subsequently been removed from the DP • revision of monitoring programs following review of the 2019/2020 Annual Environmental Monitoring Report • update of INPEX reporting structure
7	Throughout OEMP	• update to remove reference to health, safety, environment and quality management system (HSEQ-MS) and replace with business management system (BMS).
	Section 7.1.1 & 7.1.2	• update to include decommissioning of Stokes Hill monitoring station and commissioning of Francis Bay monitoring station • update to include contingency monitoring for when the acid gas incinerator(s) are offline for an extended period of time and hot venting is occurring.
8	Throughout OEMP	• amend typographical errors • revision of monitoring programs following review of the 2020/2021 Annual Environmental Monitoring Report

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TERMINOLOGY AND DEFINITIONS

Acronym/term	Definition
% w/w	Percentage weight per weight
µg/kg	micrograms per kilogram
µg/L	micrograms per litre
µg/m3	micrograms per cubic metre
µg N/L	micrograms of nitrogen per litre
µg P/L	micrograms of phosphorous per litre
µm	micrometre
µs/cm	microsiemens per centimetre
AAPA	Aboriginal Areas Protection Authority (NT)
ADG	Australian dangerous goods
AFS	anti-fouling system
AFS Convention	International Convention on the Control of Harmful Anti-fouling Systems on Ships
AGRU	acid gas removal unit
AHD	Australian height datum
Air NEPM	National Environment Protection (Ambient Air Quality) Measure
Air Toxics NEPM	National Environment Protection (Air Toxics) Measure
ALARP	as low as reasonably practicable
aMDEA	activated methyl-di-ethanol-amine
ANZECC	Australian and New Zealand Environment and Conservation Council
AOC	accidently oil contaminated
AS	Australian Standard
AS/NZS	Australian Standard/New Zealand Standard

Acronym/term	Definition
ASS	acid sulfate soil
BATNEEC	best available technology not exceeding excessive costs
BMS	Business Management System
BOD	Biochemical oxygen demand
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals
Bq/g	becquerel per gram
BTEX	benzene, toluene, ethylbenzene and xylenes
CAMBA	China Australia Migratory Bird Agreement
CBD	central business district
CCTV	closed circuit television
CCPP	combined cycle power plant
CEMP	construction environmental management plan
CO	carbon monoxide
CO2	carbon dioxide
COC	continuously oily contaminated
COD	chemical oxygen demand
CMT	crisis management team
CPF	central processing facility
CPI	corrugated plate interceptor
Cth	Commonwealth
DAF	dissolved air flotation
DAWE	Department of Agriculture, Water and the Environment (Cth)
dBA	A-weighted decibel

Acronym/term	Definition
DEPWS	Department of Environment, Parks and Water Security (NT)
DIPL	Department of Infrastructure, Planning and Logistics (NT)
DO	dissolved oxygen
DoH	Department of Health (NT)
DP	development permit
DITT	Department of Industry, Tourism and Trade(NT)
Draft EIS	draft environmental impact statement
DSDMP	dredging and spoil disposal management plan
EC	electrical conductivity
E. coli	Escherichia coli
EHS	environmental, health and safety
EIS	environmental impact statement
ENVID	environmental hazard identification
NT EPA	Northern Territory Environment Protection Authority
EPA	Environment Protection Approval
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPC	engineering, procurement and construction
EPL	Environment Protection Licence
ERT	emergency response team
feed gas	processed reservoir fluids sent to Ichthys LNG from offshore facilities via the gas export pipeline
Final EIS	refers to the Ichthys Field Gas Development Project Draft Environmental Impact Statement (EIS) and the EIS Supplement, on which final approvals for the Ichthys Project were based

Acronym/term	Definition
First Start-up	The period from when offshore Ichthys Field hydrocarbons are first introduced to the Onshore Plant via the gas export pipeline, until first steady state operations are achieved for each LNG processing train and each of the common utilities
First steady state	The period from when offshore Ichthys Field hydrocarbons are first introduced to the Onshore Plant via the gas export pipeline, until first steady state operations are achieved for each LNG processing train and each of the common utilities First start-up was achieved for: • LNG trains on 14 September 2018 • CCPP (open-cycle) on 17 October 2018 • CCPP (closed-cycle) on 11 October 2019.
FPSO	floating production storage and offtake (facility)
Frame 6 power generation turbines	GE Frame 6 turbines (dry low NOx)
Frame 7 compression turbines	GE Frame 7 compressor turbines (dry low NOx)
FRP	filterable reactive phosphorus
GE	General Electric Pty Ltd
GEP	gas export pipeline
GPS	global positioning system
GTG	gas turbine generator
H2S	hydrogen sulphide
HAT	highest astronomical tide
HDPE	high density polyethylene
Hg	mercury
HILs	health investigation levels
HP	high pressure
HRSG	heat recovery steam generator
HSEQ	health safety, environment and quality

Acronym/term	Definition
Ichthys LNG	Collectively, the onshore gas export pipeline and the gas processing plant
IFC	International Finance Corporation
IMT	incident management team
INPEX	INPEX Operations Australia Pty Ltd, the delegated operator of Ichthys LNG
ISO	International organisation for standardisation
JAMBA	Japan Australia migratory bird agreement
JHA	job hazard analysis
km	kilometre
L	litre
LAT	lowest astronomical tide
LDMP	liquid discharge management plan
Limit	A high (or low) end number which must be met by design and in operations. A limit can be set by INPEX as a commitment or be set by a regulator. E.g. NT EPA can set limits on concentrations of constituents in emission and discharge streams via the Ichthys LNG EPL. If an environmental limit on a constituent on a stream is exceeded, this will trigger significant efforts to bring the stream back to agreed concentrations ASAP. Typically, a target will be more difficult to achieve than a limit.
LNG	liquefied natural gas
LP	low pressure
LPG	liquefied petroleum gases
m	metres
m^3	cubic metres
m^3/hr	cubic metres per hour
m/s	meters per second

Acronym/term	Definition
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships 1973, as modified by the 1978 protocol
MBR	membrane bioreactor
MCHE	main cryogenic heat exchanger
MEG	monoethylene glycol
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mL	millilitres
mm	millimetres
MOC	management of change
MPN	most probable number
Mtpa	million tons per annum
MW	megawatt
N/A	not applicable
NATA	National Association of Testing Authorities, Australia
NCW	non-contaminated water
Nearshore OPEP	Nearshore Oil Pollution Emergency Plan
NEPM	National Environmental Protection Measure(s)
NFPA	National Fire Protection Association
NGERS	National Greenhouse and Energy Reporting Scheme
NO	nitrogen monoxide
NO_2	nitrogen dioxide
NOHSC	National Health and Safety Commission

Acronym/term	Definition
Normal operations	When Ichthys LNG facilities operate as designed and intended, without process or other upsets. What Ichthys LNG hopes to achieve on a normal and sustained basis.
NORMS	naturally occurring radioactive materials
NO_x	nitrogen oxides (NO and/or NO_2)
NPI	National Pollutant Inventory
NRETAS	Northern Territory Department of Natural Resource, Environment, the Arts and Sport (now disbanded)
NRMMC	Natural Resource Management Ministerial Council
NSW	New South Wales
NT	Northern Territory
NTU	nephelometric turbidity units
O_2	oxygen
O_3	ozone
OEMP	Operations Environmental Management Plan
OHSAS	Occupational Health and Safety Assessment Series
Operator	INPEX Operations Australia Pty Ltd
PAH	polycyclic aromatic hydrocarbons
PDCA	plan, do, check, act
PEMPs	provisional environmental management plans
PFES	Police Fire and Emergency Services (NT)
pH	measure of acidity or alkalinity
PL	pipeline licence
PM2.5	particulate matter (2.5 μm size class)
PM10	particulate matter (10 μm size class)

Acronym/term	Definition
PMP	pipeline management plan
ppm	parts per million
ppmv	parts per million by volume
ppt	parts per thousand
PTW	permit to work
PWC	Power and Water Corporation (NT)
ROKAMBA	Republic of Korea Australian migratory bird agreement
s	second
SDS	safety data sheet
Shut-down	Period of time while the plant is being taken out of service from normal operation to inactivity. A minor shutdown is planned for every year, with major shutdowns planned for every three to five years.
SKM	Sinclair Knight Merz
SO_2	sulphur dioxide
SO_X	sulphur oxides (SO_2 and SO_3)
Start-up (restart)	Period of time while the plant is being brought up to normal operation following a period of inactivity
Steady state operations	Normal operating phase of Ichthys LNG which includes production, storage and dispatch of hydrocarbons within the design rates and specifications of the plant. Steady state operations commence once First Start-up or subsequent Start-up (plant restart) is complete.
t/a	tonnes per annum
Target	An objective which Ichthys LNG facility designs or operations endeavour to achieve. E.g. Ichthys LNG operations could have a target of achieving yy mg/L of a constituent in a wastewater stream. A target is essentially a goal, which may be challenging to achieve.
TBT	tributyltin

Acronym/term	Definition
TCF	trillion cubic feet
TEG	triethylene glycol
the Project	the Ichthys LNG Project
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TPH	total petroleum hydrocarbons
TRC	total recordable cases
TRH	total recoverable hydrocarbons
Trigger	A criteria which, if exceeded, triggers an action of some sort; either from the Ichthys LNG control system or operators, INPEX management, or an outside organisation such a regulator. E.g. if a trigger value of xx mg/L of a constituent in a wastewater stream is exceeded, this could "trigger" a response and action of some sort, to reduce the concentration back to below the trigger value.
TSS	total suspended solids
Upset conditions	When steady-state operations cannot be maintained due to unplanned reasons. Plant restart will then be required until the entire plant or portions of the plant return to steady state.
VOCs	volatile organic compounds
WHO	World Health Organisation
WHRU	waste heat recovery unit
WMPC Act	*Waste Management and Pollution Control Act* (NT)

1 INTRODUCTION

1.1 Overview of the Ichthys Project

The Ichthys LNG Project (the Project) is a joint venture between INPEX group of companies (the Operator), Total, and the Australian subsidiaries of CPC Corporation Taiwan, Tokyo Gas, Osaka Gas, Kansai Electric Power, JERA and Toho Gas. INPEX Operations Australia Pty Ltd (INPEX) acts as the Operator of the Project.

Drawing on the hydrocarbon resources of the Ichthys gas and condensate field in the Browse Basin at the western edge of the Timor Sea offshore Western Australia, the Project is expected to produce 8.9 Mt of liquefied natural gas (LNG) and 1.6 Mt of liquefied petroleum gases (LPG) per annum, along with up to approximately 100,000 barrels of condensate, per day, at peak.

The Project has an expected operational life of at least 40 years.

The extraction of natural gas and condensate is carried out via a floating semi-submersible central processing facility (CPF) at the Ichthys Field. This removes water and most of the condensate from the reservoir fluids and the separated water and condensate are transferred to a floating production, storage and offtake (FPSO) facility moored approximately 3.5 km from the CPF. After further processing on the FPSO, the condensate is exported from the FPSO at an average rate of up to 85 000 barrels per day (at the start of LNG production).

The dehydrated gas and the remainder of the condensate are compressed and exported through an approximately 890 km long gas export pipeline (GEP) to the Project's onshore processing plant at Bladin Point in Darwin Harbour in the Northern Territory (NT) (Figure 1-1).

The Project's offshore infrastructure falls under Commonwealth jurisdiction, and is made up of the following components:

- approximately 50 subsea production wells in the Ichthys Field, drilled from between 12 and 15 drill centres and developed over a period of 40 years
- a CPF permanently moored for the life of operations at the Ichthys Field
- subsea wellheads and manifolds and the wet gas, corrosion resistant infield flowlines connecting them to the CPF
- control umbilicals and service lines
- a FPSO permanently moored 3.5 km from the CPF for the life of operations
- subsea flowlines connecting the CPF to the FPSO
- that portion of the subsea GEP from underneath the CPF to the entrance to Darwin Harbour, some 856 km long.

The Project's nearshore infrastructure, which lies within NT Government jurisdiction, is made up of the following components:

- approximately 27 km of the subsea GEP from the mouth of Darwin Harbour to the pipeline shore crossing on the western side of Middle Arm Peninsula north of Channel Island
- a module offloading facility on the north-eastern side of Bladin Point
- a two-berth product offloading jetty at the north western end of Bladin Point
- a dredged shipping channel (including the approach area and a turning basin) and the jetty pocket berthing area and jetty pocket for the product tankers.

The onshore infrastructure at Bladin Point, known as Ichthys LNG, includes an approximately 7-km–long section of the GEP which runs from the beach valve at the shore crossing area to the area just prior to the pig receiver area in the onshore processing plant. The onshore facilities consist of the following key components:

- two gas liquefaction trains, each capable of producing approximately 4.45 Mt/a of LNG
- LPG (propane and butane) recovery units and fractionation units
- condensate stabilisation units
- seven product storage tanks (two cryogenic tanks for LNG, one cryogenic tank for propane, one cryogenic tank for butane, and three ambient-temperature tanks for condensate
- a combined-cycle power plant (CCPP)
- flare systems
- a wastewater treatment system
- an operations complex
- laydown areas, warehousing facilities, field workshops and hazardous material storage areas
- temporary office facilities.

The Project's onshore facilities on Bladin Point in Darwin Harbour fall under NT Government jurisdiction. Further description of the onshore facilities is provided in Section 3.

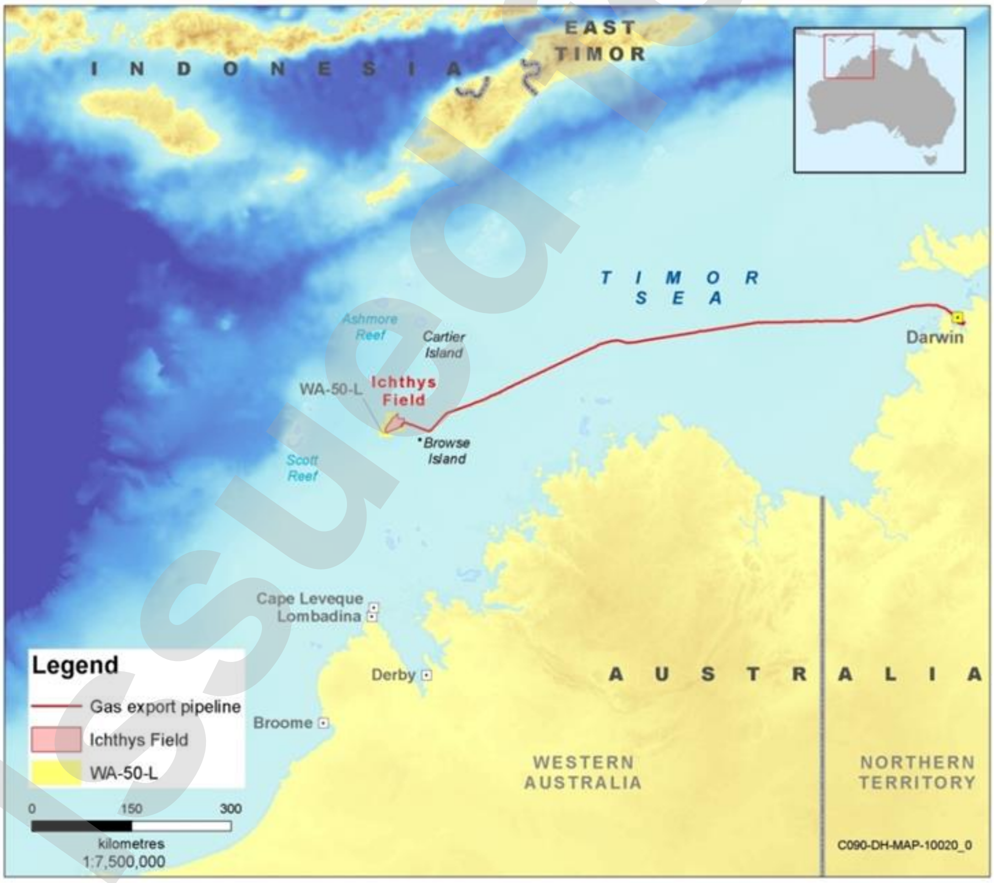

Figure 1-1: Location of the Ichthys Field and GEP route

1.2 Purpose and Scope of this OEMP

This Onshore Operations Environmental Management Plan (OEMP) describes the environmental management of the onshore facilities at Bladin Point (Ichthys LNG) during key phases of activities:

- start-up, which occurs after a planned or unplanned shutdown
- steady-state operations.

Implementation of the OEMP aims to protect the environment, demonstrate compliance with INPEX environmental policy and procedures, and reduce impacts and risks to as low as reasonably practicable.

This OEMP provides:

- NT Environment Protection Authority (NT EPA) with information to support the Environment Protection Licence (EPL)

The original version of the OEMP included detailed descriptions of the first start-up phases of Ichthys LNG, consisting of the introduction of feed gas from the Ichthys Field to Ichthys LNG and fine-tuning the facility, so it could subsequently be operated as designed, as well as operation of Ichthys LNG. This revision of the OEMP is focussed on:

- start-up (restart) activities which will be implemented in the event of a planned or unplanned shutdown
- operation of Ichthys LNG, consisting of production, storage and export of hydrocarbons at the designed production capacity.

1.2.1 Battery limits

The physical battery limits (boundary) of this OEMP are as follows:

- the onshore section of the GEP, from the beach valve to the onshore hydrocarbon processing plant boundary
- all areas of the onshore hydrocarbon processing plant, including the operations complex, utilities and hydrocarbon processing facilities contained within Ichthys LNG security fence
- the product loading jetties and module offloading facility that extend from Ichthys LNG into Darwin Harbour, to the manifold of LNG, LPG and condensate vessels (downstream limit) berthed at the product loading jetty; it does not extend to the offtake tankers
- section 1888 (a bituminised laydown area) adjacent to Ichthys LNG.

These areas are collectively referred to as Ichthys LNG for the purposes of this OEMP.

The geographical boundary of the battery limits is shown in Figure 1-2.

Figure 1-2: Battery limits

1.2.2 Activities Out of Scope for this OEMP

The following activities are out of scope for this OEMP.

Construction, pre-commissioning, commissioning, pre-operations and first start-up phases of Ichthys LNG, (including testing of equipment/units and the use of Power and Water Corporation (PWC) gas for fuel or to provide power during commissioning) are outside of the scope of this OEMP. These phases of Ichthys LNG were managed under Environment Protection Approval EPA7 (as amended), and the supporting Ichthys Onshore LNG Facilities Construction Environmental Management Plan (CEMP).

Operation and maintenance of the fuel gas pipelines, which supply domestic gas to Ichthys LNG, are outside the scope of this OEMP as these pipelines are managed in accordance with Pipeline Licence PL31 (PWC as operator), Pipeline Licence PL32 (INPEX as operator) and the corresponding pipeline management plans, approved under the *Energy Pipelines Act* (NT).

Operation and maintenance of the onshore section of the Ichthys GEP is also managed under the *Energy Pipelines Act* (NT), in accordance with Pipeline Licence PL27 (beach valve to Ichthys LNG boundary).

LNG, LPG (propane and butane) and condensate vessels will be used to transport products from Ichthys LNG to buyers. Tugs under the direction of the Darwin Harbour Master will be used to manoeuvre and position the LPG, LNG and condensate vessels into and out of the product loading berths. All tugs and tankers are outside the scope of this OEMP. However, project controls relating to maritime heritage will be communicated to all vessels contracted to INPEX. From time to time, INPEX may contract small vessels for the specific purposes (e.g. maintenance of the jetty, monitoring, seabed levelling). In such circumstances, these INPEX-contracted vessels will be subject to the specific controls in this OEMP (e.g. maritime heritage and cultural site protection). All vessels must adhere to Darwin Port Operations Pty Ltd requirements as well as relevant Australian and international legislation.

Any future maintenance dredging to retain the navigation channel, turning basin and berthing pocket for the product tankers is not included in this OEMP. Dredging activities related to operational maintenance will be managed separately under a dredging and spoil disposal management plan (DSDMP) and separate environmental approvals.

The nearshore section of the GEP in Darwin Harbour and other Territorial waters is outside of the scope of this OEMP, as are the project's marine facilities located in Commonwealth waters (i.e. beyond 3 nautical miles from land), including the CPF, FPSO and offshore section of the GEP. The operation and maintenance of the nearshore section of the GEP in Darwin Harbour and Territorial waters is approved through the Pipeline Management Plan provided to the NT Department of Industry, Tourism and Trade (DITT). The GEP infrastructure within Darwin Harbour or Territorial waters is also outside of the scope of this OEMP, and potential oil spills from the GEP in this area is managed through the Nearshore Oil Pollution Emergency Plan - Operations Phase (Nearshore OPEP) (INPEX Doc. X060-AH-PLN-60003). The Nearshore OPEP is jointly approved by the Commonwealth Department of Agriculture, Water and the Environment (DAWE) and the Marine Safety Branch of the NT Department of Transport (within DIPL), with advice from the NT EPA. The *Marine Pollution Act* (NT) is jointly administered by DIPL and the Department of Environment, Parks and Water Security (DEPWS).

Management of greenhouse gases is excluded from this OEMP, although management of air emissions is within scope of this OEMP. Greenhouse gases are monitored and reported through the National Greenhouse and Energy Reporting Scheme (NGERS). Greenhouse gases are also managed via the Safeguard Mechanism, which is part of NGERS.

1.3 Operator Details

Ichthys LNG Pty Ltd, as the lease holder of the onshore Project site and is the permit holder for the EPL.

INPEX Operations Australia Pty Ltd (INPEX) (ACN 48 150 217 262) is the delegated operator of the Ichthys Project, and acts as the agent for and on behalf of Ichthys LNG Pty Ltd.

1.3.1 Office Locations and Site Address

The location of site premises is:

Section 7002 NT Portion of Folio 813 Volume 218 144 Wickham Point Road.

The main office locations for INPEX in Australia are:

Perth Office

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1.3.2 Contact Details

The main point of contact regarding operations at Bladin Point is:

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Phone: +61 8 8982 3100

The point of contact for EPL228 is:

Ben Schmidt

Production Manager - Onshore Operations, INPEX

Phone: +61 8 8982 3100

1.4 INPEX HSEQ Policies

INPEX maintains and implements a Business Management System (BMS), which incorporates the INPEX health, safety, and environment (HSE) requirements. These requirements are designed to meet the in-principle expectations of AS/NZS ISO 45001:2018, Occupational Health and Safety Management Systems–Requirements with Guidance for Use and AS/NZS ISO 14001:2015, Environmental Management Systems—Requirements with Guidance for Use.

As part of the BMS, INPEX has developed an overarching corporate Health and Safety Policy and an associated Environmental Policy. These are provided in APPENDIX A:.

The policies provide the overall objective and strategy for the management and continuous improvement of health, safety and environmental performance. The policies also provide the framework for setting and reviewing HSE objectives and are communicated to employees, contractors and other stakeholders. INPEX's Environment Policy drives the internal commitment and recognises the responsibility to adhere to the principles of sustainable development and acknowledges INPEX's duty of care to both the natural environment and the communities in which INPEX operate.

1.5 Legal and Other Requirements

The following sections provide:

- a description of the environmental legal framework supporting the Ichthys Gas Field Development Project and this OEMP, including background into the environmental approvals and commitments applicable to Ichthys LNG
- a summary of the legislation, policies, standards and guidelines applicable to the operation of Ichthys LNG.

1.5.1 Environmental Approvals and Assessments

Ichthys Gas Field Development Project Draft Environmental Impact Statement and Supplement

The Ichthys LNG Development Project was referred for environmental approval under the *Environmental Assessment Act* (NT) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cth) in 2007 and 2008, respectively, and the level of assessment was set as an Environmental Impact Statement (EIS).

INPEX prepared the Ichthys Gas Field Development Project: Draft EIS, which was submitted to the NT and Commonwealth governments on 15 July 2010. After a period of public and government review, the Ichthys Gas Field Development Project: Supplement to the draft EIS, was developed and submitted on 5 April 2011 for a final approval decision by the Commonwealth Minister and assessment by the NT Minister. Collectively, the Draft EIS and the EIS Supplement documents are referred to as the Final EIS.

The NT Department of Natural Resources, Environment, the Arts and Sport (NRETAS) issued an Environmental Assessment Report and Recommendations (Assessment Report 65) for the Ichthys Project on 17 May 2011. Assessment Report 65 documents the findings of the environmental assessment completed under the *Environmental Assessment Act* (NT), and included 24 recommendations.

Commonwealth approval was granted under the EPBC Act by the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities on 27 June 2011 (Commonwealth Ministerial approval EPBC 2008/4208). This approval was accompanied by 18 Ministerial Conditions which require the development of activity specific management plans to minimise impacts on listed threatened species and communities, listed migratory species, and Commonwealth marine areas. These conditions are addressed in plans specific to the Condition and submitted to DAWE for approval prior to commencement of works, where appropriate.

The Final EIS contains a number of Project commitments made for the various phases of the Ichthys Project (refer to APPENDIX B:). INPEX maintains an environmental commitments register to track compliance with commitments made in the Final EIS.

Secondary Environmental Approvals

A range of secondary environmental approvals have been obtained, or will be obtained, for the Ichthys Project, under both NT and Commonwealth legislation. The following section provides an overview of these secondary environmental approvals related to the Ichthys Project in the NT.

Secondary Environmental Approvals under the Commonwealth EPBC Act

Ministerial Condition 8 of Approval Decision EPBC 2008/4208 requires the development and implementation of a Liquid Discharge Management Plan (LDMP) to mitigate the potential environmental effects of liquid discharges from the Ichthys Project, including sewage and surface water runoff and protection of habitat for listed species in Darwin Harbour. An LDMP has been prepared and provided to DAWE for approval, as per Condition 8 of EPBC 2008/4208.

Secondary Environmental Approvals Under Northern Territory Legislation

The *Planning Act* (NT) requires that a Development Permit be in place for the Ichthys Project. The Onshore Development Permit DP12/0065 (as varied) was issued by the Minister for Lands and Planning on 10 January 2012. The recommendations in Assessment Report 65 are enacted through DP12/0065 (as varied), which includes a condition requiring INPEX to undertake the Project in accordance with the commitments made in the Final EIS and the recommendations from NRETAS.

The *Waste Management and Pollution Control Act* (NT) (WMPC Act), administered by the NT EPA, requires that activities which have the potential to cause actual or potential environmental harm or pollution are undertaken under an approval, specifically an Environment Protection Approval (EPA) during construction activities, and an EPL during operational activities. For the construction phase of the Ichthys Project, a CEMP was prepared and approved by the NT EPA and endorsed by DIPL, and EPA7 (as amended) was issued to conduct the construction activities. For the start-up and operations phase an earlier draft of this OEMP was provided to NT EPA, in conjunction with an application for an EPL, to obtain approval to proceed with operations activities under the WMPC Act, subsequently EPL228 was issued for the operational phase.

The WMPC Act does not apply in relation to contaminants or waste released from a pipeline during conduct of an activity authorised under the *Energy Pipelines Act* (NT) and the *Petroleum (Submerged Lands) Act* (NT), and when confined within land that is not more than 1 kilometre from the centre of the pipeline. INPEX has obtained approval of a PMP from DITT, to allow for routine inspection, maintenance and repair activities within the pipeline licence areas during operations. No planned inspection, maintenance and repair activities have been identified which would result in a discharge of contaminants or waste beyond 1 km of the centreline of the pipeline, and as such, routine inspection, maintenance and repair activities on the GEP will not be subject to further approval from the NT EPA, and are not considered in this OEMP. The GEP infrastructure within Darwin Harbour out to 3 nm is covered under the Ichthys LNG Project Nearshore Operations Oil Pollution Emergency Plan Northern Territory Waters (X060-AH-PLN-60003) as required by Condition 28 of Development Permit DP12/0065, prepared to the requirements of the Marine Safety Branch of the NT Department of Transport and endorsed by the Development Consent Authority.

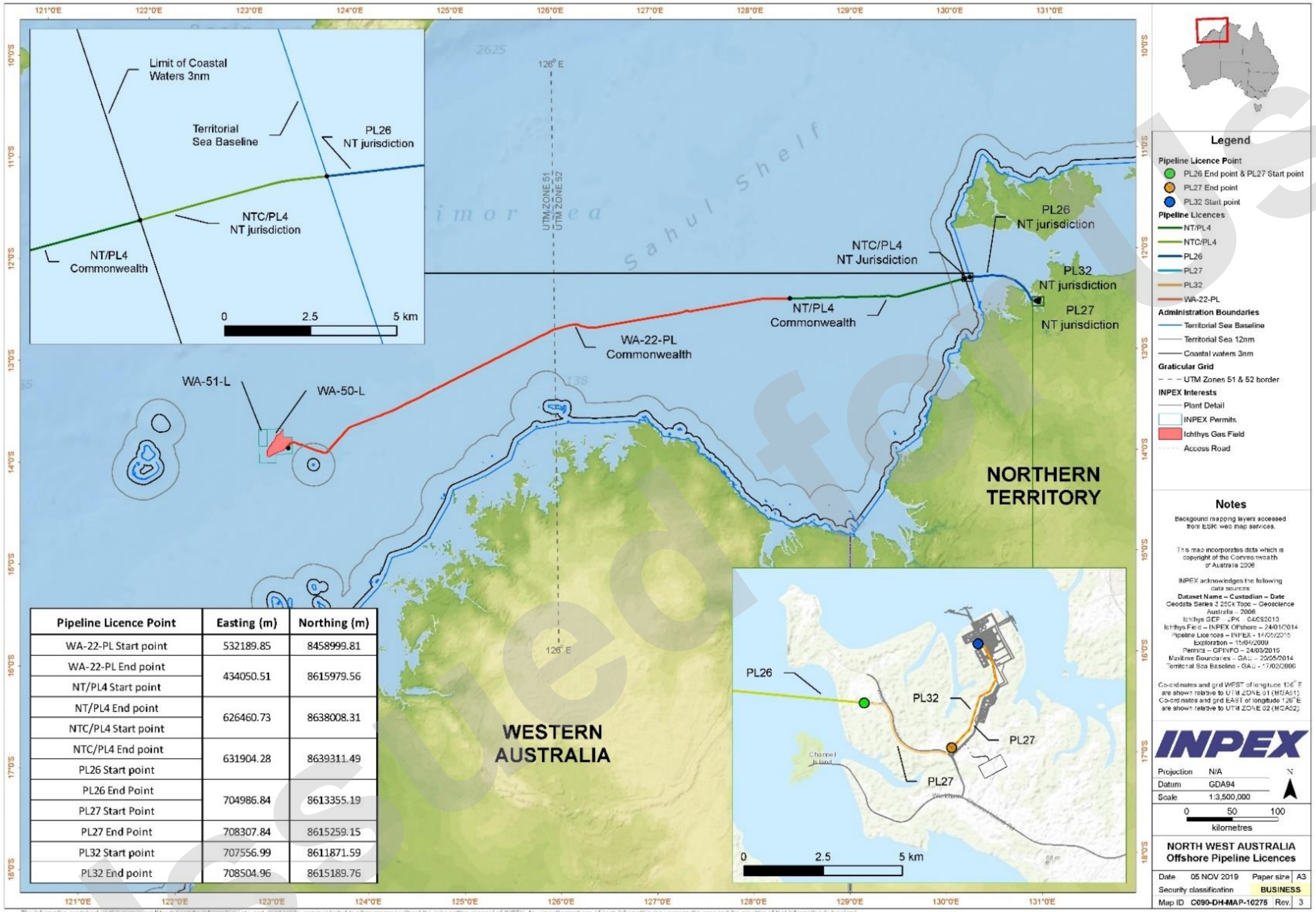
1.5.2 Other Approvals

Pipeline Approvals

The Ichthys GEP (not included in the scope of this OEMP) is subject to four pipeline licenses between the Ichthys field and the pig receiver within the plant. In Commonwealth waters, the pipeline is located within two licence areas (WA-22-PL and NT/PL4) and is subject to approvals required under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth). In the NT, the pipeline is located within four licence areas, as follows:

- NTC/PL4, which spans the short distance between the limit of coastal waters at 3 nm and the Territorial Sea Baseline (approximately 4 km) and is subject to approvals under the *Petroleum (Submerged Lands) Act* (NT)
- PL26, which extends from the Territorial Sea Baseline to the onshore beach valve south of Wickham Point Road, approved under the *Energy Pipelines Act* (NT)
- PL27, which extends from the beach valve onshore plant boundary, approved under the *Energy Pipelines Act* (NT)
- PL32, which extends from the onshore hydrocarbon processing plant boundary to the pig receiver within the plant, approved under the *Energy Pipelines Act* (NT).

The above mentioned licences are shown in Figure 1-3.



Pipeline Licence Point	Easting (m)	Northing (m)
WA-22-PL Start point	532189.85	8458999.81
WA-22-PL End point	434050.51	8615979.56
NT/PL4 Start point		
NT/PL4 End point	626460.73	8638008.31
NTC/PL4 Start point		
NTC/PL4 End point	631904.28	8639311.49
PL26 Start point		
PL26 End Point	704986.84	8613355.19
PL27 Start Point		
PL27 End Point	708307.84	8615259.15
PL32 Start point	707556.99	8611871.59
PL32 End point	708504.96	8615189.76

Figure 1-3: Pipeline licences for the Ichthys GEP

Major Hazard Facility

Ichthys LNG is considered a Major Hazard Facility under the *Work Health and Safety (National Uniform Legislation) Act 2011* (NT) and associated regulations. Ichthys LNG handles and stores a number of substances that are classified as hazardous chemicals under the Work Health and Safety (National Uniform Legislation) Regulations, including LNG, propane, butane, condensate, propane refrigerant, methane, isopentane and fuel gas.

An Onshore Operations Safety Case (INPEX Doc. L290-AH-SCA-10002) has been developed and has been submitted to the NT government in accordance with the *Work Health and Safety (National Uniform Legislation) Act 2011* (NT) and NT WorkSafe guidelines. The Safety Case outlines the safety management system that is in place for the safe operation of Ichthys LNG. This OEMP has been developed to be consistent with the Safety Case.

Emergency plans, which include details of the resources (equipment and personnel) available in the event of an emergency, emergency response procedures and communications have also been prepared in consultation with relevant NT Government Agencies including, NT WorkSafe and Fire and Rescue Services.

The transport, storage and use of dangerous goods is managed in accordance with the *Dangerous Goods Act* (NT) and its regulations, and applicable licences have been obtained from NT WorkSafe.

NT Department of Health Approvals

Ichthys LNG has DoH wastewater works design approval and product approval of the onsite wastewater system under the *Public and Environmental Health Act 2011* (NT) for the operation of the sewage treatment system, Approval number RWS2015/05.

There are currently no permanent radiation sources associated with Ichthys LNG. Specialised equipment may be used from time to time for testing purposes, these will be used by licenced contractors. In the event that radiation sources are identified or naturally occurring radioactive materials (NORMs) are generated, the appropriate processes under the *Radiation Protection Act* (NT) will be adhered to.

A Biting Insect Management Plan has been prepared and submitted to the DoH and DIPL to address the mosquito control requirements of the Public and Environmental Health Regulations, DoH guidelines for biting insects and Development Permit conditions.

1.5.3 Applicable Legislation, Standards and Guidelines

Commonwealth Legislation

The following key Commonwealth environmental legislation and associated regulations are applicable to Ichthys LNG:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- *Aboriginal Land Rights (Northern Territory) Act 1976*
- *Australian Heritage Council Act 2003*
- *Biosecurity Act 2015*
- EPBC Act
- *Hazardous Waste (Regulation of Exports and Imports) Act 1989*
- *Hazardous Waste (Regulation of Exports and Imports) Amendment Act 1996*
- *Underwater Cultural Heritage Act 2018*

- National Environment Protection (National Pollutant Inventory) Measure
- National Environment Protection (Air Toxics) Measure (Air Toxics NEPM)
- National Environment Protection (Ambient Air Quality) Measure (Air NEPM)
- National Environment Protection (Assessment of Site Contamination) Measure
- National Environment Protection (Used Packaging Materials) Measure
- National Environment Protection (Movement of Controlled Waste between States and Territories) Measure
- *National Greenhouse and Energy Reporting Act 2007*
- National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015
- *Carbon Credits (Carbon Farming Initiative) Act 2011*
- *Native Title Act 1993.*

NT Legislation

The following NT environmental legislation and associated regulations are applicable to Ichthys LNG:

- *Bushfires Act*
- *Dangerous Goods Act*
- *Darwin Port Corporation Act*
- *Energy Pipelines Act*
- Environment Protection (National Pollutant Inventory) Objective
- *Environmental Assessment Act*
- *Environmental Offences and Penalties Act*
- *Fire and Emergency Services Act*
- *Fisheries Act*
- *Heritage Act 2011*
- *Ichthys LNG Project Act 2008*
- *Litter Act*
- *Marine Pollution Act*
- *Northern Territory Aboriginal Sacred Sites Act*
- *Petroleum (Submerged Lands) Act*
- *Planning Act*
- *Public and Environmental Health Act 2011*
- *Radiation Protection Act*
- *Territory Parks and Wildlife Conservation Act*
- *Waste Management and Pollution Control Act*
- *Water Act*
- *Weeds Management Act*
- *Work Health and Safety (National Uniform Legislation) Act 2011.*

International Finance Corporation/Lender Requirements/Commitments

As part of a corporate initiative, INPEX assessed designs and activities against international guidelines that are considered international best practice alongside existing Commonwealth and NT statutes and regulations which are relevant to INPEX's activities. International guidelines that are relied upon in the international social and environmental due diligence framework are the performance standards and guidelines developed and published by the International Finance Corporation (IFC).

IFC performance standards (IFC 2006) and environmental, health and safety (EHS) guidelines (IFC 2007) have therefore been considered when preparing this OEMP, and relevant information from these documents has been incorporated into this document as applicable.

International conventions

The following international conventions are applicable to Ichthys LNG:

- China Australia Migratory Bird Agreement (CAMBA) – Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
- International Convention for the Control and Management of Ships' Ballast Water and Sediment
- International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention)
- International Convention on Oil Pollution Preparedness, Response and Cooperation 1990
- Convention on the International Regulations for Preventing Collisions at Sea 1972 (COLREGS)
- International Convention for the Prevention of Pollution from Ships 1973, as modified by the 1978 protocol (MARPOL 73/78)
- Japan Australia Migratory Bird Agreement (JAMBA) – Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment
- Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) – Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds.

Policies, Standards and Guidelines

The following policies, standards and guidelines are applicable to Ichthys LNG with respect to operational environmental management:

- ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance
- Approved Criteria for Classifying Hazardous Substances [NOHSC: 1008(2004)] (NOHSC 2004a)
- AS 1692:2006 Steel Tanks for Flammable and Combustible Fluids
- AS 1940:2004 The Storage and Handling of Flammable and Combustible Liquids
- AS 2885.1:2012 Pipelines – Gas and Liquid Petroleum – Design and Construction

- AS 3780:2008 The Storage and Handling of Corrosive Substances
- AS/NZS 3833:2007 The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers
- AS 3961:2005 The Storage and Handling of Liquefied Natural Gas
- AS 4323.1:1995 Stationary source emissions—Selection of sampling positions
- AS 4452:1997 The Storage and Handling of Toxic Substances
- Australian Ballast Water Management Requirements – Version 7 (Department of Agriculture and Water Resources 2017)
- Australian Code for the Transport of Dangerous Goods by Road & Rail (NTC 2014)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)
- Darwin Harbour Water Quality Objectives (Northern Territory Government 2010)
- Darwin Regional Weed Management Plan 2015-2020 (Department of Land Resource Management 2015)
- ISO 8995.3:2006 Lighting of work places - Part 3: Lighting requirements for safety and security of outdoor work places
- National Biofouling Management Guidance for the Petroleum and Exploration Industry Guidelines (Australian Commonwealth Government 2010)
- National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC: 2009(2004)] (NOHSC 2004b)
- NFPA 30:2008 Flammable and Combustible Liquids Code
- NFPA 59A:2009 Production, Storage, and Handling of Liquefied Natural Gas (LNG)
- Northern Territory Weed Management Handbook (Department of Land Resource Management 2014)
- NT DoH – Medical Entomology Section guidelines including:
  - Guidelines for preventing mosquito breeding associated with construction practice near tidal areas in the NT (DoH 2011)
  - Guidelines for preventing biting insect problems for urban residential developments or subdivisions in the Top End of the NT (DoH 2014a)
  - Guidelines for preventing biting insect problems for new rural residential developments or subdivisions in the Top End of the NT (DoH 201ba)
  - Mosquito breeding and sewage pond treatment in the Northern Territory (Department of Health and Families 2009a)
- NT EPA guidelines including:
  - Guideline for Reporting on Environmental Monitoring (NT EPA 2016)
  - Guideline for the Preparation of an Environmental Management Plan (NT EPA 2015a)
  - Northern Territory Noise Management Framework Guideline (NT EPA 2018)
- NT Government Water Quality Objectives for the Darwin Harbour Region – Background Document (Department of Natural Resources, Environment, The Arts and Sport 2010)
- NSW Protection of the Environment Operations (Clean Air) Regulation 2010 Group 6

- The Australian Weeds Strategy: a National Strategy for Weed Management in Australia (National Resource Management Ministerial Council 2007).

1.5.4 Regulatory Amendment

In accordance with INPEX's Environmental Policy, INPEX commits to comply with applicable laws and regulations, as amended over time. Should a change in legislative requirements occur during conduct of the Operational life of the Ichthys LNG Facility, INPEX would comply with such new requirements, as applicable.

1.6 Operations HSE Management Framework

INPEX's HSE requirements are part of the INPEX BMS, an integrated framework of policies, standards and procedures that describe how business activities at INPEX are governed and managed.

The INPEX Environmental Policy sets the direction and minimum expectations for environmental performance, and is implemented through the standards and procedures of the BMS.

HSE is planned, implemented, verified and reviewed under the principle of a "plan, do, check, act" (PDCA) continual improvement cycle. The Company HSE requirements are designed to meet the in-principle expectations of the following:

- AS/NZS 45001:2018, Occupational health and safety management systems—Requirements with guidance for use
- AS/NZS ISO 14001:2004, Environmental management systems—Requirements with guidance for use.

It provides mandatory rules and processes for the systematic and consistent management of HSE risks, demonstration of compliance, and facilitation of continual improvement. The BMS enables INPEX to ensure that:

- environmental risks of activities are identified and communicated
- organisational structures and resources are provided to ensure that control measures remain effective in reducing environmental risks to levels that are tolerable and as low as reasonably practicable (ALARP)
- performance outcomes and standards are being met
- continual improvement is achieved through application of lessons learned.

The main HSE components of the BMS are grouped into 13 elements, as shown in Figure 1-4. These elements reflect key aspects of INPEX activities requiring HSE controls. Details on how key aspects of the BMS are implemented at the Ichthys LNG facility are provided in the implementation strategy in Section 6 of the OEMP.

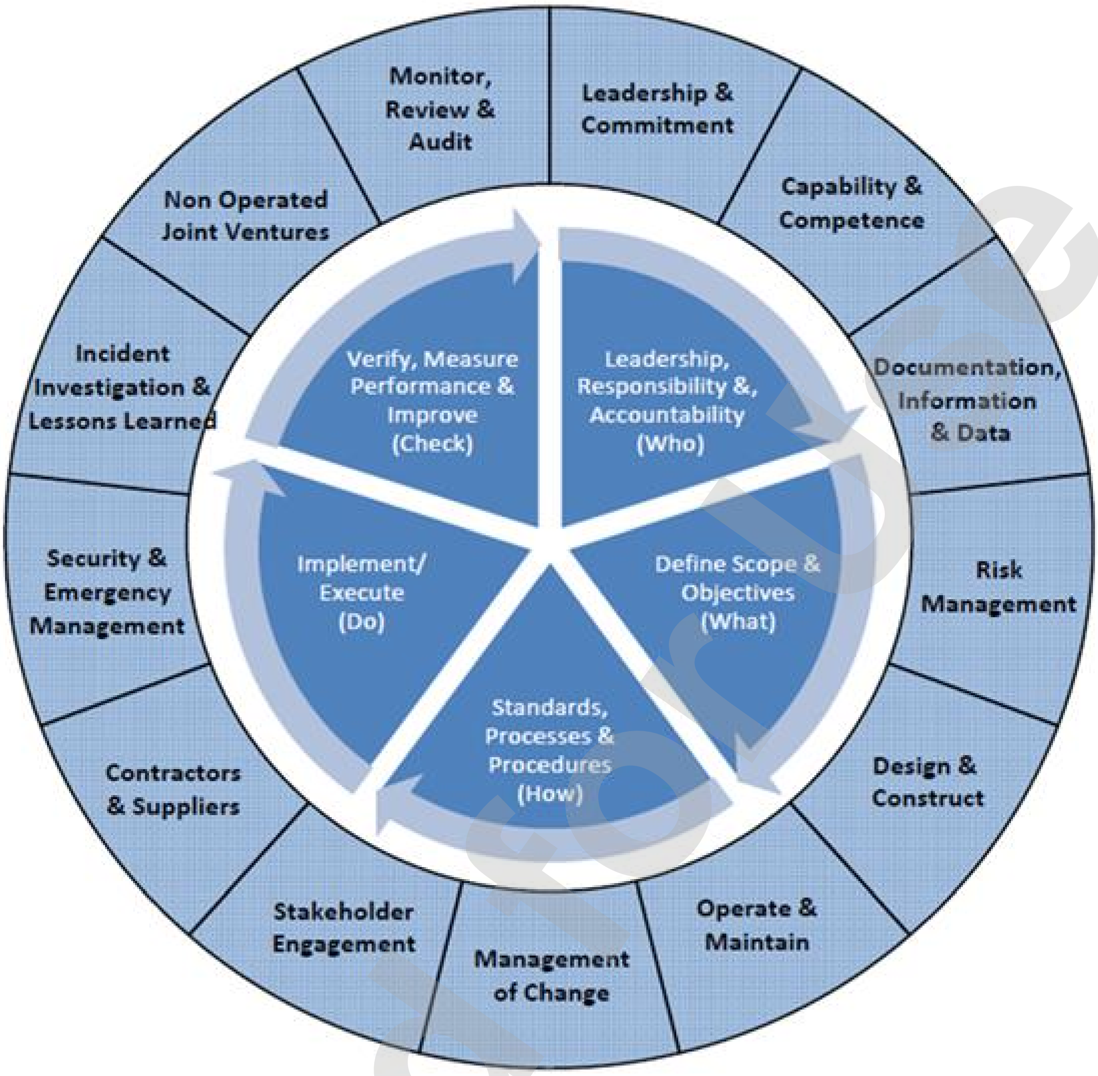


Figure 1-4: The INPEX Business Management System (BMS)

2 SOCIO-ECONOMIC AND ENVIRONMENTAL CONTEXT

The following is a description of the existing socio-economic, physical and biological environment in the vicinity of Ichthys LNG. Unless otherwise referenced in text, this information has been summarised from the Ichthys Gas Field Development Project: Draft EIS (INPEX 2010) and Ichthys Gas Field Development Project: supplement to the draft environmental impact statement (INPEX 2011).

Further information may be obtained from the following documents, which are available online at:

> http://www.inpex.com.au/our-projects/ichthys-lng-project/ichthys-commitments/environment/environmental-documents/

This information has been supplemented by environmental monitoring information, where applicable, during construction of Ichthys LNG and associated facilities to date.

2.1 Location

Ichthys LNG is located on Bladin Point, on the northern side of Middle Arm Peninsula in Darwin Harbour (Figure 2-1).

Ichthys LNG is approximately 4 km from Palmerston (the nearest residential zone) and approximately 10 km south-east of the Darwin CBD, across Darwin Harbour waters.

The information contained on this map is confidential and for information only, and must not be communicated to other persons without the prior written consent of INPEX. Any unauthorised use of such information may expose the user and the provider of that information to legal risk. While every effort has been made to ensure the accuracy and completeness of the information presented, no guarantee is given nor responsibility taken by INPEX for any errors or omissions. INPEX accepts no liability for any use of the said information or reliance placed on it.

Figure 2-1: Location of Ichthys LNG

2.2 Socio-economic Context

The following sections summarise the socio-economic (social, cultural and economic) features within and adjacent to Ichthys LNG.

2.2.1 Land use and zoning

Middle Arm Peninsula lies within the Litchfield Council and has a mixture of land uses. Ichthys LNG is zoned as Industry Development and is surrounded by areas zoned as Conservation. Other zonings on Middle Arm Peninsula include Utilities, Proposed Main Road, Future Development and Special Use (NT Government 2014). The land use zonings for Middle Arm Peninsula are shown in Figure 2-2.

The following non-INPEX facilities are located on Middle Arm Peninsula:

- Wickham Point immigration detention centre
- Channel Island and Weddell power stations
- Darwin aquaculture Centre
- Santos Darwin LNG plant and offloading facility (approximately 5 km from the INPEX Ichthys LNG).

Wickham Point Road and Channel Island Road are public access roads providing entry to the industrial premises, with associated parallel utility corridors.

Darwin Harbour is used intensively for commercial shipping, recreational boating and military activities. The following utilities are located on the seafloor within Darwin Harbour:

- underwater power and communication cables between Mandorah and Myilly Point
- the Bayu–Undan pipeline to the Santos Darwin LNG plant.

The location of onshore and nearshore facilities in relation to Ichthys LNG is shown in Figure 2-3.

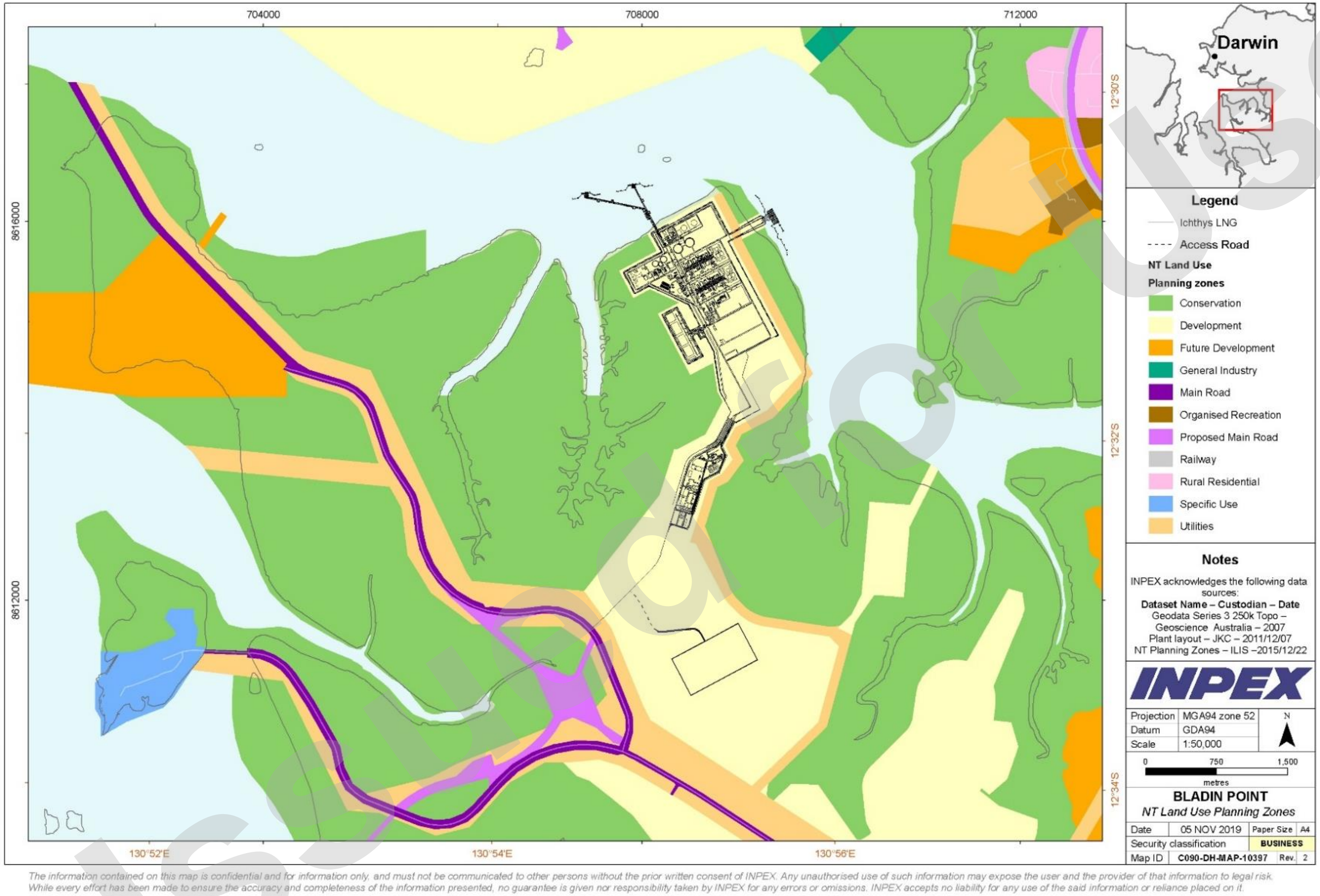


Figure 2-2: Middle Arm Peninsula land use zoning

The information contained on this map is confidential and for information only, and must not be communicated to other persons without the prior written consent of INPEX. Any unauthorised use of such information may expose the user and the provider of that information to legal risk. While every effort has been made to ensure the accuracy and completeness of the information presented, no guarantee is given nor responsibility taken by INPEX for any errors or omissions. INPEX accepts no liability for any use of the said information or reliance placed on it.

Figure 2-3: Middle Arm Peninsula and Darwin Harbour facilities

The NT Government developed the Darwin Regional Land Use Plan 2015 (NT Planning Commission 2015). Through this process, the land use objectives re-affirm that the areas of Wickham Point and Bladin Point, as well as the East Arm port precinct, are integral to Darwin as industrial areas for the purposes of oil and gas, supply and service centres.

There are currently no beneficial uses or soil quality objectives for land legislated by the NT Government. INPEX will refer to the relevant Health Investigation Levels (HILs) D (commercial/industrial land) as described by the National Environment Protection (Assessment of Site Contamination) Measure for the land occupied by Ichthys LNG, as this aligns with the Litchfield Council land use zoning of Industrial Development.

2.2.2 Heritage and Cultural Values

Onshore

Middle Arm Peninsula is located within the traditional country of the Larrakia people.

A number of Aboriginal heritage sites have been recorded adjacent to or near Ichthys LNG; these are protected under the *Heritage Act 2011* (NT) and are described in Table 2-1. There are no sites within the Ichthys LNG fence line.

Table 2-1: Archaeological sites near Ichthys LNG

Site	Description	Significance
Cultural Heritage Conservation Zone 2	Shell middens and mounds	Low to moderate
Cultural Heritage Conservation Zone 3	Shell midden and mounds	Low to high
Heritage Hill	Shell, stone and glass scatters	Low
ISO2 and ISO3	Relocated material including shell and stone artefact scatters	Low
ISO25	Quartz and three shells	Low
Site 1	Isolated scatter of quartz flakes	Low
Site 3	Shell midden	Low

Archaeological surveys on Bladin Point have also recorded WWII objects. Objects found within the vicinity of Ichthys LNG were deemed to not be of heritage value and have been removed following consultation with the NT Heritage Branch. There are no known WWII heritage sites within or adjacent to Ichthys LNG.

There are also onshore Sacred Sites around Darwin Harbour which are protected by the Northern Territory *Aboriginal Sacred Sites Act* (NT); these are identified as restricted work areas in Aboriginal Areas Protection Authority (AAPA) certificates C2011/166. None of the Sacred Sites identified within the authority certificates are located on Middle Arm Peninsula.

Nearshore

There are also a number of maritime heritage sites within Darwin Harbour, including shipwrecks and sunken aircraft, which are protected by legislation. There are also maritime wrecks; that although not protected by legislation, are subject to Project-set controls for vessels contracted by INPEX. These sites are summarised in Table 2-2. The *USS Peary*, *USS Meigs*, *USS Mauna Loa*, *British Motorist*, *Zealandia*, *Neptuna*, *Booya*, Catalinas 1-6 and RAAF Douglas C-47 Dakota (A54-115) are also afforded further protection under the Underwater *Cultural Heritage Act 2018* (Cth), as these shipwrecks and sunken aircraft are over 75 years old.

Darwin Harbour has various Sacred Sites which are protected by the Northern Territory *Aboriginal Sacred Sites Act* (NT). INPEX has four AAPA authority certificates that describe the Sacred Sites relevant to activities in Darwin Harbour, these being C2011/170, C2011/166, C2014/007 and C2013/177.

Table 2-2: Archaeological and cultural sites in Darwin Harbour

Site	Type	Level of protection
SS Ellengowan	Shipwreck	Declared Area under the *Heritage Act 2011* (NT) Protected under the *Underwater Cultural Heritage Act 2018* (Cth)
USS Peary	Shipwreck	Declared Area under the *Heritage Act 2011* (NT) *Protected under the Underwater Cultural Heritage Act 2018* (Cth) The Booya is also subject to an exclusion zone under the *Darwin Port Corporation Act* (NT)
USS Meigs	Shipwreck	
British Motorist	Shipwreck	
USS Mauna Loa	Shipwreck	
Zealandia	Shipwreck	
Neptuna	Shipwreck	
Kelat	Shipwreck	
Booya	Shipwreck	
RAAF Catalina 1	Sunken Aircraft	Protected under the *Underwater Cultural Heritage Act 2018* (Cth)
RAAF Catalina 2	Sunken Aircraft	Protected under the *Underwater Cultural Heritage Act 2018* (Cth)
RAAF Catalina 3	Sunken Aircraft	Protected under the *Underwater Cultural Heritage Act 2018* (Cth)

Site	Type	Level of protection
United States Navy Catalina 4	Sunken Aircraft	Declared Area under the *Heritage Act 2011* (NT) Protected under the *Underwater Cultural Heritage Act 2018* (Cth) Sunken Military Craft Act (US) Catalina 6 is also subject to an exclusion zone under the *Darwin Port Corporation Act* (NT)
United States Navy Catalina 5	Sunken Aircraft	
United States Navy Catalina 6	Sunken Aircraft	
RAAF Douglas C-47 Dakota (A54-115)	Sunken Aircraft	Declared Area under the *Heritage Act 2011* (NT) Protected under the *Underwater Cultural Heritage Act 2018* (Cth)
Reef between Channel Island and the mainland	Reef	Declared Area under the *Heritage Act 2011* (NT)

2.2.3 Recreational use of Darwin Harbour

Darwin Harbour is a prime recreational and tourism resource for the NT, with activities such as fishing, boating, water skiing and beach use being popular activities. Fish species commonly targeted in Darwin Harbour by recreational fishers include snapper, mud crab, barramundi, small bait fish and some game fish. Boat ramps in the inner Darwin Harbour include Channel Island, Dinah Beach, East Arm and Palmerston.

For safety reasons, a 500 m safety zone is in place around Ichthys LNG product loading jetties and berths, as well as the module offloading facility. There is also a 'no anchoring' zone west of the product loading jetty. The safety zone and no anchoring zones are planned to be designated on navigation charts, and are shown in Figure 2-4.

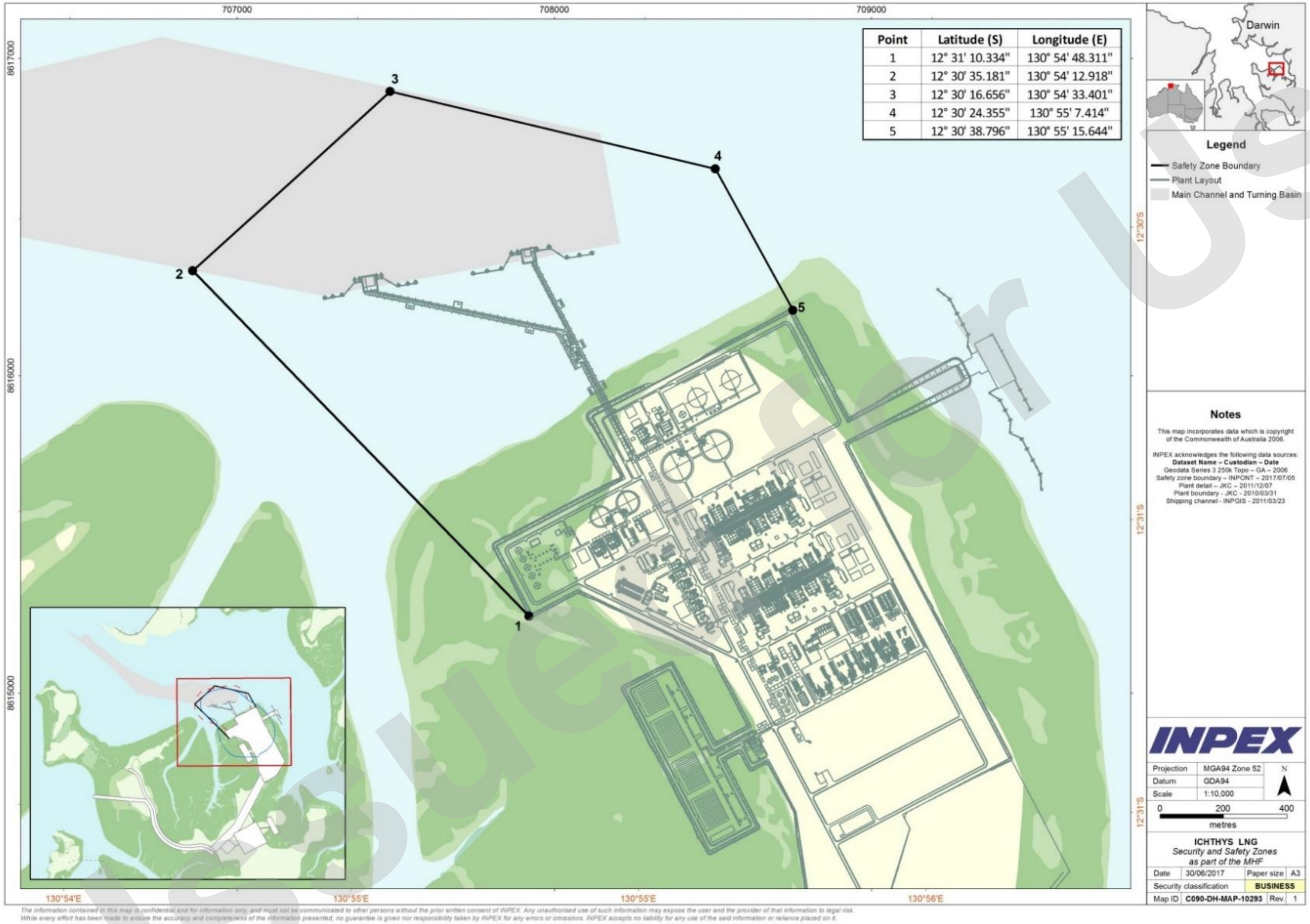


Figure 2-4: Marine safety zone and no anchoring zone around Ichthys LNG

2.3 Environmental Context

2.3.1 Climate and Meteorology

Ichthys LNG lies in the monsoonal tropics of northern Australia, which has two distinct seasons - a hot wet season from November to April and a warm dry season from May to October. April and October are transitional months between the wet and dry seasons. Darwin has a mean annual rainfall of 1 711 mm, with rain falling on an average of 111 days (mainly in the wet season). The mean annual evaporation rate is 2 630 mm. Table 2-3 describes the average monthly conditions for Darwin.

During the wet season, which has an official start date of 1 November each year, prevailing winds are westerly and west-north-westerly. Winds in the dry season, which has an official start date of 1 May each year, vary from south-easterly to northerly. Wind roses for Darwin are shown in Figure 2-5.

The area is subject to tropical low-pressure systems and cyclones, particularly from November to April. Tropical cyclones bring strong winds, heavy/squally rainfall, local flooding and storm surges. Damage from cyclones can occur up to 50 km inland from the coast.

Table 2-3: Average monthly weather conditions for Darwin

Month	Average maximum temperature (°C)	Average minimum temperature (°C)	Average monthly rainfall (mm)	Average relative humidity 9 am (%)	Average relative humidity 3 pm (%)
January	31.8	24.8	426.3	81	70
February	31.4	24.7	374.6	83	72
March	31.9	24.5	319.0	82	67
April	32.7	24.0	102.2	74	52
May	32.0	22.1	21.2	65	43
June	30.6	19.9	1.8	60	38
July	30.6	19.3	1.2	60	37
August	31.4	20.4	4.9	64	40
September	32.6	23.0	15.3	68	47
October	33.2	24.9	70.6	69	52
November	33.3	25.3	141.7	72	58
December	32.6	25.3	250.8	76	65

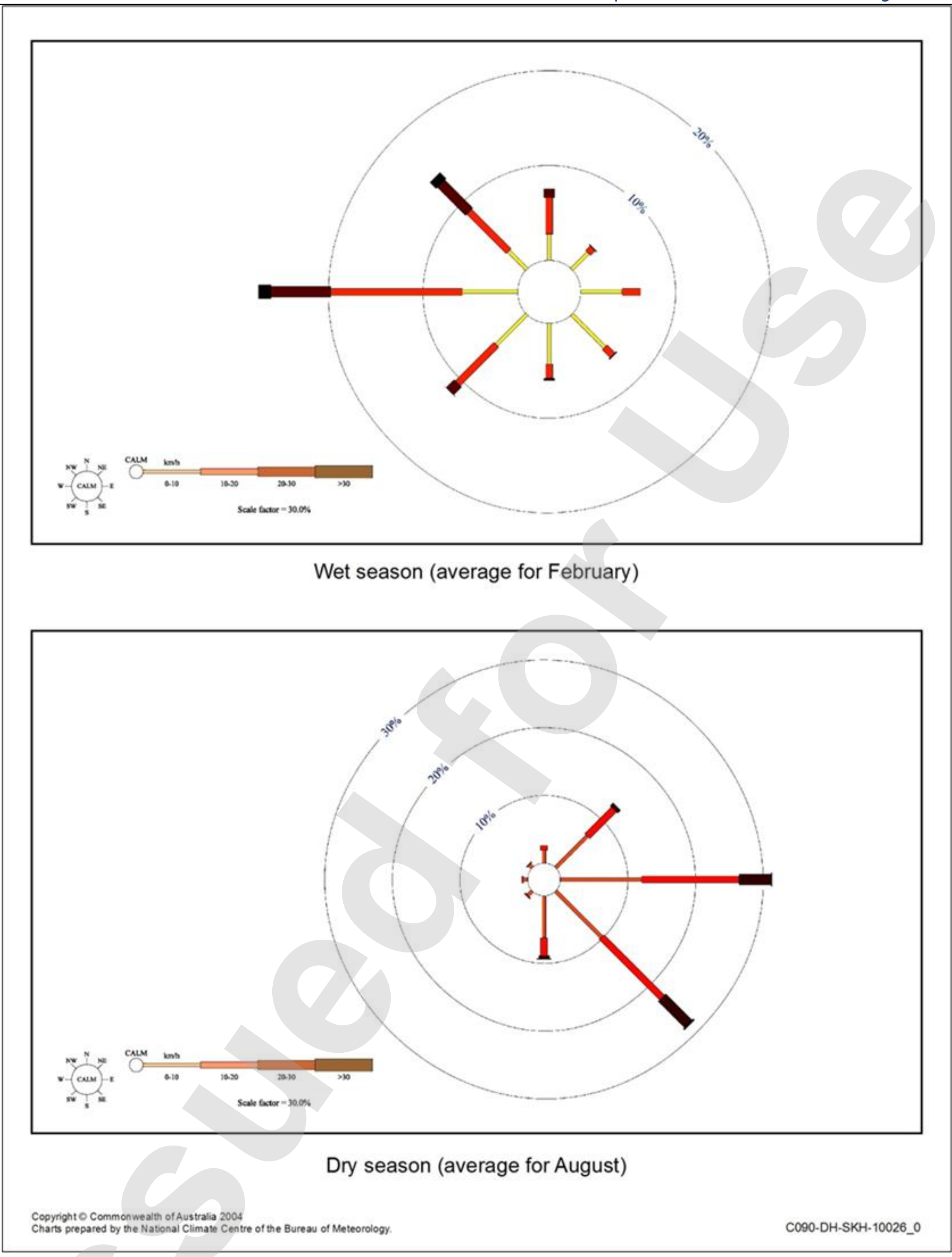


Figure 2-5: Wind roses for the Darwin area

2.3.2 Noise

Given the location of Ichthys LNG on Bladin Point, there are limited off-site noise sensitive receptors in close proximity to the facility. Nonetheless, as part of good industry practice, noise has been monitored and assessed during the project planning and construction phases.

Ambient noise levels were measured prior to construction of Ichthys LNG at O'Farrell's Road, Bayview Haven and Constance Court, Palmerston (SVT Engineering Consultants 2009). During construction, continuous airborne noise monitoring was undertaken at Ichthys LNG site as well as at Palmerston; minor noise exceedances were recorded in Palmerston, however none of the exceedances were considered to be project-attributable (URS 2013; AEC Environmental 2014, 2015). The ambient and construction noise level measurements provide a baseline for the operational phase.

2.3.3 Air Quality

Ambient air quality in the Darwin airshed is influenced by a number of sources, including biogenic sources (soil, natural and agricultural vegetation), smoke from bushfires, vehicles and industrial sources. Generally, the concentrations of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and photochemical oxidants (as measured by ozone, O_3) in the Darwin airshed are relatively low. Particulate levels in the Darwin airshed are also usually relatively low; however, PM10 concentrations are higher in the dry season than the wet season because of increased bushfires.

The nearest sensitive receptors for air quality from Ichthys LNG are the residential areas of Palmerston (Section 2.1).

The Ambient Air Quality National Environment Protection Measure (AAQ NEPM) specifies maximum acceptable ground-level concentrations for a range of common parameters relevant to airsheds across Australia. Of these, the parameters relevant to Ichthys LNG context in Darwin are NO_2, O_3, SO_2 and particulates (measured as PM2.5 and PM10). A cumulative air quality assessment was undertaken for the Draft EIS in 2010 (SKM 2010), and updated to incorporate revised plant configuration in 2014 (Pacific Environment 2014). The 2010 air quality assessment included establishment of the background air quality using air emissions from biogenic sources (soil and vegetation), vehicles, shipping traffic and industrial sources already present on Middle Arm Peninsula prior to construction of Ichthys LNG (ConocoPhillips Darwin LNG plant, Channel Island power station and Weddell power station) (SKM 2010). The background air quality was found to be good; the maximum ground level pollutant concentrations for NO_2 (1 hr average), O_3 (1 hr average), SO_2 (1 hr average) and PM10 (1 day average) were found to be 27%, 20%, 12% and 22% of the NEPM criteria, respectively.

2.3.4 Geology and Geomorphology

Onshore

Bladin Point is a low-lying peninsula, which is separated from the mainland by a mudflat. The area is underlain by Early Proterozoic and Burrell Creek Formation rocks, with some Cretaceous Darwin Formation rocks along the shoreline. Soils over half of the site are very gravelly, massive earths that range in depth from shallow (<0.25 m) to moderately deep (0.25 to <0.5 m) (Fogarty et al. 1984).

The following soil families have been identified at Bladin Point: Bladin (red, fine sandy clay loam); Hotham (brown, massive, fine sandy loam with medium gravel); Koolpinyah (yellow sandy loam over sandy clay loam); Mullalgah (deep, peaty soils on marine sediments); Euro (hydrosols on intertidal flats); Maand (poorly drained marine muds); and Rinamatta (siliceous sands).

The Mullalgah, Euro, Maand and Rinamatta soil families contain varying levels of acid sulphate soils (ASS). Geotechnical investigations for Ichthys LNG construction phase identified areas of ASS within Ichthys LNG footprint, with key areas being the ground flare pad, tankage flare, condensate tank area, module offloading facility causeway and tidal area of the haul road (JKC 2014).

Nearshore

Darwin Harbour is a large ria (drowned river valley) system of approximately 500 km^2, and consists of three main components (East Arm, Middle Arm and West Arm) which merge before joining the ocean. The Darwin and Blackmore rivers flow into Middle Arm; and the Elizabeth River flows into East Arm. Freshwater inflow into the Harbour occurs from January to April, when estuarine conditions prevail.

The main channel for the Port of Darwin favours the eastern side of the Harbour, averages 15-25 m deep and has a maximum depth of approximately 36 m. Intertidal flats and shoals are generally more extensive on the western side than the eastern side of the Harbour.

2.3.5 Hydrology and Hydrogeology

Bladin Point is generally flat, and varies only 10 m in topography. After rainfall, the majority of surface water flows east into the Elizabeth River and west into Lightning Creek, with some surface water discharging north into Darwin Harbour and south towards a tidal salt flat.

Groundwater levels are generally shallow, with recharge mainly occurring by rainfall infiltration during the wet season. A semi-confined aquifer in the clayey sand/gravel horizons of the Darwin Formation generally follows the topography of the site with the lowest levels located near the coast. The groundwater levels in this aquifer fluctuate seasonally between 0.5 and 5 m, and are also influenced by the Darwin Harbour tides in coastal areas.

The 100-year storm surge level at Bladin Point is estimated at 4.9 m AHD and the 500-year storm surge level is estimated at 5.6 m AHD. Most Ichthys LNG facilities (including all critical facilities) are located above 6.5 m AHD, with some non-critical support infrastructure located above 5.8 m AHD which provides 0.2 m above the estimated 500-year storm surge level to account for potential sea level increase.

2.3.6 Groundwater Quality

Aquifers in the Darwin Formation are typically acidic to neutral, with a pH ranging from 4.1 to 7.6 (Radke et al. 1998).

Sampling of groundwater in Ichthys LNG site prior to construction recorded fresh to saline water with pH levels of 4.7 to 6.3, dissolved sodium chloride salts and some areas of high calcium carbonate concentrations. Concentrations of copper, zinc, cadmium, manganese, nickel and zinc were higher than ANZG (2018) trigger values prior to commencement of construction.

Groundwater monitoring carried out throughout Ichthys LNG construction phase analysed a large number of parameters. The natural groundwater pH values during construction were consistently lower than pH 7 and in some cases were as low as pH 3 although there was no notable decreasing trend over the monitoring periods (AEC Environmental 2015). The groundwater levels during construction rose and fell in accordance with the season, with the lowest levels in 2013/2014 being recorded in October (dry season end) and the peak levels being reached in late-March/early-April (wet season end) (AEC Environmental 2014). Naturally elevated concentrations of copper, zinc, manganese, lead, aluminium, arsenic and cobalt were above the ANZG (2018) nominated trigger values during the 2013/2014 and 2014/2015 monitoring periods (AEC Environmental 2014, 2015).

Under the *Water Act* (NT), beneficial uses for groundwater have been declared for the Elizabeth-Howard Rivers Region which extend across the Ichthys LNG site. These are listed as aquaculture, environment, public water supply and rural stock and domestic. Water quality objectives for groundwater in the region have been set as listed in Table 2-4. Baseline sampling of groundwater undertaken before Ichthys LNG construction commenced indicated that the groundwater at Bladin Point naturally contains constituents at levels that exceed the Elizabeth-Howard Rivers Region groundwater quality objectives. Due to the naturally low pH and other exceedances, this generally precludes application of the groundwater quality objectives at Ichthys LNG site.

Table 2-4: Groundwater quality objectives

Indicator	Indicator for environmental use: Aquatic Ecosystem Protection - Groundwater
pH	Maintain between 7 – 8.5
Conductivity	Maintain < 400 µS/cm

Source: NT Government (2010)

2.3.7 Harbour Hydrodynamics and Metocean Conditions

Darwin Harbour has a large tidal range. Tides are predominantly semidiurnal (two high tides and two low tides per day). Tidal ranges can be up to 7.5 m during spring tides and as low as 1.4 m during neap tides. Tidal excursions range from 8 to 15 km during spring tides and 2 to 8 km during neap tides. The large tidal ranges produce strong currents that peak at speeds of up to 2-2.5 m/s.

Darwin Harbour is considered well protected from waves, with most waves generated within the Harbour or in Beagle Gulf. Waves during the summer months can reach heights of up to 1 m, although average wave height are generally less than 0.5 m with short mean periods of 2-5 s. Average wave heights and periods during the winter months are even lower. Tsunamis and swell waves (long–period waves) are unlikely to occur in Darwin Harbour due to its orientation and the protection from ocean swells by the Tiwi Islands.

2.3.8 Harbour Water Quality

Darwin Harbour is a naturally turbid environment due to the large tidal ranges and associated currents (see Section 2.3.7), with clearest water occurring during neap tides while the spring tides are associated with increased turbidity due to increased current velocities.

During the wet season, monsoonal troughs and tropical cyclones (events) significantly influence water quality, in particular turbidity. These events increase metocean conditions (wind and waves) which suspend sediments resulting in high turbidity levels (>150 NTU daily average) in coastal waters outside the Harbour, while waters within the Harbour are typically sheltered. If these events coincide with spring tides, the tidal currents can advect the highly turbid coastal waters into the Harbour resulting in increased turbidity (>100 NTU daily average) (Cardno 2015; URS 2009). Turbidity inside the harbour will also be increased by increased sediment loading from surface runoff associated with increased rainfall during such events.

Conversely, metocean conditions in the dry season are relatively benign, with water quality primarily driven by tides. As a result, clearer waters are measured inside and outside the Harbour, with turbidity typically between 1 and 7 NTU (median daily average).

Dissolved oxygen in Darwin Harbour typically ranges from 74-96% (mean 84%), with no seasonal effects (INPEX 2011; Padovan 1997). Seasonal rainfall events often produce 'first-flush' loads of stressors that can cause rapid changes in stressor concentrations (ANZECC ARMCANZ 2000). The 2017 wet season is noted for being the third-wettest on record (BOM 2017). Darwin also experienced the strongest monsoon burst (rainfall event) of the 2017 wet season in early February (BoM 2017). Organic matter decay processes can significantly reduce dissolved oxygen concentrations (ANZECC ARMCANZ 2000). Therefore, localise wet-season turbidity events associated with large amounts of organic terrigenous material entering the harbour (as a result of increased rainfall in catchment areas) and decaying may cause localised reduced dissolved oxygen. The mean dissolved oxygen level of 87.8% over the 2017 wet season indicates that dissolved oxygen range was skewed to higher than the median, and likely within the acceptable range of 80-100%.

Water temperature typically varies from 24°C in the dry season to over 30°C in the wet season, however the timing, duration and frequency of wet season events can significantly influence water temperature causing declines of 2 °C to 4 °C. The rainfall associated with these events can also drive fluctuations in salinity within Darwin Harbour, with salinity at upstream sites capable of dropping below 20 ppt following rainfall events (URS 2009).

Overall, Darwin Harbour water quality is considered to be good (Fortune 2015); a seasonal summary of mean water quality is provided in Table 2-5.

Table 2-5: Mean water quality levels recorded near Bladin Point

Parameter	Dry season	Wet season
Temperature	24.5 °C*	30.6 °C*
Salinity	35.5 ppt*	29 ppt*
Dissolved oxygen	(median 35.83 g/L)†	(median 32.37 g/L)†
pH	93.3% of saturation*	87.8% of saturation*
Turbidity	(median 88.3% in July 2017)†	(median 75.9% in February 2017) †

* URS 2009

† AEC Environmental 2017

Under Section 73 of the *Water Act* (NT), beneficial uses in relation to water or a class of water can be declared to reduce the effects of water pollution and assist with protection and management of water and aquatic ecosystems. Beneficial uses for Darwin Harbour are listed as aquaculture, environment and cultural for saline waters. Water Quality Objectives for Darwin Harbour have been set by the NT government for a number of water types; those relevant to the saline waters around Bladin Point are the objectives for mid estuary and upper estuary waters as listed in Table 2-6.

Table 2-6: Water quality objectives for Darwin Harbour upper estuary

Indicator	Upper estuary water quality objectives
Indicator for Environmental Use: Aquatic Ecosystem Protection	
Dissolved oxygen	Maintain DO between 80–100% saturation
pH	Maintain pH between 6–8.5
Turbidity	-
Conductivity	-
Total nitrogen (TN)	Maintain TN <300 µg/L
NOx	Maintain NOx <20 µg/L
Ammonia	Maintain Ammonia <20 µg/L
Total phosphorus (TP)	Maintain TP <30 µg/L
Filterable reactive phosphorus (FRP)	Maintain FRP <10 µg/L
Chlorophyll a	Maintain Chlorophyll a <4 µg/L
TSS	Maintain TSS <10 mg/L
Indicator for Protection of Cultural Use: Recreation Primary Contact	
Enterococci	All samples to be less than or equal to 50 Enterococci/100 mL
Escherichia coli (E. coli)	No single sample greater than 200 E. coli/100 mL
Pathogenic protozoans	<10 pathogenic protozoans/100 mL
Indicator for Protection of Cultural Use: Aquatic Foods	
Guideline for water in shell fish growth harvest areas	Median concentration of faecal coliform should not exceed 14 MPN/100 mL (no more than 10% of the samples exceeding 43 MPN/100 mL)
Standard in edible tissue	Fish for human consumption should not exceed a limit of 2.3 MPN E. coli/g of flesh with a standard plate count of 100 000 organisms/g
Toxicants	Refer to ANZG (2018)

Source: NT Government (2010)

2.3.9 Harbour Sediment Quality

Marine surface sediments within Darwin Harbour range from terrigenous gravels in the main Darwin Harbour channel; calcareous sands close to small coral communities and shoals at East Point, Lee Point and Channel Island; terrigenous sands on beaches and spits; and mud and fine sand on intertidal mudflats. Silts and fine sands occur around the northern end of Bladin Point.

Surface marine sediments in the nearshore development area were sampled and analysed for a suite of parameters in 2008 (URS 2009). Generally metal levels were below screening levels, with the exception of elevated levels of arsenic, chromium and mercury (note chromium and mercury were not recorded at concentrations above the maximum guideline level). The arsenic occurs naturally in the marine sediment and is unlikely to be toxic in the marine environment. Tributyltin (TBT) compounds and BTEX compounds were below laboratory detection limits for surface sediments. Total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH) were well below guideline screening levels. Total organic carbon and nutrient levels recorded for surface marine sediments are presented in Table 2-7.

Table 2-7: Total organic carbon and nutrients in surface marine sediment samples

Parameter	Darwin Harbour average result	East Arm average result
Total organic carbon (TOC)	0.5% w/w (5 mg/g)	0.3% w/w (3 mg/g)
TN	581 mg/kg	356 mg/kg
TP	315 mg/kg	509 mg/kg
Total sulfur	0.18%	0.8%

Source: URS (2009)

Subsurface sediments were also sampled and analysed for levels of metal. Metal levels in subsurface sediments were lower than the relevant screening levels, with the exception of arsenic at a number of sites, and nickel at one site. Routinely recorded elevated levels of arsenic from various sediment studies in Darwin Harbour have been considered to be an indication of local geology rather than an anthropogenic source, most likely reflecting natural weathering of arsenic rich coastal substrata (Fortune 2006). There is high potential for ASS in the subtidal and intertidal areas around Bladin Point, particularly in marine muds and mangrove zones.

The subtidal benthos baseline survey undertaken between May and July 2012 (prior to dredging) measured particle size distribution at 24 sites within Darwin Harbour. It was found that Darwin Harbour contained sand with varying proportions of clay, silt and gravel. Sites located to the far west of Darwin Harbour Inner had a high clay and silt content, whereas samples collected from the central channel tended to contain higher proportions of gravel than elsewhere. Samples collected from within the East Arm were mostly sandy with smaller proportions of clay and silt (Cardno 2013a).

The intertidal benthos baseline survey completed between June and August 2012 (prior to dredging) measured particle size distribution at 18 sites, each with 2 sub-sites to assess fine scale variability. Sediments sampled generally consisted of a high proportion of clay and silt (<60 µm) with varying amounts of fine sand and small proportions of gravel at some sites. Intertidal sediments at northeast Wickham Point and at the mouth of Woods Inlet had notably higher proportions of sand than other sites. A large amount of fine organic matter was noted within the sediment samples collected in the field, particularly within the creeks (Cardno 2013b).

2.3.10 Ecosystems, Vegetation Communities and Habitats

Terrestrial

Bladin Point lies within the Darwin Coastal Bioregion, which is characterised by mangroves, monsoon vine forest and tall open eucalypt forest (Figure 2-6). Whilst there are no listed threatened ecological communities adjacent or near to Ichthys LNG, the mangrove communities around the onshore facilities (including the GEP) and monsoon vine forest near the GEP are considered to have high conservation value in Darwin Harbour for biological and cultural reasons.

Marine

The most common marine habitat around Bladin Point is soft-bottom benthos and sediment (Figure 2-7). There are also small areas of mixed community reef and reef with less than 10% macrobiota in the vicinity of Bladin Point. Other marine communities in Darwin Harbour include communities dominated by macroalgae, filter-feeders and hard corals. The composition, abundance and/or spatial extent of some communities in Darwin Harbour (such as macroalgae and seagrass) varies between the wet season and dry season. There are no significant marine habitats in the vicinity of Ichthys LNG; the closest communities of significance are the small hard coral communities at Channel Island and Weed Reef.

Figure 2-6: Vegetation communities on Bladin Point

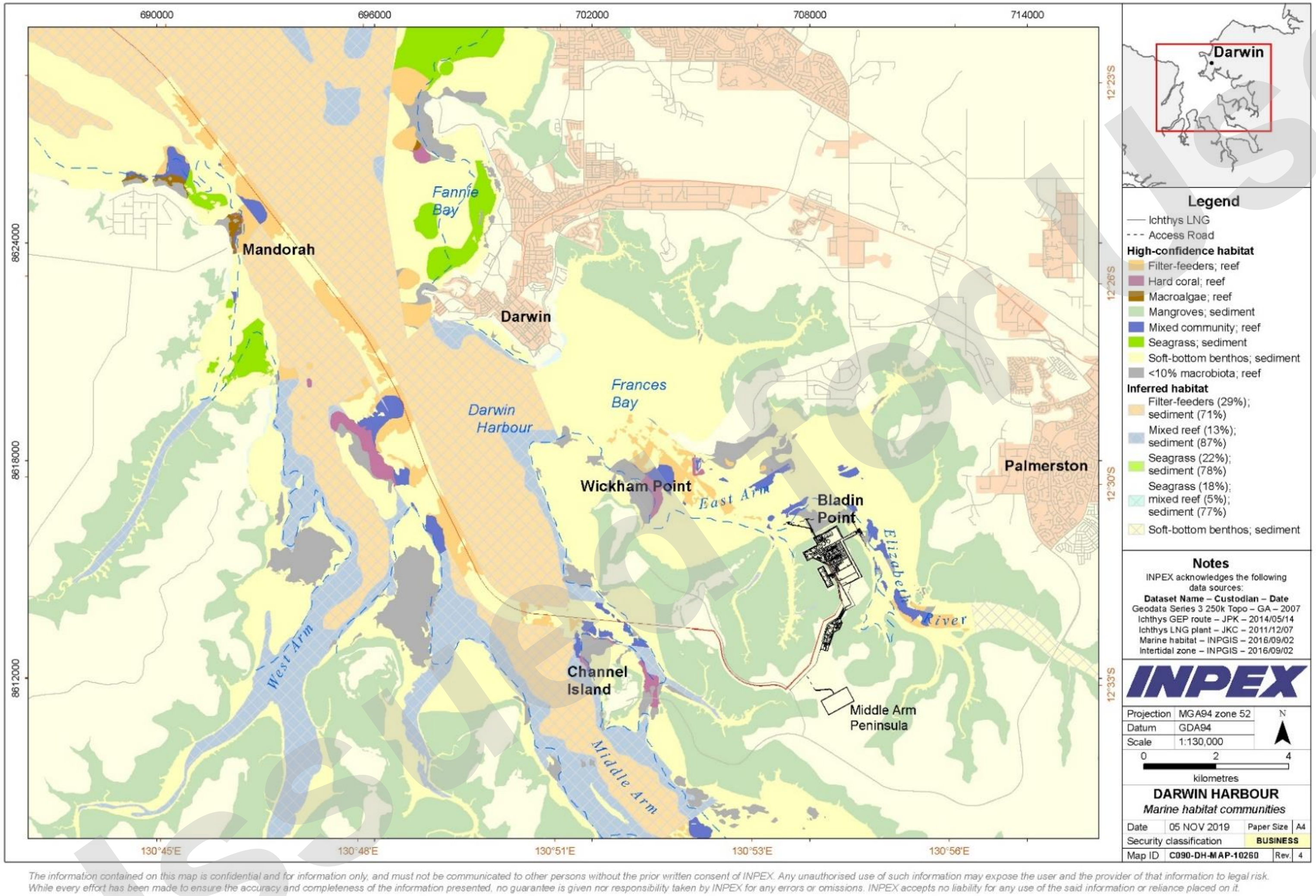


Figure 2-7: Near-shore marine habitat communities

2.3.11 Flora and Fauna

Terrestrial Flora

One protected flora species was recorded on Bladin Point, the cycad Cycas armstrongii which is listed as threatened under the *Territory Parks and Wildlife Conservation Act* (NT). Although cycads were cleared within Ichthys LNG battery limits during construction in accordance with environmental approvals, cycads are still present on Bladin Point outside Ichthys LNG.

Annual weed surveys have been undertaken in and around Ichthys LNG since 2008. Weed surveys undertaken in November 2014 and February 2015 (AEC Environmental 2015, 2017) recorded the following weed species which are listed as declared weeds under the *Weeds Management Act* (NT):

- Gamba grass *Andropogon gayanus* (also listed as a Weed of National Significance under Commonwealth legislation): located south of Ichthys LNG
- Lantana *Lantana camara* (also listed as a Weed of National Significance under Commonwealth legislation): located south of Ichthys LNG
- Flannel weed *Sida cordifolia*: located on the south eastern boundary of the operations complex
- Lion’s tail *Leonotis nepetifolia*: located on the south eastern boundary of the operations complex
- Barnyard grass *Echinochloa colona*: located on the eastern boundary of Ichthys LNG
- *Hyptis suavaeolens*: located south of Ichthys LNG
- Perennial mission grass *Cenchrus polystachios* (formerly known as *Pennisetum polystachion*): located in the south western corner of the operations complex and south of Ichthys LNG.
- Mimosa *Mimosa pigra*: recorded in small isolated patches of the site.
- Sicklepod *Senna obtusifolia*: recorded in small isolated patches of the site.

Terrestrial Fauna

Fauna surveys at Bladin Point recorded 148 vertebrate species, including nine mammal species, 106 bird species, 22 reptile species and 11 frog species (GHD 2009). No threatened fauna species (as listed under the *Territory Parks and Wildlife Conservation Act* (NT) or the EPBC Act) were recorded in the vicinity of Ichthys LNG. Middle Arm Peninsula may provide habitat for several migratory bird species which are listed under the EPBC Act and international conventions, however, the area cannot be defined as ‘important habitat’ for seabirds (GHD 2009). A survey of biting insects at Bladin Point found that biting midges were much more abundant than mosquitoes (Department of Health and Families, 2009a). The most common biting midge recorded was *Culicoides ornatus* (mangrove biting midge) and the most common mosquito species recorded was *Aedes vigilax* (northern salt marsh mosquito).

Introduced terrestrial fauna species recorded on Bladin Point include the cane toad *Rhinella marina*, feral pigs *Sus scrofa*, cats *Felis catus*, black rat *Rattus rattus* and insect pest species. The cane toad is the most widely occurring pest species recorded on Bladin Point. Feral cats were recorded along the GEP in December 2013 (AEC Environmental 2014). The tracks of dogs or dingos were also recorded in December 2013; however, no animals were sighted (AEC Environmental 2014).

Marine Fauna

Marine fauna that inhabit or frequently visit Darwin Harbour and are listed under the *Territory Parks and Wildlife Conservation Act* (NT) and/or EPBC Act include, but are not limited to, the Australian snubfin dolphin *Orcaella heinsohni*, Indo-Pacific humpback dolphin *Sousa chinensis*, Indo-Pacific bottlenose dolphin *Tursiops aduncus*, false killer whale *Pseudorca crassidensis*, common dolphin *Delphinus delphis*, dugongs *Dugong dugon*, sea snakes, salt-water crocodiles and marine turtles. There are no significant marine turtle nesting beaches or dugong feeding habitats in the vicinity of Ichthys LNG.

Several marine pest monitoring programs have been undertaken in Darwin, with some continuing as ongoing marine pest surveillance. The NT Aquatic Biosecurity unit of the DITT regularly monitors the marine fouling communities of the NT coastline for the early detection of marine pest populations. Routine inspections of artificial settlement units are made in Darwin Harbour marinas and open water sites. No recognised marine pest species were observed during 2012-13 monitoring (DPIF 2014). The NT Fisheries Group also routinely inspects vessels wishing to enter Darwin marinas that are unable to demonstrate that their hulls have been cleaned or antifouled in Australia.

Targeted marine pest monitoring within Darwin Harbour was also undertaken between 2012 and 2014 for the Ichthys Nearshore Environmental Monitoring Program (Cardno and Golder Associates 2012; 2015). A selection of 42 taxa was targeted, and the following target species were recorded: *Amphibalanus amphitrite* (barnacle), *Bugula neritina* (bryozoan), and ascidians *Botryllus schlosseri*, *Botrylloides leachi*, *Didemnum* sp and *Didemnum perlucidum*. These taxa are considered to have a relatively low level of biosecurity risk, based either on their cosmopolitan distribution or the lack of extensive populations in Darwin Harbour at monitoring sites (Cardno and Golder Associates 2012). *Didemnum perlucidum* was first officially reported in the NT in May 2012 when samples from a pearl farm near Gove were sent to the Cawthorn Institute's laboratory for identification. The introduction of *D. perlucidum* to Darwin Harbour is considered likely to be due to pearl farm vessels which are known to visit the harbour, and at times remain for extended periods (M. Barton, Aquatic Biosecurity, Fisheries Division, DPIF (2014), pers. comm., 5 June 2014) (Cardno 2015).

2.3.12 Conservation Values

The regional conservation values in the vicinity of Ichthys LNG are mangroves, monsoon vine thicket, the cycad species Cycas armstrongii and hard coral communities.

Mangrove communities are common in the intertidal areas surrounding Bladin Point. However, these communities are zoned for "conservation" in the NT Planning Scheme (DPI 2008) in recognition of their ecological importance. Mangroves provide habitat for a variety of fauna, assist in stabilising shore lines and provide nursery grounds for commercial fish species.

Monsoon vine thickets are also a significant onshore habitat at Wickham Point, adjacent to the onshore section of the GEP, and contain a large number of fruit-bearing plants that are food sources for birds and other animals. These thickets are regarded as significant or sensitive communities under the clearing guidelines of the *Planning Act* (NT).

The cycad *Cycas armstrongii* is endemic to the NT. It is locally common in the Darwin area and found surrounding Bladin Point, however less than 1% of the species' populations are protected by conservation reserves so it is listed as threatened under the *Territory Parks and Wildlife Conservation Act* (NT).

Coral communities are found in a limited number of locations in Darwin Harbour and are considered to be of conservation significance. Of particular note is the coral community between Middle Arm Peninsula and Channel Island; this community is a declared area under the *Heritage Act 2011* (NT) due to the presence of a relatively diverse coral community located in an area of high turbidity, strong tidal currents, seasonally low salinity, and deep, fine muds. The Channel Island coral reef is also listed as place ID 16462 on the Register of the National Estate, a non-statutory archive of heritage places.

Channel Island Leprosarium is a declared area under the *Heritage Act 2011* (NT) and is listed on the Register of National Estate as place ID: 14869. This site refers to the location of a quarantine station and leprosy hospital from the 1920s to 1955.

Darwin Harbour is listed as a wetland of national significance in the Directory of Important Wetlands in Australia (Port Darwin NT029) and is a good example of a shallow branching embayment that supports important habitats (e.g. mangrove swamps) and has high cultural significance.

Key Ecological Features

A search of DAWE Conservation Values Atlas did not identify any key ecological features which occur within the vicinity of Ichthys LNG. The closest key ecological feature is the carbonate bank and terrace system of the Van Dieman Rise, which is approximately 107 km from Ichthys LNG at its closest point.

Matters of National Environmental Significance

A search of the DAWE Protected Matters database was conducted for Ichthys LNG area on 14 November 2019. The search encompassed the perimeter of Ichthys LNG (including jetty outfall) and a 1 km buffer around the perimeter. The search identified a total of 37 threatened species, 55 migratory species, 93 listed marine species and 12 whales and other cetaceans as potentially utilising Ichthys LNG area. A full list of species of conservation significance is summarised in APPENDIX B:. In addition to the DAWE Protected Matters database results, one cetacean species has been identified as occurring in Darwin Harbour and this has been included in APPENDIX B:. There are no known significant feeding, breeding or aggregation habitats for the species listed in APPENDIX B: adjacent to or near Ichthys LNG.

The search also identified Darwin Harbour as being listed as a wetland of national significance in the Directory of Important Wetlands in Australia (Port Darwin NT029).

No threatened ecological communities were identified during the Protected Matters database search.

Australian Marine Parks

Ichthys LNG is not located within or in the vicinity of any Australian marine parks.

3 ONSHORE GAS PLANT FACILITY DESCRIPTION

3.1 Plant Overview and Layout

Ichthys LNG receives processed reservoir fluids (feed gas) from offshore facilities located approximately 890 km away via the GEP. The GEP crosses the shore south of Wickham Point, Middle Arm Peninsula, and travels approximately 7 km over land to Ichthys LNG's onshore arrival system at Bladin Point.

Ichthys LNG has a footprint of approximately 275 hectares and comprises the following major components:

- Onshore arrival system (Section 3.3): This consists of an inlet throttling station, and a slug catcher.
- Condensate processing (Section 3.3): This consists of condensate stabilisation units and condensate mercury removal units.
- LNG and LPG processing (Section 3.3): The key hydrocarbon processing units consist of two LNG trains, and include mercury removal, acid gas removal, dehydration, LPG recovery, fractionation, refrigeration and liquefaction.
- Product storage and loading (Sections 3.3 and 3.7): Ichthys LNG produces condensate, LPGs (propane and butane) and LNG which are stored in tanks prior to products being loaded onto tankers. The product storage system includes boil off gas (BOG) recovery systems for LPGs and LNG.
- Utilities (Section 3.4): Key utility systems include the flare and vent systems, a CCPP which produces the power required to run Ichthys LNG, and drainage and wastewater treatment system. Other utility systems include demineralised water and firefighting water, fuel gas, compressed air, nitrogen, heating medium and cooling medium.
- Ancillary facilities (Section 3.6): Ancillary facilities are located in the operations complex and areas of site not used for processing and include a security gatehouse, permanent and semi-permanent offices, central control building, kitchen and canteen, training facilities, medical centre, a laboratory, hazardous goods storage areas, permanent and field warehouses and workshops, refuelling area, a waste management area and laydown areas.

The onshore facilities will normally be operated 24 hours per day, seven days a week. In most cases during maintenance shutdown, only one train will be offline at a time, permitting production to continue during shutdowns by using the other train.

A summary of the key characteristics of Ichthys LNG is provided in Table 3-1 and the layout is provided in Figure 3-1.

Table 3-1: Key characteristics of Ichthys LNG

Key characteristics	Description
GEP (onshore section)	42″ (1 067 mm) diameter Approximately 7 km from the beach valve to the gas processing plant
Section 1888	Offsite 35 hectare hardstand laydown storage area
Nominal production for export	15 000 bbls/day condensate 1.6 Mtpa LPG 8.9 Mtpa LNG
Product storage	Condensate Storage: Two x 60 000 m^3 floating roof storage tanks and one 6 500 m^3 buffer tank LPG Storage – Propane: One x 85 000 m^3 full containment storage tank LPG Storage – Butane: One x 60 000 m^3 full containment storage tank LNG Storage: Two x 165 000 m^3 full containment storage tanks
Relief flares	Ground flare system (warm/cold) Tankage flare system (LNG/LPG) Liquid flare system
CCPP	Five gas turbine generators (GTGs) with duct burners and Heat Recovery Steam Generators (HRSGs) Three steam turbine generators
Drainage and effluent treatment	Continuously oil contaminated (COC)/accidentally oil contaminated (AOC) drains and treatment system Sewage and grey water treatment system Demineralisation plant brine CCPP steam blowdown Non-contaminated water (NCW) Chemical sewer
Utility systems	High-pressure (HP) and low-pressure (LP) fuel gas system Isopentane and diesel fuel system Heating medium system Water supply and demineralised water Cooling medium system Firefighting system Compressed air Nitrogen Refrigeration and refrigerant storage Solvent (aMDEA) storage

Key characteristics	Description
Operations complex and ancillary facilities	Security gatehouse Reception and offices Central control building Kitchen, canteen and training facilities Laboratory Permanent and field workshops Permanent and field warehouses (including hazardous goods storage areas) Fire station Medical centre and ambulance Waste management area Refuelling area Permanent and semi-permanent office facilities
Jetty berths	One for LPG/condensate tankers and one for LNG tankers
Typical offtake cargo volume	Condensate: 60 000 m^3 LPG: 75 000 m^3 LNG: 180 000 m^3
Typical loading time	12-24 hours (including mooring and casting off)
Estimated number of offtakes per year	Condensate: 12 LPG: 40 LNG: 120

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Figure 3-1: Ichthys LNG layout

3.2 Operation of Facilities

The first start-up phase (now completed) was a 24-hour operation that involved bringing systems online, testing the performance of the systems to enable safe production of hydrocarbons and introducing offshore Ichthys Field hydrocarbons to Ichthys LNG via the GEP. Start-up initially concentrated on common utilities and then progressed to common hydrocarbon handling systems such as the onshore arrival system, product storage and loading, and then finally the LNG trains. Individual units within each LNG train were brought online sequentially which resulting in the production of condensate, LPG and LNG. Once production commenced, a series of performance and emergency shutdown tests were performed and portions of Ichthys LNG will transferred across to steady-state operations.

During first start-up, common utilities used either gas from the onshore arrival system or imported gas from PWC via a 12 inch diameter (324 mm) pipeline. The PWC gas supply pipeline is approximately 4 km long to a tie-in isolation point on the existing Wickham Point PWC gas pipeline.

Steady-state operation refers to the normal operating phase of Ichthys LNG which includes production, storage and dispatch of hydrocarbons within the design rates and specifications of the plant. During this time, activities are managed concurrently under the respective approvals. During steady-state operations, emissions and discharges are expected to be relatively stable (Section 3.8). Ichthys LNG has been designed such that flaring will be minimal during steady-state operations.

Upset conditions can occur when there is a 'trip' in the system (e.g. equipment fault). Unplanned flaring and/or venting may occur during upset conditions. During upset conditions, emissions and discharges will vary from those during steady-state operations, dependant on the type of upset/equipment that 'trips'.

Maintenance and shutdowns will occur throughout the life of Ichthys LNG. General maintenance activities will be undertaken during steady-state operations, and include activities such as change out of consumables (e.g. filters), change out of minor equipment (e.g. replacement of valves), refilling lubricants, refilling production chemicals and cleaning equipment. Solid and liquid waste will be generated during general maintenance, for example empty oil drums, lube containers and oily rags.

Ichthys LNG has been designed to minimise the need for shutdowns; however, it is anticipated that minor shutdowns will be needed annually (generally several weeks in duration) and major shutdowns will occur approximately every three years (typically one-month duration). During shutdowns it is normally planned to undertake maintenance on one train only, so production can continue on the second train. Shutdown activities will generate liquid and/or solid waste due to activities such as change-out of chemicals, filter beds or flanges. Emissions and discharges during shutdown will be variable, but generally less than during steady state operations. Once shutdown activities are complete, there may be the need to flare hydrocarbons to bring systems back into steady-state operations.

Ichthys LNG will also need to carry out minor plant debottlenecking and equipment refurbishment during the 40 year operations phase, to further optimise the plant. Any debottlenecking and equipment refurbishment work will be undertaken within the conditions of the EPL and will not include additional emissions beyond those described and assessed within the Project's Final EIS.

Minor maintenance and civil works will also be undertaken periodically as part of overall site maintenance. This may include, but not be limited to, resurfacing of bitumen/concreted areas and/or adding bitumen/concrete to unsealed areas, painting, installing fencing and similar barriers, replacing piping insulation, minor excavations to access and inspect/repair pipes and/or electrical cabling, repair of or addition to internal drainage structures, clearing of unwanted regrowth in firebreaks and/or the GEP corridor, and installation of new or replacement of existing field workshops/shade structures. No concrete batching or bitumen manufacture (for example) would occur on site, with these services being provided by third party contractors/subcontractors and any required materials brought to site.

From time to time, seabed levelling may be required in the dredge footprint, in order to maintain design requirements and aid safe and effective navigation. Seabed levelling will be carried out to level high spots, for example from naturally occurring sand waves or sediment deposition, without the need to remove any sediment from the seabed. A seabed leveller consists of a sweep bar connected to a vessel, which moves sediment from one location to another in a proximate area. Sea bed levelling activities, if required during operations, are not expected to be occur frequently (expected to be approximately once per year, with the activity estimated to be undertaken over a five-week period during daylight). Activities are expected to be restricted to the turning basin and berthing pocket areas of the existing dredge footprint near the permanent jetties.

Available literature indicates that seabed levelling may cause localised and short-term elevations in turbidly near the seabed. To examine whether seabed levelling has the potential to affect sensitive receptors through elevated suspended sediment concentrations, sediment transport modelling undertaken to inform future maintenance dredging activities was assessed as a surrogate. This is a conservative approach as the available modelling is based on the use of a trailing suction hopper dredge (TSHD), which is a self-propelled hydraulic dredge that essentially vacuums sediment via a draghead and a suction pipe. Interrogation of the results from the most representative modelling phase (i.e. dry season; spring-neap cycle (0 to 14 days)) suggest that seabed levelling will have no impacts on high-confidence or inferred sensitive receptor habitat (e.g. coral communities at South Shell Island). Further, based on the model simulation, it is expected that elevated SSC will be confined to the dredge footprint for the majority of the time, with minor elevations extending upstream on occasion during flood spring tides.

As such, there are no material risks to the environmental values of Darwin Harbour expected from this activity. Standard management controls outlined in Section 5 of this document (e.g. waste, heritage, biosecurity, emergency response and stakeholder and community relations and regulatory engagement) will be applied to manage the potential generic environmental and social risks associated with seabed levelling.

3.3 Process Design and Configuration

Ichthys LNG is comprised of a number of processing units or systems. Each system houses specific equipment to complete a certain stage of the overall hydrocarbon production process. The systems and their general position within the hydrocarbon production process are shown in Figure 3-2, and described in the rest of Section 3.

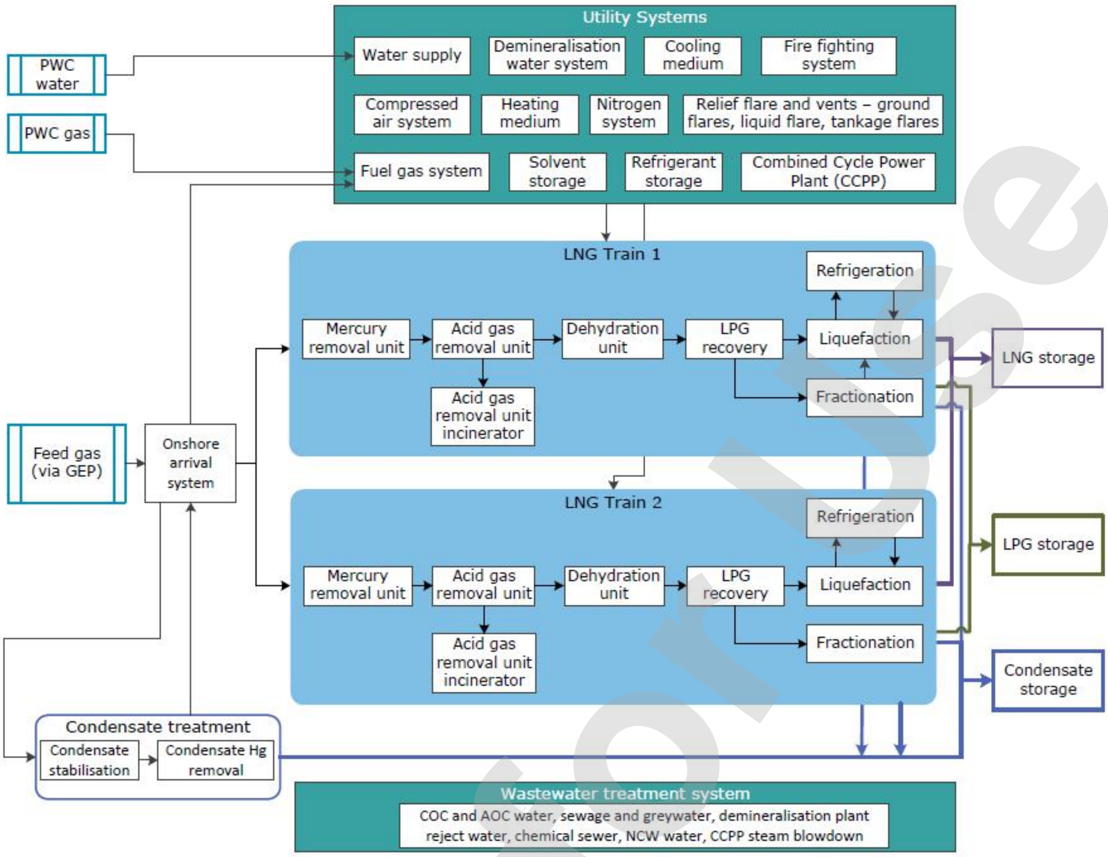


Figure 3-2: General process flow diagram

3.3.1 Gas Export Pipeline

The onshore portion of the GEP begins at a remotely operated beach valve which is located approximately 500 m from the Highest Astronomical Tide (HAT) water mark and provides the interface between the offshore pipeline and onshore pipeline. The beach valve is located within a securely fenced area and is motor operated. It provides a means of isolating Ichthys LNG (including the onshore section of the GEP) from the offshore pipeline.

The GEP is a 42 inch (1 066.8 mm) carbon manganese steel pipeline designed to meet AS2885.1-2007: Pipelines – Gas and Liquid Petroleum Part 1: Design and Construction. The onshore section of the GEP is buried and runs approximately 7 km in a dedicated corridor from the beach valve to the onshore arrival system. A vehicle access track runs alongside the buried GEP to enable inspection and maintenance of the GEP and beach valve.

3.3.2 Onshore Arrival System

The onshore arrival system receives the processed reservoir fluids (feed gas) from the offshore facilities via the GEP. The feed flows through an inlet throttling station, which reduces the pressure of the feed gas, and then through a slug catcher, which separates any liquids from the feed gas. A slug is a mass of liquid (e.g. condensate) that travels through the pipeline along with the gas.

The onshore arrival system also includes a pig receiver to enable cleaning and inspection of the pipeline while in service. Pigs can be launched either from offshore or onshore. Normally pigs will be launched offshore to clean and inspect the GEP. If needed for GEP repair, pigs may also be launched from the onshore end. The pig receiver is isolated and depressurised when not in use.

The feed gas then passes through a high integrity pressure protection system, which limits the maximum pressure of the feed gas and protects downstream equipment. Liquids are removed by feed gas separators and sent to the condensate stabilisation units while the feed gas is sent to the LNG trains.

3.3.3 Condensate Treatment

Stabilisation

The liquids from the onshore arrival system are directed to condensate stabilisation units to separate hydrocarbon liquids and vapours. The hydrocarbon vapours are removed by heating the condensate (using heating medium) and flashing off the lighter components which are routed back to the onshore arrival system. The stabilised condensate is then cooled and directed to the condensate mercury removal units.

Removal of Mercury

The condensate mercury removal units remove mercury from the stabilised condensate, to ensure it conforms to buyers' quality requirements. Mercury will be absorbed onto media in the catalyst beds. The catalyst beds will likely require change-out every three to five years. After mercury removal the condensate is then combined with a condensate stream from the fractionation process (which has also had mercury removed) and transferred to the condensate storage tanks (Section 3.7).

3.3.4 LPG and LNG Processing and Loading

The gas from the onshore arrival system will be directed to the LNG trains. The LNG trains will be used to process the gas into LNG and LPGs (propane and butane). There are a number of steps involved in the process:

- removal of mercury
- removal of acid gases, comprising carbon dioxide (CO_2) and sulfur compounds such as hydrogen sulphide (H_2S) and mercaptans
- dehydration to remove water
- LPG recovery to separate methane from ethane, LPGs (propane and butane) and heavier hydrocarbons
- fractionation to separate the hydrocarbons heavier than methane to produce ethane, propane, butane, isopentane and condensate
- liquefaction and refrigeration to chill the natural gas to produce LNG
- directing of products to storage tanks.

Removal of Mercury

The feed gas to each train first passes through a mercury removal unit (similar to the condensate mercury removal unit) to remove trace amounts of mercury from the gas stream. Mercury will be adsorbed onto media in a catalyst bed, which will require change-out every three to five years. The treated gas then goes to the acid gas removal unit (AGRU).

Removal of Acid Gas

The AGRU removes acid gases (primarily reservoir CO_2, H_2S and mercaptans) from the feed gas. Removal of CO_2 is required to prevent freezing and blockage in the downstream cryogenic equipment, and to meet buyers' specifications. Removal of H_2S and mercaptans is required to meet buyers' specifications.

The AGRU comprises two subsystems; the first absorbs the acid gases into the aMDEA and the second is a higher-temperature regeneration system that separates the acid gases back out of the aMDEA to enable reuse of the aMDEA. Demineralised water is added to the AGRU from the downstream dehydration unit and the demineralisation plant to maintain the water content of the aMDEA solvent.

The acid gases are removed by active absorption by activated methyl-di-ethanol-amine (aMDEA) solvent. The feed gas enters the bottom of the AGRU absorber and flows upwards through structured packing against a downward flow of lean aMDEA solvent. As the feed gas flows past the aMDEA, the CO_2, H_2S and mercaptans are absorbed into the aMDEA.

Once removed, the acid gases and small trace amounts of co-absorbed hydrocarbon are sent to an incinerator (one per train) where the H_2S, mercaptans and trace hydrocarbons are combusted into CO_2, sulfur oxides (SO_X) and water vapour. The flue stacks are approximately 40 m high to allow sufficient dispersion of flue gases.

If one of the AGRU incinerators is offline; the acid gases will be hot vented through the LNG train's mixed refrigerant compressor turbine exhaust stack.

Following treatment in the AGRU, the feed gas then progresses to the dehydration units.

Dehydration

The gas will be water-saturated after the AGRU unit. Molecular sieves will be used in the dehydration unit to remove the water. The dried gas will then continue to the LPG recovery units.

The molecular sieves will be regenerated by passing hot fuel gas through the sieves to remove adsorbed water. The resultant water vapour from the sieve regeneration will be condensed and normally returned to the AGRU, but it can also be directed to the AOC/COC wastewater treatment system. The dewatered fuel gas will be returned to the fuel gas system. The molecular sieves will likely need change-out every four years.

LPG Recovery

The LPG recovery units use a demethaniser distillation column to separate methane from the heavier hydrocarbons. The heavy hydrocarbons are directed to the fractionation units and the predominantly methane gas streams are directed to the liquefaction units.

Fractionation

The fractionation units further separate the heavy hydrocarbon components that were removed by the LPG recovery units by passing the hydrocarbons through a series of distillation columns to produce ethane, propane, butane, isopentane and condensate streams. The products from the fractionation units are used as follows:

- Ethane will be used either as mixed refrigerant in the liquefaction process or as fuel gas. Ethane can also be re-injected back into the process gas before it enters the main cryogenic heat exchangers (MCHE) in the liquefaction units.
- Propane will be sent to the LPG storage and loading facility for export by ship. Some of the propane will be used as propane refrigerant in the liquefaction process.
- Butane will be sent to the LPG storage and loading facility for export by ship.

- Isopentane will be used as fuel in the CCPP, vaporised and burned in ducts downstream of CCPP gas turbines. A significant amount of isopentane will also remain in the condensate product. Isopentane that cannot be used in the CCPP or incorporated into condensate will need to be directed to the liquid flare.
- Condensate will be sent to the condensate storage and loading facility for export by ship.

Liquefaction and Refrigeration

The gas streams from the LPG recovery units will be directed to the liquefaction units to liquefy the gas to produce the final LNG product. At this point, the gas stream will be mostly methane with some argon, nitrogen and ethane.

The liquefaction units chill the gas down to a temperature at which LNG can be produced. Liquefaction (chilling) is a three-stage process; first liquid propane is used to chill the gas stream, then liquid mixed refrigerant is used as a second stage of cooling. Essentially, much of the heat in the gas is extracted by flowing the gas down one side of the main cryogenic heat exchangers (MCHE), past the liquid propane and then past the liquid mixed refrigerant which flow down the other side of the heat exchangers. The transfer of heat from the gas to the refrigerants causes the liquid propane and mixed refrigerants to evaporate.

In the third stage of cooling, the natural gas leaves the MCHE at -150 °C prior to entering the end flash section. The end flash process drops the pressure to near atmospheric pressure through an expander, further reducing the temperature to approximately 160 °C and turning most of the gas into liquid (i.e. LNG). There will also be some end flash gas (a mixture of argon, nitrogen and methane). The LNG will then be directed to the LNG storage and loading facility for export by ship. The end flash gas will be directed to the fuel gas system for reuse within Ichthys LNG.

For the process to be continuous, the gaseous propane and mixed refrigerant streams need to be recompressed and cooled back to liquid state for reuse in the heat exchangers. The recompression is accomplished by GE Frame 7 dry low NO_x compressor drivers (Frame 7 compression turbines), running on fuel gas. In each train, one Frame 7 compression turbine is used to recompress propane and one Frame 7 turbine is used to recompress mixed refrigerant.

3.3.5 Product Storage and Loading

Following processing, the condensate, LPG and LNG products will be stored in tanks (Section 3.7). When the product storage tanks have reached a sufficient level, the condensate, LPG and LNG are loaded onto tankers for export via the product loading jetty.

During LPG and LNG storage, boil off gas (BOG) will be produced. BOG will be managed by BOG recovery systems. BOG will be created when liquid cryogenic products evaporate and become gaseous. This will occur when heat penetrates the cryogenic storage tanks and ship loading lines. BOG will also be sent ashore from ships as liquid products are loaded into the ships.

For the two LPG products, the BOG will be recovered by changing it back to liquid. The BOG recovery systems are slightly different for propane and butane. The propane BOG recovery system will use compressors and condensers to recover the propane. Butane will be recovered by spraying subcooled butane inside from the top of the butane tank; this will recondense any vapour generated inside the butane storage tank. The LNG BOG recovery system will use a knock-out drum and compressors, with the recovered gas normally being sent to the fuel gas system.

The product loading jetty has two jetty arms and each jetty arm has a loading berth; one dedicated to both condensate and LPG export and the other dedicated to LNG export. Each jetty arm has a central loading platform that supports the loading arms and associated piping, valves, control cabin, fire monitors, crane and gangway tower. The loading platforms at the two jetty arms are approximately 500 m apart to enable concurrent loading at each of the two berths. The pipe racks along the jetty carry lines (pipes) for product loading, vapour return, cool-down, firewater and services as well as electrical and communication cable trays.

The nominal two-train LNG production rate of 8.9 Mtpa will require loading of approximately 12 condensate carriers, 40 LPG carriers and 120 LNG carriers per year, totalling approximately 172 ship movements per annum. Loading of each ship will take approximately 12-24 hours, including mooring and casting off.

3.4 Utility Systems

Ichthys LNG has a number of utility systems that provide various functions such as disposing of hydrocarbon releases safely through flares and supplying air, power, nitrogen and water etc. This section describes the utility systems, these being:

- relief flare system
- power generation (including emergency backup diesel generators)
- fuel gas
- isopentane
- diesel fuel
- heating medium
- water supply and demineralised water plant
- cooling medium
- firewater
- compressed air
- nitrogen system
- refrigeration and refrigerant storage
- solvent (aMDEA) storage.

Relief Flare System

The purpose of the relief flare system is to collect and safely dispose of the various gas and liquid releases that occur within Ichthys LNG. All flares have been designed for smokeless operation and to meet health and safety radiation and noise requirements.

Ground Flares

Ichthys LNG has three separate ground flare systems (warm and wet; cold and dry; and spare) situated on a common 12 hectare flare pad (along with the liquid flare) on the west-central side of the site. The three ground flares are required in the event that a large inventory of hydrocarbon gas needs to be disposed of safely and quickly. The ground flares are designed to minimise smoke production over a range of conditions, and the entire pad is surrounded by shielding to minimise radiation of noise, light and heat.

The warm and wet ground flare will be used for gas from the warm flare headers that will also contain water vapour. The cold and dry ground flare will dispose of gas from cold sources that have been dehydrated, such as the liquefaction sections of the LNG trains, and any gases from the propane and mixed refrigerant loops. The two types of ground flares are needed because of the extreme differences in temperature and water vapour content.

The spare ground flare is designed to receive gas from either the warm and wet or the cold and dry flare header. This will enable planned shutdown and maintenance on either of the primary two ground flares without having to shut down Ichthys LNG.

All the ground flares will be open (multi-point) in order to handle the large instantaneous flow rates which may need to be disposed of in the event of an emergency.

The flare headers have knock-out drums to remove liquids prior to flaring. The liquids are recycled back through Ichthys LNG process. Each flare will be equipped with pilots and electronic ignition systems.

During normal operation the ground flares will emit very low levels of air emissions, noise, light and heat from the pilot lights and flare system purge. Flare header purge will be needed to keep the flame fronts off the individual burners.

Liquid Flare

The liquid flare is contained within the same ground flare enclosure as the three ground flares.

Normally all the isopentane produced from hydrocarbon processing will either be left in the condensate (which will then be sold), or be vaporised and used as fuel in the CCPP duct burners. However, if more isopentane is produced than can be left in the condensate (i.e. it exceeds sale specifications) and used in the CCPP, the liquid flare will be used to combust the excess isopentane. This is not expected to occur, but a liquid flare has been provided as contingency.

The liquid flare will not be used unless Ichthys LNG either needs to dispose of isopentane that condensate storage and the CCPP cannot use, or one of the condensate stabilisation units is unavailable and when liquid builds up in the warm flare knock-out drum.

Tankage Flares

Ichthys LNG has three enclosed tankage flare systems located near the LNG and LPG tanks – an LNG flare (two flares), an LPG flare (two flares) and a common spare flare (one flare) systems. The tankage flares are small, enclosed flares that use refractory shells to contain noise, light and heat.

The LNG tankage flare handles gas collected in the LNG BOG collection header when the LNG BOG re-compressor isn't operational or when vapours are generated from a very warm or an inerted LNG ship after dry dock. There may also be occasions where ship vapours are very warm, so that a fraction of the BOG needs to be flared while the rest is recovered by the BOG compressors to fuel gas.

The LPG tankage flare handles gas collected in the LPG BOG collection headers when the LPG BOG re-compressors (for propane or butane) aren't operational or when vapours (containing gases other than LPGs) are being generated from an inerted LPG ship after dry dock.

The spare tankage flare is designed to handle vapours from either the LNG or the LPG headers in the event that a primary tankage flare is unavailable, e.g. due to planned maintenance.

During normal operations the tankage flares will have pilot lights running. They will also require purge gas.

Power Generation

CPPP

The CCPP provides electrical power to Ichthys LNG. The CCPP is comprised of five GE Frame 6 dry low NOx gas turbines (Frame 6 power generation turbines), equipped with duct burners to provide additional heat to the heat recovery steam generation system.

Steam is generated through heat recovery steam generators (HRSGs) that recover heat from the gas turbine exhausts. Steam from the HRSGs drives up to three steam turbines. Ichthys LNG's electrical load will be distributed across both the gas and steam turbines and managed through a power management system.

During normal operations the Frame 6 power generation turbines will run on fuel gas, and vaporised isopentane will be burned in duct burners in the HRSGs to generate steam.

A small amount of the condensed steam will be "bled" from the steam loop to the wastewater treatment system to maintain very low levels of silicate and other minerals, which would otherwise precipitate on steel surfaces. Bleeding some condensed steam will thus minimise build-up of hardness within the system. Demineralised water will be added to the steam loop to maintain constant water quantity. The steam loop bleed will be cooled using heat exchangers from about 100 °C to 45 °C (just above ambient temperature) prior to commingling with other treated wastewater streams, before discharging via the jetty outfall (Section 3.8.6).

The maximum nominal power output of the CCPP is 490 MW with all gas turbines, duct burners, HRSGs and steam turbines running at maximum rates. Each Frame 6 power generation turbine can produce 38 MW (nominal output), while each steam turbine will be capable of producing 100 MW (nominal output) when all turbines and duct burners are firing fully. The duct burners will increase the flow rate and temperature of the exhaust gas to the heat recovery steam generators and steam turbines. The exhaust ducts of the turbines are designed to burn vaporised isopentane to further increase flue gas temperature ahead of the HRSGs.

Emergency Backup Diesel Generators

In addition to the CCPP, diesel backup generators will be able to supply a limited amount of emergency power in the event of CCPP power failure (i.e. a black out), for example by providing power for lighting or to power firewater backup pumps.

Fuel Gas System

The fuel gas system receives fuel gas from several sources and distribute it as high-pressure or low-pressure fuel gas to various equipment and utility systems within Ichthys LNG.

The high-pressure system supplies fuel gas to all the LNG train Frame 7 compression turbines and the CCPP Frame 6 power generation turbines.

The low-pressure system provides fuel gas to the incinerators and fired heaters, CCPP duct burners and pilot light and purge gas for all flare systems.

Isopentane and diesel fuel systems

Isopentane is produced in the fractionation units during separation of liquid hydrocarbons (Section 3.3). Isopentane that cannot be blended with condensate for sale will be used as a gaseous fuel in the CCPP duct burners.

A diesel system within Ichthys LNG will store and distribute diesel for CCPP emergency generators and the firewater pumps. Two separate diesel storage and supply areas will be provided for this purpose (Section 3.7).

Heating Medium

A hot oil closed loop system provides the heating medium for various systems within Ichthys LNG, including the onshore arrival system, condensate stabilisation units and AGRU regenerators.

Initially, one furnace in each LNG train will heat the medium, but once there is sufficient available waste heat from the exhausts of the Frame 7 compression turbines through waste heat recovery units (WHRUs), the furnaces will be placed into standby mode.

A heating medium storage tank is located in the common utility area. It is sized for 110% of the heating medium inventory in one LNG train to enable it to store heating medium during a shutdown (Section 3.7).

Water Supply and Demineralised Water Plant

The combined operational drinking and service water requirement for Ichthys LNG was conservatively estimated to be approximately 2 000 m^3/day, as a worst-case maximum number. The water will be sourced from PWC and mostly used for production of demineralised water.

The demineralisation plant supplies demineralised water to many of the systems within Ichthys LNG, such as the AGRUs and the steam loop within the CCPP. Demineralisation plant reject water (often referred to as brine) is discharged continuously at low rates through the jetty outfall (Section 3.8.6).

Cooling Medium

The cooling medium systems use treated water as a cooling medium in closed loop systems to provide cooling for heat exchangers in the LNG trains. Water is circulated via cooling medium circulation pumps and hot returns will be cooled in cooling medium coolers.

Firewater System

Due to potential for various types of fires at the facility there are number of manual and fixed extinguishing systems at the site. The selection of manual versus automatic fire fighting systems is based on a number of factors including likelihood of release and ignition, personnel exposure, potential for escalation, the need to minimise fire-fighting manpower and risk to fire fighters.

The firewater system includes deluge and fire monitoring systems (which include fixed and mobile foam systems). During normal operations, the pressure is maintained in the firewater ring main with supply from a fresh water tank. The fresh water is sourced from PWC. Backup seawater supply to the firewater system is also available but will normally only be used if fresh water is not available.

High expansion foam systems provide coverage of the impoundment ponds for LNG spills and low expansion foam systems protects the condensate tanks (for rim seal fires) and LPG/condensate loading jetty. The high expansion foam system provides synthetic foam concentrate (Expandol) for at least 30 minutes. The low expansion foam system provides 3% aqueous film forming foam (AFFF Tridol C6 S3) for at least 20 minutes. A foam proportioning unit with local on-off switch is located at least 20 m away from the area being protected.

During an emergency event, reasonable and practicable measures will be made to contain foam from entering into the environment.

INPEX will implement best available practices for phasing out use of firefighting foams containing PFOA, PFOS, PFHxS and precursor compounds, where this does not compromise safety requirements, or is required under legislation. When these firefighting foams are phased out of use, INPEX will implement all reasonable measures to ensure there is no PFOA, PFOS, PFHxS and precursor compound contamination, such as from residues of these compounds in the firefighting system, in liquid discharges from the site. INPEX will, through its annual compliance report, advise regulators (including the DAWE) when the phasing out of the use of these foams has been completed.

Where foam testing is required in order to demonstrate compliance to our performance standards, INPEX will submit for approval an Addendum to this OEMP advising the Minister of the testing and mitigations proposed to prevent discharges to the environment and obtain regulatory approval prior to commencement of that testing.

Compressed Air

Compressed air is provided via a centralised bank of air compressors and associated vessels. These supply Ichthys LNG with air for general use (including air powered tools), instrument air for control systems (including operation of valves etc.) and as feed for the nitrogen system.

Nitrogen System

The nitrogen system generates, stores and distributes nitrogen to several systems throughout Ichthys LNG, including the onshore arrival system, LNG trains, and product loading jetty (e.g. to purge the loading arms after product loading and maintenance). The nitrogen system will consist of air separation units, liquid nitrogen storage and vaporiser units.

Refrigeration and Refrigerant Storage

The refrigerant storage system provides the required refrigerants to the liquefaction systems via the propane and mixed refrigerant circuits. Mixed refrigerant is a mixture of nitrogen, methane, ethane and propane.

Propane provides chilling for the feed gas and the mixed refrigerant circuit, as well as the fractionation and dehydration processes. Mixed refrigerant is used to cool feed gas in the MCHE in the fractionation process. The evaporated propane and mixed refrigerant gases will be recompressed back to liquid then cooled for reuse in each train.

Solvent (aMDEA) Storage

The solvent storage system stores and distributes both aMDEA and wash water associated with the operation and maintenance of the AGRUs. There are two tanks, each sized to store 110% of the aMDEA inventory of one AGRU. The aMDEA and wash water tanks are located in the central utilities area.

3.5 Security

Access to Ichthys LNG during operations is managed by a security gatehouse, security fencing around the perimeter of the plant and closed-circuit television (CCTV).

3.6 Operation Complex and Ancillary Facilities

The operations complex houses facilities to support the day-to-day operational activities and cleared areas of site not currently used for processing house field warehouses and workshops, laydown areas and semi-permanent offices. A summary of the facilities is as follows:

- a security gatehouse
- a reception and permanent office buildings
- a central control building, which houses the central control room. The central control room has comprehensive displays, alarms and control interfaces, along with diagnostic facilities to enable the safe and efficient control of Ichthys LNG
- a kitchen and canteen with seating for 75 personnel (expandable to 125 personnel) during steady-state operations. The canteen is also designed to be used as a training facility
- a National Association of Testing Authorities, Australia (NATA) accredited laboratory, with the primary purpose for testing the products and process chemistry. In addition, the laboratory facilities and personnel will be used to sample and analyse exhaust gases and wastewater samples from Ichthys LNG. No biological analysis will be undertaken in the in-house laboratory; biological analyses will be undertaken off-site by external providers
- a workshop for the general maintenance and repair of equipment, including sheet-metal work, welding and pipefitting, machining, general equipment overhaul, instrument and electrical work
- permanent and field warehouses and laydown areas for the storage of spares and consumables, including dedicated, secure hazardous materials storage areas for the storage of chemicals including paints, grease, oils and production chemicals (Section 3.7)
- a fire station equipped with a fire truck, portable firefighting equipment (e.g. foam trailers and extinguishers), fireman suits, breathing apparatus sets and rescue equipment
- a medical centre and an ambulance
- a refuelling area for light vehicles and service trucks (Section 3.7)
- a waste management area for the segregation and storage of solid wastes, including recyclables and putrescible waste, prior to collection for disposal offsite at licenced waste facilities (Section 3.8)
- semi-permanent offices and facilities for use by shutdown and maintenance overflow workforce, to be connected to permanent water, sewage and electrical systems infrastructure
- a bitumised laydown area adjacent to the site
- portable toilets on trailers, positioned at key locations in the processing area where permanent facilities do not exist.

Figure 3-3 shows the main facilities within the operations complex.

Additional services will be brought onto site as required dependent on activities. For example, during an activity such as a shutdown or major rectification works with increase in workforce, portable toilets will be installed in key locations.

Figure 3-3: Facilities within the Operations complex

3.7 Hydrocarbon and Bulk Chemical Storage

Ichthys LNG has five locations for the storage of hydrocarbons and bulk chemicals; the condensate, LPG and LNG storage tank areas Figure 3-1); the hazardous materials warehouse; and a refuelling area (Figure 3-3).

The condensate storage tanks store the condensate product that comes from the condensate mercury removal units and the fractionation units (Section 3.3), prior to it being pumped to the product loading jetty for loading into condensate tankers. Each condensate tank has been fitted with an internal floating roof with double rim seals and a fixed dome roof. Condensate will be stored at ambient temperature. The condensate tanks are located on bunded concrete hardstand areas which include separate drainage systems for AOC water system and COC (Section 3.8.6). Clean bund water is discharged via the non-contaminated water (NCW) system.

The two LPG tanks receive either propane or butane from the fractionation process (Section 3.3) for storage before the two products are exported to tankers via the product loading jetty. The propane tank is 31.9 m high and has a diameter of 76 m, and the butane tank is 29.8 m high and has a diameter of 59 m. The tanks have fixed roofs, and have inner and outer steel tanks which are encapsulated in concrete. The propane and butane tanks will be operated at atmospheric pressure and temperatures of approximately -42 °C and -5 °C, respectively. The LPG storage area has been built with AOC/COC water drainage and NCW water systems (Section 3.8.6).

There are two LNG storage tanks. The tanks are approximately 50 m tall and have a diameter of 89 m. The LNG tanks are full containment, insulated cryogenic tanks that comprise of an inner and an outer tank encapsulated in concrete (similar to the LPG tanks, Figure 3-4). The LNG will be stored at a temperature of approximately -161 °C. The LNG storage area is built with an AOC water system for areas that may accidently be contaminated with hydrocarbons, a separate COC water system for contaminated water and the NCW water system for clean bund water (Section 3.8.6).

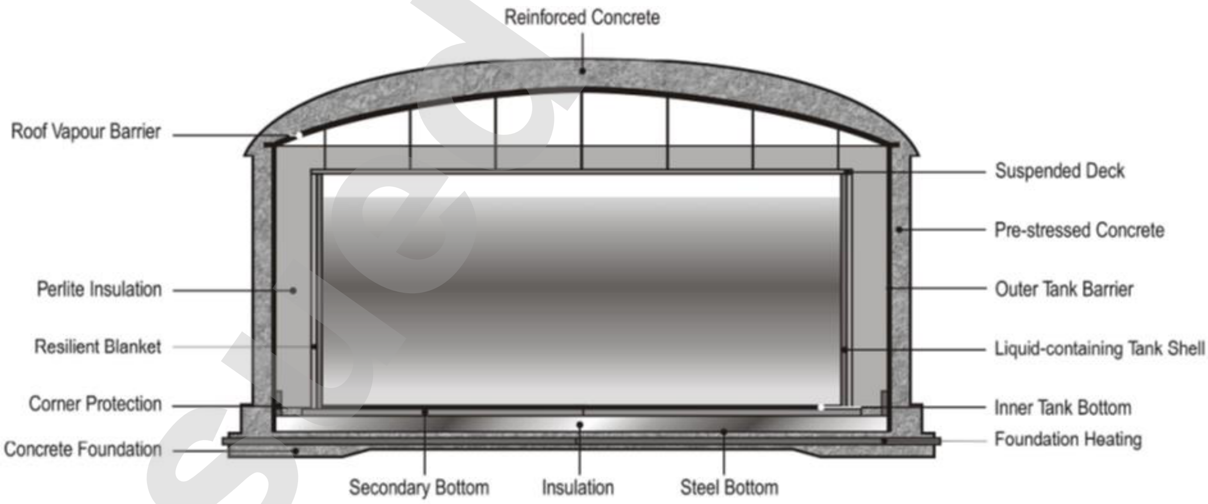


Figure 3-4: Cross-section of LPG and LNG storage tanks

The hazardous materials warehouse in the operations complex has been designed for the secure storage of chemicals and hazardous liquid chemical waste in accordance with the *Dangerous Goods Act* (NT) and AS 1940:2004 The storage and handling of flammable and combustible liquids. The warehouse is enclosed and designed to enable safe segregated storage of dangerous goods and hazardous materials at sufficient distance from other facilities considering the quantities and characteristics of the materials stored. Bunding has been provided in various forms, depending on the type of chemicals being stored, and includes self-bunded containers and bunded pallets. In addition, a purpose-built hazardous materials/waste storage area established during the construction phase has been retained. It consists of two secure and segregated areas and includes an interceptor tank to collect any potentially contaminated runoff.

Ichthys LNG has two diesel storage areas; one located in the common utilities complex (which is in the vicinity of the CCPP) and one in the operations complex. Both diesel storage areas have a carbon-steel cone-roof tank and a diesel distribution pump. Diesel will be supplied by road tanker trucks, which will pump the diesel directly into the storage tanks. The diesel storage area in the common utilities complex will provide diesel for emergency generators, which will provide a backup system in case of power failure. The diesel storage area in the operations complex will provide diesel for the firewater pumps; this storage area is located in an area that has a COC wastewater drainage system.

The operations complex also has a refuelling area for light vehicles and service trucks, which comprises an above-ground double skinned diesel tank with a bowser, located on a concrete paved area. The refuelling area has been designed in accordance with AS 1940:2004.

Heating medium (Shell Thermia Oil B) is used for various processes in Ichthys LNG. An identical heating medium distribution system is provided for each LNG train. The heating medium is stored in a common tank at the common utility area (Section 3.4).

Propane refrigerant is used for chilling processes (Section 3.4). The propane refrigerant is stored in liquid form at ambient temperature in a single pressurised spherical tank. The capacity of the tank is sufficient to supply the propane refrigeration loops for both LNG trains.

Mixed refrigerant is also used to cool feed gas (Section 3.4). The mixed refrigerant is contained in a closed loop circuit in each LNG train.

The AGRUs use aMDEA solvent to remove acid gases from the feed gas stream (Section 3.3.4). The aMDEA is stored in a carbon steel, domed atmospheric tank on a paved area.

The fuel gas distribution system (Section 3.4) contains approximately 15 t of isopentane and 5 t of fuel gas inventory at any given time. These inventories are contained in various types of equipment such as heat exchangers, knock-out drums, mixing drums and pipework.

The onshore arrival system does not contain any dedicated hydrocarbon storage tanks; however, the system itself (including pipework) receives the offshore feed gas and therefore contains an inventory of approximately 150 t of hydrocarbons at any time. If liquid slugs are present in the offshore feed gas as it comes through the onshore arrival system, these are removed by the slug catcher and the hydrocarbon inventory in the system can increase to approximately 250 t.

Similarly, the LNG trains 1 and 2 aren't dedicated storage tanks but have hydrocarbons flowing through the equipment and pipework as they process the feed gas. Each LNG train contains approximately 1 500 t of hydrocarbon liquids and 400 t of hydrocarbon vapour at any one time during steady-state operations.

Whilst the bulk of the final products are stored in the condensate, LPG and LNG storage tanks, there will also be product present in the pipework that runs from the storage tanks to the jetty loading berths. The pipework systems contain 30 t of LNG, 30 t of LPG or 10 t of condensate.

The hydrocarbon and bulk chemical inventory for Ichthys LNG is presented in Table 3-2. The figures shown in Table 3-2 are indicative of the typical volumes that are held onsite.

Table 3-2: Hydrocarbon and bulk chemistry inventory

Hydrocarbon type	Number and capacity of storage tanks	Location
Condensate	Two 60 000 m^3 tanks and one 6 500 m^3 buffer tank	Condensate storage area
LPG	One 85 000 m^3 tank for propane	LPG storage area
LNG	One 60 000 m^3 tank for butane	LNG storage area
Condensate, LPG, LNG	Two 165 000 m^3 tanks	Pipework in the product loading jetties during loading.
Diesel (for emergency generators, firewater pumps and emergency air compressors)	10 t condensate	Common utility area and
Diesel (for vehicle refuelling)	30 t LPG	Operations complex
Heating medium	30 t LNG	Operations complex
Propane refrigerant storage	One 171 m^3 tank	Onshore arrival system
Mixed refrigerant	One 35 m^3 tank	Common utility area
Solvent (aMDEA)	One 50 m^3 tank	LNG trains
Isopentane	One 1 630 m^3 tank	Common utility area
Fuel gas	One 1 960 m^3 tank	Fuel gas system
Natural gas and hydrocarbon slugs	250 t	Fuel gas system
Hydrocarbon liquids and vapours	One 2 020 m^3 tank	Onshore arrival system

3.8 Emissions, Discharges and Greenhouse Gases

3.8.1 Air emissions

The primary air pollutants that are emitted from Ichthys LNG are NO_X (measured as NO_2), SO_X (measured as SO_2) and particulate matter (measured as PM2.5 and PM10). Ozone (O_3) is not emitted directly by Ichthys LNG activities but is generated as a result of photochemical reactions in the atmosphere as part of the result of Ichthys LNG emissions.

Air Emissions During Steady-state Operations

During steady-state operations, the most significant air emission sources in Ichthys LNG is from the combustion of fuel gas in the four Frame 7 compression turbines (Section 3.3), the five CCPP Frame 6 power generation turbines and their isopentane duct burners (HRSG stacks) (Section 3.4), and the two AGRU Incinerators (Section 3.3). Other sources, such as the flares and heating medium furnaces do not emit significantly under normal operating conditions. They either normally run on standby only (emitting at very low rates) or function as cold spares with no emissions until/unless started up.

Flaring is also required for LNG and LPG vessels connected to the product loading jetty, for example flaring for vessel cool-downs and gas-ups of inerted vessels. Flaring for vessel activities is only expected to be necessary occasionally, as most vessels will be cooled-down and gassed-up (containing only vaporised LNG) prior to arriving at Ichthys LNG.

If CO_2 is present in the gas stream during the liquefaction (chilling) process, it would freeze and result in blockage and failure of the equipment. To prevent this, the reservoir CO_2 is always removed from the feed gas in the AGRUs. The CO_2 is emitted to the atmosphere after it has passed through one of the two incinerators (Section 3.3.4).

Venting also takes place when condensate is loaded into condensate ships. The extent of venting is dependent on the ambient temperature and the vapour pressure of the condensate being loaded.

There is also flaring during upset conditions (e.g. when equipment 'trips') and during/after shutdown maintenance as equipment is brought online again.

Normally the acid gas (including CO_2) removed in the AGRU is incinerated prior to being vented to atmosphere; however, Ichthys LNG has been designed such that the acid gas from either LNG train can be routed directly to a Frame 7 compression turbine stack vent if one of the two incinerators is unavailable during upset conditions or shutdown. The AGRU gas vent outlets are approximately 1 m higher than the top of the turbine stack to ensure sufficient atmospheric dispersion and to prevent any health, safety or environment risks.

The point sources for air emissions are presented in Table 3-3 and Figure 3-5.

Non-combustion emissions, consisting primarily of VOCs, are produced from Ichthys LNG. The main source is expected to be from condensate ships during loading. Fugitive emissions from compressor seals, valves, flanges and pumps are expected to be minor.

Table 3-3: Air emissions point source information

Source	Easting (m)	Northing (m)	Stack height (m)
Compressor turbine WHR West 1 (frame 7)	708,506	8,615,448	43
Compressor turbine WHR West 2 (frame 7)	708,771	8,615,589	43
Compressor turbine WHR East 1 (frame 7)	708,626	8,615,222	43
Compressor turbine WHR East 2 (frame 7)	708,891	8,615,363	43
CCPP GTG 1 Conventional Stack	709,057	8,615,156	40
CCPP GTG 1 Heat Recovery Steam Generator	709,041	8,615,186	40
CCPP GTG 2 Conventional Stack	709,012	8,615,133	40
CCPP GTG 2 Heat Recovery Steam Generator	708,994	8,615,162	40
CCPP GTG 3 Conventional Stack	708,966	8,615,109	40
CCPP GTG 3 Heat Recovery Steam Generator	708,949	8,615,137	40
CCPP GTG 4 Conventional Stack	708,900	8,615,070	40
CCPP GTG 4 Heat Recovery Steam Generator	708,885	8,615,103	40
CCPP GTG 5 Conventional Stack	708,856	8,615,046	40
CCPP GTG 5 Heat Recovery Steam Generator	708,840	8,615,078	40
Acid Gas Incinerator 1	708,692	8,615,709	40
Acid Gas Incinerator 2	708,813	8,615,483	40
Hot oil furnace 1	708,346	8,615,452	58

Source	Easting (m)	Northing (m)	Stack height (m)
Hot oil furnace 2	708,362	8,615,461	58
Ground flare 5 (Warm)	708,309	8,614,986	3
Ground flare 2 (Cold)	708,463	8,614,702	3
Ground flare 1(spare)	708,369	8,614,879	3
Tank flare 1 (LNG)	707,892	8,615,433	25
Tank flare 2 (LPG)	707,947	8,615,329	25
Tank flare 3 (spare)	707,919	8,615,381	25
Off spec condensate (liquid) flare	708,541	8,614,568	3
Emergency diesel generator 1	708,725	8,615,062	8
Emergency diesel generator 2	708,734	8,615,066	8
Emergency diesel generator 3	708,742	8.615,070	8
Emergency diesel generator 4	708,750	8,615,074	8
Emergency diesel generator 5	708,758	8.615,077	8
Emergency diesel generator 6	708,767	8,615,081	8
Firewater pump utility 1	708,706	8,613,421	4
Firewater pump utility 2	708,709	8,613,421	4
Firewater pump utility 3	708,714	8,613,421	4

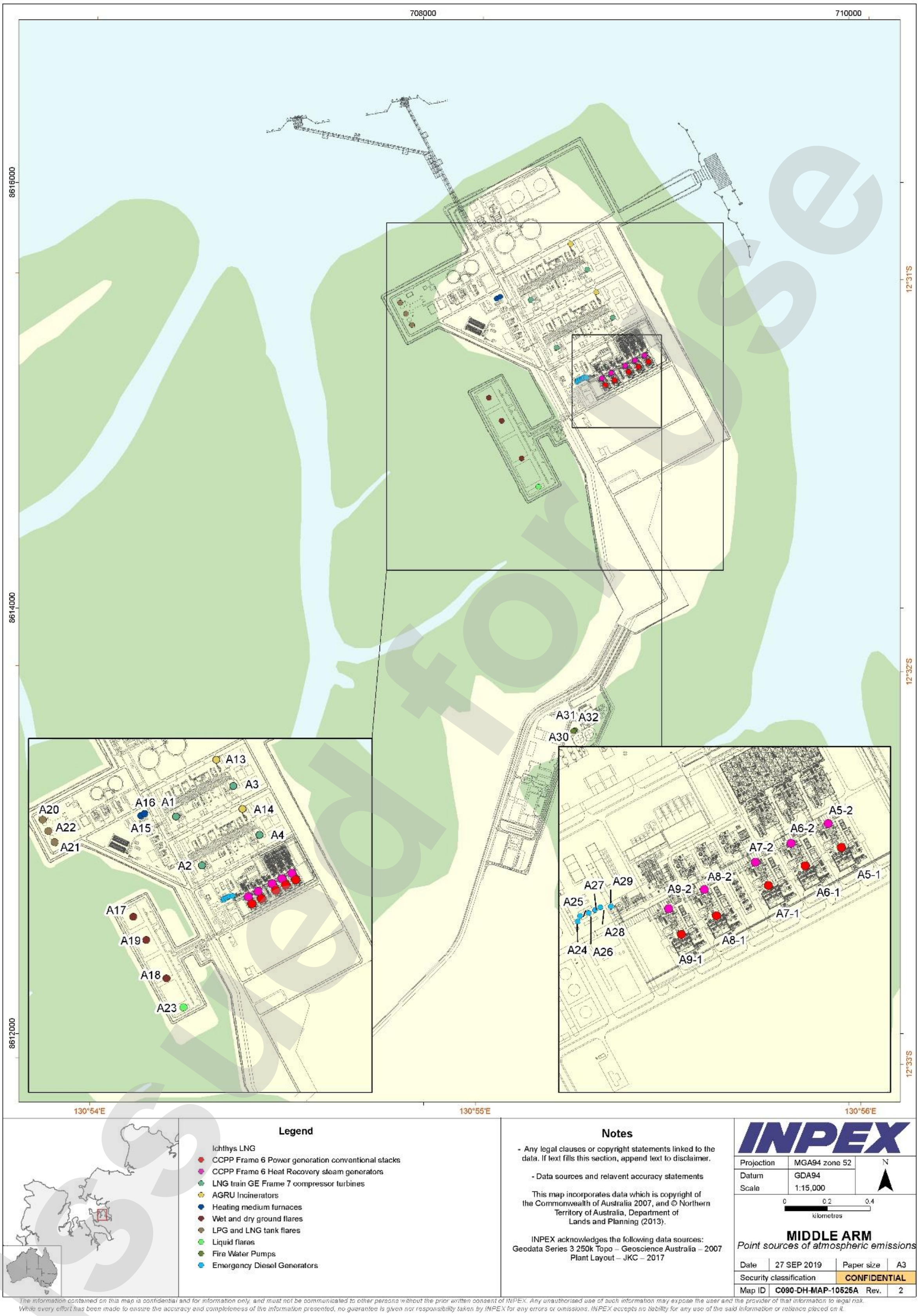


Figure 3-5: Point sources of atmospheric emissions

Table 3-4 lists Ichthys LNG's point emission sources, their normal operating mode (operating, stand-by, or not operating) during steady-state (for both Train 2 and Train 1 in production), and the primary air pollutants that will be generated.

Table 3-4: Overview of Ichthys LNG air emission sources

Emission source	Number of sources	Fuel type / stream being combusted	Normally operating	Primary air pollutants
LNG train Frame 7 compression turbines	4	Fuel gas	Yes, all four turbines will normally be operating	NO_x, PM2.5, PM10
CCPP Frame 6 power generation turbines with vaporised isopentane duct burning downstream	5	Fuel gas to turbines; fuel gas or vaporised isopentane to duct burners in turbine exhausts (HRSGs)	Yes, expected four turbines will normally be operating (one on standby)	NO_x, PM2.5, PM10
AGRU incinerators	2	AGRU offgas and fuel gas	Yes, both incinerators will normally be operating	NO_x, SO_2
Heating medium furnaces	2	Fuel gas	No, both furnaces will be required during start-up but will not be operating under normal conditions as heat will be provided by the waste heat recovery systems (WHRUs) on the Frame 7 compression turbines	NO_x, PM2.5, PM10
Ground flares (warm, cold, spare)	3	Fuel gas/ natural gas, gaseous propane or mixed refrigerant	Two flares will be on stand-by One flare is a spare (not normally operating)	NO_x, PM2.5, PM10
Liquid flare	1	Liquid isopentane or off-specification condensate	No, this flare will not normally be operated	NO_x, PM2.5, PM10

Emission source	Number of sources	Fuel type / stream being combusted	Normally operating	Primary air pollutants
Tankage flares	3	Butane, propane or natural gas BOG	Two flares will be on stand-by	NO_x, PM2.5, PM10
Emergency diesel generators	6	Diesel	One flare will be a spare (not normally operating)	NO_x, PM2.5, PM10
Fire water pumps utility	3	Diesel	Not normally operating	NO_x, PM2.5, PM10

Table 3-5 presents NSW emission standards and relevant IFC guidelines for NOX in relation to the major emission sources during Ichthys LNG normal operations. The emission concentrations expected from Ichthys LNG during normal operations are expected to be the same as, or less than the NSW standards and the IFC guidelines.

Table 3-5: NSW Protection of the Environment Operations (Clean Air) Regulations 2010 and IFC NO_x targets

Emission source	Pollutant	NSE Protection of the Environment Operations (Clean Air) Regulation 2010 Group 6	IFC Guidelines for General EHS, Onshore Oil & Gas, LNG, and Thermal Power
LNG train refrigerant compressor driver gas turbines (Frame 7 compression turbines)	NO_x	35 ppmv @ 15% O_2 (dry) [electricity generation; any turbine operating on gas]	25 ppmv @ 15% O_2 (dry) [turbines burning gas]
CCPP gas turbine generators (Frame 6 power generation turbines) - before duct burning	NO_x	35 ppmv @ 15% O_2 (dry) [electricity generation; any turbine operating on gas]	25 ppmv @ 15% O_2 (dry) [turbines burning gas]
CCPP gas turbine generators (Frame 6 power generation turbines) -- after also burning vaporised isopentane in duct burners	NO_x	175 ppmv @ 15% O_2 (dry) [afterburners and other thermal plant; any afterburner or other plant]	N/A
AGRU incinerators	NO_x	175 ppmv @ 15% O_2 (dry) [afterburners and other thermal plant; any afterburner or other plant]	N/A

Emission source	Pollutant	NSE Protection of the Environment Operations (Clean Air) Regulation 2010 Group 6	IFC Guidelines for General EHS, Onshore Oil & Gas, LNG, and Thermal Power
Heating medium furnaces	NO_x	175 ppmv @ 3% O_2 (dry) [petroleum refining; any fuel burning equipment]	N/A

INPEX has also undertaken cumulative air quality modelling for NO_X, SO_X, O_3 and PM10 during operations which investigated the predicted air emissions from Ichthys LNG in addition to existing biogenic sources, vehicles, shipping and Middle Arm Peninsula industrial sources (SKM 2010, Pacific Environment 2014). Both the 2010 and 2014 modelling studies concluded that the cumulative ground-level concentrations of air pollutants during Ichthys LNG operations will increase slightly from ambient (background) air quality (Section 2.3.3), but will remain well within the NEPM standards for NO_2, O_3, SO_2 and PM10. The results of the 2014 cumulative air modelling study are presented in Table 3-6, Figure 3-6 and Figure 3-7.

Table 3-6: Maximum predicted ground level concentrations NO_2, O_3, SO_2 and PM10 under normal operating conditions

Pollutant	Modelled grid	Averaging period	NEPM criteria* (ppm)	Maximum on grid	Percent of NEPM criteria (%)
NO_2	1 km	1 hour	0.12	0.03	27%
		Annual	0.03	0.005	16%
Photochemical oxidants (as O_3)	3 km	1 hour	0.1	0.02	20%
		4 hour	0.08	0.02	24%
SO_2	1 km	1 hour	0.2	0.02	12%
		1 day	0.08	0.006	7%
Particles as PM10†	1 km	Annual	0.02	0.002	11%
		1 day	50	11	22%

*Criteria sourced from National Environment Council 2003
†Concentrations for Particulates as PM10 are μg/m^3

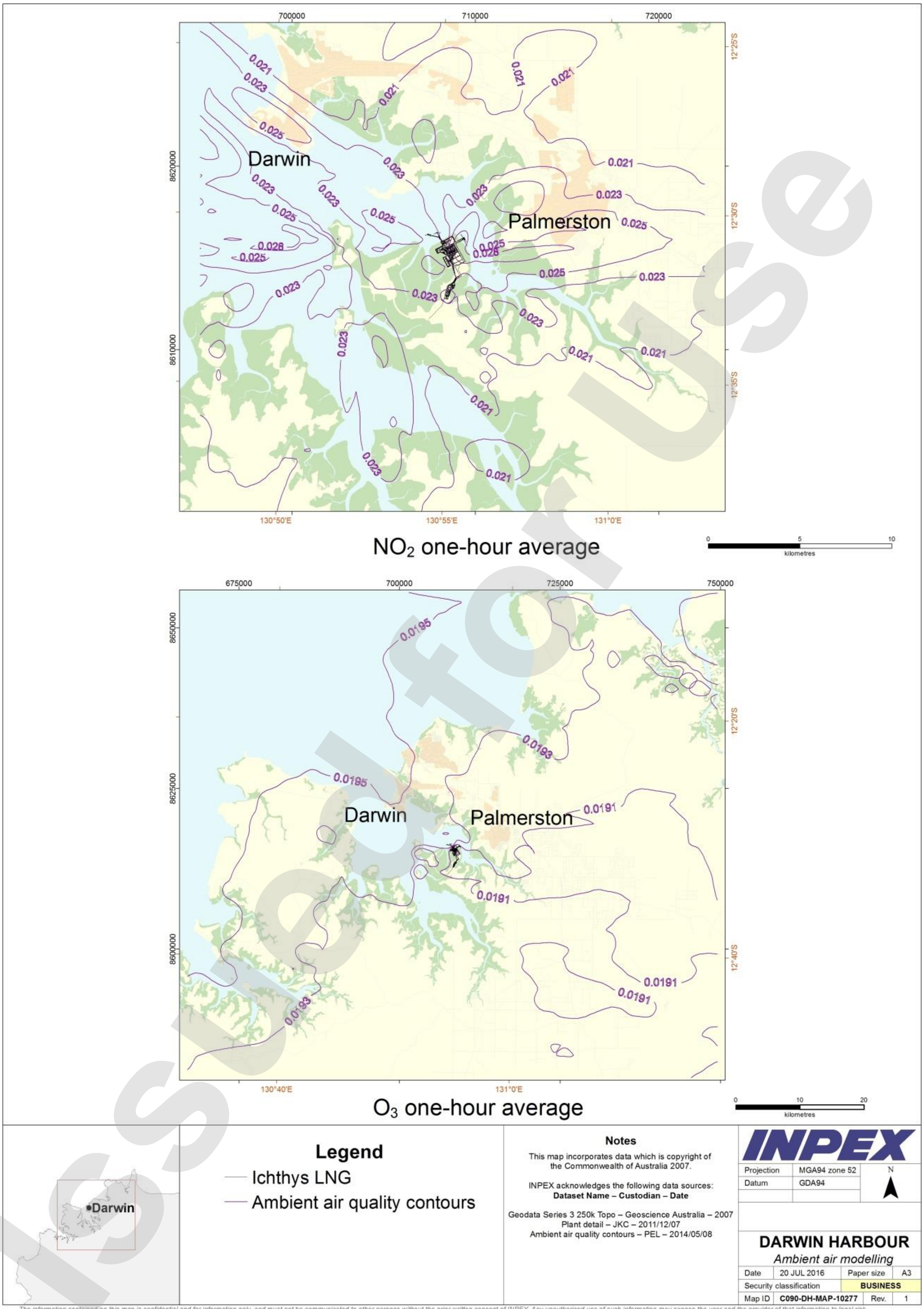


Figure 3-6: Ambient air modelling results for NO_2 and O_3

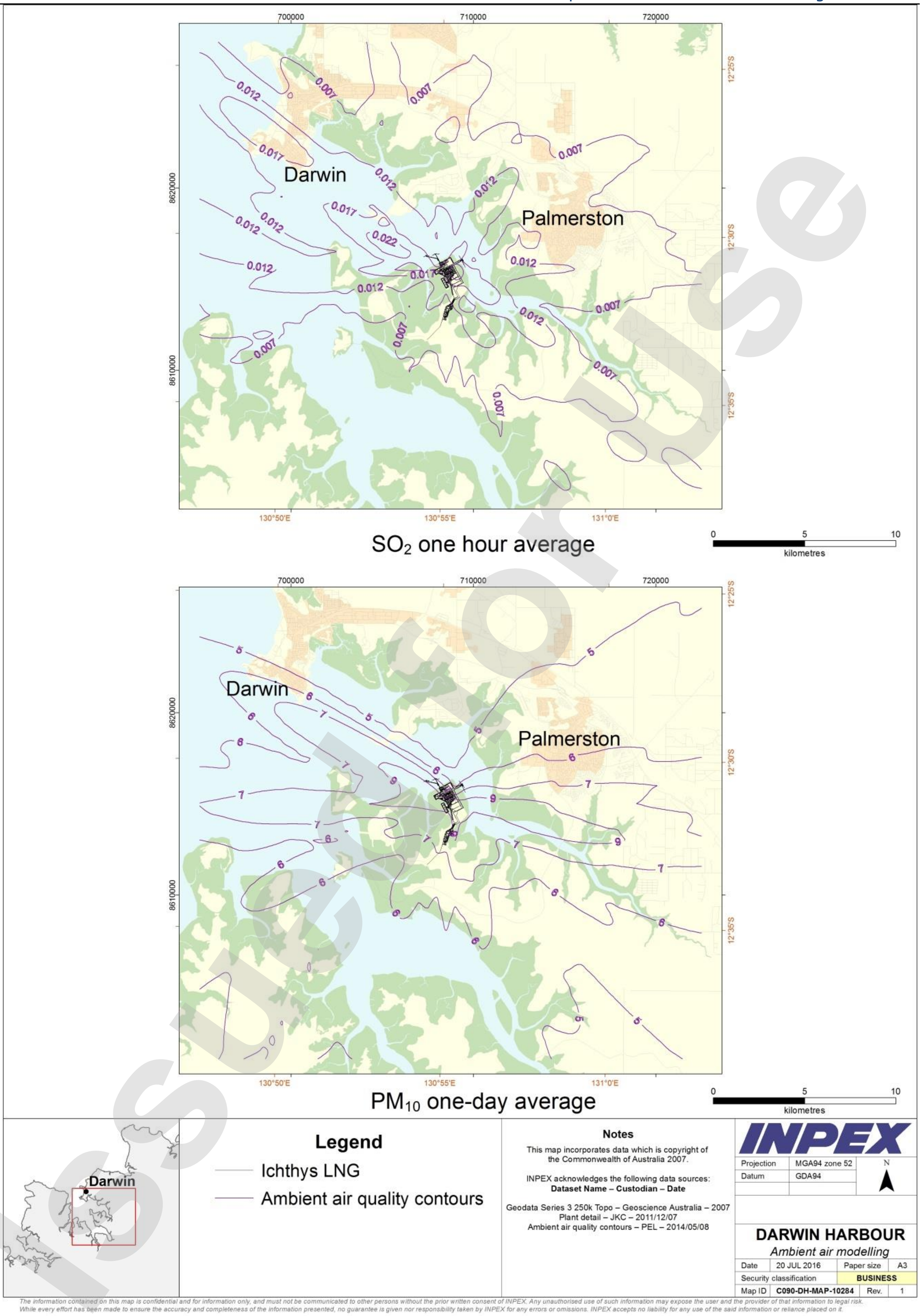


Figure 3-7: Ambient air modelling results for SO_2 and PM_{10}

3.8.2 Odour

INPEX has performed modelling to confirm that ground level concentrations of H_2S and benzene are not expected to exceed the World Health Organisation (WHO) guidelines for odour emissions and ambient air quality and Air Toxics NEPM guidelines.

The WHO guidelines for odour emissions state that H_2S concentrations should not exceed 7 µg/m^3 for any 30-minute period at any location outside an operating plant (WHO 2000). INPEX completed a risk assessment to assess the potential likelihood and consequences of odour emissions from Ichthys LNG for the Draft EIS, and determined that the likelihood of exceeding the WHO air-quality guidelines in any one year is six in a million. As a result, it is considered that odour emissions from Ichthys LNG are so unlikely to cause nuisance to the community or pose environmental risks that further management controls are not warranted. No management measures for odour are provided in this OEMP.

3.8.3 Noise and Vibration

Ichthys LNG has a number of rotating or other moving equipment that generate noise and/or vibration under normal operations, including pumps, refrigerant compressors, fin-fan coolers, turbines, motors and general utilities. Noise will also be generated during flaring.

A number of noise and vibration minimisation measures have been installed throughout Ichthys LNG, including silencers, acoustic enclosures, acoustic insulation, shielding around flares and anti-vibration mounts. Additionally, equipment and machinery will be monitored for vibration and be shut down for safety reasons if excessive vibration is detected.

Noise modelling undertaken in 2009 shows that 24-hour operations and emergency flaring noise will stay well below the pre-project ambient noise levels measured at nearest noise-sensitive receptors at Bayview Haven and the western limit of Palmerston (Section 2.3.2). Noise modelling contours are presented in Figure 3-8 and Figure 3-9.

Additional noise modelling was undertaken in 2014, which predicted the during normal steady state operations noise levels within Ichthys LNG will comply with the environmental noise limits of 70 dBA at the site boundary (as predicted in the Final EIS) and 55 dBA during the daytime (and 40 dBA at night-time) at urban residential areas (Palmerston). The predicted environmental noise emission level under normal operation has been modelled to be 38 dBA at Palmerston outskirts reference location (712598E 8617104N) (SLR Consulting 2014).

The predicted noise emission levels from start-up flaring complied with the environmental noise limits of 55 dBA during the daytime and 40 dBA during the night-time at suburban residential areas (NT EPA 2018). This was confirmed through noise monitoring undertaken during the first start-up phase, in Palmerston, Bladin Village and on the site boundary, which showed that the flaring noise did not exceed the requirements of the current Northern Territory Noise Management Framework Guideline (NT EPA 2018).

The predicted noise emission level at Palmerston during maximum possible emergency flaring is predicted to be 61 dBA (compared with a daytime suburban residential and industry interface level of 60 dBA). The design includes radiation/noise barriers around the flare pits (approximately 15 m high) which are considered a reasonable and practical mitigation measures to employ to minimise any potential noise impacts. During short periods of exceptional emergency circumstances, elevated noise levels will be acceptable due to the measures necessary to maintain health and safety (SLR Consulting 2014).

This noise level is not damaging to human health and is equivalent to the noise level of a normal conversation.

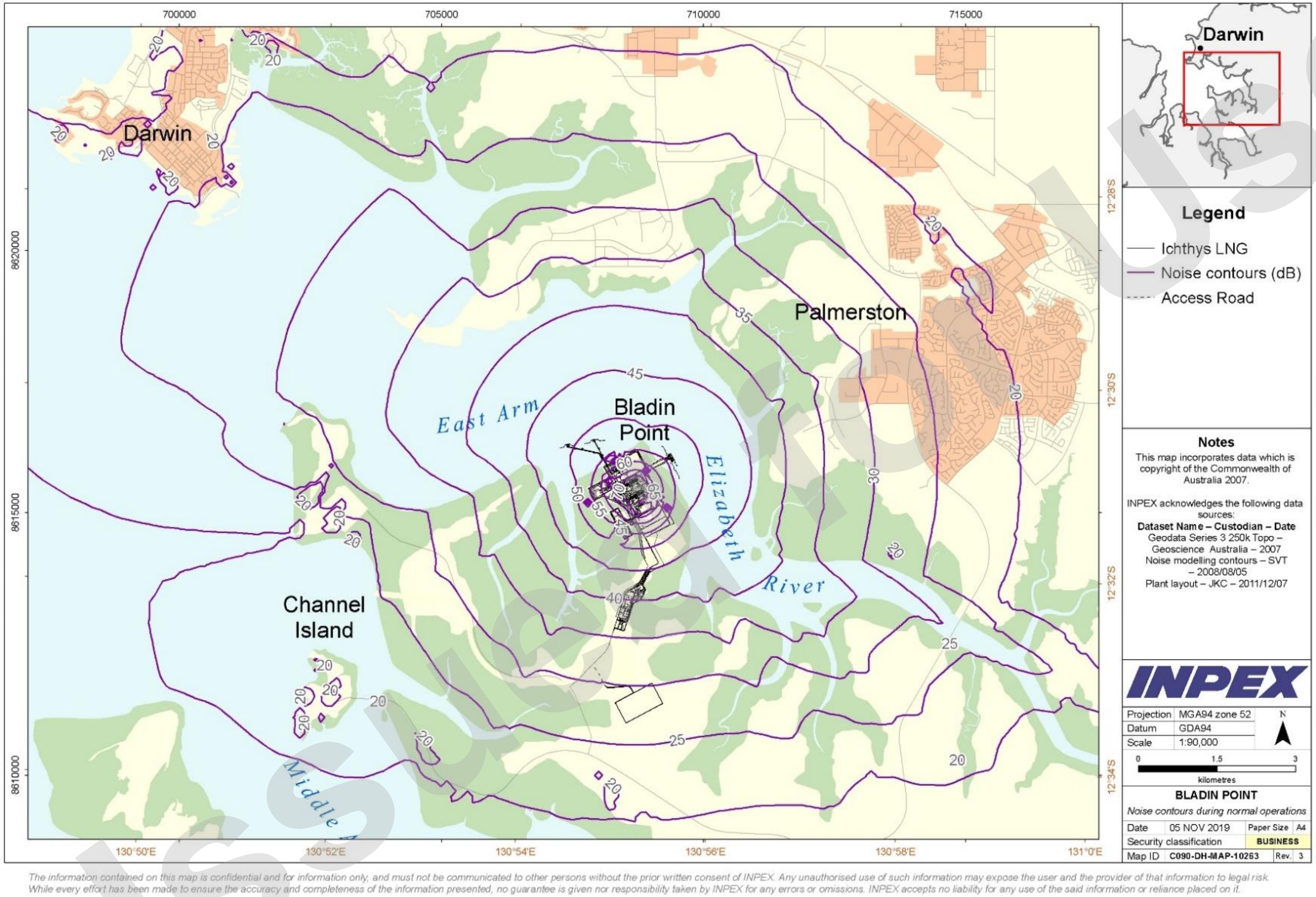


Figure 3-8: Noise contours during normal operations

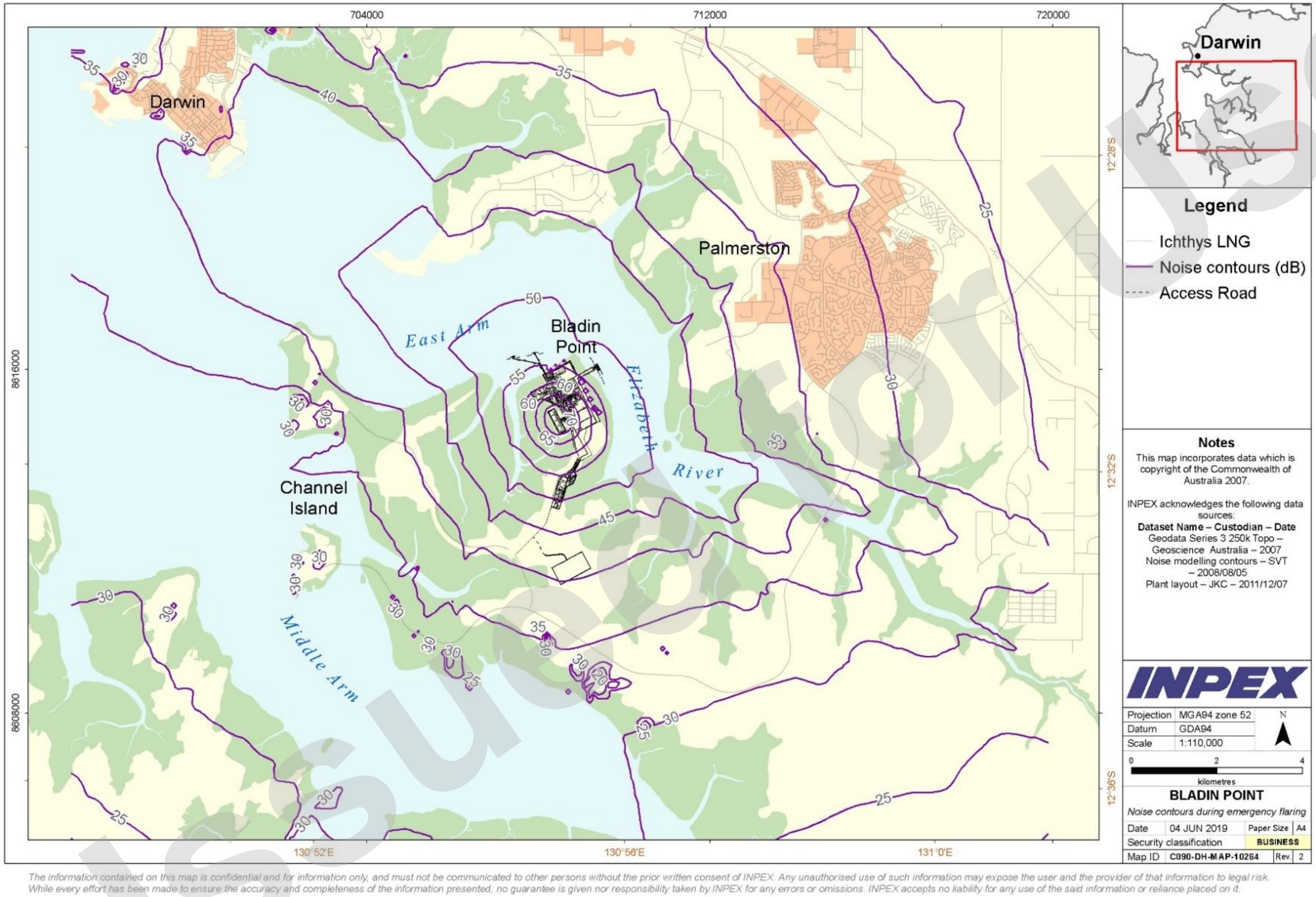


Figure 3-9: Noise contours during emergency flaring

3.8.4 Light and Heat

Ichthys LNG operates 24 hours a day and lighting is necessary for safe operations. Workplaces are lit to meet ISO 8995.3:2006 Lighting of work places – part 3: Lighting requirements for safety and security of outdoor work places. Areas that are normally lit include walkways, equipment, utilities and ancillary systems, product storage tanks and the product loading jetty. The types and brightness of light varies depending on the areas that need to be illuminated and the type of work that takes place in each area. Ichthys LNG is also equipped with emergency lighting which is normally turned off but will turn on automatically to illuminate escape routes in the event of an emergency.

Light is also be emitted from the ground flares, tankage flares and liquid flare (Section 3.4). Light from flaring predominantly takes place during start-up. Planned flaring during steady-state operations and LNG ship cool downs is expected to be minimal, although there will be light from flaring during or after shutdown maintenance if flaring is needed to bring equipment back online. Some unplanned flaring will also occur during operations, for example if flaring is needed in upset conditions. Flaring during upset conditions is generally of brief duration, generally less than several hours.

Ichthys LNG has been designed to minimise light spill and the light glow that will be visible at residential areas (e.g. Palmerston) and Darwin CBD. To achieve this, enclosed tankage flares and ground flares were selected, and the flares have been located on the western side of Ichthys LNG to shield the community from light emissions. Additionally, shielding around the flare pad minimises light spill.

Figure 3-10 provides the locations of the main sources of light emissions.

Figure 3-10: Point sources of light emissions

Heat is generated from all combustion sources. A number of elements have been included in the design of Ichthys LNG to significantly reduce the risk of potential impacts from heat to the environment. The use of an elevated flare pad with radiation shielding around the ground flares and liquid flare, enclosed tankage flares and the buffer zone between the flares and the edge of Ichthys LNG footprint reduces the potential impacts of heat from flaring, including the risk of heat impacts on nearby mangrove communities. The heat-emitting equipment and combustion sources have been positioned well within the boundary of Ichthys LNG and away from vegetation. This reduces the risk of heat impacts to the environment. A radiation study has been undertaken and demonstrates that heat under start-up and normal operations is not anticipated to result in any impacts to adjacent vegetation; therefore, no additional management controls have been identified in this OEMP for heat.

3.8.5 Greenhouse Gas Management, Energy Efficiency and Best Practice in Design and Operations

INPEX's Environmental Policy (refer to APPENDIX A:) requires minimisation of greenhouse gas emissions across all operations in a safe, technically and commercially viable manner. It also requires continual improvement with respect to emissions, discharges, wastes, energy efficiency and resource consumption.

Natural gas and LNG have an important part to play in global emissions reductions. Of all the fossil fuels, natural gas generates the least amount of greenhouse gas emissions when combusted. Although the liquefaction process can be energy and emissions intensive, the life cycle emissions associated with generation of power from LNG is much lower than those associated with coal or oil.

The minimisation of greenhouse gas emissions and maximisation of energy efficiencies were key drivers in the design and operational philosophies for the Ichthys LNG Project. Chapter 9 of the Draft Environmental Impacts Statement for the Project (INPEX Browse 2010) outlined the estimated GHG emissions over the 40-year life of the Project along with the technical abatement options which were under investigation to reduce GHG emissions from the Project.

The OEMP is able to confirm the technical abatement programs which have been integrated into the Ichthys LNG design and operational practices and which significantly reduce Project GHG emissions compared to what they otherwise would be without these design features.

It is estimated that the technical abatement options outlined below will reduce Project GHG emissions over the 40-year life of the Project by more than 100 million tonnes.

Table 3-7 summarises the design features of the Project that were included in the final design. Abatement options include those applied in the offshore portion of the Project, as well as the onshore plant.

Table 3-7: GHG abatement and energy efficiency options included in design

Abatement	Description	Estimated emission reduction (t CO_2-e/a)
Combined cycle power plant	For power generation on site, a combined cycle power plant has been constructed. The Ichthys Project is the only LNG facility in Australia to have this type of power generation, which is significantly more efficient than open cycle gas turbines. In this arrangement, the heat in the gas turbine exhaust, in conjunction with additional heat from duct burners, is used to raise steam, which is used to generate electricity in steam turbines.	500 kt
Waste heat recovery units – onshore turbines	Waste heat recovery has been installed on the exhausts of the non-power plant gas turbines in the onshore facility. The waste heat is recovered into the heating medium used on site. The use of waste heat in this way means that the fired heaters are not required during normal operation, just for upset conditions such as start up after a shutdown or plant trip.	500 kt
Waste heat recovery units – acid gas incinerators	The acid gas incinerator exhaust also contains waste heat recovery coils. These are used to preheat both the combustion air and the acid gas feed to the incinerator, minimising fuel gas requirements in the burners.	50 kt
Turbine selection	Turbine selection in all gas turbine applications has been matched to required load and efficient turbines have been chosen. In the offshore facilities, aero-derivative turbines have been selected, which are more efficient than frame turbines for the same load.	80 kt
Operational (steady state) venting and flaring	The Project has been designed such that there is no continuous venting or flaring during normal operation, with the exception of fuel gas for the flare pilots and a small amount of purge gas to ensure oxygen is excluded from the flare headers and flare lines.	Difficult to quantify

Abatement	Description	Estimated emission reduction (t CO_2-e/a)
Fugitive emissions reductions	The following design decisions have been taken, which reduce the volume of fugitive emissions: • Dry gas seals on compressors – these prevent fugitive emissions of hydrocarbon gases to atmosphere through compressor seals through the use of dry, inert gas. Dry seals also do not require oil so this is an added environmental benefit. • Floating roof tanks (condensate) – the condensate tanks onshore have internal floating roofs and external domed roofs to minimise rainwater ingress. The floating roofs minimise fugitive emissions. • Subcooling on butane tanks – the butane tanks store subcooled butane, which minimises fugitive emissions and venting by ensuring the liquid butane is kept at a low temperature. Subcooled butane is sprayed into the top of the tank which is sufficient to reliquefy any evolved vapour. • Gas driven devices – instrument air is used in the Project which obviates the need for devices such as control valves and pumps to be gas driven thus reducing fugitive emissions.	10 kt
Boil off gas recovery	Both the propane tank and the LNG tanks have boil off gas compressors fitted. These compressors take the gas from the vapour space in the tanks and recompress it for use instead of venting or flaring it. The LNG boil off gas is directed to the fuel gas system and is used throughout the facility. Boil off gas is recovered from the propane tank and recompressed as feed gas to the propane liquefaction circuit.	250 kt

Abatement	Description	Estimated emission reduction (t CO_2-e/a)
Solvent selection	In the acid gas removal units, an amine solution (aMDEA) has been selected as the solvent. In the acid gas removal units, the solvent flows downward against the upward flow of process gas. The acid gas components in the process gas, including CO2, are absorbed into the solution; which is then regenerated using heat. The energy required to regenerate aMDEA is lower than that required for other solvents so energy and GHG reductions are achieved. In addition, aMDEA is more selective for the acid gas components, which minimises carryover of methane and other hydrocarbons into the regeneration circuit and ultimately the acid gas incinerator.	1 Mt
Power sharing cable offshore	The offshore design includes a unique power sharing cable between the central processing facility and the floating production, storage and offtake facility. This cable enables better control of the power generation on each facility and treats power generation as a single unit. This will result in emissions reductions as, between the two facilities, a generator will be able to be taken off line.	45 kt
Flash gas recompression offshore	The flash gas from the FPSO trains offshore is compressed in a dedicated flash gas compressor and used as fuel for that facility. In addition, any flash gas in excess of the fuel gas requirements is piped back to the CPF and used as feed gas – to ultimately be sent onshore and liquefied. This has been an inclusion in the design after the development of the EIS and results in emissions reductions as this excess would normally be flared.	600 kt
Vent recovery offshore	On both offshore facilities, any gas that would normally be vented is recovered to the off gas recovery compressors. These compressors take these vent gases and direct them to the fuel gas system for use as fuel.	300 kt

In addition to the above abatement options that were included in the final Project design, a number of initiatives were used to reduce emissions during the start-up of the Project. These included:

- A tanker of third-party LNG was imported and used to cool down the refrigeration systems faster than would have been possible under normal start-up procedures. This reduced flaring during cool-down operations.
- The coolant for the refrigeration cycles (propane and ethane/nitrogen 'mixed refrigerant') is normally extracted from the initial offshore gas production. Once sufficient coolant has been extracted, the refrigeration cycle was started and LNG produced. The Ichthys facility purchased liquid propane refrigerant from a third-party, to reduce flaring of gas by shortening the start-up process.
- Start-up of the CCPP occurred with gas purchased from the Power and Water Corporation, rather than with gas produced from the offshore facility. This also made the plant start-up process more efficient and reduced the amount of flaring.
- The turn down ratio for the plant has been improved compared to other LNG plant designs. This means that the plant can operate at lower rates and minimise the need for flaring.
- The two trains have been designed such that Train 1 (the second train to come on line) could be cooled down using the products being made in the operational Train 2. Like the import of an LNG cargo as detailed above, this strategy reduced the amount of flaring required during start-up.

These strategies are estimated to reduce start-up GHG emissions by approximately 1 million tonnes of CO_2-e.

There is a possibility, under both existing and potential GHG policy at a national level, that INPEX will be required to acquire Australian Carbon Credit Units (ACCUs) in the future. Decisions will be made at an appropriate time regarding sourcing ACCUs. They could be purchased directly from other market participants with surplus, or INPEX may choose to participate in offset projects. These include projects such as savannah fire management and reforestation projects as these types of projects have been utilised in the oil and gas industry before.

The Ichthys LNG facility has been designed as "CCS-ready", meaning that provisions have been made in the design to be able to retrofit the facility with CCS capability in the future. INPEX has conducted investigations into capturing reservoir CO_2 from the AGRU and re-injecting this CO_2 in a suitable reservoir. This included a detailed site selection and characterisation assessment, which indicated that suitable storage reservoirs may exist but at a significant distance from the LNG facility.

To date, in excess of $10 million has been spent on evaluating CCS as an abatement option for the Ichthys LNG Project. Studies confirmed that, whilst there may be no technical barriers to implementation, the cost of CCS is very high and the economics of such a project has an estimated break-even carbon price of around $100/t CO_2-e or more. Therefore, implementation of CCS cannot be commercially justified at this stage.

Future identification and implementation of GHG abatement and energy efficiency projects is achieved through internal standards that require continuous improvement practises to be in place during the Operations phase. The general process is via a regular interrogation of the Project's information systems to determine where energy is used and emissions are created, the quantity of energy and emissions and trends of energy consumption and emissions over time at an equipment level. This information is then presented at workshops with a view to identifying opportunities to reduce emissions or save energy through the entire operation. These opportunities are then analysed to determine the business cases for each and whether they should proceed or not. The same standards are used to ensure any new project or plant modifications are designed and executed such that emissions and energy consumption are minimised. Analysis of emissions and energy must occur at every stage of the project execution process.

In addition to identification and analysis of specific GHG abatement opportunities, periodic GHG business planning is conducted. This process examines trends of emissions both in the past and forecasted for the life of the field and also looks at international and national policy drivers that may impact the operation of the Project. Risks associated with GHG emissions are regularly reviewed with actions put in place to manage these risks. All of these actions combined (investigation of abatement options, trends and forecasts of emissions, external factors and risk analysis) form the core of GHG management for the project.

3.8.6 Liquid Discharges, Surface Water Runoff and Drainage Processes

The Ichthys LNG wastewater treatment systems collect, treat, and dispose of wastewaters generated by Ichthys LNG. The wastewater treating systems cater for the entire Ichthys LNG area and accommodate potential increases in wastewater during major shutdowns, as well as allowing for severe weather conditions and emergency situations such as spills.

Different wastewater streams from various parts of Ichthys LNG, as well as from the operations complex areas, are collected through segregated collection networks and sent to respective treatment systems before final disposal of commingled treated wastewaters.

Ichthys LNG routinely generates the following wastewater streams that will be treated and commingled prior to discharge via a jetty diffuser:

- Continuously oily contaminated (COC) water: Wastewater from some sources that contain hydrocarbons are treated as COC water. COC water includes effluent from bunds, sumps, rotating equipment (e.g. pumps), pits, hydraulic units, water drains from the condensate storage tanks and wash-down pads.
- Accidentally oily contaminated (AOC) water: The AOC water is potentially contaminated effluent from unexpected or unpredicted accidents (such as leakage from equipment or contaminated water from fire-fighting) and surface water runoff from kerbed and bunded areas that may potentially contain hydrocarbons.
- Sewage and grey water: Sewage and grey water are generated from ablution facilities in Ichthys LNG and from the buildings in the operations complex such as ablution facilities, the kitchen and first aid room.
- Demineralisation plant reject water: Reject water from the demineralisation plant is salt-concentrated potable water from PWC.
- CCPP steam blowdown water: The CCPP generates steam to drive the three steam turbines. The steam is produced by the five HRSGs. A slip stream of the re-condensed steam (i.e. water) needs to be removed from the steam system to avoid build-up of silicates and other minerals. Ammonia dosing with a phosphate back-up system is employed with dosing rates typically below the required specification levels.

The location of the jetty outfall is, Easting 707399.64 and Northing 8616299.29 at a depth of approximately 12 m (LAT).

Ichthys LNG has been designed with a chemical sewer system (CS) that will collect spent chemicals and non-aqueous liquids in areas where fixed chemical systems are used. This includes solvent-contaminated water. Wastewater collected from the CS will either be sent to the onsite evaporation basin or offsite to a licenced facility. Occasional trace amounts of aMDEA and/or glycol in wastewater from the CS is pumped into the AOC; this is consistent with the Ichthys LNG design, which allows for pumping of wastewaters into the AOC if contaminants are confirmed at trace levels.

Non-contaminated water (NCW) is also generated at Ichthys LNG. NCW is considered to be non-contaminated, free of hydrocarbons and other chemicals. NCW includes clean surface water runoff, overflow and drainage from building roofs which will have no significant potential for contamination and, during heavy rainfall events, some water from the AOC system (where the cleanest AOC water will be diverted through a series of underflow/overflow weirs prior to discharge to the NCW system). Small quantities of air conditioning condensate drain water will also be directed to the NCW. For the air conditioning units cooling buildings located on the jetty, this clean waste stream will be directed to the harbour.

Figure 3-11 depicts the various wastewater streams and treatment systems.

Continuous online instrumentation is used to confirm the treated water quality at various stages of the treatment process, including in the AOC/COC, sewage, CCPP steam blowdown and the demineralised plant systems. A flowmeter is also installed on the jetty outfall line to continuously monitor the discharge rate. An alarm is raised if water quality becomes out of specification. When this occurs, adjustment to process is undertaken, wastewater is diverted for re-processing (either automatically or by an operator) or, in some circumstances, off specification wastewater will be disposed of off-site by a licenced waste contractor. The online analysers include TOC, TSS, pH, DO and temperature, with the alarms set below or in the ranges of the required discharge targets. The measurement of TOC is a conservative surrogate for TPH, as the TOC analysis encompasses all the organic carbon in the sample, which includes the entire TPH fraction.

The liquid discharges generated from Ichthys LNG, and the expected sources, quantities and end destinations (for each of the discharges) are summarised in Table 3-8. The quantities listed in Table 3-8 are indicative only and are provided to demonstrate the anticipated nature and scale of discharges during steady-state operations. Minor amendments to these quantities should not be considered a non-conformance with this OEMP. The collection and treatment of these wastewater streams is described in further detail below.

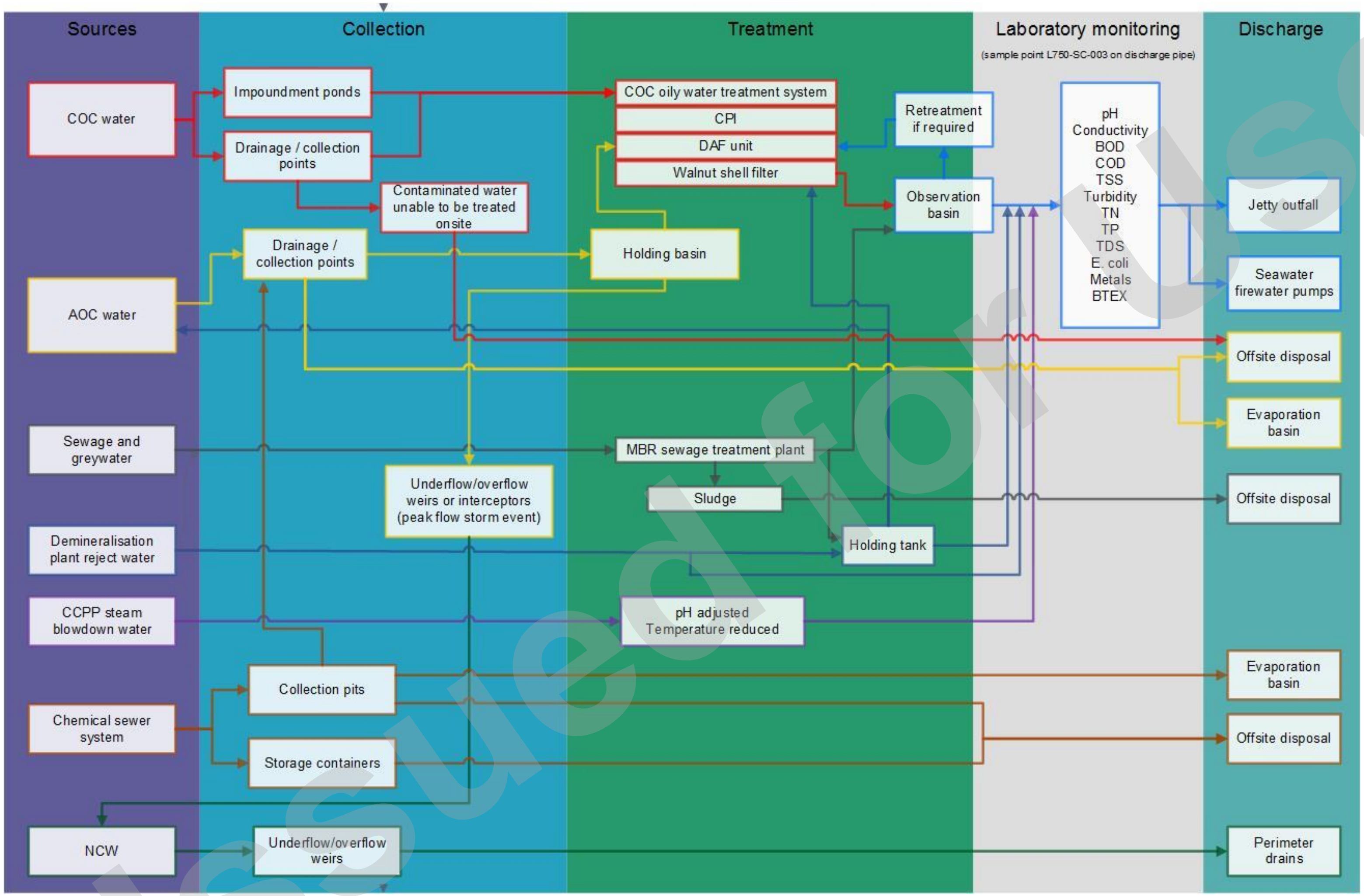


Figure 3-11: Flow diagram of drainage and treatment effluent system

Table 3-8: Summary of liquid discharge sources, expected quantities and handling

Liquid discharge	Classification	Description	Source	Approximate volumetric flow rate (m^3/h)		Handling and end destination
				Typical (continuous)	Maximum (intermittent)	
COC and AOC water	Hazardous	COC wastewater from areas contaminated by hydrocarbons.	Bunds, sumps, pits and wash-down pads	<<1	110	Discharged as a commingled liquid discharge via the jetty outfall, following three (COC) or two (AOC) treatment stages.
Treated sewage / grey water	Non-hazardous	AOC wastewater (stormwater runoff) from areas that could contain contaminants and from bunded areas that may potentially be contaminated.	Ichthys LNG and operations complex ablution facilities, kitchen and first aid room	3	20	Discharged as a commingled liquid discharge via the jetty outfall following treatment with the MBR sewage treatment plant.
Demineralisation plant reject water	Non-hazardous	Sewage produced as a result of daily activities such as ablutions, catering and dishwashing etc.	Demineralisation plant	7	16	Discharged as a commingled liquid discharge via the jetty outfall.

Liquid discharge	Classification	Description	Source	Approximate volumetric flow rate (m^3/h)		Handling and end destination
				Typical (continuous)	Maximum (intermittent)	
CCPP blowdown water	Non-hazardous	Salt-concentrated reject water from the demineralisation plant.	CCPP	8	14	Discharged as a commingled liquid discharge via the jetty outfall, following treatment to adjust pH and reduce temperature.
Chemical sewer system	Hazardous	A slip stream of the condensed steam recovered from the CCPP steam turbines, which will contain very low levels of impurities such as silicates and will be dosed with ammonia or phosphate	Chemicals from fixed chemical systems and non-aqueous liquids	Operation dependent.		Not discharged unless tested to confirm suitable for discharge (predominantly stormwater) Chemical sewer water will be collected and removed by vacuum truck for offsite disposal by a licenced contractor or disposed in Ichthys LNG evaporation basin.

Liquid discharge	Classification	Description	Source	Approximate volumetric flow rate (m^3/h)		Handling and end destination
				Typical (continuous)	Maximum (intermittent)	
NCW	Non-hazardous	Chemical sewers are provided for effluent in areas where fixed chemical systems will be used.	Areas with surface runoff or overflow, non-bunded tank drains	Weather / rainfall and operation dependent. Perimeter drain system is designed to cope with a 1 in 100 year rainfall event.		Discharged as a separate stream via the perimeter drain system to land/natural drainage features directly adjacent to Ichthys LNG. Some discharge may flow into Darwin Harbour, where it will disperse within the intertidal zone.

Note: The typical continuous discharge to the jetty outfall is ~ 18 m^3/h. The maximum intermittent discharge is ~160 m^3/h. A slipstream of commingled wastewater may be discharged through the firewater pump intake line, to limit marine growth.

COC and AOC water

The oily (AOC and COC) effluents are treated to meet the discharge water quality requirements.

The AOC/COC oily water treatment system has three sections:

- primary treatment by corrugated plate interceptor (CPI) – COC
- secondary treatment by dissolved air flotation (DAF) unit – AOC, COC (CPI treated)
- tertiary treatment by walnut shell filter – AOC, COC (CPI treated).

Under normal operations, continuous and intermittent wastewater that contains or could contain high concentrations of TPH (e.g. wastewater in oily separator drains or effluent from rotating equipment such as pumps) will be collected in impoundment ponds or drainage/collection points and sent to the COC oily water treatment system.

Wastewater normally containing low concentrations of hydrocarbons, e.g. rain runoff from areas around equipment containing hydrocarbons, is directed to the AOC system. AOC effluents are gravity drained to a drainage and effluent treatment area or local collection points, where the effluent is pumped out to the nearest AOC drainage system. Non-polluted effluent can be diverted to the NCW system.

The design of the Ichthys LNG drainage network is such that chemical sewers in the trains area, which are designed to collect amine and glycol, also collect rainwater. When there is no significant chemical contamination present, this rainwater may be pumped to the AOC also. Similarly, the vehicle washdown area and wash waters from cleaning operations in the trains may also be directed to the AOC if not contaminated.

First flush AOC water flows to a holding basin; thereafter it is processed through a DAF unit and a walnut shell filter before being directed to a final observation basin prior to discharge through the jetty outfall.

Runoff from the areas at low risk of hydrocarbon contamination, such as the operations complex, that will not gravity flow to the holding basin is directed through underflow/overflow weirs or proprietary interceptor(s), then discharged to the NCW system.

Table 3-9 shows the expected treated water quality from the COC/AOC water treatment system, prior to commingling and discharge.

Table 3-9: Expected COC/AOC system water quality

Parameter	Value
pH	6-9
TSS	< 10 mg/L
TPH	< 6 mg/L

Sewage and Grey Water

Domestic sewage and grey water are treated through a membrane bioreactor (MBR) sewage treatment plant. This process consists of aerobic activated sludge biological oxygen demand (BOD) treatment, followed by membrane filtration. The MBR is capable of treating 210 m^3/day. Following MBR treatment, the wastewater is sent to an ultraviolet light/chlorine disinfection package to reduce coliform levels. The treated wastewater is discharged from the jetty outfall.

The following chemicals are required for effluent treatment:

- sodium hydroxide
- sodium hypochlorite
- demulsifier
- coagulant and flocculant (ferric chloride and polyelectrolyte).

Details of chemicals are as per each applied treatment program, which may vary with supplier.

Table 3-10 shows the expected treated water quality under normal operating conditions from the sewage treatment system, prior to commingling and discharge.

Table 3-10: Expected sewage treatment plant water quality

Parameter	Value
pH	6-9
TSS	< 10 mg/L
BOD	< 20 mg/L
Total Nitrogen	< 10 mg/L
Total Phosphorus	< 2 mg/L
Faecal coliforms	< 400 cfu/100 mL
Escherichia coli (*E. coli*)	< 75 MPN/100 mL

Demineralisation Plant Reject Water

The demineralisation plant uses PWC water to produce very low salinity water, referred to as demineralised water (Section 3.4). The reject water is discharged to Darwin Harbour through the jetty outfall during normal operations. The demineralisation plant is occasionally cleaned, using a back-flush method with the water being discharged to the NCW system.

During the dry season, part of the reject water is used to flush the AOC system and to maintain water seals in the AOC pipework. The water that does not evaporate enroute through the AOC drains is commingled with other AOC water, treated, and discharged to Darwin Harbour. Using the reject water in this way avoids the need to use potable water for this purpose.

The following chemicals are required for treatment of demineralised water:

- anti-scalant
- de-chlorination solution
- low pH cleaner
- high pH cleaner
- sodium chloride
- sodium hydroxide

- hydrochloric acid.

Table 3-11 shows the expected water quality of reject water from the demineralisation plant under normal operating conditions.

Table 3-11: Expected demineralisation plant reject water quality

Parameter	Value
pH	5-9
TDS	< 5 000 mg/L

CCPP Steam Blowdown Water

The CCPP provides electrical power to Ichthys LNG (Section 3.4). Steam is generated through HRSGs from the gas turbine exhausts. A small amount of the condensed steam from the steam loop is directed to the wastewater treatment system. This is necessary to maintain very low levels of silicate and other minerals in the steam loop. Demineralised water is added to the steam loop continuously to maintain constant water quality and quantity.

The steam loop uses an ammonia dosing system with a phosphate back-up. The steam loop bleed is treated to adjust the pH, and the temperature is reduced using a heat exchanger prior to commingling and discharge into the sea at the jetty outfall.

The CCPP blowdown water contains very low levels of minerals such as silicates. Any chemical additives are managed to maintain very low levels of nutrients such as nitrogen or phosphorus. Table 3-12 shows the expected water quality of the CCPP blowdown water.

Table 3-12: Expected CCPP blowdown water quality

Parameter	Value
pH	6-9
TN	< 10 mg/L
TP	<2 mg/L
Maximum temperature	< 45 °C

Collection and Treatment of Wastewater Streams

The following collection and treatment methods are used for wastewater at Ichthys LNG:

- CPI – COC
- a DAF unit and a walnut shell filter for processing for AOC, COC (CPI treated) wastewater
- MBR sewage treatment plant processing sewage and grey water
- pH adjustment and cooling of CCPP steam blowdown water
- evaporation Basin – slightly chemically contaminated wastewater - CS.

Once treated, the majority or all of the COC and AOC , sewage and grey, demineralisation plant and CCPP steam blowdown waters are commingled then discharged to Darwin Harbour through a diffuser at the base of the LPG/condensate product loading jetty. A slipstream of the treated commingled effluent may be used in the back-up seawater firewater pumps to control marine growth and is discharged to Darwin Harbour via the firewater pumps.

The jetty diffuser is approximately 15 m long and comprises high-density polyethylene (HDPE) pipework attached to the product loading jetty (Figure 3-12). The design of the diffuser has taken into account a number of considerations in order to minimise environmental impacts, including tides, currents, wave loading, dispersion and dilution of the wastewater, corrosion and strength of diffuser materials. The diffuser lies in approximately 12 m water depth (LAT) (Figure 3-13), and discharges the treated effluent through four diffuser valves located above the sea floor, spaced at 5 m intervals. Discharge from the diffuser is directed outwards and upwards into the dredged berthing pocket.

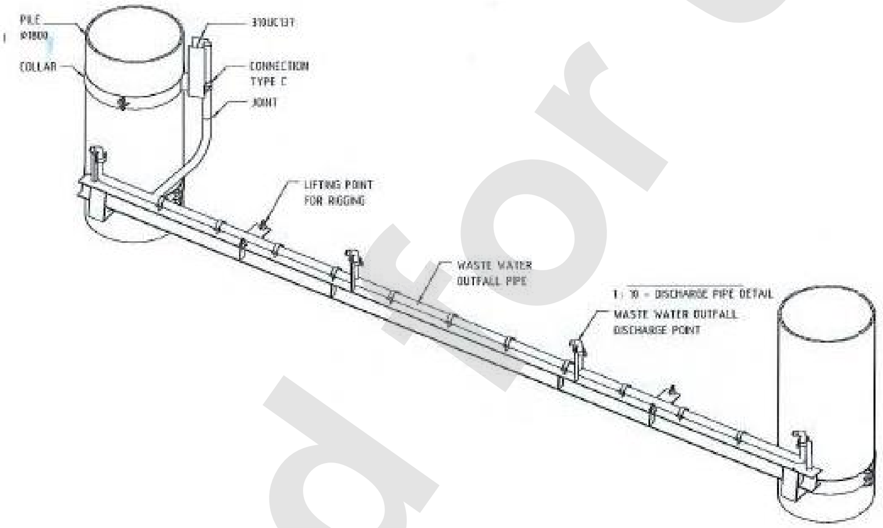
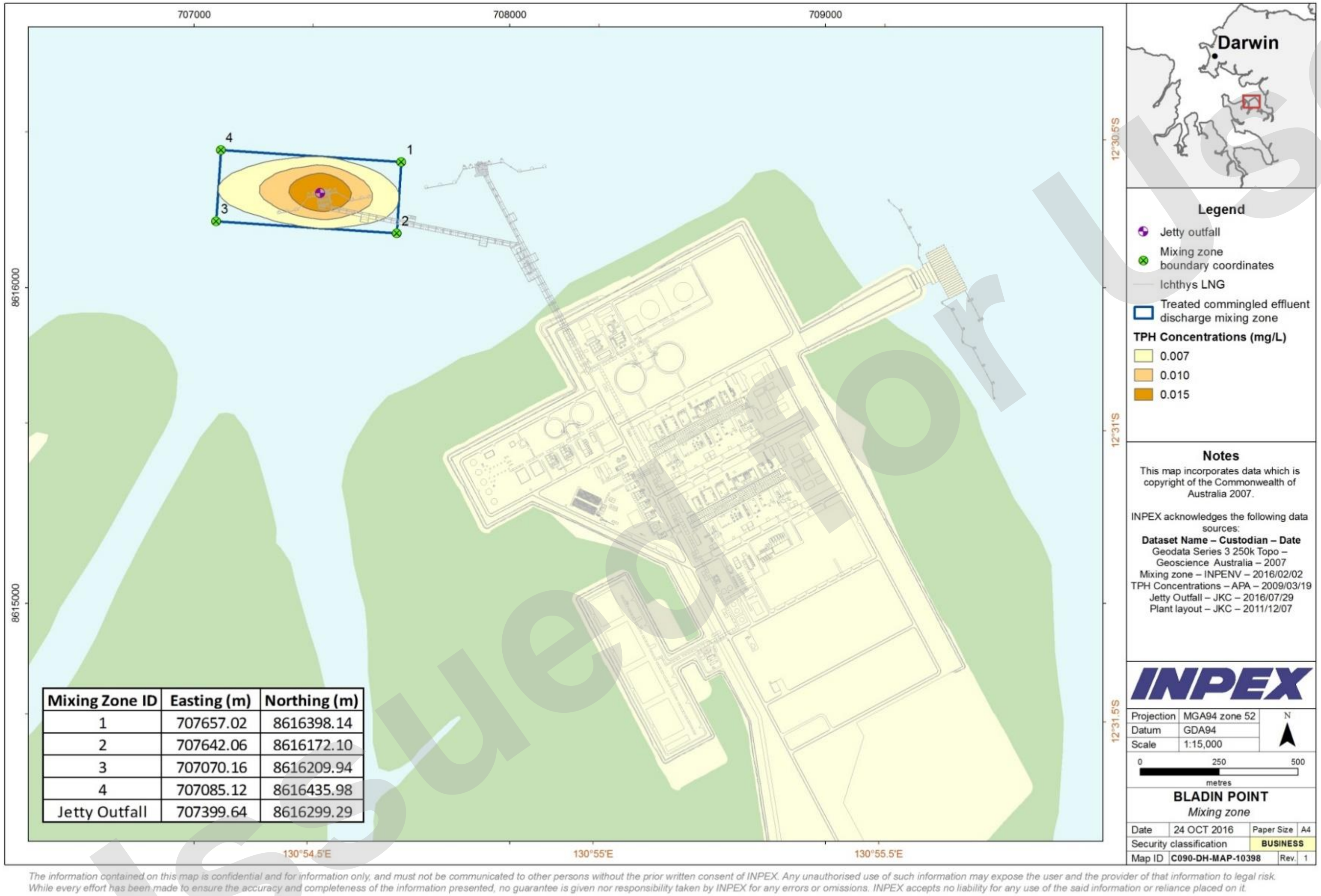


Figure 3-12: Jetty diffuser



Mixing Zone ID	Easting (m)	Northing (m)
1	707657.02	8616398.14
2	707642.06	8616172.10
3	707070.16	8616209.94
4	707085.12	8616435.98
Jetty Outfall	707399.64	8616299.29

Figure 3-13: Mixing zone for treated commingled effluent discharge

Wastewater discharge modelling was undertaken to investigate the mixing and dispersion of the treated commingled effluent as it is discharged through the jetty diffuser (APASA 2009). The effluent is more buoyant than the receiving water, and therefore rises up towards the surface which results in enhanced mixing of the treated effluent and Darwin Harbour waters. The treated effluent plume also oscillates and changes direction with each flood and ebb tide event. The model shows that a TPH concentration of 0.007 mg/L will be reached 86 m from the jetty diffuser for the 50th percentile and 330 m for the 95th percentile (APASA 2009). Validation of the wastewater discharge modelling was undertaken during commissioning of the system. Based on the verified model results, a mixing zone has been defined for the discharge of the commingled treated effluent which is shown in Figure 3-13.

Chemical Sewer System

The chemical sewer system within the trains area collects sources that are not treated onsite and is not allowed to flow to the harbour, unless present in trace amounts only and diluted with rainwater runoff. Chemical drains include a normally closed valve to enable local recovery of chemicals. Sumps and pits will be checked for possible chemical contamination and where testing shows only trace amounts of contaminants, any rainfall collected in the sewer will be diverted to the AOC.

Contaminated chemical sewer water and non-aqueous liquids is collected in pits and recovered by vacuum truck for offsite treatment and disposal by a licensed waste contractor or is sent to the onsite evaporation basin.

The evaporation basin has been constructed of concrete, and periodically will be de-sludged to allow for the removal of solids. The basin is also equipped with a closable roof to prevent rainwater from entering. In the wet season the effluent is removed by truck for disposal to a suitably licensed outside facility.

Spent undiluted chemicals and oils from the laboratory are stored in small individual containers and treated as liquid hazardous waste rather than disposed of into the chemical sewer system.

Disposal of Wastewater Offsite

In the event of a spill, leak or exceedance of COC or AOC wastewater specifications, the wastewater maybe removed from site by a licensed operator using a vacuum truck for appropriate disposal at a licensed third-party facility. This may entail holding the wastewater in one of the three holding basins for a period of time prior to disposal. The Ichthys LNG drainage and wastewater system also has the capability to re-treat wastewater that exceeds specifications (for certain constituents), or the wastewater can be sent to the evaporation basin.

Non-contaminated Water (NCW) System

The NCW system collects non-contaminated surface water/stormwater runoff from areas outside of the AOC catchments which does not contain sources of contamination. The NCW system also accepts runoff that exceeds the treatment and storage capacity of the AOC system during exceptionally heavy and prolonged rainfall events.

The NCW is discharged separately from the other wastewater streams. NCW is not commingled with the treated wastewater streams and is not sent to the jetty outfall. Generally, NCW water flows away from Ichthys LNG, through underflow/overflow weirs, then is discharged through a series of perimeter drains. The perimeter drains direct the NCW through to adjacent mangrove areas. Water velocity is controlled by use of baffles and rock armour. Some of the NCW infiltrates the ground and the majority flows to Darwin Harbour.

Some areas within Ichthys LNG will contain loose gravel finish and other areas will be grassed. Gravelled and grassed areas encourage aquifer recharge by allowing water to infiltrate the ground.

Table 3-13 shows the expected water quality of NCW.

Table 3-13: Expected NCW quality

Parameter	Value
pH	6-9

Spill Containment Systems

Ichthys LNG has been designed with impoundment ponds and bunding to contain spills around equipment.

The impoundment ponds are used in areas which handle LNG and LPG, including the onshore arrival system, LNG trains, the LNG and LPG storage tanks and BOG recovery systems, refrigerant storage tanks, jetty loading arms, tankage flare and open ground flares. The impoundment pounds are fitted with pumps to remove rainwater. Uncontaminated rainwater is pumped out and discharged via the NCW system. Contaminated water is pumped into the AOC water system for treatment.

Bunding has been provided for condensate, heating medium, diesel, solvent, AGRU drain and chemical storage tanks. Water within the bunds is:

- discharged to the NCW system if it is not contaminated, or
- discharged to the AOC water system if there is minor contamination, or
- removed by vacuum truck for disposal offsite to a licensed facility, or
- removed by vacuum truck and taken to the evaporation basin (for contaminated liquids in the solvent storage tank bunds).

Figure 3-14 describes the different methods for managing spills at Ichthys LNG.

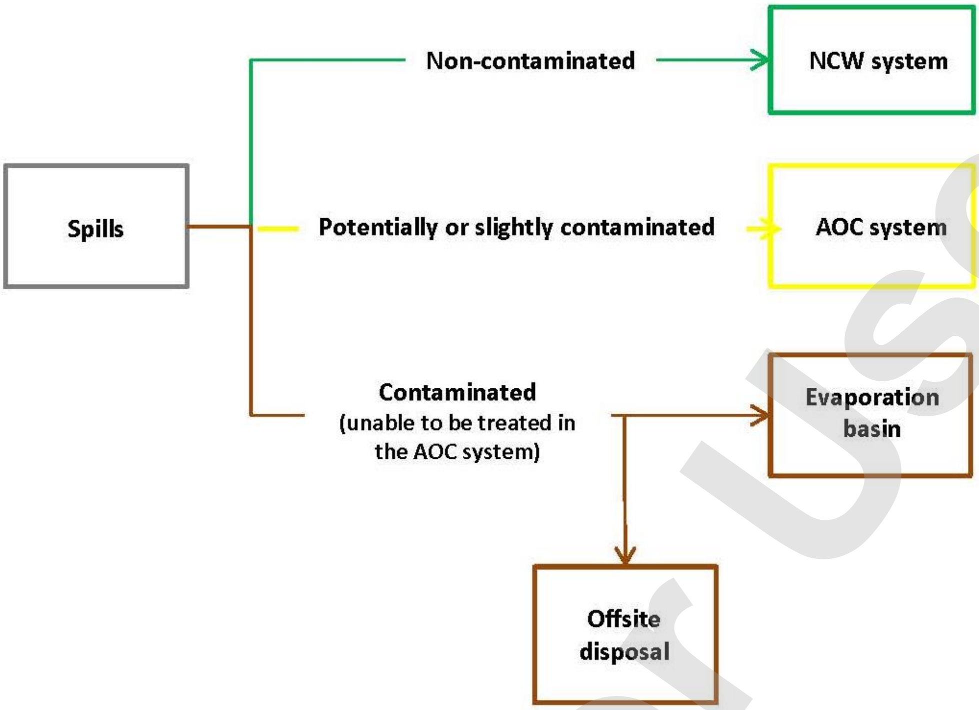


Figure 3-14: Flow diagram of potential spills at Ichthys LNG

3.8.7 Solid and Liquid Waste

The key wastes associated with the operations of Ichthys LNG are:

- office and cafeteria or kitchen wastes
- warehouse wastes
- green waste (vegetable matter etc.)
- mechanical workshop wastes
- fuel and chemical storage receptacles
- general LNG train, storage and loading, utilities and maintenance wastes
- shutdown waste streams
- biological waste (e.g. medical and biosolids)
- waste generated in the unlikely event of a chemical or hydrocarbon spill
- wastes generating from rectification and maintenance work, such as painting and insulation replacement programs.

The waste streams expected to be produced by Ichthys LNG can be categorised into four broad categories:

- recyclable (non-hazardous) waste: Where cost effective recyclable opportunities can be achieved, recyclable non-hazardous wastes are segregated from other water types and sent to appropriate recycling facilities.
- non-recyclable (non-hazardous) waste: All non-recyclable, non-hazardous waste can be disposed at licensed facilities in the NT. These wastes are segregated and transferred to a licensed waste contractor for disposal at a licensed landfill waste facility.

- recyclable (hazardous) waste: These wastes are handled and treated as a hazardous waste and are segregated from non-hazardous wastes. Where cost effective recyclable opportunities can be achieved, recyclable hazardous waste are transferred to a licensed waste contractor for treatment and recycling at a licensed waste facility.
- non-recyclable (hazardous) waste: These waste streams are typically sent to appropriately classed landfills, or for high temperature incineration. Non-recyclable hazardous wastes are segregated and transferred to a licensed waste contractor for treatment to comply with threshold criteria for acceptance to landfill at a licensed waste facility, or for direct disposal to a licensed waste facility.

"Listed" wastes are those waste streams classified under Schedule 2 of the Waste Management and Pollution Control (Administration) Regulations (NT). Listed (controlled) wastes are subject to special monitoring and reporting requirements and can only be disposed of at licensed landfill sites or sent for treatment or destruction. It is anticipated that a significant proportion of the listed (controlled) waste generated by Ichthys LNG will require disposal interstate, with some waste potentially having to be transported overseas for specialised recycling, by licenced waste contractors.

The solid and liquid wastes that are expected to be generated at Ichthys LNG are listed in Table 3-14. Some solid and liquid waste volumes are likely to be more variable during re-starts than during steady state operations, and some waste types will only be generated during major maintenance/shutdown activities.

Table 3-14: Expected solid and liquid wastes

Waste classification	Type	Approximate quantities and disposal frequencies
Recyclable (non-hazardous)	Paper and cardboard, glass, metal cans and tins, plastic bottles, plastic and steel drums, scrap metal, activated alumina, wood, organic green waste	32.55 t/a
Non-recyclable (non-hazardous)	General commingled waste and domestic waste	~450 t/a.
	Air filters	Once every 4 to 5 years
	Ion-exchange resins used in electro-deionisation (EDI)	3 pieces that are 500 mm in diameter and approximately 2 m in length. Disposed of at a very low frequency.
	Reverse osmosis (RO) membrane	168 pieces. Disposed of at a very low frequency, if required.
	Non-recyclable plastics and rubber	0.25 t/a
	Electronics	1 t/a

Waste classification	Type	Approximate quantities and disposal frequencies
Hazardous (recyclable)	Batteries	15 t/a
	Oils (including synthetic)	Various oils, ranging in volume from approximately 960 L to approximately 23 000 L. Change out every 8 years (dependent on oil condition).
Hazardous (non-recyclable)	Contaminated receptacles and materials	200 t/a
	Lighting (e.g. globes, light tubes)	0.005 t/a
	Aerosols	0.3 t/a
	Used spill response material (non routine)	Dependent on occurrence and nature of spill.
	Insulation waste	75 t/a
	Chemicals (expired or spent)	30 t/a
	Firefighting foam	Change out will occur as per manufacturers' recommendation, generally every 10 years (12 tonnes). Training foam and cleaning of fire equipment wastewater 150 t/a
	Medical waste (e.g. sanitary and laboratory medical equipment)	0.5 t/a
	Hydrocarbon sludge	Frequency and volume depend on the operating condition of offshore facilities. Approximately every 5 years for pigging operations. Standard operations 6 t/a.
	Mercury adsorbent	Once every 3 years (one train ~ 250 tonnes).
	Ceramic balls	Various sizes from approximately 6,700 kg to ~100,000 kg. Change out once every 3–4 years.

Waste classification	Type	Approximate quantities and disposal frequencies
	Waste cartridge filters	Filters range in size from 95 mm diameter to 160 mm diameter. Intermittent replacement (once every few years).
	Activated carbon	~90,000 kg. Intermittent. Once every few years.
	Molecular sieve	Once every 4 years (one train 165 tonnes).
	Silica gel	4,300 kg once every 4 years.
	Oily-water treatment sludge	Intermittent removal of sludge using a vacuum truck.
	Filter media	The filter media used (walnut shells) have a very long media life; thus an entire media replacement will not be required under normal operating conditions.
	Sewage treatment sludge	450 t/a

The waste control hierarchy (Figure 3-15) is the primary tool used by INPEX for the sustainable management of waste generated by Ichthys LNG. The hierarchy entails the following practices (in order of preference):

1. **Avoid**—modify design and operating practices so that waste is not generated. Waste prevention is achieved through the consideration of alternative products, the implementation of alternative technologies, engagement of companies that encourage sustainable waste management practices, and the procurement of prefabricated materials
2. **Reduce**—generate less waste by better management and by material substitution or choose the least hazardous chemicals (if not cost prohibitive) fit for purpose. Waste minimisation is typically applied in the procurement stage (i.e. the tendering and contracting process) and aims to reduce consumption of resources by minimising the amount of packaging material purchased and by increasing demand for recycled content. However, this concept is also applicable during the operation of Ichthys LNG. Measures to minimise the amount of waste produced may include the following:
   - analysing waste streams and developing strategies to reduce waste
   - using rechargeable batteries, where practicable
   - using all waste receptacles to maximum capacity
   - increasing the time, where practicable and depending on condition-testing, between filter, chemical and oil changes as opposed to replacement on a routine basis.

3. **Reuse, recycle and/or recover**—reuse item in its original form, or recycle or reprocess the item to incorporate it into a new product or new use, or extract materials or energy from a waste material or item. Reuse is achieved initially by identifying reuse opportunities and subsequently through identifying the market demand for various waste items. To maximise reuse opportunities, wastes are segregated according to type. Future investigations regarding waste reuse will continue and will be managed through the INPEX adaptive management process (Section 6.6). In addition, the marketability of wastes will be regularly reviewed to verify that potential new and emerging opportunities for their reuse are maximised. Reuse opportunities may include using filters that can be cleaned and reused; returning used batteries to an approved vendor for exchange or to be sent to a reclaimer; or reusing product containers (e.g. drum cleaning). Recycling represents an important component of the waste management strategy, and wastes are segregated to enable recycling. Recovery of waste at Ichthys LNG is predominantly achieved by recovery energy. The energy recovery concept reduces the input of energy into a system by using energy from other parts of the overall system. Where practicable, energy recovery will be employed as part of the waste control hierarchy.

4. **Treat**—mitigate the hazard of the waste by destruction, detoxification, neutralisation, etc. Waste treatment aims to mitigate hazards posed by the waste through means such as destruction, detoxification or neutralisation of residues through processing. At Ichthys LNG this includes, for example, incineration of hydrocarbon waste and sanitary, laboratory and medical equipment.

5. **Dispose**—remove the waste to an approved location such as a landfill site or disposal facility. Waste is disposed of to landfill where no other practical option is available.

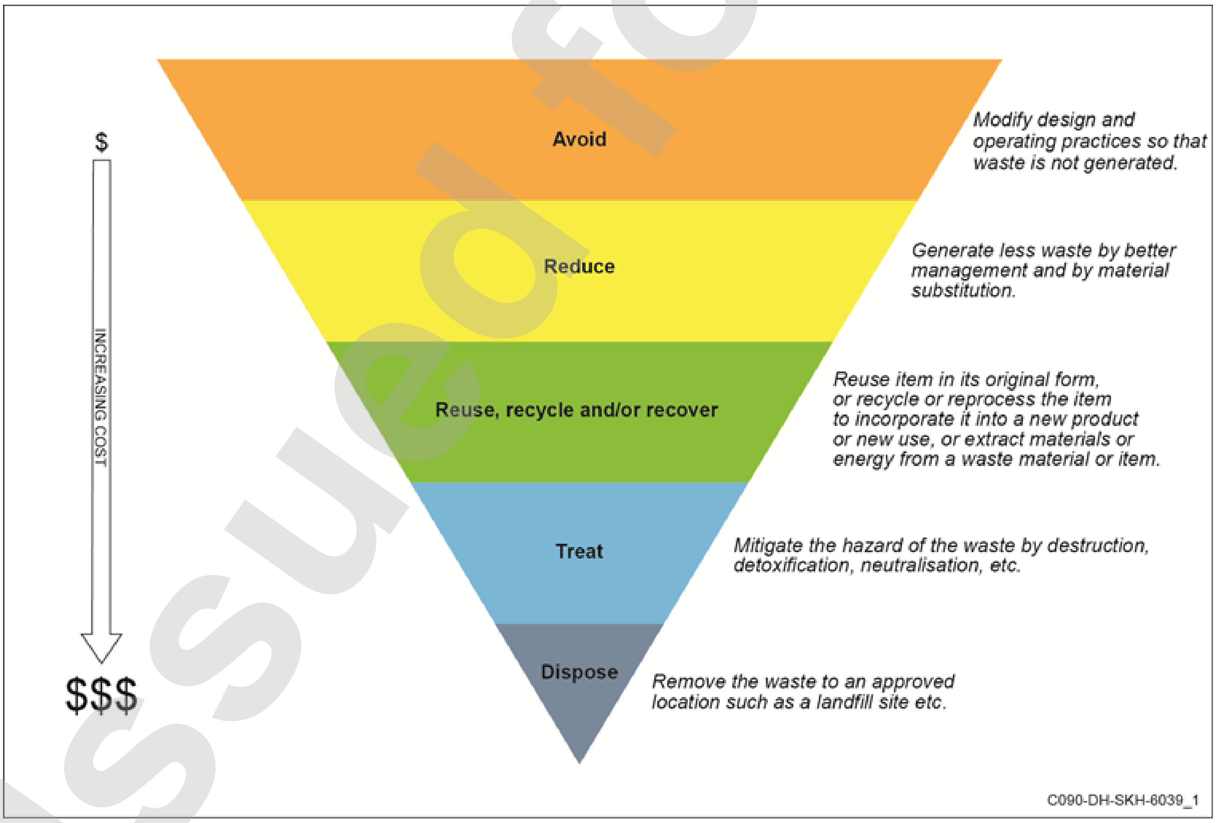


Figure 3-15: Waste control hierarchy

Various waste transfer stations have been installed around Ichthys LNG so wastes can be segregated and stored in appropriate receptacles prior to transfer to the waste management area in the operations complex.

The waste management area in the operations complex is located on a hardstand surface and provides areas for the segregation and storage of solid and liquid waste prior to removal from site by licensed contractors. A variety of receptacles (e.g. skips, bins and bunds) are provided for different waste types. The waste management area is also designed for the segregation and separate storage of recyclable waste. Different waste types are labelled for easy identification.

3.9 Chemical Selection Process

INPEX has a robust chemical selection process which outlines requirements for selection, assessment and approval of hazardous and non-hazardous chemicals for use on INPEX sites or facilities to verify that INPEX complies with relevant legislation. Any chemical products requested for use on Company sites or facilities which would be released to the environment under normal operating conditions, or have the potential to be released to the receiving environment in the event of a loss of containment, and that have an environmental hazard (toxic to flora, fauna etc.) defined by the risk phrase between R50 and R59 on a Safety Data Sheet are assessed by an Environmental Advisor. The assessment includes a review of toxicity, expected volumes and consistency with environmental approvals.

This chemical selection process limits the potential impacts from chemicals used on site and contained within liquid discharges by requiring that chemical products used in Ichthys LNG start-up and steady-state operations are reviewed by an Environmental Advisor prior to selection, in line with INPEX assessment procedures.

INPEX operates a chemical management system called ChemAlert, which provides information on environmental criteria for chemical products and ensures that appropriate fluids are used with minimal anticipated environmental impact and, where possible, pose little or no risk to the environment.

3.10 Summary of Best Practice Design Environmental Benefits

Best practice design has been identified for Ichthys LNG through design and technology selection processes that include assessing against a range of criteria such as energy efficiency; equipment operational parameters; reduction of emissions; discharges and waste generation; maintenance requirements; costs and HSE risk assessments.

Material selection is also an important component of best practice design; selection of materials that can withstand corrosion and other environmental stressors results in minimised resource consumption and reduces the potential for environmental impacts. The material selection process has taken into account factors such as the climate/atmospheric corrosion; design temperature and operating conditions; climatic conditions; and corrosion potential from atmospheric, soil and seawater interfaces.

It is recognised that the most significant gains in environmental performance, including energy and greenhouse gas efficiency, are achieved through early planning and design. The sub-sections below demonstrate INPEX's commitment to environment-in-design that benefits environmental outcomes during operation.

3.10.1 Turbine selection

INPEX sought to minimise NO_X, PM2.5 and PM10 emissions from Ichthys LNG by specifying low NO_X and low particulate emitting combustion equipment. All plant equipment is new and in most cases includes the latest supplier technology with respect to emission reduction. The gas turbines selected for Ichthys LNG have the latest low NOX technology consistent with good international practice defined by the IFC EHS Guidelines.

Selection of the dry low NO_x technology means that water injection is not required for the turbines, and this greatly reduces the water consumption during hydrocarbon processing.

INPEX has also selected energy-efficient turbines.

3.10.2 Flaring and Venting During Restarts

Ichthys LNG is designed for hydrocarbon flaring during plant restarts rather than venting, as flaring converts the hydrocarbons into CO_2 which has a lower global warming potential than the gases released through venting.

Flaring and Venting During Steady-state Operations

Ichthys LNG has been designed so continuous flaring is not required during normal operations other than flaring of the pilot lights and minimum purge gas to protect the flare burners.

The number of relief valves in the overall Ichthys LNG design, which could vent gases to the atmosphere, has also been reduced.

Ichthys LNG flares have been designed to minimise dark-smoke production by improving air-fuel mixing to ensure sufficient oxygen for complete combustion.

Power Plant Selection

A CCPP has been selected to generate electricity for Ichthys LNG instead of an open cycle power plant configuration; this significantly improves Ichthys LNG energy efficiency and reduces air emissions.

During normal operations the Frame 6 power generation turbines are designed to run on fuel gas, with vaporised isopentane burned in duct burners in the exhaust system (HRSG) of the gas turbines. This makes the CCPP more energy efficient and provides a use for excess isopentane.

Mercury Removal

Unlike other hydrocarbon processing plants, which have the mercury removal units after dehydration, Ichthys LNG has been built with the gas phase mercury removal units positioned ahead of the AGRUs. This reduces the risk of mercury being released to the atmosphere through the AGRU incinerator stacks or bypass vents.

Use of aMDEA as the Solvent in the AGRU

A solvent is required in the AGRU to remove CO_2 and other acid gases from the gas prior to liquefaction. The acid gases will be removed by flowing gas upwards against a downward flow of solvent, causing the acid gases to be absorbed into the solvent. The used solvent is then heated to release the acid gases (including CO_2) so the solvent can be reused. There are a number of solvent products that can be used in the process; however, aMDEA was selected because it provides the following benefits:

- Co-absorption of CH_4 and other hydrocarbons is minimised, which in turn reduces the amount of CH_4 and hydrocarbons that are flashed off, which are then incinerated during solvent regeneration process.
- Less energy is required to regenerate aMDEA, which in turn reduces resource consumption and atmospheric emissions.

Heat Recovery Systems

Heat is required for many processes in Ichthys LNG, particularly in the AGRUs which require heat to regenerate the aMDEA and for condensate stabilisation.

Ichthys LNG has been designed with waste heat recovery units (WHRUs), including units in the Frame 7 compression turbine stacks in the LNG trains to recover waste heat from the exhausts of the Frame 7 compression turbines. The recovered heat is used to heat the heating medium. Reusing the recovered waste heat in the hydrocarbon production process eliminates the need for operational fired heaters, with fired heaters only needed during start-up (and not during steady-state operations).

The AGRU incinerators have been designed with an advanced waste heat recovery system that uses exhaust heat to pre-heat the combustion air, thus minimising the need for gas firing to maintain sufficient combustion temperature.

The CCPP has been designed with a waste heat steam generation unit that generates steam through heat recovery steam generators using heat in the Frame 6 power generation turbines, in addition to steam generated by utility boiler.

Use of waste heat recovery systems reduces overall fuel consumption and air emissions.

Condensate Tank Roof Design

Each condensate tank has been designed and built with a domed roof that sits over the internal floating roof. This prevents rain water from entering the tank, thus reducing rainwater ingress, which in turn reduces the frequency of tank draining which reduces wastewater volumes and the need to treat contaminated water to remove hydrocarbons.

The condensate tanks are also designed with double seals to minimise fugitive emissions.

Flash Gas Recovery

End flash gas from the fractionation and liquefaction process is recovered and directed to the fuel gas system, which then distributes the gas for use in various equipment and utility systems within Ichthys LNG. The alternative to recovering flash gas is to incinerate the gas, which would result in atmospheric emissions and less overall energy efficiency. The recovery of flash gas not only decreases the need for additional resources (fuel gas) but also reduces overall air emissions.

Motor Specifications

The best available technology not exceeding excessive costs (BATNEEC) principle has been applied when selecting technology for Ichthys LNG, including during the selection of motors. Environmental benefits include overall reduction in air emissions, reduction in maintenance (which reduces the volume of consumables and chemicals used on site) and increased energy efficiency.

LNG Boil-off Gas Recovery

Two LNG BOG compressors have been installed, with each compressor designed for 50% of the loading mode BOG rate. Due to the highly efficient thermal insulation built into the LNG storage tanks, only a small amount of boil off will occur whilst maintaining the LNG product at cryogenic temperature inside the tanks. The BOG compressors are used to recover and compress the LNG BOG that does get generated, thus avoiding the need to flare most of the time. Flaring is only required if a compressor is down for maintenance, an exceptionally warm ship needs to be loaded, or an inerted ship needs to be loaded.

Propane Tank Vapour Recovery

Propane product from fractionation is stored in a cryogenic atmospheric storage tank. The system has been designed to minimise flaring of propane BOG by recycling the propane BOG via the propane BOG compressor and associated refrigeration circuit. This reduces the need to flare, although flaring will not be entirely eliminated, for example flaring will occasionally be needed to defrost the chillers for maintenance.

Butane Tank Vapour Recovery

Butane product is also stored in a cryogenic atmospheric pressure tank. The pressure in the Butane Storage Tank will be held constant by varying the amount of butane rundown flow into the Butane Product Subcooler. The subcooled butane will then be sprayed from the top of the inside tank, recondensing all vapour generated. This cools it enough to reliquefy it, so it does not need to be flared.

Dry Gas Seals

Seals have been installed throughout Ichthys LNG, particularly on compressors, to prevent gas from escaping in the future as fugitive emissions. There are various types of wet and dry seals available on the market, however dry gas seals have been selected for Ichthys LNG as they provide a number of environmental benefits. Dry gas seals result in the lowest fugitive emissions leakage rate of all available seals; they do not need oil circulation pumps/systems, which results in reduced power consumption and lower maintenance. Dry seals also do not require lubricating oils (therefore reducing the amount of chemicals needed on site).

4 HAZARD IDENTIFICATION AND RISK ASSESSMENT

This section provides a description of the environmental hazard and risk assessment process that was undertaken to identify the environmental risks associated with the start-up and operations phase of Ichthys LNG.

4.1 Environmental Hazards and Risk Assessment

INPEX has an established risk management process (including internal standards, guidelines and procedures) to ensure that activities are and will continue to be undertaken such that risks are managed.

The risk assessment process aligns with the procedures outlined in the Australian and New Zealand Standards AS/NZS ISO 31000:2009, Risk management––Principles and guidelines and HB 203:2012, Managing environment––Related risk. The process is documented at various levels throughout the organisation and is supported by risk management standards, procedures and tools.

The risk management process is conducted in a manner consistent with the INPEX Risk Matrix (Figure 4-1).

Key elements of the risk management process are as follows:

- Identification of sources of risk/hazard: identifies the sources of risks (hazards) and their environmental and socio-economic impacts.
  - Identification of risks – the identification of unplanned environmental effects or unplanned interactions between aspects of the Project and environmental and socio-economic receptors. Due to being unplanned, a risk has a varying probability of occurrence and therefore, the likelihood of the risk occurring needs be classified.
  - Identification of impacts – the identification of planned environmental effects or interaction, which can be either continuous or intermittent. The probability of an impact occurring is certain; therefore, the likelihood of the impact (based on the INPEX Risk Matrix) is always considered to be highly likely and a risk ranking is not allocated.
- Residual Risk analysis: determines the ranking of an environmental risk as per the INPEX risk matrix. Residual risk is the product of the consequence of a risk on the environment and the likelihood of that risk occurring at a defined location in a specified period of time, assuming that all control measures are in place and implemented.

INPEX

Risk Matrix

LIKELIHOOD TABLE

	6	5	4	3	2	1
Time Frame Could be experienced	100 year timeframe or less	50 year timeframe	10 - 20 year timeframe	5 year strategic planning time frame	1 -2 year budget timeframe	Once or more during the next year
Experience History of occurrence in Company or Industry	Unheard of in the industry or in Projects	Has occurred once or twice in the industry or rarely occurs in Projects	Has occurred many times in the industry but not in the company or in <1 out of 100 Projects	Has occurred once or twice in the company or in <1 out of 10 Projects	Has occurred frequently in the company or in many Projects	Has occurred frequently at the location or in every Project
Frequency Continuous Operation	Once every 10 000 – 100 000 years at location	Once every 1,000 – 10 000 years at location	Once every 100 - 1000 years at location	Once every 10 - 100 years at location	Once every 1 - 10 years at location	More than once a year at location or continuously
Probability Single activity	1 in 100 000 – 1 000 000	1 in 10 000 – 100 000	1 in 1000 – 10 000	1 in 100 - 1000	1 in 10 - 100	>1 in 10

CONSEQUENCE TABLE

CONSEQUENCES

Severity Level	Financial NPV	Financial A$	Health & Safety	Environment	Reputation	Cultural & Social Heritage	Legal
A	>$1B	> $5B Project Schedule >24 months	>20 fatalities or permanent total disabilities	Regional scale event, permanent impact on environment. Eradication of local populations of protected species	Prolonged international multi-NGO and media and by public protests. Loss of host government support and/ or social licence to operate. Company reputation severely tarnished	Permanent, long-term impact on social structure, and destruction of highly-valued heritage, aesthetic, economic or recreational items	Criminal prosecution, potential jail sentences for directors and senior officers. Civil prosecution, class actions. Heavy fines, threat to licence to operate or future approvals
B	$100M – $1B	$1B – $5B Project Schedule 12 – 24 months	2 – 20 fatalities or permanent total disabilities	Large scale event, long term impact on environment. Extensive impact on populations of protected species	International multi-NGO and media condemnation. Host government registers concerns. Prolonged large protests. Company reputation seriously impacted	Widespread disruption to a number of communities with damage to highly-valued heritage, aesthetic, economic or recreational items	Criminal prosecution for directors and senior officers. Civil prosecution and class actions. Heavy fines, threat to licence to operate
C	$10M – $100M	$100M – $1B Project Schedule 6 – 12 months	Single fatality or Permanent Total Disability	Medium to large scale event, medium term impact on environment. No threat to overall population viability of protected species	Serious public or national media outcry. Damaging NGO campaign. Large protests. Company reputation impacted	Significant impact to regional communities, and to heritage, aesthetic, economic or recreational items of significant value	Significant, multiple breaches of regulation or licence conditions. Significant litigation and fines
D	$1M – $10M	$10M – $100M Project Schedule 1 - 6 months	Major injury or illness, permanent partial disability, lost time injury	Local to medium scale event with short to medium term impact on environment. No threat to overall population viability of protected species	Major adverse national media, public or NGO attention. Significant protests. Asset reputation impacted	Regional community disruption with moderate impact on heritage, aesthetic, economic or recreational values	Serious breach of regulation. Investigation by regulatory authorities. Potential litigation and moderate fines
E	$100K– $1M	$1M – $10M Project Schedule 2 - 4 weeks	Minor injury or illness, alternative duties injury, medical treatment injury	Local scale event with short term impact on the environment. Minor and temporary impact on a small portion of the population of protected species	Attention from regional media with heightened concern with local community. Criticism by community or NGOs	Isolated community disruption with limited adverse impact on heritage, aesthetic, economic or recreational values	Minor legal issues. Report provided to regulatory authorities. Potential for minor fines
F	<$100K	<$1M Project Schedule <2 weeks	Slight injury or illness, first aid injury	Local scale event with temporary impact on environment. Behavioural responses inconsequential ecological significance to protected species	Short term local concern or complaints. Low level media or regulatory issue	Minor impact on heritage, aesthetic, economic or recreational values	Breach of internal standards. Potential scrutiny by regulatory authorities

Likelihood Level

Severity	6 Remote	5 Highly Unlikely	4 Unlikely	3 Possible	2 Likely	1 Highly Likely
A Catastrophic	6	5	4 Critical Risk	3	2	1
B Major	7	6	5	4	3	2
C Significant	8	7	6 High Risk	5	4	3
D Moderate	9	8	7	6	5	4
E Minor	10	9	8 Moderate Risk	7	6	5
F Insignificant	10	10	9 Low Risk	8	7	6

INPEX Risk Matrix
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Figure 4-1: INPEX Australia risk matrix

4.2 Risk Identification

Risk identification for the operation of Ichthys LNG was initially undertaken through an environmental hazard identification (ENVID) workshop in November 2014. The ENVID workshop took place over two days. Since then, further ENVIDs have been conducted, as needed. As with all risk assessments, there is a level of uncertainty in predicted risk levels; however to reduce the level of uncertainty ENVIDs are undertaken by experienced personnel from a variety of disciplines (including HSE, engineering, operations and maintenance personnel) using a robust risk assessment process. The initial ENVID was informed by:

- a review of Ichthys LNG design, construction and operations documents
- a review of previous construction ENVIDs undertaken for Ichthys LNG
- the experience of environmental and technical practitioners undertaking the ENVID.

Risks as a result of interactions between environmental and socio-economic receptors (Section 2) and aspects of Ichthys LNG (Section 3) were identified and assessed, and a risk ranking was allocated to each item.

Following completion of the ENVID, the risk and management controls were consolidated into an impacts and aspects registers, which is provided in Table 4-1 to Table 4-3 of this document. Note the potential social and environment interactions are described such as there are no controls in place.

The risk assessment was then translated into a conceptual site model to verify that discharge sources have been identified, check for any information gaps and present the risk assessment in a diagrammatic manner. The conceptual site model is presented in Figure 4-2.

Further detail regarding the management of risks is provided in Section 5.

Table 4-1: Emissions to air

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls **Note: more detail is provided in Section 5**	C	L	Residual risk
Flaring (planned and unplanned).	Three ground flares. Three tankage flares. One liquid flare.	NOX, SOX, greenhouse gases, particulates (PM10, PM2.5). Dark-smoke. O3 (as a secondary pollutant, not a primary emission)	Reduction in ambient air quality. Reduction in visual amenity. Contribution to greenhouse gases. Adverse effects on the natural environment and human health. Note: air modelling results indicate that air pollutants are not expected to exceed NEPM standards (Section 2.3.3)	Engineering (as-built) controls. Process monitoring, detection and alarm systems. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Operating targets and standards. Management plans/systems. Operating procedures. Inspections and preventative maintenance. Visual monitoring. Community/regulator engagement.	Planned flaring		
					F	6	Moderate
					Unplanned flaring		
					E	2	Moderate

Aspect	**Source**	**Emission / discharge**	**Potential social and environmental interaction**	**Key controls** **Note: more detail is provided in Section 5**	**C**	**L**	**Residual risk**
Combustion of fuel gas (including isopentane)	Four LNG train Frame 7 compression turbines. Five CCPP Frame 6 power generation turbines with vaporised isopentane duct burning downstream. Two AGRU Incinerators. Two heating medium furnaces.	NOX, SOX, greenhouse gases, particulates (PM10, PM2.5). O3 (as a secondary pollutant, not a primary emission)	Reduction in ambient air quality. Contribution to greenhouse gases. Adverse effects on the natural environment and human health. Note: air modelling results indicate that air pollutants are not expected to exceed NEPM standards (Section 2.3.3)	Engineering (as-built) controls. Technology, equipment and/or materials selection. Design requirements. Procedural controls. Management plans/systems. Operating procedures. Performance monitoring.	Combustion of fuel gas (including isopentane)		
					F	6	Moderate
					Incomplete combustion of fuel gas (including isopentane)		
					F	4	Low

<table>
<tr><th>Aspect</th><th>Source</th><th>Emission / discharge</th><th>Potential social and environmental interaction</th><th>Key controls
Note: more detail is provided in Section 5</th><th>C</th><th>L</th><th>Residual risk</th></tr>
<tr><td>Combustion of diesel.</td><td>Diesel emergency generators.
Diesel firewater pumps.
Vehicles.</td><td>NOX, SOX, greenhouse gases, particulates (PM10, PM2.5).
O3 (as a secondary pollutant, not a primary emission)</td><td>Reduction in ambient air quality.
Contribution to greenhouse gases.
Adverse effects on the natural environment and human health.
Note: air modelling results indicate that air pollutants are not expected to exceed NEPM standards (Section 2.3.3)</td><td>Procedural controls.
Operating procedures.
Inspections and preventative maintenance.</td><td>F</td><td>6</td><td>Moderate</td></tr>
<tr><td rowspan="4">Venting</td><td rowspan="4">Condensate tankers (during loading).
AGRU acid gases (due to incinerator trip or shutdown).
Solvent tanks and amine wastewater tanks.
Heating medium tank.
Diesel tanks.</td><td rowspan="4">VOCs (including BTEX), H2S, greenhouse gases.</td><td rowspan="4">Reduction in ambient air quality.
Contribution to greenhouse gases.
Adverse effects on the natural environment and human health.</td><td rowspan="4">Engineering (as-built) controls.
Design requirements.
Technology, equipment and/or materials selection.
Procedural controls.
Operating procedures.</td><td colspan="3">Planned venting (e.g. during condensate loading AGRU incinerator shutdowns and from tanks)</td></tr>
<tr><td>f</td><td>6</td><td>Moderate</td></tr>
<tr><td colspan="3">Unplanned venting (e.g. AGRU incinerator trips)</td></tr>
<tr><td>F</td><td>3</td><td>Low</td></tr>
</table>

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls Note: more detail is provided in Section 5	C	L	Residual risk
Fugitive emissions	Leaks from equipment such as flanges, valves, pumps, gaskets, seals and connections, and condensate tanks.	Greenhouse gases, VOCs (including BTEX), other contaminants (e.g. Hg, H2S).	Reduction in ambient air quality. Contribution to greenhouse gases. Adverse effects on the natural environment and human health.	Engineering (as-built) controls. Technology, equipment and/or materials selection. Design requirements. Procedural controls. Visual inspections. Management plans/systems. Operating procedures.	F	3	Low

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls **Note: more detail is provided in Section 5**	C	L	Residual risk
Loss of containment - Hydrocarbon (gas)	Failure, rupture or leakage from de-ethaniser, de-propaniser, de-butaniser and associated equipment. Failure or rupture of LPG, LNG or propane storage tanks and loading arms. Leakage/release from tanks, pipework, seals, pumps, drums etc.	VOCs (including BTEX), other contaminants (e.g. Hg, H2S).	Reduction in ambient air quality. Contribution to greenhouse gases. Adverse effects on the natural environment and human health.	Engineering (as-built) controls. Process monitoring, detection and alarm systems. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Visual inspections. Inspections and preventative maintenance. Operating procedures. Management plans/systems.	D	5	Moderate

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls **Note: more detail is provided in Section 5**	C	L	Residual risk
Use of rotating/ moving equipment. Flaring (planned and unplanned). Venting.	Four LNG train Frame 7 compression turbines. Five CCPP Frame 6 power generation turbines with vaporised isopentane duct burning downstream. Three CCPP Utility boilers. Two AGRU Incinerators. Two heating medium furnaces. Three ground flares. Three tankage flares. One liquid flare. Diesel emergency generators. Diesel firewater pumps. Vehicles. Noise from operating	Noise and vibration.	Contribution to off-site noise/vibration effects at nearest receptors. Nuisance to the community. Change in fauna behaviour (e.g. mating, feeding). Fauna moving away from or avoiding habitat areas. Adverse effects on the natural environment and human health.	Engineering (as-built) controls. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Inspections and preventative maintenance. Community/regulator engagement. Management plans/systems	F	6	Moderate

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls Note: more detail is provided in Section 5	C	L	Residual risk
General lighting for 24 hour operations. Flaring (planned and unplanned).	Three ground flares. Three tankage flares. One liquid flare. Diesel emergency generators. Diesel firewater pumps. Vehicles. Noise from operating equipment. Three ground flares. Three tankage flares. One liquid flare. Product loading jetty and jetty dolphins. LPG, LNG and condensate tankers. General lighting of work areas and access areas	Light	Light pollution (e.g. light glow, light spill). Change in fauna behaviour (e.g. mating, feeding). Fauna moving away from or avoiding habitat areas. Loss of visual amenity. Nuisance to community.	Engineering (as-built) controls. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Inspections and preventative maintenance. Community/regulator engagement.	F	6	Moderate

Table 4-2: Discharges to water

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls Note: more detail is provided in Section 5	C	L	Residual risk
Generation of liquid discharges.	AOC/COC water system. Sewage and grey water. Demineralisation plant reject water. CCPP steam blowdown water. NCW drainage (during rainfall)	Treated water discharged into Darwin Harbour. NCW (clean stormwater) discharged into Darwin Harbour via perimeter drain.	Pollution of marine water (Darwin Harbour). Bioaccumulation and toxicity effects. Alteration of the marine environment through wastewater discharges. Impact to commercial (aquaculture) and recreational fish species. Impact to vegetation.	Engineering (as-built) controls. Process monitoring, detection and alarm systems. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Operating procedures. Inspections and preventative maintenance.	F	6	Moderate
Spill/Leak to Darwin Harbour – non-hydrocarbons.	Inappropriate storage, handling, distribution or disposal of chemicals/liquid (hazardous) waste. Loss of containment of chemicals/liquid (hazardous) waste.	Liquid waste, chemicals or insufficiently treated wastewater discharged into Darwin Harbour.	Pollution of marine water (Darwin Harbour). Damage to benthic environment (Darwin Harbour). Bioaccumulation and toxicity effects.	Engineering (as-built) controls. Design requirements. Procedural controls. Operating procedures. Inspections and preventative maintenance. Training/inductions.	E	3	Moderate

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls **Note: more detail is provided in Section 5**	C	L	Residual risk
	Leakage of chemicals from valves, pipes, loading arms, tanks, seals, etc. Inappropriate handling of wastewater. Accidental contamination of wastewater treatment systems. Accidental discharge of insufficiently treated wastewater.		Alteration of the marine environment through wastewater discharges. Impact to commercial (aquaculture) and recreational fish species. Impact to vegetation.	Management plans/systems. Provision of spill response equipment. Provision made to vacuum truck to offsite disposal any wastewater that cannot be treated to meet discharge specifications to Darwin Harbour.			
Loss of containment to Darwin Harbour – hydrocarbons (liquid).	Failure or rupture of condensate loading lines and arms. Leakage of hydrocarbons from tanks, pipework etc. Hydrocarbons (liquid).	Hydrocarbons (liquid).	Pollution of marine water (Darwin Harbour). Damage to benthic environment (Darwin Harbour). Bioaccumulation and toxicity effects. Alteration of the marine environment through wastewater discharges.	Engineering (as-built) controls. Process monitoring, detection and alarm systems. Design requirements. Technology, equipment and/or materials selection. Procedural controls.	D	4	Moderate

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls **Note: more detail is provided in Section 5**	C	L	Residual risk
			Impact to commercial (aquaculture) and recreational fish species. Impact to vegetation.	Inspections and preventative maintenance. Operating procedures. Provision of spill response equipment. Training/inductions. Management plans/systems.			

Table 4-3: Discharges to land

Aspect	**Source**	**Emission / discharge**	**Potential social and environmental interaction**	**Key controls** **Note: more detail is provided in Section 5**	**C**	**L**	**Residual risk**
Surface water runoff and drainage.	NCW system.	Non-contaminated water.	Erosion and sedimentation (from NCW discharge). Damage to/death of vegetation.	Engineering (as-built) controls. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Operating procedures. Inspections and preventative maintenance.	F	5	Low
Loss of containment to land – hydrocarbons (liquid).	Failure or rupture of hydrocarbon storage and loading facilities, including: • Condensate tanks • Diesel storage tanks • Heating medium storage tanks • Isopentane system.	Hydrocarbons (liquid).	Contamination of groundwater. Contamination of soil. Impact to vegetation.	Engineering (as-built) controls. Process monitoring, detection and alarm systems. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Operating procedures.	D	5	Moderate

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls **Note: more detail is provided in Section 5**	C	L	Residual risk
	Leakage of hydrocarbons from tanks, pipework etc. Loss of containment from liquid flare system.			Inspections and preventative maintenance. Training/ inductions. Provision of spill response equipment. Management plans/systems.			
Spill/leak to land.	Inappropriate storage, handling, distribution or disposal of chemicals/liquid (hazardous) waste. Leakage of chemicals from tanks, pipework, pumps, valves, transfers etc. Leakage or failure of COC/AOC drainage system.	Liquid waste, chemicals or wastewater.	Contamination of groundwater. Contamination of soil. Impact to fauna. Impact to vegetation.	Engineering (as-built) controls. Process monitoring, detection and alarm systems. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Operating procedures. Inspections and preventative maintenance. Training/ inductions. Provision of spill response equipment.	E	4	Moderate

Aspect	Source	Emission / discharge	Potential social and environmental interaction	Key controls **Note: more detail is provided in Section 5**	C	L	Residual risk
				Management plans/systems.			
Generation of waste.	Inappropriate storage, handling, distribution or disposal of waste or sludge. Inappropriate practices during use of consumables or replacement of parts.	Liquid (hazardous) waste. Liquid (non-hazardous) waste. Solid (hazardous) waste. Solid (non-hazardous) waste. Biological waste.	Contamination of groundwater. Contamination of soil. Impact to fauna. Attraction of fauna/introduced terrestrial species to waste. Indirect impacts to fauna through predation. Generation of odour. Impact to vegetation.	Engineering (as-built) controls. Design requirements. Technology, equipment and/or materials selection. Procedural controls. Operating procedures. Inspections and preventative maintenance. Training/ inductions. Provision of spill response equipment. Management plans/systems.	F	4	Low

Source	Potential Release Mechanism	Pathway	Emission / Discharge	Exposure Route	Receptors: Human	Vegetation T	Vegetation M	Fauna T	Fauna M
Flares	Flaring (planned and unplanned)	Air	NO_x, SO_x, GHG, particulates, dark smoke	Inhalation, photosynthesis, physical contact, visual	✓	✓		✓	
Turbines, boilers, incinerators, furnaces	Combustion of fuel gas	Air	NO_x, SO_x, GHG, particulates	Inhalation, photosynthesis, physical contact, visual	✓	✓		✓	
Generators, pumps, vehicles	Combustion of diesel	Air	NO_x, SO_x, GHG, particulates	Inhalation, photosynthesis, physical contact, visual	✓	✓		✓	
Vents on tanks, AGRU	Venting	Air	VOCs, H_2S, GHG	Inhalation, photosynthesis, physical contact, visual	✓	✓		✓	
Gaseous inventory	Release of fugitive emissions	Air	GHG, VOCs, other contaminants (e.g Hg, H_2S)	Inhalation, photosynthesis, physical contact, visual	✓	✓		✓	
Hydrocarbon inventory in storage and equipment	Loss of containment – hydrocarbons (gas)	Air	VOCs, other contaminants (e.g Hg, H_2S)	Inhalation, photosynthesis, physical contact, visual	✓	✓		✓	
Various equipment, flares, vehicles	Rotating / moving equipment, flaring, venting	Air	Noise and vibration	Physical contact	✓			✓	
Flares, jetty, tankers, general lighting	General lighting for 24 hour operations, flaring	Air	Light	Visual	✓			✓	
AOC/COC water, sewage and greywater, demineralisation plant reject water, CCPP steam blowdown water	Planned discharge of treated waste water	Water	Treated water discharged into Darwin Harbour	Physical contact, bioaccumulation, toxicity	✓		✓		✓
Chemicals/liquid waste, accidental contamination of wastewater treatment system, insufficiently treated wastewater	Accidental discharge of insufficiently treated wastewater	Water	Liquid waste, chemicals or insufficiently treated water discharged into Darwin Harbour	Physical contact, bioaccumulation, toxicity	✓		✓		✓
Hydrocarbon inventory in storage and equipment	Loss of containment – hydrocarbons (liquid)	Water	Hydrocarbons (liquid) into Darwin Harbour	Physical contact, bioaccumulation, toxicity	✓		✓		✓
NCW system	Surface water runoff and drainage	Intertidal	Non-contaminated water	Physical contact		✓	✓		✓
Failure or rupture of storage tanks or equipment (e.g. pipework), loss of containment from liquid flare	Loss of containment – hydrocarbons (liquid)	Land Groundwater	Hydrocarbons (liquid)	Physical contact, toxicity	✓	✓		✓	
Chemicals/liquid waste, leakage, failure of AOC/COC drainage system	Spill/leak	Land Groundwater	Liquid waste, chemicals or wastewater	Physical contact, toxicity		✓		✓	
Waste, sludge, consumables and replaced parts	Generation of waste	Land Groundwater	Hazardous and non-hazardous solid and liquid waste, biological waste	Physical contact, toxicity, odour	✓	✓		✓	

Legend
T = terrestrial
M = marine

Figure 4-2: Ichthys LNG conceptual site model

5 ENVIRONMENTAL MANAGEMENT STRATEGIES

In 2011, INPEX provided provisional environmental management plans (PEMPs) in the Draft EIS for the Ichthys Project (Section 1.5.1). The PEMPs were developed while the Ichthys Project was in design stage, and presented indicative management strategies for significant environmental aspects or specific activities identified in the Draft EIS.

As the Ichthys Project progressed through construction, greater technical detail became available to further inform the environmental management of Ichthys LNG. The PEMPs have been used as the basis of the environmental management strategies presented in this Section. The PEMPs have been reviewed along with current design documents, construction documents and operational procedures. The relevant detail from these documents has been incorporated into the environmental management strategies presented below. Additional control measures identified in the onshore ENVID workshop (Section 4.2) have also been incorporated.

5.1 Air Quality

Table 5-1 presents the management measures used to minimise potential impacts to air quality.

A description of the existing ambient air quality and cumulative air modelling relevant to this OEMP is discussed in Section 2.3.3. The standard air emissions generated from start-up and operations of Ichthys LNG are presented in Section 3.8.1.

Table 5-1: Air emissions management strategy

Air quality
Potential interaction with environmental and socio-economic receptor
• Reduction in ambient air quality. • Reduction in visual amenity. • Contribution to greenhouse gases. • Adverse effects on the natural environment and human health.
Applicable legislation, standards and guidelines
• Environment Protection (National Pollutant Inventory) Objective (NT). • National Environment Protection (National Pollutant Inventory) Measure (Cth). • National Environment Protection (Ambient Air Quality) Measure (Cth). • National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) (Cth). • *National Greenhouse and Energy Reporting Act 2007* (Cth). • WMPC Act. • IFC EHS Guidelines 2007. • NSW Protection of the Environment Operations (Clean Air) Regulation 2010 Group 6. • AS 4323.1:1995, Stationary source emissions—Selection of sampling positions.

Air quality		
Performance objectives	**Targets**	**Key performance indicators**
Emissions to air adhere to the EPL approval conditions.	Zero exceedances of EPL criteria for air emissions.	Environmental incident records.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. General	1. Process monitoring systems, alarm systems, flame detectors, gas detection system and emergency shutdown systems are installed throughout Ichthys LNG for early detection of faults, leaks, loss of containment and potential upset conditions. 2. Refrigerant with lowest ozone depleting substance rating or global warming potential, that still meets technical requirements, have been selected where practicable. 3. Valves are installed in the process system to allow for inventory isolation.	1. Steady-state and normal operations will adhere to the INPEX emissions and discharges standards. 2. Flaring will be minimised to as low as reasonably practicable. 3. A routine inspection and preventative maintenance program has been implemented to verify that equipment is working efficiently and within operational specifications. 4. The local community will be notified in advance of extended or elevated periods of flaring which may cause visual impacts. 5. A community hotline is provided for community feedback.

Air quality		
2. Flaring: • planned flaring during Ichthys LNG start-up activities • planned flaring from steady-state operations of pilot lights and flare system purge • planned flaring due to maintenance and shutdowns • planned flaring from LNG and LPG vessel cool-downs and gas-ups • unplanned flaring due to trips or upset conditions.	1. Ichthys LNG has been designed to minimise continuous flaring except as required for safe operation of the safety flare system (pilot lights and flare system purge) which will be continuous. 2. Ichthys LNG (including the flare systems) has been designed for reliability and stability, which minimises the risk of needing to flare (at above pilot light and purge rates) due to upset conditions. 3. Unplanned flaring from upsets will be minimised due to equipment design, technology selection and alarm systems. 4. A flare monitoring and control system, including flow meters and CCTV monitoring of flares, is used to manage the flare systems. CCTV monitoring will occur through numerous cameras including a dedicated infrared thermal imaging camera for nigh-time use. 5. Used regeneration gas for the dehydration system is normally be recovered and returned to the fuel gas system.	1. Ship loading rates for LPG and LNG tankers are regulated to minimise flaring from loading activities. 2. Procedures to reduce fuel gas imbalance will are implemented, which reduces the need to flare off-specification fuel gas. 3. A power management system is used for the CCPP to maintain a power load above 20% (this reduces incomplete combustion of fuel in the turbines and boilers) and distribute the load across the various turbines and boilers, to effectively and efficiently run the power plant. 4. Performance monitoring of the CCPP system (including turbines and boilers) is undertaken to minimise incomplete combustion of fuel.

Air quality		
	6. BOG from LNG storage tanks and LNG offtake tanker loading operations is recovered by BOG recompression systems and directed to the fuel-gas supply. 7. BOG from LPG storage tanks is recovered, chilled and directed back to the storage tanks. 8. Flow meters are installed on the flare systems to monitor volumes of hydrocarbons that are combusted.	
3. Combustion of fuel gas and isopentane: • combustion of low-pressure fuel gas during operation of incinerators, fired heaters, CCPP boilers, pilot lights and as purge gas for the flares • combustion of high-pressure fuel gas during operation of the Frame 7 compression turbines and Frame 6 power generation turbines • combustion of isopentane during operation of the CCPP, including duct burners in the exhaust system of the Frame 6 power generation turbines and utility boilers.	1. Frame 6 and Frame 7 compression turbines are fitted with dry low NOX burners that are designed to achieve low NOX emissions when burning fuel gas at design rates. 2. aMDEA is used as a solvent in the AGRU rather than Sulfinol, which significantly reduces hydrocarbon entrainment (potential greenhouse gases) release. 3. The AGRU incinerators have been designed to pre-heat acid gas prior to incineration of the waste gas stream. 4. Flow meters have been installed on turbines to monitor quantities of fuel gas that are combusted.	-

Air quality		
	5. Easily accessible sampling points have been provided on major emission points such as turbines and AGRU exhaust stacks. 6. Waste-heat recovery and steam generation units have been installed at key locations on the Frame 7 stacks and Frame 6 power generation turbines to economically use waste heat in the hydrocarbon processing system and reduce the requirement for fuel gas. 7. The AGRU incinerator has been designed for reliability, which minimises likelihood of upset conditions. 8. Ichthys LNG has been designed with a CCPP rather than an Open Cycle Power Plant, thus delivering significant energy efficiency benefits.	
4. Combustion of diesel: • combustion of diesel due to use of vehicles, emergency generators, firewater pumps, and other equipment.	-	1. Low sulfur diesel is used for diesel-driven equipment (generators, pumps) and site vehicles. 2. Routine inspection and maintenance of diesel-driven equipment (generators, fire pumps) and vehicles are undertaken to enable efficient combustion of fuel.

Air quality		
5. Venting: • venting during condensate tanker loading • venting due to AGRU incinerator trip or shutdown • venting from various storage tanks including, solvent (aMDEA), amine wastewater, heating oil, diesel, and bulk condensate storage tanks.	1. Residual H2S, mercaptans and hydrocarbons will be removed from the emission stream by the AGRU incinerators. In the unlikely event that either of the AGRU incinerators are shut down, exhaust gases (including H2S, mercaptans and residual hydrocarbons) will be hot-vented through a Frame 7 compression turbine exhaust stack in each train, to facilitate the safe dispersion of gases. 2. The height of AGRU vents mounted on the Frame 7 exhaust stacks have been designed for optimal dispersion and atmospheric mixing of any vented AGRU gas. 3. There will be no intentional venting of primary compressor seals to the atmosphere. 4. The condensate storage tanks are fitted with high point vents on the dome roofs to allow for sufficient dispersion of emissions.	-

Air quality		
6. Fugitive emissions: • unplanned gas emissions resulting from equipment leaks, including leaks from flanges, valves, pumps, gaskets, seals and connections.	1. The design and material selection of equipment with the potential to leak (such as flanges, valves, gaskets, seals and connections) has been undertaken to minimise fugitive emissions. 2. The design and material selection of the condensate, LPG and LNG storage tanks has been undertaken to minimise fugitive emissions. 3. The condensate storage tanks are fitted with double seals to minimise fugitive emissions.	1. Visual inspections of equipment such as flanges, valves, gaskets, seals and connections are undertaken. 2. A flange management system is used for the regular inspection, maintenance and change-out of flanges. 3. Operational procedures will be used for maintenance to prevent damage to pumps.
7. Generation of dark-smoke: • planned or unplanned flaring.	1. The ground and tankage flares have been designed to minimise the generation of particulates (dark smoke) through the complete combustion of hydrocarbons.	1. Visual monitoring and CCTV monitoring of flares is undertaken to detect dark-smoke events.
8. Loss of containment – hydrocarbons (gas): • failure or rupture of LPG, LNG or propane storage tanks and loading arms • failure, leakage or release from tanks, pipework, seals, pumps, drums and containers etc.	1. The design and material selection of equipment (e.g. seals, pipework) has been undertaken to minimise the potential for corrosion (thus minimising potential for loss of containment).	1. A flange management system is used for the regular inspection, maintenance and change-out of flanges. 2. An emergency response plan is activated in the event of major loss of containment.

Air quality		
		3. If required (depending on the type of loss of containment), a post-release sampling program and follow-up response (e.g. clean-up) will be undertaken to remediate.
Environmental performance monitoring and reporting requirements		
Annual reporting in accordance with the EPL (Section 6.3.3). ~~Ambient air quality monitoring (Section **Error! Reference source not found.**).~~ Monitoring of point source air emissions (Section **Error! Reference source not found.**).		

5.2 Airborne Noise and Vibration

Table 5-2 provides the management strategy for airborne noise and vibration.

A description of the noise conditions in Palmerston, the closest residential area to Ichthys LNG, is provided in Section 2.3.2. The sources of noise and vibration from Ichthys LNG are presented in Section 3.8.3.

Table 5-2: Airborne noise and vibration management strategy

Airborne Noise and Vibration
Potential interaction with environmental and socio-economic receptor
• Contribution to off-site noise / vibration effects at nearest receptors. • Nuisance to the community. • Change in fauna behaviour (e.g. mating, feeding). • Fauna moving away from or avoiding habitat areas adjacent to Ichthys LNG. • Adverse effects on human health.
Applicable legislation, standards and guidelines
• WMPC Act. • *Work Health and Safety (National Uniform Legislation) Act 2011* (NT). • National code of practice for noise management and protection of hearing at work (NOHSC 2009).

Airborne Noise and Vibration		
Performance objectives	**Targets**	**Key performance indicators**
Noise emissions at Ichthys LNG boundary are consistent with Project design criteria and noise modelling assessments.	Operational noise levels at Ichthys LNG boundary do not exceed 70 dBA.	Airborne noise monitoring study results.
Noise emissions from Ichthys LNG do not result in negative impacts on residential areas.	Zero community complaints related to noise emissions.	Occupational health noise monitoring results.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. General	-	1. A routine inspection and preventative maintenance program is implemented to verify that equipment is not vibrating or making noise.
2. Noise from flaring: • planned flaring from Ichthys LNG start-up activities • planned flaring due to maintenance / shutdowns • planned flaring from LNG and LPG vessel cool-downs and gas-ups • unplanned flaring due to trips or upset conditions.	1. The design of the flares has taken noise into consideration. Ground flares will be shielded and tankage flares will be enclosed to reduce noise emissions. 2. Equipment has been designed and/or is fitted with noise reduction controls such as acoustic lagging, noise enclosures, silencers and noise insulation to reduce noise emissions to as low as reasonably practicable. 3. Low noise fans have been selected on all on-site air coolers.	1. Performance monitoring of the CCPP system (including turbines and boilers) is undertaken, and remedial actions will be undertaken if noise issues are identified. 2. A community hotline is provided for community feedback.

<table>
<tr><th colspan="3">Airborne Noise and Vibration</th></tr>
<tr><td>3. Vibration from rotating/ operating equipment:
• Frame 7 compression turbines
• CCPP Frame 6 power generation turbines
• LNG train fin fan coolers
• compressors, generators, pumps
• workshop tools/equipment in the operations complex.</td><td>1. Comprehensive vibration studies have been conducted during the design of Ichthys LNG to eliminate the likelihood of failure of equipment from vibration-induced fatigue.
2. Process monitoring systems to sense vibration from rotating equipment will be installed throughout Ichthys LNG for early detection of faults or fatigue.
3. Anti-vibration mounts have been installed on rotating moving equipment.</td><td>1. A vibration assessment will be performed throughout start-up on areas designated as having high potential for vibration-induced fatigue to validate Ichthys LNG design and identify areas for rectification if required.</td></tr>
<tr><th colspan="3">Environmental performance monitoring and reporting requirements</th></tr>
<tr><td colspan="3">A once off airborne noise monitoring study during steady-state operations to compare against modelling predictions (Section 7.1.3).</td></tr>
</table>

5.3 Light Management

Table 5-3 provides the management strategy for artificial lighting.

Ichthys LNG sources of light are described in Section 3.8.4.

Table 5-3: Light management strategy

Light emissions
Potential interaction with environmental and socio-economic receptor
• Light pollution (e.g. light glow, light spill). • Change in fauna behaviour (e.g. mating, feeding). • Fauna moving away from or avoiding habitat areas adjacent to Ichthys LNG. • Loss of visual amenity. • Nuisance to community.
Applicable legislation, standards and guidelines
• WMPC Act. • EPBC Act (Cth). • ISO 8995.3:2006 Lighting of work places - Part 3: Lighting requirements for safety and security of outdoor work places.

Light emissions		
Performance objectives	**Targets**	**Key performance indicators**
Light emissions from Ichthys LNG do not result in negative impacts on residential areas.	Zero community complaints related to light emissions.	Records of community feedback.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. General: • lights on the product loading jetty and jetty dolphins • general lighting of work areas and access areas.	1. The lighting design for Ichthys LNG has been selected with consideration of the visual impact to the community while meeting personnel safety requirements. 2. Lighting has been designed in accordance with Australian standards and safety requirements.	1. A community hotline is provided for community feedback.
2. Flaring: • planned flaring from Ichthys LNG start-up activities • planned flaring from steady-state operations of pilot lights and flare system purge • planned flaring due to maintenance/ shutdowns • planned flaring from LNG and LPG vessel cool-downs and gas-ups • unplanned flaring due to trips or upset conditions.	1. Ground flares have been selected (rather than elevated flares) in part to reduce light emissions. Ground flares are shielded to help reduce light penetration. 2. The tankage flares are enclosed to reduce light emissions. 3. Flares have been located on the western side of Ichthys LNG in part to screen the flares from the Darwin CBD and Palmerston.	1. The local community will be notified in advance of extended or elevated periods of flaring which may cause visual impacts.

Light emissions
Environmental performance monitoring and reporting requirements
No reporting or monitoring requirements have been identified for light emissions.

5.4 Liquid Discharges, Surface Water Runoff and Drainage

Table 5-4 presents the management measures used to minimise the risk from liquid discharges, surface water run-off and drainage.

A description of the local hydrology and hydrogeology is provided in Section 3.3.5. Groundwater characteristics of Bladin Point are discussed in Section 2.3.6. A description of Darwin Harbour (including water and sediment quality) is provided in Sections 2.3.7 to 2.3.9.

The liquid discharges, surface water runoff and drainage associated with Ichthys LNG are presented in Section 3.8.6.

Table 5-4: Liquid discharges, surface water runoff and drainage management strategy

Liquid Discharges, Surface Water Runoff and Drainage
Potential interaction with environmental and socio-economic receptor
• Pollution of marine water (Darwin Harbour). • Bioaccumulation and toxicity effects in marine sediments. • Alteration of the marine environment through wastewater discharges. • Impact to commercial (aquaculture) and recreational fish species. • Erosion and sedimentation (from NCW discharge). • Impact to vegetation. • Contamination of groundwater. • Contamination of soil.
Applicable legislation, standards and guidelines
• EPBC Act (Cth). • *Dangerous Goods Act* (NT). • Environment Protection (National Pollutant Inventory) Objective (Cth). • *Fisheries Act* (NT). • *Marine Pollution Act* (NT).

Liquid Discharges, Surface Water Runoff and Drainage		
• WMPC Act. • *Water Act* (NT). • *Public and Environmental Health Act 2011* (NT).		
Performance objectives	**Targets**	**Key performance indicators**
Discharges to water adhere to the EPL228 approval conditions.	Zero exceedances of EPL228 discharge criteria for discharges to water (refer to Section 7.2).	Environmental incident records.
Communicate the importance of appropriate liquid discharge and drainage management practices to Ichthys LNG workforce.	100% of workforce (including contractors) has completed a HSE induction which will include information regarding spill response, clean-up and reporting.	Records showing number of personnel who have completed HSE inductions.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. General	1. Drainage at Ichthys LNG has been designed to isolate areas that could be exposed to hydrocarbon contamination, with wastewater from these areas directed to the AOC/COC water system. 2. Bunds are provided for the condensate, heating medium, diesel, solvent (aMDEA), AGRU drain and chemical storage tanks.	1. A routine inspection and preventative maintenance program has been implemented to verify efficiency of the bunds, sumps, washdown pits, wastewater treatment system plant and sewage treatment plant. 2. The INPEX chemical selection procedure is used to select least hazardous chemicals (while maintaining required technical performance).

Liquid Discharges, Surface Water Runoff and Drainage		
	3. Areas which process or store LNG and LPG, and where there is potential for loss of containment of hydrocarbons, are designed and built with spill impoundment ponds in accordance with National Fire Protection Association standard NFPA 59A Standard for the production, storage, and handling of liquefied natural gas and European Standard EN1473 Installation and equipment for liquefied natural gas - design of onshore installations. 4. The wastewater outfall diffuser has been designed to optimise near-field dispersion of the treated effluent. 5. Ichthys LNG has been designed with alarm systems to alert operators to wastewater exceedances of online metering limits and failure of equipment. In the event of an alarm the operator will respond to resolve the alarm, by either directing off-specification water for retreatment or adjusting treatment processes to ensure off-specification wastewater is not discharged to the environment.	3. A dangerous goods and hazardous substances register is maintained on site. 4. Up-to-date Safety Data Sheets (SDSs) for chemicals used are kept on site in accessible locations. 5. Spill kits are located on site in accessible locations. 6. Spill kits are regularly inspected and maintained. 7. Spill response training is provided for personnel handling chemicals. 8. Ichthys LNG inductions will include information regarding spill response, clean-up and reporting. 9. Regular sampling of each of the influents, wastewater streams and treated water is undertaken prior to comingling, including through online monitoring and laboratory testing. 10. Routine inspection and calibration of monitoring instrumentation is undertaken to verify that the instruments are operating effectively. 11. Wastewater treatment plant operating procedures are implemented for the efficient operation of the plant and to verify that the effluent is being produced within specified performance parameters.

Liquid Discharges, Surface Water Runoff and Drainage		
2. Discharges of treated wastewater: • AOC/COC	1. The AOC/COC wastewater treatment system (which includes CPI, DAF and walnut shell filter) is designed to produce effluent within specific performance parameters. 2. Drainage at Ichthys LNG, including the AOC/COC water system and evaporation basin, is designed to treat effluent during start-up, steady-state operations and major shutdowns. 3. Bunds and sumps are incorporated into the design to collect AOC/COC water. 4. The AOC / COC system has been designed and built with online analysers to enable monitoring of effluent. 5. Chemical drains are fitted with a normally closed valve to isolate chemically contaminated water, which can be opened to allow stormwater to enter AOC after testing to confirm contamination status.	1. Operational procedures are implemented for the AOC/COC system during heavy rainfall events to minimise the risk of accidental contamination of the NCW system. 2. Visual inspections are undertaken of the AOC/COC drainage system (e.g. bunds, sumps, washdown pits) and sludge / liquid waste will be removed by a licensed waste contractor if required. 3. A waste management strategy has been implemented for the clean-up and disposal of chemicals and contaminated wastewater. 4. Chemically contaminated water is collected and recovered by vacuum truck for either outside by disposal by a licensed waste contractor or disposal via the onsite evaporation basin.
3. Discharges of treated wastewater: • demineralisation plant reject water	1. The demineralisation plant has been designed and built to produce reject brine within the specific performance parameters.	-

Liquid Discharges, Surface Water Runoff and Drainage		
4. Discharges of treated wastewater: • sewage and grey water	1. A permanent sewage treatment plant has been designed and installed to treat sewage and grey water produced during start-up, steady-state operations and major shutdowns. 2. The MBR sewage treatment plant has been designed to produce effluent within specified low TN and TP performance parameters.	1. Sewage treatment plant operating procedures are implemented for the efficient operation of the plant and to verify that the effluent is being produced within specified performance parameters.
5. Discharges of treated wastewater: • CCPP steam blowdown	1. The treatment system for the steam blow down comprise of pH neutralisation package and a heat exchanger to reduce the temperature and is designed to produce effluent within the specific performance parameters.	1. Steam blowdown treatment plant operating procedures are implemented for the efficient operation of the plant and to verify that the effluent is being produced within specified performance parameters.
6. Discharges of treated wastewater: • NCW including surface water runoff and drainage, including surface water runoff within the GEP corridor	1. The NCW system has been designed with underflow/overflow weirs (designed to capture free phase hydrocarbons), perimeter drain outlets and baffles to reduce the velocity of water leaving Ichthys LNG site. 2. The NCW system perimeter drain outlets are designed for even out-flow of water, rather than discharging water at concentrated point sources. 3. The NCW system has been designed for a 1 in 100-year rainfall event.	1. Regular inspections of the NCW drainage system will be undertaken (with drains being kept clear of debris and vegetation), including the perimeter drain outfalls, to check for signs of erosion. 2. Erosion determined to result from the discharge of NCW from Ichthys LNG will be remediated by erosion control/ replacement stabilisation.

Liquid Discharges, Surface Water Runoff and Drainage		
	4. Rock armour is provided around the perimeter drain outfalls to reduce erosion. 5. The GEP corridor (including the maintenance access track) has been designed and contoured to minimise erosion from surface water runoff.	3. The majority of the GEP corridor will be rehabilitated, except for the maintenance access track and the area containing the pipeline (which need to remain free of vegetation for safety, inspection and maintenance purposes), to minimise exposed areas that may be vulnerable to erosion caused by surface water runoff. 4. Regular inspections will be undertaken of the onshore GEP corridor during the wet season to check for signs of erosion. 5. Erosion within the onshore GEP will be remediated by erosion control / replacement stabilisation.
Environmental performance monitoring and reporting requirements		
Annual reporting in accordance with the EPL requirements (Section 6.3.3). Treated wastewater monitoring prior to discharge using online analysers and meters (Section 7.2). Commingled treated effluent monitoring prior to discharge (Section 7.2.1). Darwin Harbour sediments monitoring program (Section 7.2.2). Groundwater monitoring program (Section 7.3.1). Mangrove health monitoring program (Section 7.4.6).		

5.5 Potable Water Use and Water Conservation

Table 5-5 presents the management measures used to minimise potable water use. The main use of potable water will be for the demineralisation plant. Other potable water use includes general domestic, service and firewater.

A description of the demineralisation plant (used to process PWC water) and the systems that require water, including the AGRU, CCPP, service water system and firewater system are provided in Sections 3.3 and 3.4.

Table 5-5: Potable water use and water conservation management strategy

Potable water use and water conservation
Potential interaction with environmental and socio-economic receptor
• Excessive resource (water) consumption.
Applicable legislation, standards and guidelines
• *Public and Environmental Health Act 2011* (NT). • *Water Act* (NT). • *Water Efficiency Labelling and Standards Act 2005* (Cth).

Potable water use and water conservation		
Performance objectives	**Targets**	**Key performance indicators**
Minimise potable water consumption.	100% of water fittings (e.g. taps, urinals and toilets) on site have a Commonwealth water efficiency labelling and standards (WELS) rating of three stars or higher, unless safety specifications require high-flow (e.g. eye wash stations).	Records showing water fittings, urinals and toilets on site have a WELS rating of at least three stars.
Communicate the importance of water conservation to Ichthys LNG workforce.	100% of workforce (including contractors) has completed a HSE induction which will include information regarding the need to conserve water.	Records showing the number of personnel who have completed HSE inductions.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. Use of PWC potable water: • domestic purposes, including drinking and kitchen facilities • safety systems, including firewater, eye wash stations and safety showers • service water • treatment via the demineralisation plant, which provides treated water for equipment/processing; the main water uses are for AGRU regeneration and CCPP steam generation.	1. Use of PWC potable water results in a reduced amount of water needed for the demineralisation plant compared to using more saline water, and less reject water is produced. 2. Water conservation has been taken into consideration in the selection of ablutions facilities.	1. The Bladin Point gas facility incorporates best-practice water conservation measures into the design where practicable. If new equipment is installed/ replaced it is to be with water efficient parts.

Potable water use and water conservation		
	3. The dehydration units have been designed to recover water from molecular sieves and recycle the water back into the AGRUs; this reduces the overall quantity of water that the demineralisation plant needs to produce. 4. The demineralisation plant has been designed to recycle water from its secondary reverse osmosis unit. 5. The demineralisation plant selected for Ichthys LNG has a four-step process to produce water, which is more efficient than other types of demineralisation plants. 6. Ichthys LNG has been designed to use demineralisation plant reject water and/or treated effluent to flush the AOC system and to maintain water levels in seals in the AOC underground drain lines (to prevent migration of potentially flammable vapours), which avoids the need to use potable water for this purpose during operations. 7. Ichthys LNG has been designed to use treated wastewater to maintain an outflow in the firewater pumps, to prevent marine growth, which reduces the overall amount of water used during operations.	

Potable water use and water conservation		
	8. The NCW system has been designed to recharge groundwater aquifers under Ichthys LNG by infiltrating through areas surfaced with loose gravel or grass. 9. The GEP maintenance track will be unsealed which allows groundwater recharge by rainfall.	
Environmental performance monitoring and reporting requirements		
Monthly monitoring of PWC potable water usage.		

5.6 Hazardous Materials and Dangerous Goods Management

Table 5-6 presents the management measures used to minimise potential impacts from hazardous materials and dangerous goods.

The hazardous materials and dangerous goods storage areas are described in Section 3.7.

Table 5-6: Hazardous materials and dangerous goods management strategy

Hazardous materials and dangerous goods
Potential interaction with environmental and socio-economic receptor
• Pollution of marine water (Darwin Harbour). • Damage to benthic environment (Darwin Harbour). • Bioaccumulation and toxicity effects. • Impact to fauna. • Impact to commercial (aquaculture) and recreational fish species. • Impact to vegetation. • Contamination of groundwater. • Contamination of soil.
Applicable legislation, standards and guidelines
• Dangerous Goods Act (NT). • Environmental Offences and Penalties Act (NT). • Environmental Protection (National Pollutant Inventory) Objective [Northern Territory]. • Marine Pollution Act (NT). • WMPC Act. • AS 1692:2006 Steel Tanks for Flammable and Combustible Fluids.

Hazardous materials and dangerous goods		
• AS 1940:2004 The Storage and Handling of Flammable and Combustible Liquids. • AS 2885.1:2012 Pipelines – Gas and Liquid Petroleum – Design and Construction. • AS 3780:2008 The Storage and Handling of Corrosive Substances. • AS 3961:2005 The Storage and Handling of Liquefied Natural Gas. • AS 4452:1997 The Storage and Handling of Toxic Substances. • NFPA 30:2008 Flammable and Combustible Liquids Code. • NFPA 59A:2009 Production, Storage, and Handling of Liquefied Natural Gas (LNG).		
Performance objectives	**Targets**	**Key performance indicators**
Minimise potential environmental impacts from the storage, handling and transport of hazardous materials and dangerous goods.	100% compliance with hazardous materials and dangerous goods legislation, Australian Standards and SDS requirements.	Environmental incident records. Inspection records. Audit results.
Communicate the importance of good spill prevention and response practices to Ichthys LNG workforce.	100% of workforce (including contractors) has completed a HSE induction which will include information on spill prevention and response.	Records showing the number of personnel who have completed HSE inductions.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. Storage, distribution and use: • process chemicals (e.g. aMDEA and other solvents, hydraulic fluids, corrosion inhibitors, biocides, firefighting foam).	1. The condensate storage tanks are located on bunded concrete hardstand areas with pressure safety valves and separate AOC / COC water drainage systems.	1. Maintenance procedures and a permit to work system is implemented for general maintenance activities requiring the use of hazardous materials and dangerous goods.

Hazardous materials and dangerous goods		
• chemicals for general maintenance (e.g. grease, oils, lubricants, cleaning agents).	2. The LPG and LNG storage tanks are located in bunded impoundment ponds with pressure safety valves and separate AOC / COC water drainage systems. 3. The hazardous goods storage area has been designed for the secure storage of chemicals and hazardous liquid chemical waste in accordance with the Dangerous Goods Act (NT). 4. Ichthys LNG diesel and condensate storage tanks are designed and built in accordance with AS 1940:2004. 5. The operations complex refuelling area has been designed and built in accordance with AS 1940:2004. 6. Dry-break, breakaway couplings are installed and used where practicable during refuelling operations. 7. An emergency shutdown interface is in place between condensate, LPG and LNG loading vessels and Ichthys LNG during product loading activities. 8. Reinforced concrete collection pits are provided below the product jetty deck to collect any spill or leaks from hydraulic oil units located in the product loading area.	2. Maintenance of Ichthys LNG systems and equipment will be undertaken on hardstand areas with drainage directed to the AOC or chemical sewer system. 3. Maintenance of smaller equipment and vehicles will be undertaken on hardstand areas or in the operations complex workshop. 4. Refuelling of vehicles will only occur in designated areas. 5. There will be no refuelling of vehicles on the GEP access track, except in emergency situations in which case a drip tray will be used and refuelling will be visually monitored to minimise spills. 6. Hazardous materials and dangerous goods will be transported, stored and handled in accordance with legislation, Australian Standards and SDS requirements. 7. Hazardous materials and dangerous goods waste (including empty containers) will be transported, stored and handled in accordance with legislation, Australian Standards and SDS requirements (Section 5.7). 8. Chemicals and hazardous liquid waste will be segregated in accordance with the Dangerous Goods Act (NT).

Hazardous materials and dangerous goods		
		9. The INPEX chemical selection process is used to select least hazardous chemicals (while maintaining required technical performance). 10. A dangerous goods and hazardous substances register is maintained on site. 11. Up-to-date SDS for chemicals used will be kept on site in accessible locations.
1. Leakage: • chemicals from pipework • tanks • transfers.	1. The design of equipment that distributes or stores dangerous goods/hazardous materials (e.g. pipework, tanks) and the selection of materials for such equipment (e.g. tank coatings) has been undertaken to prevent corrosion and minimise leaks. 2. The condensate storage tanks are fitted with double rim seals, leak detection systems and alarms. 3. The LPG and LNG tanks consist of an inner tank and outer steel tank encapsulated in concrete and are fitted with leak detection systems and alarms.	1. A routine inspection and preventative maintenance program is implemented including maintenance, integrity testing and inspection programs on product flowlines and loading arms. 2. Visual inspections of hazardous materials and dangerous goods storage areas and tanks will be undertaken. 3. Spill kits are located on site in accessible locations. 4. Spill kits will be regularly inspected and maintained. 5. Spill response training is provided for personnel handling chemicals. 6. Ichthys LNG inductions will include information regarding spill response, clean-up and reporting.

Hazardous materials and dangerous goods		
		7. A Nearshore OPEP will be implemented, which outlines the activities and arrangements, and provides a framework for response to hydrocarbon releases from Ichthys LNG. 8. All transfer lines, pumps and valves used during product loading are checked for integrity. 9. Vessel approach speeds to the berth are monitored by a speed-of-approach laser system and the data will be transmitted to the vessel pilot to minimise risk of vessel collision with the product loading jetty. 10. Loading operations are continuously monitored. 11. During product loading, radio contact will be maintained between each product vessel and Ichthys LNG. 12. Loading operations are monitored by an Ichthys LNG representative on the jetty and a ship representative on board the condensate, LPG or LNG vessels. 13. A variety of temporary bunding is available for use around the site, including bunded pallets and drip trays. 14. Temporary bunding is used where chemicals are used outside of contained (permanently bunded) work areas.

Hazardous materials and dangerous goods		
		15. Bunds will be checked and emptied before and after heavy rain events.
Environmental performance monitoring and reporting requirements		
Commingled treated effluent monitoring prior to discharge (Section 7.2.1). Darwin Harbour sediments monitoring program (Section 7.2.2). Groundwater monitoring program (Section 7.3.1). Mangrove health, intertidal sediment and bio-indicator monitoring program (Section 7.4.6).		

5.7 Waste Management

Table 5-7 presents the management measures used to minimise potential impacts from incorrect or inappropriate handling, transport and storage of solid and liquid waste on site.

A description of the local terrestrial and marine environment that could be impacted upon in presented in Section 2, including groundwater characteristics (Section 2.3.6) and marine water quality (Section 2.3.7).

Section 3.8.7 describes the solid and liquid waste types that could be generated, and the waste segregation and storage facilities available at Ichthys LNG.

Table 5-7: Solid and liquid waste management strategy

Solid and liquid waste
Potential interaction with environmental and socio-economic receptor
• Contamination of groundwater. • Contamination of soil. • Contamination of surface water. • Pollution of marine water (Darwin Harbour). • Damage to benthic environment (Darwin Harbour). • Bioaccumulation and toxicity. • Impact to fauna. • Attraction of fauna or introduced terrestrial species to waste. • Indirect impacts to fauna through predation. • Impact to vegetation. • Generation of odour.
Applicable legislation, standards and guidelines
• Dangerous Goods Act (NT).

Solid and liquid waste

- *Environmental Offences and Penalties Act 1996* (NT).
- Environmental Protection (National Pollutant Inventory) Objective [Northern Territory].
- *Litter Act* (NT).
- *Marine Pollution Act* (NT).
- National Environment Protection (Movement of Controlled Waste between States and Territories) Measure (as varied December 2004) (Cth).
- National Environment Protection (Used Packaging Materials) Measure (as varied July 2005) (Cth).
- National Transport Commission. 2014. Australian Code for the Transport of Dangerous Goods by Road & Rail. Electronic Version, August 2014. The National Transport Commission, Melbourne. www.ntc.gov.au
- WMPC Act.
- Australian Dangerous Goods Code (ADG7) (NTC 2014).
- AS/NZS 3833:2007, The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers.
- AS 1692:2006, Steel tanks for flammable and combustible liquids.
- AS 1940:2004, The storage and handling of flammable and combustible liquids.
- National Waste Policy (DEWHA 2009).

Performance objectives	**Targets**	**Key performance indicators**
Prevent environmental impacts from waste generated during the operations phase	Zero environmental waste related incidents.	Environmental incident records.
Communicate the importance of good waste management practices to Ichthys LNG workforce.	100% of workforce (including contractors) has completed a HSE induction which will include information on waste management practices.	Records showing the number of personnel who have completed HSE inductions.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**

Solid and liquid waste		
1. General: • General Ichthys LNG operational activities. • General administration and office activities. • Kitchen and mess activities. • Landscaping.	1. Waste management areas are designed and built within the operations complex for the segregation and storage of solid and liquid waste. 2. Skip bins and wheelie bins are placed in designated locations throughout Ichthys LNG and operations complex.	1. All waste is managed in accordance with the INPEX waste management processes and the waste control hierarchy (avoid, reuse, recycle or recover, treat, dispose). 2. All personnel undergo site inductions that will include information regarding waste management roles, responsibilities and procedures. 3. Personnel who routinely handle hazardous materials or wastes receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices. 4. Any waste generated along the GEP (e.g. during beach valve maintenance) will be contained and taken back to Ichthys LNG for segregation and storage in designated waste areas. 5. All waste is segregated into the four main waste streams hazardous (recyclable), hazardous (non-recyclable), non-hazardous (recyclable) and non-hazardous (non-recyclable). Recycling will occur only if cost effective and practicable solutions are available.

Solid and liquid waste		
		6. Waste receptacles are placed around Ichthys LNG site at designated areas to collect general day-to-day operational waste and enable waste segregation. 7. All waste receptacles are clearly labelled to identify the waste type to be disposed of in the container. 8. All waste is placed in designated areas and segregated into hazardous waste and non-hazardous waste and, where possible, into recyclable or reusable hazardous waste and recyclable or reusable non-hazardous waste. 9. Receptacles supplied for disposal of hazardous waste or contaminated soil are sealed (leak-proof) and fit for purpose. 10. Waste receptacles are kept in a neat, clean and safe condition. 11. Waste receptacles will not be overfilled. 12. Receptacles will not be moved without prior approval from the on-site waste coordinator. 13. Regular housekeeping inspections are undertaken of waste receptacles and waste storage areas. 14. Waste is removed by a waste service provider and taken to an appropriately licensed recovery or disposal facility.

Solid and liquid waste		
		15. A licenced waste contractor is used to remove wastes from site.
2. Hazardous wastes: • Maintenance and change-out of equipment. • Shutdown activities. • Workshop, laboratory and warehouse activities. • Disposal of sludge from the sewage treatment plant. • Operation of the fire station and medical facility.	1. A dedicated hazardous waste transfer station with clear signage is provided within the operations complex for the segregation and storage of hazardous solid and liquid waste.	1. Operating procedures are implemented for maintenance activities that generate liquid waste (e.g. cleaning strainers in the sewage treatment plant, change-out of lubricants and other chemicals) that will include the requirement for appropriate containment (temporary bunding) to be used during maintenance. 2. Equipment that could leak is located on hardstand, bunded areas to prevent penetration of liquid into soil. 3. Up-to-date SDS for chemicals used are kept on site in accessible locations. 4. Spill kits are located on site in accessible locations. 5. Spill kits will be regularly inspected and maintained. 6. Spill response training is provided for personnel handling chemicals. 7. Ichthys LNG inductions will include information regarding spill response, clean-up and reporting.

Solid and liquid waste		
		8. Regular visual inspections are undertaken of the AOC / COC drainage system (e.g. bunds, sumps, washdown pits, reinforced concrete collection pits) and liquid waste will be removed by a licenced waste contractor for disposal at a licence facility if required. 9. Operating procedures and permit to work system are implemented for maintenance activities that generate hazardous solid waste (e.g. change-out of filters and mercury adsorbent beds). 10. Maintenance activities that generate hazardous solid waste will be undertaken on hardstand areas.
Environmental performance monitoring and reporting requirements		
Annual reporting in accordance with the EPL (Section 6.3.3). Commingled treated effluent monitoring prior to discharge (Section 7.2.1). Darwin Harbour sediments monitoring program (Section 7.2.2). Groundwater monitoring program (Section 7.3.1).		

5.8 Bushfire Prevention

Table 5 8 presents the management measures used to minimise environmental and social impacts from bushfires. Health and safety requirements related to bushfire risk are outside the scope of this OEMP and are covered under Major Hazard Facility certification requirements and the Safety Case.

Table 5-8: Bushfire management strategy

Bushfires
Potential interaction with environmental and socio-economic receptor
• Generation of particulates (PM2.5 and PM10). • Damage to vegetation. • Impact to fauna.
Applicable legislation, standards and guidelines
• *Bushfires Act* (NT). • *Fire and Emergency Act* (NT).

Bushfires		
Performance objectives	**Targets**	**Key performance indicators**
Prevent loss or damage to vegetation and habitats from unauthorised bushfires.	Zero incidents of unauthorised burning of natural vegetation by Project personnel.	Environmental incident reports.
Communicate the importance of protecting the ecological values of Bladin Point to Ichthys LNG workforce.	100% of workforce (including contractors) has completed a HSE induction which will include information on ecological values and bushfire prevention.	Records showing the number of personnel who have completed HSE inductions.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. General: • Hot work activities, such as welding. • Faulty electrical equipment. • Machinery and vehicle exhausts. • Uncontrolled events such as lightning strikes and arson.	1. Ichthys LNG is designed with strategically located firefighting equipment, including a fire station, fire truck, fixed firefighting system, fire hydrants, portable firefighting equipment and accessible supplies of water. 2. Fire extinguishers are located in buildings, various locations around Ichthys LNG and in all site vehicles. 3. The majority of Ichthys LNG consists of hardstand, non-flammable surfaces (including concrete and gravel/blue metal).	1. Firefighting equipment is and will continue to be maintained and tested according to the relevant Australian standards and regulatory requirements. 2. Firebreaks have been established and will be maintained around Ichthys LNG in accordance with NT Bushfires Council firebreak requirements for Bladin Point. 3. The GEP access track will be kept free of vegetation. 4. Grassy vegetation in Ichthys LNG footprint will be controlled to reduce available fuel loads and prevent bushfires. Control methods may include slashing and spraying.

Bushfires		
	4. The flare systems have been designed with buffer zones and shielding to minimise risk of impacts upon surrounding vegetation.	5. An internal "hot work" permit system will be implemented for cutting, welding and any other work considered to have high potential for starting a fire. 6. All site vehicles will be serviced regularly and maintained to minimise the risk of fires from engines and exhausts. 7. Vehicles and machinery will be restricted to designated roads except in the event of an emergency. 8. Potential ignition sources such as lighters, matches and electronic devices with batteries (e.g. cameras, mobile phones) will be strictly controlled within Ichthys LNG. 9. Trained emergency response personnel will be available to provide first response in the event of fire within Ichthys LNG battery limits.

Bushfires		
		10. In the event of a fire outside Ichthys LNG battery limits, trained emergency response personnel will provide notification to the NT Police, Fire and Emergency Services (NT PFES) and will provide first response if the fire poses immediate threat to the safety of personnel and Ichthys LNG. Further support will be provided to NT PFES for fires external to Ichthys LNG in agreement with NT PFES. 11. Effective waste management practices will be implemented to ensure that combustible wastes (e.g. timber, cardboard, paper) do not accumulate and pose a fire hazard.
Environmental performance monitoring and reporting requirements		
Firefighting equipment inspections Housekeeping inspections		

5.9 Heritage

Table 5-9 presents the management measures used to minimise potential impacts on heritage sites and cultural values. Sections 2.2.2 and 2.2.3 describe the heritage sites and cultural values within the vicinity of Ichthys LNG.

Table 5-9: Heritage management strategy

Heritage management strategy		
Potential interaction with environmental and socio-economic receptor		
• Damage to declared heritage sites. • Loss of cultural values.		
Applicable legislation, standards and guidelines		
• *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth). • *Aboriginal Land Rights (Northern Territory) Act 1976* (Cth). • *Australian Heritage Council Act 2003* (Cth). • EPBC Act (Cth). • *Heritage Act 2011* (NT). • *Underwater Cultural Heritage Act 2018* (Cth). • *Northern Territory Aboriginal Sacred Sites Act* (NT).		
Performance objectives	**Targets**	**Key performance indicators**
Avoid disturbance to heritage sites.	Zero incidents involving disturbance to heritage sites.	Environmental incident records.

Heritage management strategy		
Communicate the importance of the Aboriginal and non-Aboriginal cultural values of sites in the vicinity of Ichthys LNG to Ichthys LNG workforce.	100% of workforce (including contractors) has completed a HSE induction which will include information regarding cultural heritage sites.	Records showing the number of personnel who have completed HSE inductions.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. General: • Accidental interference with or damage to onshore or nearshore heritage sites by Ichthys LNG personnel.	1. Site fencing is installed around the perimeter of Ichthys LNG, which limits personnel access to heritage sites.	1. All personnel will complete the Operations HSE induction, which includes information regarding onshore and marine (Darwin Harbour) declared heritage sites and Sacred Sites. 2. Site personnel are prohibited from interfering with heritage sites. 3. All site personnel are required to stay within Ichthys LNG site security fencing, unless permission is granted to undertake activities outside the perimeter fence for special purposes (e.g. environmental monitoring programs). 4. The Non-Aboriginal Heritage Management Plan: Nearshore Development Area (C025-AG-PLN-0029) and the controls within, will be implemented should INPEX undertake any on-water activities.

Heritage management strategy		
		5. A heritage management process has been developed, which includes the following requirements: • Personnel are not be permitted to enter known Aboriginal heritage sites without approval • Personnel will report any disturbance which occurs to sites • If a potential Aboriginal heritage site or object is discovered during ground-disturbing activity, personnel are required to stop work immediately and follow the chance find procedure • If a potential WWII heritage site or object is discovered during ground-disturbing activity, personnel are required to stop work immediately and follow the chance find procedure 6. When working near or in Sacred Sites, personnel are required to undertake activities as per the relevant Sacred Site AAPA certificates and comply with the conditions specified in the certificates. No work is permitted within the 'Restricted Work Areas' shown on the map attached to each Sacred Site AAPA certificate.

Heritage management strategy
Environmental performance monitoring and reporting requirements
Cultural heritage site monitoring (Section 7.4.1).

5.10 Biosecurity (Marine Pests, Introduced Terrestrial Fauna Species, Weeds)

Table 5-10 presents the management measures used to minimise potential impacts from marine pests, weeds and introduced terrestrial fauna species.

A description of ecosystems on Bladin Point and in Darwin Harbour is provided in Section 2.3.10. Terrestrial and marine flora and fauna, including weed species, terrestrial pests and marine pest species are described in Section 2.3.11.

Table 5-10: Biosecurity management strategy

Biosecurity
Potential interaction with environmental and socio-economic receptor
• Competition for resources with native species. • Predation of native species. • Introduction of diseases.
Applicable legislation, standards and guidelines
• *Biosecurity Act 2015* (Cth). • *Fisheries Act* (NT) • Department of Agriculture and Water Resources. 2016. Australian ballast water management requirements. Version 7. Department of Agriculture and Water Resources, Canberra, ACT. • *Weeds Management Act* (NT). • The Australian weeds strategy: a national strategy for weed management in Australia (NRMMC 2006). • Northern Territory weed management handbook (DLRM 2014). • Northern Territory weeds management strategy [1996–2005] (DPIF 1996).

Biosecurity		
Performance objectives	**Targets**	**Key performance indicators**
Minimise the risk of introduction of marine pests to the product loading jetty.	Zero introductions of invasive marine pests to the product loading jetty by LNG, LPG or condensate vessels and other support vessels	Environmental incident reports.
To prevent the introduction of new weed species to Ichthys LNG site as a results of operational activities	Zero introduction of new weeds as a results of operational activities	Annual weed report recording the weed species lists for Ichthys LNG.
Minimise the risk of introduction of introduced terrestrial fauna species into Ichthys LNG area.	Zero breaches of terrestrial biosecurity management requirements.	Environmental incident reports.
Communicate the importance of biosecurity management to Ichthys LNG workforce.	100% of workforce (including contractors) has completed a HSE induction which will include information regarding introduced terrestrial fauna species and weeds.	Records showing the number of personnel who have completed HSE inductions.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**

Biosecurity		
1. Accidental introduction of marine pests via: • Vessels tied alongside the product loading jetty	-	1. All condensate, LNG and LPG vessels entering Australian waters (i.e. 12 nm) are required to manage ballast water in accordance with the Biosecurity Act 2015 and in manner consistent with the Australian Ballast Water Management Requirements (DAWR 2016).All condensate, LNG and LPG vessels entering Australian waters will comply with the requirements of the Biosecurity Act 2015.
2. Accidental introduction of introduced terrestrial fauna species and weeds via: • vehicles entering Ichthys LNG site • vehicles travelling along the GEP for inspections and maintenance • transport of machinery and equipment from interstate or overseas • personnel movements.	1. Ichthys LNG has been designed and built with hardstand areas, dedicated internal roads and dedicated access ways/ footpaths, which reduces the available area for weed species to grow and establish.	1. Site inductions include information regarding weed and terrestrial pest identification and management. 2. When required vehicles, machinery and equipment entering and exiting the site from outside of Darwin will be subject to cleaning such that the vehicle is clean and free from weed and seed material. 3. Vehicles are restricted to driving on designated roads within Ichthys LNG site and along the GEP access track. 4. Vehicles, equipment and machinery washdown is only undertaken at designated washdown areas. 5. Weed control activities are undertaken on a regular basis in accordance with the NT Weed Management Handbook.

Biosecurity		
		6. Personnel directly involved with weed control activities are appropriately licenced. 7. The INPEX chemical selection procedure is used to select least hazardous chemical herbicides used for weed control (while maintaining required technical performance). 8. All chemicals are registered and applied strictly in accordance with the directions on the container label. The appropriate SDSs should be consulted. 9. Weather conditions (e.g. wind, temperature and humidity) are incorporated into weed control planning. 10. Chemical herbicides will not be applied in windy conditions to prevent accidental spray drift. 11. Weed material that is manually removed from the ground will be placed into a plastic rubbish bag, which will be securely sealed and disposed of in the general waste bins on site.
3. Attraction of introduced terrestrial fauna species to site.	1. Site fencing has been installed around the perimeter of Ichthys LNG site (which prevents access by larger introduced terrestrial fauna species such as feral pigs).	1. The site security fence is monitored and maintained to prevent ingress of larger introduced terrestrial fauna species (e.g. feral pigs).

Biosecurity		
		2. Baiting and trapping for invertebrate pests (e.g. cockroaches, ants) and rodents (rats and mice) is undertaken in areas as required. 3. In the event that a feral cat or feral pig is observed within Ichthys LNG, personnel will be required to report the sighting to the Onshore HSE team, including details of the location and the time of day that the animal was sighted. The Onshore HSE team will coordinate the response as necessary. 4. If it is determined by the Onshore Environmental Adviser or maintenance department that control of pest species is required, this activity will be undertaken by an appropriately licensed pest controller. 5. All pest control will be undertaken in a manner which is target species specific to minimise impact on native animals. 6. Housekeeping and waste management practices will be implemented as per Section 5.7 to minimise the attraction of introduced terrestrial fauna species. 7. The management of pooling water and drainage for biting insect control (Section 5.12) will minimise the attraction of introduced terrestrial fauna species (e.g. cane toads).

Biosecurity
Environmental performance monitoring and reporting requirements
Reporting of pest or weed species (Section 6.3.3). Marine pest monitoring program (Section 7.4.2). Introduced terrestrial fauna species monitoring program (Section 7.4.3). Weed monitoring program to detect and control weeds (Section 7.4.4).

5.11 Terrestrial Fauna

Table 5-11 presents the management measures used to minimise potential impacts to terrestrial native fauna due to the physical presence of Ichthys LNG and workforce. Management measures for other potential impacts to fauna are covered in the following sections of this OEMP: Section 5.2 (noise), Section 5.3 (light), Section 5.4 (liquid discharges, surface water runoff and drainage), Section 5.6 (hazardous materials) and Section 5.7 (waste).

A description of ecosystems on Bladin Point and in Darwin Harbour is provided in Section 2.3.10. Terrestrial fauna are described in Section 2.3.11.

Table 5-11: Terrestrial fauna management strategy

Terrestrial fauna
Potential interaction with environmental and socio-economic receptor
• Impact to fauna.
Applicable legislation, standards and guidelines
• EPBC Act (Cth). • *Territory Parks and Wildlife Conservation Act* (NT).

Terrestrial fauna		
Performance objectives	**Targets**	**Key performance indicators**
Minimise the risk of injury to terrestrial fauna.	No incidents related fauna injuries or deaths.	Environmental incident reports.
Establish and maintain awareness of the importance of protecting terrestrial fauna.	100% of workforce (including contractors) has completed a HSE induction which will include information regarding terrestrial fauna.	Records showing the number of personnel who have completed HSE inductions.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. General: • Accidental entrapment in Ichthys LNG facilities/equipment. • Vehicle strike.	1. Site fencing is installed around the perimeter of Ichthys LNG site, which prevents access by larger fauna species (e.g. wallabies, crocodiles).	1. Site inductions include information regarding fauna and ecological values adjacent to the Onshore Site, key operations that may impact on fauna and fauna management requirements. 2. Vehicles are restricted to driving on designated roads within Ichthys LNG site and on the GEP access track. 3. Site speed limits is enforced to avoid or minimise vehicle strike incidents. 4. Catching, feeding or intentionally harming native or feral animals is prohibited. 5. No pets will be permitted on the site.

Terrestrial fauna		
		6. The site security fence is monitored and maintained to prevent ingress of larger fauna species. 7. Humming tape has been installed and the perimeter lighting along the security fence to reduce the risk for Fruit Bat entanglement. 8. All personnel directly involved in wildlife handling and relocation are appropriately trained and hold required permits.
2. Crocodile management	-	1. In the event that a crocodile is observed within Ichthys LNG fence line, the following actions will be taken during the day: • the Onshore HSE team and control room will be contacted immediately and provided with the location, the estimated size of the crocodile and the time of day that it was sighted • the Onshore HSE team will arrange barricading of the area if required • the Onshore HSE team will contact the Crocodile Management Team of the Parks and Wildlife Commission (NT) (telephone 0419 822 859 or 8999 4691) or a licensed company to manage (capture and relocate) the animal if required.

Terrestrial fauna		
		2. In the event that a crocodile is observed within Ichthys LNG fenceline, the following actions will be taken during the night: • the security office and control room will be contacted immediately and provided with the location, the estimated size of the crocodile and the time of day that it was sighted • the security office will arrange barricading of the area if required and contacting the Crocodile Management Team of the Parks and Wildlife Commission (NT) (telephone 0419 822 859 or 8999 4691) or a licensed company to manage (capture and relocate) the animal if required urgently • the security office will report to the Onshore HSE team on the following day, after which the Onshore HSE team will contact the Crocodile Management Team of the Parks and Wildlife Commission (NT) (telephone 0419 822 859 or 8999 4691) or a licensed company to manage (capture and relocate) the animal if required.

Terrestrial fauna		
3. Wildlife relocation	-	1. If injured or trapped native fauna is found within Ichthys LNG, personnel will contact the Onshore HSE team or security office immediately to coordinate the removal and relocation of the animal. 2. If the fauna is injured, either the Onshore HSE team or the security office will contact the organisation Wildcare Inc. NT for its rescue service (telephone 8988 6121 or 0408 885 341). 3. If the fauna is uninjured, the animal will be captured and released by an accredited wildlife handler in an area of suitable habitat adjacent to Ichthys LNG. 4. If a snake is observed at Ichthys LNG site, an accredited snake-handler will capture and remove the snake from work areas for relocation. For assistance with snake-handling, the Snake Callouts service of the Parks and Wildlife Commission of the NT should be called (telephone 1800 453 210).
Environmental performance monitoring and reporting requirements		
Reporting of environmental incidents relating to terrestrial fauna (Section 6.3.3).		

5.12 Biting Insects

Table 5 12 presents the management measures used to minimise the creation of biting insect habitat.

A description of biting insects that have been recorded in the vicinity of Ichthys LNG is provided in Section 2.3.11.

Table 5-12: Biting insects management strategy

Biting insects
Potential interaction with environmental and socio-economic receptor
• Transmission of mosquito borne diseases. • Reactions to midge bites including itching, nuisance/discomfort, skin infections and allergic reactions.
Applicable legislation, standards and guidelines
• *Work Health and Safety (National Uniform Legislation) Act* (NT). • *Public Health Act* (NT). • *Public and Environmental Health Act* (NT). • Public Health (General Sanitation, Mosquito Prevention, Rat Exclusion and Prevention) Regulations (NT). • Guidelines for preventing mosquito breeding associated with construction practice near tidal areas in the NT (DoH 2011) • Guidelines for preventing biting insect problems for urban residential developments or subdivisions in the Top End of the NT (DoH 2014a) • Guidelines for preventing biting insect problems for new rural residential developments or subdivisions in the Top End of the NT (DoH 201b) • Mosquito breeding and sewage pond treatment in the Northern Territory (Department of Health and Families 2009a)

Biting insects		
Performance objectives	**Targets**	**Key performance indicators**
To prevent the creation of pools of stagnant water that could become breeding habitat for mosquitoes.	No stagnant pools or ponds on site. No drainage lines, ponds, depressions or drains to contain vegetation, sediment or other waste material which could cause the obstruction of water flow and the pooling of water. No man-made containers and waste items left on site that are capable of ponding water.	The number of reported stagnant pools or ponds. The number of drainage lines, depressions or drains not being kept clear on the site. The number of reported man-made receptacles left on site that are capable of ponding water.
To decrease the potential for the spread of mosquito borne diseases to site personnel.	No mosquito–transmitted diseases infecting site personnel.	The number of personnel reported as having been infected with mosquito transmitted disease.
To decrease the pest problems associated with the presence of biting midges.	No workers significantly affected by midge bites.	The number of personnel reported as having been adversely affected by biting midges.
Source / activity	**Engineering (as-built) controls**	**Procedural controls**
1. Creation of biting insect habitat: • Inappropriate storage of waste that can contain water • Poorly managed water drainage systems including pooling of water in drains, pits, culverts and bunds.	1. Surface-water drainage channels throughout Ichthys LNG are designed to minimise the creation of breeding habitat for biting insects.	1. Regular visual inspections are carried out for mosquito larvae in high-risk areas and controls / remediation will be implemented as required.

Biting insects		
	2. The NCW system is designed to maintain dry drains and free flowing release of water through the perimeter outfall drains which helps prevent creation of biting insect habitats.	2. A biting insect management plan is implemented in collaboration with the NT Department of Health that includes the following controls: • depressions that pond with tidal or rain water will be filled in or a drainage system established to remove potential habitat • areas will be graded to be free of depressions capable of ponding water for periods greater than three consecutive days in tidal areas, and five days in onshore areas, to prevent mosquito breeding • any receptacle containing ponded water should be disposed of, stored under cover, have drainage holes drilled or treated with an appropriate insecticide on an appropriate schedule • storage/evaporation ponds will be inspected weekly and appropriate treatment (larvicide, drain the area) applied if the presence of insect larvae is detected • drains will be kept free of vegetation and other flow obstructions, and regular monitoring will be scheduled to maintain this

Biting insects		
		• a maintenance program will be established to de-silt/clear vegetation from stormwater drains and repair any erosion in drains and discharge sites.
Environmental performance monitoring and reporting requirements		
Visual inspections (Section 6.3.2).		

5.13 Emergency Preparedness and Response

5.13.1 Emergency Response System

INPEX has adopted the emergency management principles of "prevention, preparedness, response, and recovery" in the management of emergency and crisis events. The aim of emergency management arrangements is to respond effectively to emergency and crisis situations such that the impacts to personnel, environment, assets, reputation and sustainability (PEARS) are reduced to as low as reasonably practicable.

INPEX has a comprehensive emergency response system, which includes a suite of internal processes, standards and guidelines as well as emergency response planning and readiness activities.

Ichthys LNG is designed with a number of fire, gas and leak detection systems in accordance with Australian and international standards, including systems to detect flammable gas, toxic gas, spills, fire, smoke and heat. Ichthys LNG is also designed with manual alarm call points, which enables personnel to manually raise an alarm. These systems will provide early warning to site personnel, while the emergency response team (ERT) and/or incident management team (IMT) will be notified by the onsite incident controller.

In addition to detection systems, Ichthys LNG is equipped with a range of emergency response equipment, including the plant deluge and fire monitoring systems (Section 3.4), a fire station located at the operations complex, which will have a fire truck and portable firefighting equipment (Section 3.6), a hazardous materials spill response trailer, fire extinguishers and spill response kits located around the site.

INPEX maintains three teams of trained personnel to respond to emergencies: an ERT, an IMT and a crisis management team (CMT). The ERT is based on site and comprises specially trained Ichthys LNG operators who provide first response to emergencies and are trained in the use of the onsite emergency response equipment. There are IMTs located in Darwin and Perth to provide operational support to the ERT. The CMT is located in Perth and works to provide strategic direction to minimise business disruption. These teams are responsible for coordinating incident and crisis management actions for Australian sites. INPEX personnel are trained to work in conjunction with the NT PFES in order to plan effectively for any major emergencies.

Emergency Response Drills

The readiness and competency of personnel to respond to incidents and emergencies is maintained and tested by conducting periodic emergency response drills. Elements within the emergency response system and Nearshore OPEP are tested on a regular basis (as defined within each respective document). Emergency response drills are varied to incorporate realistic, potential emergency scenarios and may involve local communities and government authorities if appropriate.

The testing of response arrangements includes a post-assessment and review of the effectiveness of response arrangements against the objectives of the emergency response drills.

Information from incidents, emergencies and exercise drills is reviewed to identify trends and improvement opportunities and these are communicated to affected personnel and shared. Lessons learned, recommendations and outcomes of previous emergency response drills are incorporated into procedures and plans through the INPEX management of change process (Section 6.5) and corrective and preventive actions (Section 6.3.4), as appropriate.

5.14 Nearshore OPEP

The purpose of the Nearshore OPEP (INPEX Doc. X060-AH-PLN-60003) is to detail activities and arrangements, and provide a framework for response to any accidental or unintended hydrocarbon spill from INPEX nearshore operations activities for Ichthys LNG.

The Nearshore OPEP outlines spill preparedness requirements, including information on hydrocarbon characteristics, priority protection areas, exercises, drills and audits. It also outlines the activities that need to be undertaken if a hydrocarbon discharge or spill occurs in Darwin Harbour, including notification and reporting, roles and responsibilities, incident management guides, standard operating procedures, health and safety considerations and waste management. Post-spill scientific monitoring is also described in the Nearshore OPEP.

5.15 Cyclone Response

Tropical cyclones have the potential to damage equipment, risk to the safety and health of personnel and spills of hazardous materials into the environment. INPEX has detailed procedures for responding to cyclone events. The overall priorities for a cyclone event are:

- protection of personnel
- protection of the environment
- care of facility and equipment
- minimisation of downtime.

All structures and buildings located at Ichthys LNG have been designed to withstand cyclones. The product loading jetty has been designed for cyclone conditions according to Australian Standard AS 4997:2005 Guidelines for the design of maritime structures. The loading arms can be tied down in the event of a cyclone.

5.16 Stakeholder and community relations

INPEX has continued to undertake community and stakeholder engagement from construction through to operations.

INPEX believes effective community and stakeholder engagement is essential in maximising the safety of the company and Project personnel and the community and in establishing, building and maintaining community support and trust.

During the operations phase, INPEX has continued to regularly communicate information to the Darwin community and utilise Project updates as appropriate, including advertising, bulletins, newsletters, fact sheets, the Project website, email, formal and informal meetings, information sessions, posters and displays.

Following on measures and practices implemented through the construction phase to enhance positive impact and mitigate negative impact on communities, INPEX continues to:

- monitor health, social and traffic impacts as required
- hold community information sessions providing updates on Project activities as required
- undertake supplier and contractor briefings with Aboriginal and Torres Strait Islander and non- Aboriginal and Torres Strait Islander businesses
- maintain ongoing engagement with the Larrakia Development Corporation and Larrakia Nation Aboriginal Corporation and the utilisation of the Larrakia Advisory Group for broader community consultation with Larrakia families

- maintain cultural heritage management plans to protect sacred and cultural heritage sites.

Key areas of potential social impact that are managed during Operations include:

- flaring from the Ichthys LNG site (maintain community awareness of any visual impacts associated with flaring)
- vessel movements (LNG and LPG transportation carriers) in to and exiting Darwin harbour to the Ichthys LNG product loading jetty
- maintenance shutdowns at the Ichthys LNG site, including accommodation demand and road transport task) and potentially excess road transportation use (typically over a three-month period, every two-three years)
- maintaining community awareness of any environmental monitoring programs undertaken at Bladin Point that may impact local fishing or recreational vessel activities
- ongoing engagement on heritage and cultural issues engagement with the Larrakia traditional owners.

During Operations, INPEX's approach to integrated stakeholder engagement, continues to be based on five key principles:

- regular personal contact with priority stakeholders
- consistent, timely, coordinated and responsive communication across all stakeholder groups
- upfront communication about Project issues and impacts
- easily accessible information
- ongoing monitoring and improvement.

The INPEX Australia website www.inpex.com.au provides telephone and email contact details and an online enquiry form to enable the community to provide feedback and seek additional information on Project activities.

5.16.1 Public Safety

INPEX recognises that Darwin Harbour is valued for recreational activities including fishing. As such the safety zone around the product loading jetty, berths and module offloading facility and the no anchoring zone west of the product loading jetty (Figure 2-4) may inconvenience some members of the general public.

The safety zone and no anchoring zone are in place for the safety of vessels loading product and are communicated to harbour users by the Darwin Harbour master. INPEX continues to engage with stakeholders as appropriate, including through engagement with the harbour master, regarding the use of marine waters around/adjacent to the Onshore Plant.

5.17 Regulatory consultation

INPEX provides notifications to the NT EPA prior to events which may generate public comment, such as flaring events associated with scheduled maintenance shutdowns or plant upsets.

Unplanned events that are classified as non-compliances with the EPL approval conditions are reported to the NT EPA as per the incident reporting outlined in Section 6.3.3.

INPEX also proactively notifies the NT EPA as soon as practicable of unplanned events, which are not classified as incidents but may be of interest to the NT EPA.

6 IMPLEMENTATION STRATEGY

6.1 Organisational Structure and Responsibility

INPEX has established a well-delineated chain of command to manage the operations of Ichthys LNG. The overall responsibility for environmental management will rest with the Operations Vice President, who provides the leadership and drive for environmental compliance and implementation of this OEMP. A summary of the environmental responsibilities is provided in the following sections.

6.1.1 Vice President Operations

The Operations Vice President is responsible for:

- ensuring overall compliance with the INPEX BMS including environmental standards and outcomes
- providing leadership and resources needed for effective communication and implementation of this OEMP
- verifying that regular audit and review processes are conducted to maintain the effectiveness of this OEMP.

6.1.2 General Manager – Onshore Operations

The General Manager is responsible for:

- verifying that activities are undertaken according to this OEMP and any approval conditions
- communicating any changes to operations that may affect the performance objectives and environmental control measures detailed in this OEMP to the INPEX Environmental Advisor/s
- providing ongoing support and ensuring Operations has the resources required to meet the requirements of the EPL and this OEMP
- checking that reporting of environmental incidents meets external reporting requirements and INPEX incident reporting requirements
- verifying that corrective actions raised from environmental audits, inspections and incident investigations are tracked and closed out.

6.1.3 Production Manager – Onshore Operations

The Production Manager is the nominated contact person for EPL228, and is responsible for:

- implementing production related tasks to ensure compliance with the Environmental Management Strategies (Section 5).

6.1.4 Onshore Implementation Manager/Production Manager – Onshore Operations

Both the Onshore Implementation Manager and Production Manager are responsible for:

- implementing maintenance related tasks to ensure compliance with Environmental Management Strategies (Section 5).

6.1.5 HSE Operations Manager/Environmental Operations Team Lead

Both the HSE Operations Manager and Environmental Operations Team Lead and HSE Operations Manager are responsible for:

- providing support to the Environmental Advisor/s for implementation and update of this OEMP
- reviewing information related to environmental management of the onshore operations, including environmental statistics, environmental reporting and environmental programs
- verifying that regular audit and review processes are conducted to maintain the effectiveness of this OEMP
- verifying that activities during operations are planned and managed to minimise environmental impacts and comply with this OEMP.

6.1.6 Senior Environmental Advisor

The Senior Environmental Advisor is responsible for:

- communicating the requirements of this OEMP to Ichthys LNG workforce, including contractors
- participating in Operations meetings and promoting environmental awareness
- ongoing monitoring of environmental performance in relation to the EPL and this OEMP
- facilitating and/or participating in regular audit and review processes to maintain the effectiveness of this OEMP
- carrying out regular environmental inspections of Ichthys LNG
- assisting all personnel with the reporting of environmental hazards and incidents
- responding to and investigating environmental hazards and incidents
- monitoring and assisting with the closeout of corrective actions from audits, inspections and environmental incident investigations
- facilitation of site-based environmental monitoring programs
- consulting with regulators and other key stakeholders in relation to this OEMP
- undertaking internal verification to ensure Environmental Management Strategies (Section 5) are implemented.

6.1.7 All Personnel

All personnel are responsible for:

- protection of the environment
- participating in inductions, training and meetings as required
- complying with all applicable INPEX policies, standards, procedures, practices and laws
- working in accordance with this OEMP and supporting guidelines, procedures and work method statements
- proactively identifying, reporting and responding to environmental hazards and incidents
- active participation in environmental initiatives and programs

- intervening and stopping work where at-risk conditions or behaviours are observed.

6.2 Awareness, Training and Competency

6.2.1 HSE Training and Competency

Training programs are used to communicate environmental responsibilities to personnel and facilitate the understanding of environmental topics and control measures to minimise environmental risks.

All personnel are required to complete HSE inductions and training relevant to their role at Ichthys LNG. A training matrix is maintained to identify job or task specific environmental training requirements, for example spill clean-up, emergency response and waste management training. Training records are maintained as evidence of completion of HSE inductions and specific training courses.

The HSE induction informs personnel of the social and environmental sensitivities in the vicinity of Ichthys LNG (Section 2) and covers specific environmental management requirements (Section 5) including the following:

- a general description of the Ichthys LNG, including any environmentally critical activities
- adherence to standards and procedures; the use of job hazard analyses (JHAs) and permits to work (PTWs) systems; hazard identification and management process
- spill management, including prevention, response and clean up, location of spill kits and reporting requirements
- chemical management requirements
- waste management requirements (segregation and appropriate storage of wastes)
- hazard identification and management process
- reporting of environmental incidents and hazards.

INPEX Emergency Response Training

Personnel will participate in emergency response training commensurate with allocated roles and responsibilities. Training will be scheduled and maintained in accordance with the requirements of the relevant emergency response plans, Nearshore OPEP and HSE training programs.

The INPEX incident management team and crisis management team personnel complete competency-based training in emergency response through an accredited provider. Incident management team personnel are also trained in emergency management in accordance with the emergency management system by in-house emergency response personnel.

6.2.2 HSE Awareness

Environmental information is communicated to the workforce using a number of different techniques, including formal HSE meetings and HSE awareness materials.

Formal HSE meetings are conducted at regular intervals by various workforce groups including HSE committees and work teams. The main purpose of these meetings is to communicate relevant HSE information, discuss HSE related issues including environmental issues related to specific tasks, review HSE control measures and reinforce HSE related messages. In addition to meetings, environmental awareness is promoted through the use of HSE materials that are distributed to Ichthys LNG workforce. These materials include:

- HSE newsletters, bulletins and incident alerts
- HSE noticeboards to display important environmental information
- environmental awareness posters.

6.2.3 Contractor Management

INPEX contractor management procedures are applied to pre-qualify and select contractors and vendors who have the capacity to meet Ichthys LNG requirements. Considerations of HSE and social risk management capability are intrinsic to this process. Work scope specific HSE and social performance requirements are contained in each contract.

Contractors are required to complete HSE inductions, have relevant certification and competency for their roles and participate in formal HSE meetings.

6.3 Environmental Performance Monitoring and Reporting

INPEX uses audits, inspections and management reviews to assess and monitor environmental performance, as described in Sections 6.3.1 to 6.4.

The results of these programs are reported as outlined in Section 6.3.3.

Any opportunities for improvement are captured and progressed in accordance with the non-conformance and corrective actions process described in Section 6.3.4.

6.3.1 Verification Audits

INPEX is committed to continual improvement in all aspects of its activities. Routine internal audits are used to determine compliance with the EPL and this OEMP as part of the overall review and improvement program.

Regular internal audits are conducted during operations to verify that environmental performance is consistent with the control measures described within this OEMP and compliant with the EPL and relevant NT and Commonwealth legislation. An internal audit schedule is maintained and updated on an annual basis. The audits are conducted by suitably trained and experienced INPEX auditors in accordance with INPEX's internal audit processes.

Audits by regulators are undertaken at the regulators' discretion to verify compliance with environmental approval commitments, including:

- commitments in this OEMP
- conditions outlined in EPL228
- conditions outlined in Ministerial Statement EPBC 2008/4208.

As per the requirements of EPL228, an external annual environmental audit is to be undertaken by a qualified auditor (a person included on the register established and maintained pursuant to section 68 of the WMPC Act) for the preceding 12 month reporting period (14 September to 13 September for each year of the licence following and including first day of First Start-up and each subsequent period of 12 months).

The audit is to evaluate compliance with:

- the conditions of EPL228, including the OEMP, environmental monitoring programs and environmental performance
- the WMPC Act and the *Water Act* (NT).

INPEX must submit the proposed scope for the environmental audit to the NT EPA for approval, no later than 15 business days prior to the proposed commencement date of the environmental audit (which must be specified when the proposed scope is submitted).

INPEX must receive written approval for the audit scope from the NT EPA before the environmental audit can commence.

INPEX must ensure that:

- a written environmental audit report is prepared and signed by the qualified auditor who conducted the audit;
- the written environmental audit report is completed within two calendar months of the audit scope being approved under condition 37 of this licence, unless authorised by the NT EPA; and
- the written environmental audit report is provided in full to the NT EPA within five business days of being certified and signed by the qualified auditor conducting the audit.

A record of all audits, including audit outcomes, is maintained, and actions arising from audits will be tracked until their close-out as outlined in Section 6.3.4.

6.3.2 Inspections

A routine inspection and preventative maintenance program is implemented to verify that equipment is working efficiently and in good working condition, which reduces the potential for environmental impacts from sources such as fugitive air emissions, excessive noise and vibration, leaks, spills and environmental incidents.

A flange management system is used to systematically inspect and maintain flanges throughout Ichthys LNG, which also helps reduces fugitive emissions and resultant impacts on air quality.

In addition to the systems outlined above, regular visual workplace inspections are undertaken. The Environmental Advisor/s also undertake routine environmental site inspection of Ichthys LNG work site to verify that activities comply with environmental requirements.

6.3.3 Reporting

Routine Internal Reporting

Information on a number of relevant environmental facets of start-up and steady-state operations is collected, such as environmental performance statistics, records of environmental audits and inspections, results of environmental monitoring programs and data regarding emissions, discharges and waste. This information is reported internally within the business, and forms part of the INPEX-wide environmental performance tracking.

Routine Reporting (External)

INPEX reports environmental performance information to regulators, as summarised in Table 6-1.

Table 6-1: Routine external reporting

Report	Recipient	Frequency	Content of report
EPL Annual Return	NT EPA	Annual, due within 10 business days after each anniversary of the EPL	Details of compliance with the EPL conditions
Annual Environmental Monitoring Report	NT EPA	Annual, due 30 September each year	Report on monitoring required under the EPL and as per the EPL condition 87
Annual Environmental Audit Report	NT EPA	Annual, due within 5 business days of the date the audit is signed	As per requirements in EPL

Incident Reporting

All personnel working for, and on behalf of, INPEX are required to report all environmental events (incidents, near misses, hazards, non-compliances with the EPL and OEMP, and exceedances of targets and triggers of EPL228). Personnel have been made aware of these reporting requirements through the HSE induction process.

Events are reported in line with internal INPEX BMS standards and procedures which enable a detailed and consistent approach in reporting. These events are documented, reviewed for their actual and potential consequence severity (levels), and investigated as appropriate to these levels.

The BMS procedures have processes relating to incidents which include the following stages: recording incident information into incident management software, completing incident investigations, identifying and closing out corrective actions and disseminating incident information to the workforce.

In addition to the internal reporting requirements, external reporting and notification of environmental incidents to regulators is undertaken in accordance with the INPEX External Event Notification procedure.

It is the responsibility of the INPEX General Manager – Onshore Operations to check that reporting of environmental incidents meets both regulatory reporting requirements and the INPEX BMS standards and procedures.

External regulatory reporting requirements for environmental incidents are outlined in Table 6-2.

Table 6-2: External incident reporting requirements

Incident	Reporting to	Timing
Any non-compliance with the approval conditions of the EPL.	NT EPA	As soon as practicable and in any case within 24 hours after first becoming aware of the non-compliance.
Material or serious environmental incidents as defined by Section 14 of the WMPC Act.	NT EPA	As soon as practicable and in any case within 24 hours after first becoming aware of the non-compliance.

6.3.4 Non-conformance and Corrective Actions

Actions required to prevent the recurrence of environmental events or to close out audit non-conformances and recommendations are identified and tracked in an actions register. The actions register documents the actions and is used as a tool to verify their completion in a manner consistent with INPEX's internal BMS requirements.

Remedial actions may include changes to documentation (e.g. risk registers, standards or procedures), additional training for personnel, different tools or different equipment. Remedial actions are assigned on a case-by-case basis and are appropriate to the nature and scale of the event.

6.4 Management Review

INPEX is committed to conducting its activities in a manner that is environmentally responsible and implementing a continuous improvement process. As part of the continuous improvement process, this OEMP may be reviewed regularly for the purposes of continual improvement. Reviews will include, but not be limited to, consideration of improvements to this OEMP as a result of incident investigations, performance of equipment and environmental monitoring results.

In addition to regular reviews, this OEMP will be reviewed in the event of significant incidents, new or significant changes to identified risks, new or significant modification in activities and as part of emergency testing reviews. These include changes in environmental legislation affecting the OEMP, changes to emissions or discharges from the LNG facility and addition of emission and discharge points at the LNG facility.

6.5 Management of Change

Where an additional activity or change to activity is proposed, an internal management of change (MOC) process will be implemented and notification will be communicated via a MOC request. The request will identify the proposed change(s) along with the underlying reasons and highlight potential areas of environmental risk or impact.

An assessment will be made to determine whether or not the proposed change(s):

- will cause, or increase the potential for environmental harm as defined under the WMPC Act
- identifies whether any additional controls are required.

Under INPEX business rules it is mandatory to undertake an environmental risk assessment where change could affect the environment. The MOC request is circulated to an Environmental Advisor, who will then determine the necessary approval/endorsement pathway.

6.6 Adaptive Management Framework

This OEMP incorporates the basic principles of adaptive management as set out in ANZG (2018):

'a continuous cycle of improvement based on setting goals and priorities, developing strategies, taking action and measuring results, and then feeding the results of monitoring back into new goals, priorities, strategies and actions.'

Figure 6-1 provides an overview of the adaptive management framework that is implemented under this OEMP. This follows the basic principles of adaptive management:

- Plan - Section 3 describes the design of the plant and the in-built controls and alarm systems. Section 5 also includes management tables that further describe the operational controls to minimise environmental impact.
- Design – as above, Section 3 describes the design of the plant and the in-built controls and alarm systems. Section 5 also includes management tables that further describe the operational controls to minimise environmental impact
- Implement – Section 6 describes the implementation strategy for environmental performance monitoring, reporting and reviewing outcomes of audits, inspections, incidents and monitoring
- Monitor - Section 7 describes the monitoring programs and performance indicators (e.g. discharge limits, trigger values) based on environmental risks identified in the plan.
- Evaluate – Section 7.5.2 describes the evaluation process of monitoring results that exceed performance indicators.
- Adjust – Sections 6.6 and 7.5.4 describe how the monitoring and management can be adjusted based on best practise and results of this OEMP
- Report – Section 6.3.3 describes the external reporting requirements
- Respond – Section 7.5.3 describes the management response process for performance indicator exceedances attributable to the activities detailed in the plan.

The adaptive management framework has been designed to allow for regular review and revision of the monitoring and management undertaken as part of this OEMP. Monitoring and management requirements may change as a result of the following:

- changes in Ichthys LNG plant operations;
- as part of the MOC process (Section 6.5); or
- on the basis of monitoring results.

Updates to the OEMP, resulting from the implementation of the adaptive management process, will be reviewed and endorsed by a Qualified Professional. In accordance with EPL228 requirements, the Qualified Professional review and the updated OEMP will be submitted to the NT EPA at least ten (10) business days prior to any changes being implemented.

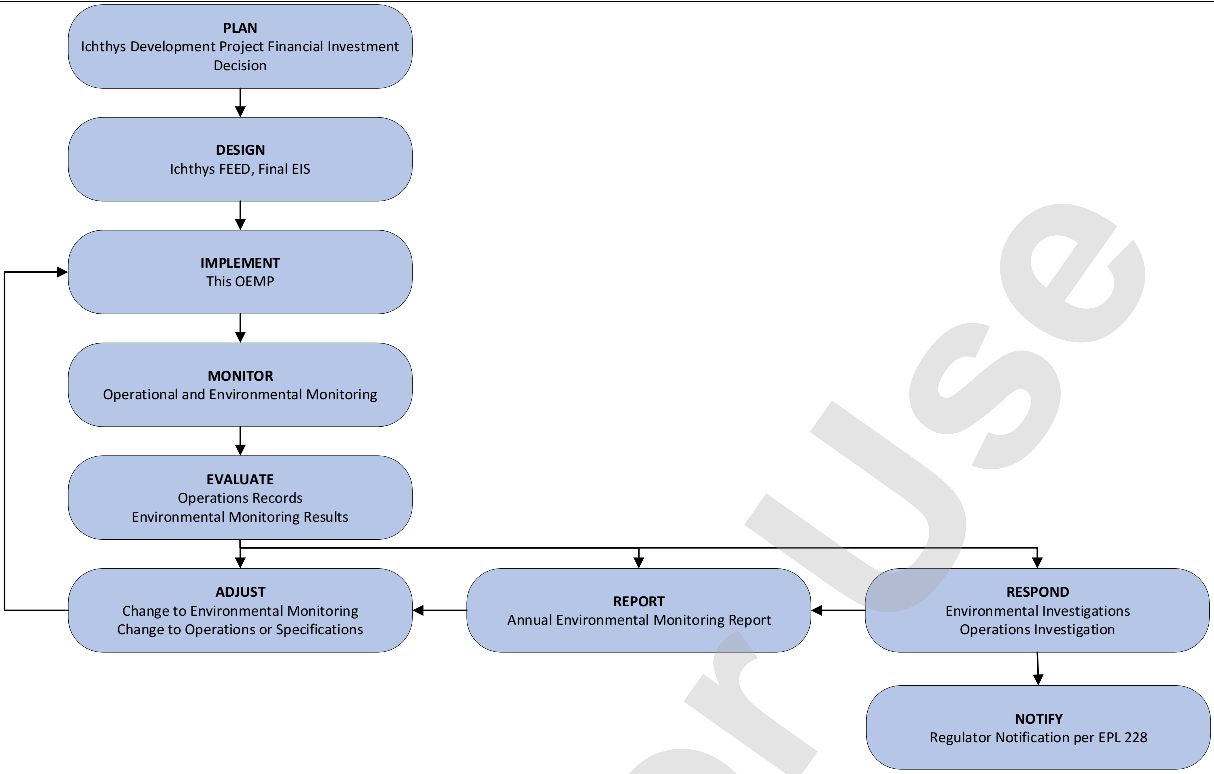

Figure 6-1: Adaptive management framework

6.7 Documents and Records

INPEX maintains document control procedures to ensure that all information necessary for the consistent implementation this OEMP is documented, legible, identifiable and kept up to date. Records to demonstrate implementation of the management system and compliance with legal and other obligations are identified and maintained. These include:

- external communications
- training and competency assessments
- emissions and discharges monitoring data
- performance measurement criteria data
- inventory and/or movement of dangerous goods, wastes and hazardous materials
- records of HSE, security and emergency drills
- records of periodic tests and maintenance of HSE related (and other) equipment and tools
- incident and/or near miss investigation reports
- audit and inspection reports, test certificates, and follow up action reports
- improvement plans (corrective actions, key performance indicators)
- record of compliance with approvals
- regulatory compliance documentation.

7 ENVIRONMENTAL MONITORING

INPEX has developed a multi-tiered approach to environmental monitoring, which consists of the following:

1. Online analysers and meters: These are provided at various points within Ichthys LNG to conduct continuous monitoring of specific emissions and discharges. The data from most of the analysers and meters are available to personnel in the control room, and are linked to alarms to notify personnel of impending exceedances or to automatically redirect wastewater for retreatment. The data also enables historical trending and analysis of emissions and discharges.
2. In-house laboratory and field analysis: In addition to online analysers and meters, sampling and analysis of wastewater is undertaken by the INPEX laboratory technicians. The samples are analysed on site, at Ichthys LNG's NATA accredited laboratory, for a broader suite of parameters than the online analysers and meters measure, to provide more comprehensive characterisation of the emissions and wastewater streams. Undertaking the sampling and analysis in-house means the results are available in a short timeframe and enables timely response if issues are detected.
3. External laboratory analysis and monitoring: External, independent NATA accredited laboratories are used to test and analyse air emissions and wastewater samples that the INPEX laboratory is not equipped to handle. This supplements the onsite analysis undertaken by INPEX.
4. Environmental monitoring programs: Receptor monitoring is undertaken to detect changes and potential impacts to the environment around the Ichthys LNG, including the atmospheric, terrestrial and marine environment.

Table 7-1 provides a summary of the environmental monitoring programs, and the relevant sections within this OEMP that provide further detail of the programs. For each individual monitoring program, where information such as sampling method, calibration, sample filtration/preservation, decontamination, QA/QC process and procedures are not contained within the OEMP, this is included in relevant INPEX or Contractor deliverables, which are consolidated document(s) that are auditable.

Baseline data and environmental monitoring results from the construction phase of the Ichthys Project have been used to inform the development of these environmental monitoring programs. The results of the operations environmental monitoring programs are reported internally as part of the routine internal reporting (Section 6.3.3). External reporting will be undertaken in accordance with the EPL (Table 6-1 and Table 6-2).

Table 7-1: Summary of Environmental Monitoring Programs

Category	Monitoring program	Frequency	Section
Emissions to air	Point source emissions to air (stack testing)	Quarterly for first 18 months of steady-state operations Annually thereafter	7.1.1
	Dark-smoke events	As required (triggered by a dark-smoke event)	7.1.3
	Airborne noise	As required	7.1.3

Category	Monitoring program	Frequency	Section
Discharges to water (Darwin Harbour)	Commingled treated effluent (750-SC-003)	Monthly testing Continuous flow rate monitoring	7.2.1
	Harbour sediments	Every two years	7.2.2
Discharges to land	Groundwater quality	Biannual	7.3.1
Heritage, flora and fauna	Cultural heritage	Annually	7.4.1
	Marine pests	As per DITT monitoring program frequency	7.4.2
	Introduced terrestrial fauna species	Annually or as required	7.4.3
	Weeds	Annually (end of wet)	7.4.4
	Vegetation rehabilitation and erosion	Every two years	7.4.5
	Mangrove health, intertidal sediment and bio-indicator monitoring	Every two years	7.4.6

* Additional surveys completed as reported in the 2018-2019 AEMR.

7.1 Emissions to Air

7.1.1 Point Source Emissions to Air

INPEX monitors stack emission point sources. This was conducted quarterly for the first 18 months after completion of First Start-up and is currently annually following the review of emission results, consistent with NRETAS Recommendation 16 (NRETAS 2011) and EPL228 requirements.

During the start-up phase of each train no stack testing was undertaken due to the majority of fuel burning equipment being unable to operate in a normal steady state mode due to low loads and/or variable start up rates. During the start-up period the GTGs do not operate efficiently and are not be able to operate in the dry low NOX burner mode. Stack testing therefore commenced when stable operation and steady production rates were reached. Once steady state operations were achieved the gas turbines were able to operate in the dry low NOX mode.

Stack emissions monitoring is undertaken at 16 point sources (with 20 stacks) on the Frame 7 compression turbines, CCPP Frame 6 power generation turbines, CCPP utility boilers, AGRU Incinerators and heating medium furnaces. For the CCPP Frame 6 turbines, each turbine has two stacks, one which allows for normal operation of the turbine (with exhaust emissions directed to a conventional stack) and a separate stack with an associated HRSG, allowing for steam to be generated through the duct burning of isopentane. The two stacks cannot be operated together so stack monitoring is dependent on which stack is in use at the time of sampling.

Table 7-2 shows the constituents that are monitored and Figure 7-1 shows the locations of the stack emissions monitoring. In addition to the constituents in Table 7-2, stack emissions monitoring also record temperature, flow, O_2 and moisture.

The following locations are inline gas sampling points (not ports): 551-SC-003 (release point number A13-2), 552-SC-003 (release point number A14-2), 541-SC-001 (release point number A13-3) and 542-SC-001 (release point number A14-3) and as such are exempt from the standard methods for stack sampling. INPEX conducts inhouse gas sampling and analysis from these locations for BTEX, H_2S and Hg using conventional industry methods which are not NATA accredited, noting the analysis is conducted using a test method that is managed under a NATA accredited Quality Management System.

In addition estimates based on engineering process controls to calculate and record the time and duration of emissions, volumetric flow rates and efflux velocity for each of the authorised stationary source emission release points listed in Table 7-2 are conducted. Estimates are based on fuel usage and design specifications of the fuel burning equipment.

Stack samples are either collected by INPEX laboratory technicians and tested in the on-site NATA-accredited laboratory or are collected by an external NATA-accredited contractor and analysed in the field and offsite.

All stack sampling ports have been installed in accordance with AS4323.1-1995 Stationary source emissions – Selection of sampling ports. While all stack sampling, where applicable, is undertaken in accordance with:

- NSW Department of Environment and Conservation Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales; or
- USEPA Method 30B for mercury emissions.

Targets and limits proposed for air emission point source monitoring are provided in Table 7-4.

The stack testing results are used to confirm that INPEX is satisfied with vendor-supplied equipment and systems, to optimise the efficiency of Ichthys LNG facilities and to verify compliance with EPL228 conditions.

Table 7-2: Stack emissions monitoring constituents

Release point number	Emission source	Constituents	
		NO_x as NO_2, N_2O, Hg, PM2.5, PM10, CO, temperature, efflux velocity, volumetric flow rate	BTEX, H_2S, Hg, volumetric flow rate
A1	Compressor turbine WHRU West 1 (Frame 7)	X	
A2	Compressor turbine WHRU West 2 (Frame 7)	X	
A3	Compressor turbine WHRU East 1 (Frame 7)	X	
A4	Compressor turbine WHRU East 2 (Frame 7)	X	
A5-1	Power generation turbine 1 (Frame 6)	X	
A6-1	Power generation turbine 2 (Frame 6)	X	
A7-1	Power generation turbine 3 (Frame 6)	X	
A8-1	Power generation turbine 4 (Frame 6)	X	
A9-1	Power generation turbine 5 (Frame 6)	X	
A5-2	Power generation turbine 1 HRSG (Frame 6)	X	
A6-2	Power generation turbine 2 HRSG (Frame 6)	X	
A7-2	Power generation turbine 3 HRSG (Frame 6)	X	
A8-2	Power generation turbine 4 HRSG (Frame 6)	X	

Release point number	Emission source	Constituents	
		NO_x as NO_2, N_2O, Hg, PM2.5, PM10, CO, temperature, efflux velocity, volumetric flow rate	BTEX, H_2S, Hg, volumetric flow rate
A9-2	Power generation turbine 5 HRSG (Frame 6)	X	
A13-1	AGRU Incinerator – LNG Train 1	X	
A13-2	AGRU Hot Vent – LNG Train 1, prior to release at A3		X
A14-1	AGRU Incinerator – LNG Train 2	X	
A14-2	AGRU Hot Vent – LNG Train 2, prior to release at A4		X
A15	Heating medium furnace 1	X	
A16	Heating medium furnace 2	X	

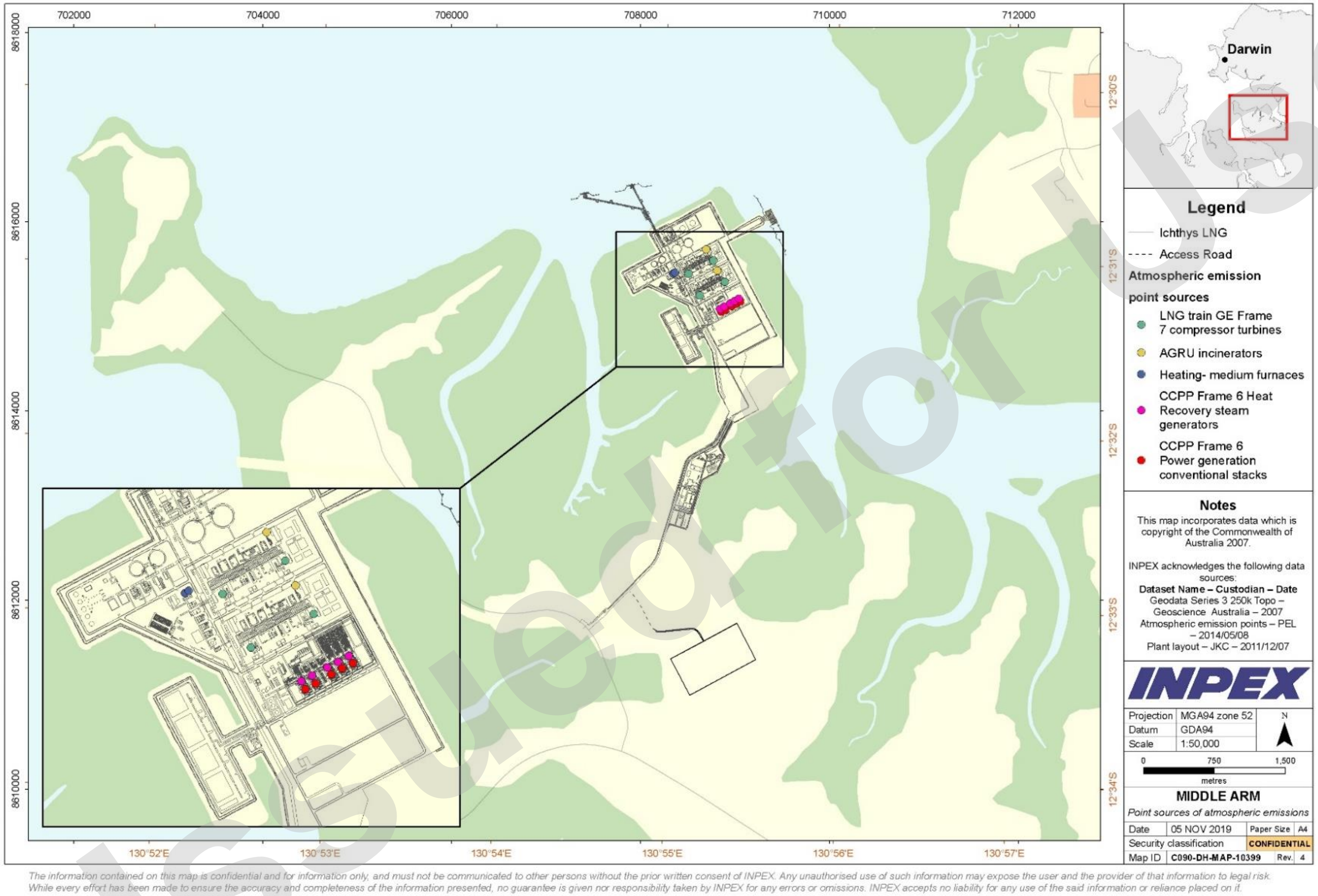

Figure 7-1: Stack emissions monitoring locations

Table 7-3: Stack emission monitoring

Emission source	Pollutant	Target	Limit
LNG Train Refrigerant Compressor Driver Gas Turbines (GE Frame 7s)	NO_x as NO_2	25 ppmv @ 15% O_2 (dry) [Electricity Generation; any turbine operating on gas]	35 ppmv @ 15% O_2 (dry)
CCPP Gas Turbine Generators (GE Frame 6's) -- before duct burning, conventional stack	NO_x as NO_2	25 ppmv @ 15% O_2 (dry) [Electricity Generation; any turbine operating on gas]	35 ppmv @ 15% O_2 (dry)
CCPP Gas Turbine Generators (GE Frame 6's) -- after also burning vaporised iso-pentane in duct burners, – HRSG in use	NO_x as NO_2	75 ppmv @ 15% O_2 (dry) [Afterburners and other thermal plant; any afterburner or other plant]	175 ppmv @ 15% O_2 (dry)
AGRU Incinerators	NO_x	160 ppmv @ 3% O_2 (dry) [Afterburners and other thermal plant; any afterburner or other plant]	175 ppmv @ 15% O_2 (dry)
Heating Medium Furnaces	NO_x	80 ppmv @ 3% O_2 (dry) [Petroleum refining; any fuel burning equipment]	175 ppmv @ 3% O_2 (dry)

7.1.2 Dark Smoke Events

Ichthys LNG has been designed to minimise dark-smoke events. However, dark-smoke can be caused during flaring due to incomplete combustion of hydrocarbons. The environmental impacts from smoke emitted from an LNG plant are considered negligible; though smoke could cause a visual amenity impact and community concern.

In the event that smoke is produced during operations, the shade (or darkness) of the smoke is estimated using the Australian Miniature Smoke Chart (AS 3543:2014 Use of standard Ringelmann and Australian Standard miniature smoke charts). The shade and duration of the dark-smoke event are recorded. Dark smoke monitoring targets and limits for all the flare systems are provided in Table 7-5.

Table 7-4: Dark smoke monitoring

Emissions source	Pollutant	Target	Limit
Flares	Smoke	< Ringelmann 1	Visible smoke emissions darker than Ringelmann shade 1.

7.1.3 Airborne Noise

'For cause' environmental and occupational health and safety noise surveys may be undertaken; these will be focused on the health and safety of the workforce, and on potential environmental or social impacts due to noise emissions.

7.2 Discharges to Water

7.2.1 Commingled Treated Effluent (750-SC-003)

Ichthys LNG discharges commingled treated effluent to Darwin Harbour via the jetty diffuser (Section 3.8.6). INPEX monitors the commingled treated effluent prior to discharge using the following techniques:

- Continuous monitoring of flow rate by online instrumentation and meters.
- Water quality sampling and laboratory analysis. Samples of the commingled treated effluent are taken from a sample point provided on the discharge pipe that carries the commingled treated effluent out to the jetty diffuser. The sample point 750-SC-003 is located upstream of the diffuser, prior to the product loading jetty.
- All treated water samples collected are analysed by a NATA accredited laboratory and compared against the EPL targets to verify compliance with approval conditions.
- A daily visual inspection is conducted by operational staff to monitor for any visible sheen caused by hydrocarbons at the location of the jetty outfall.

Parameters, sampling frequencies and water quality targets are described in **Error! Reference source not found.**. For the parameters with no prescribed limit a precautionary approach is taken to analyse for a range of chemicals that are not expected to be present within the wastewater.

Table 7-5: Commingled treated effluent monitoring

Parameter	Units	Sampling method[1]	Monitoring frequency[2]	Discharge limit[3]
Volumetric flow rate	m^3/hr	CFI	Continuous	180
pH	-	SFLA	Monthly	not less than 6.0 & not greater than 9.0
Electrical conductivity	µS/cm	SFLA	Monthly	N/A
Temperature	°C	CFI	Monthly	35

Parameter	Units	Sampling method[1]	Monitoring frequency[2]	Discharge limit[3]
Turbidity	NTU	CFI or SFLA	Monthly	N/A
Dissolved Oxygen	%	CFI	Monthly	N/A
TPH as oil and grease	mg/L	SFLA	Monthly	6
TPH/TRH	µg/L	SFLA	Monthly	N/A
TSS	mg/L	SFLA	Monthly	10
BOD	mg/L	SFLA	Monthly	20
COD	mg/L	SFLA	Monthly	125
Free Chlorine	mg/L	SFLA	Monthly	2
Ammonia	µg N/L	SFLA	Monthly	N/A
TN	µg N/L	SFLA	Monthly	10,000
TP	µg P/L	SFLA	Monthly	2,000
Filterable Reactive Phosphorus	µg P/L	SFLA	Monthly	N/A
Cadmium	µg/L	SFLA	Monthly	N/A
Chromium	µg/L	SFLA	Monthly	N/A
Copper	µg/L	SFLA	Monthly	N/A
Lead	µg/L	SFLA	Monthly	N/A
Mercury	µg/L	SFLA	Monthly	N/A
Nickel	µg/L	SFLA	Monthly	N/A
Silver	µg/L	SFLA	Monthly	N/A
Zinc	µg/L	SFLA	Monthly	N/A
Enterococci	cfu/100 mL	SFLA	Monthly	N/A
E. coli	cfu/100 mL	SFLA	Monthly	100

Parameter	Units	Sampling method[1]	Monitoring frequency[2]	Discharge limit[3]
Faecal coliform	cfu/100 mL	SFLA	Monthly	400
Anionic surfactants	mg/L	SFLA	Monthly	N/A
aMDEA	mg/L	SFLA	Monthly	N/A
Glycol	mg/L	SFLA	Monthly	N/A

[1]CFI: Calibrated field instrument; SFLA: sample for laboratory analysis

[2]Sampling was undertaken weekly during start-up when discharging, and has reverted to monthly following Ichthys LNG achieving steady state operations for the first time

[3]N/A: No limit set for the purpose of reporting events to the NT EPA, as not expected to be present in wastewater in significant concentrations. Testing is precautionary measure, to ensure receiving environment water quality guidelines are achieved at the boundary of the mixing zone.

7.2.2 Harbour Sediments

Surficial marine sediments are monitored in proximity to the Ichthys LNG outfall located on the condensate/LPG jetty to demonstrate that the commingled treated liquid discharge from plant operations have not had adverse impacts on sediment quality.

Surficial marine sediments are monitored annually for the first 36 months following first start-up of LNG Train 1 and 2. Based on review of these results, which indicated no detectable (ecologically significant) impacts to sediment quality from the discharge, the monitoring frequency has been reduced to biennial (every two years).

Monitoring sites have been selected based on the modelled mixing zone assessment (95% percentile; worst-case scenario), primary hydrodynamic flow and location of infrastructure. Impact sites have been selected at a gradient away from the outfall, within and outside of the modelled mixing zone to ensure sufficient spatial extent. Control sites have been selected further afield, where similar hydrodynamic and sediment characteristics prevail. The locations of the marine sediment sampling sites are presented in Figure 7-2.

Sediment samples are collected using a benthic grab and treated/stored according to laboratory requirements. All samples are analysed by a laboratory using NATA accredited methods. Parameters to be monitored are described in Table 7-6.

Table 7-6: Marine sediment monitoring parameters

Parameter	Units / descriptor	Monitoring frequency
Metals (Al*, Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	mg/kg	Biennial (every two years)
TOC	mg/kg	
TRH	mg/kg	
BTEX	µg/kg	

*Note aluminium has only been included for normalisation purposes

Sediment results are compared against benchmark levels to ascertain whether a trigger exceedance has occurred. An exceedance of a benchmark level occurs when:

- a measured analyte exceeds the SQGVs described in ANZG (2018), and
- a measured analyte exceeds background levels for Darwin Harbour sediments.

Where measured metal or metalloids exceed SQGVs, results where possible are normalised for aluminium concentrations based on the methods described in Munksgaard (2013) and Munksgaard et al. (2013) and compared to background levels (i.e. baseline or reference levels).

If a trigger value is exceeded, refer to Receiving Environment Adaptive Management Framework outlined in Section 7.5.3.

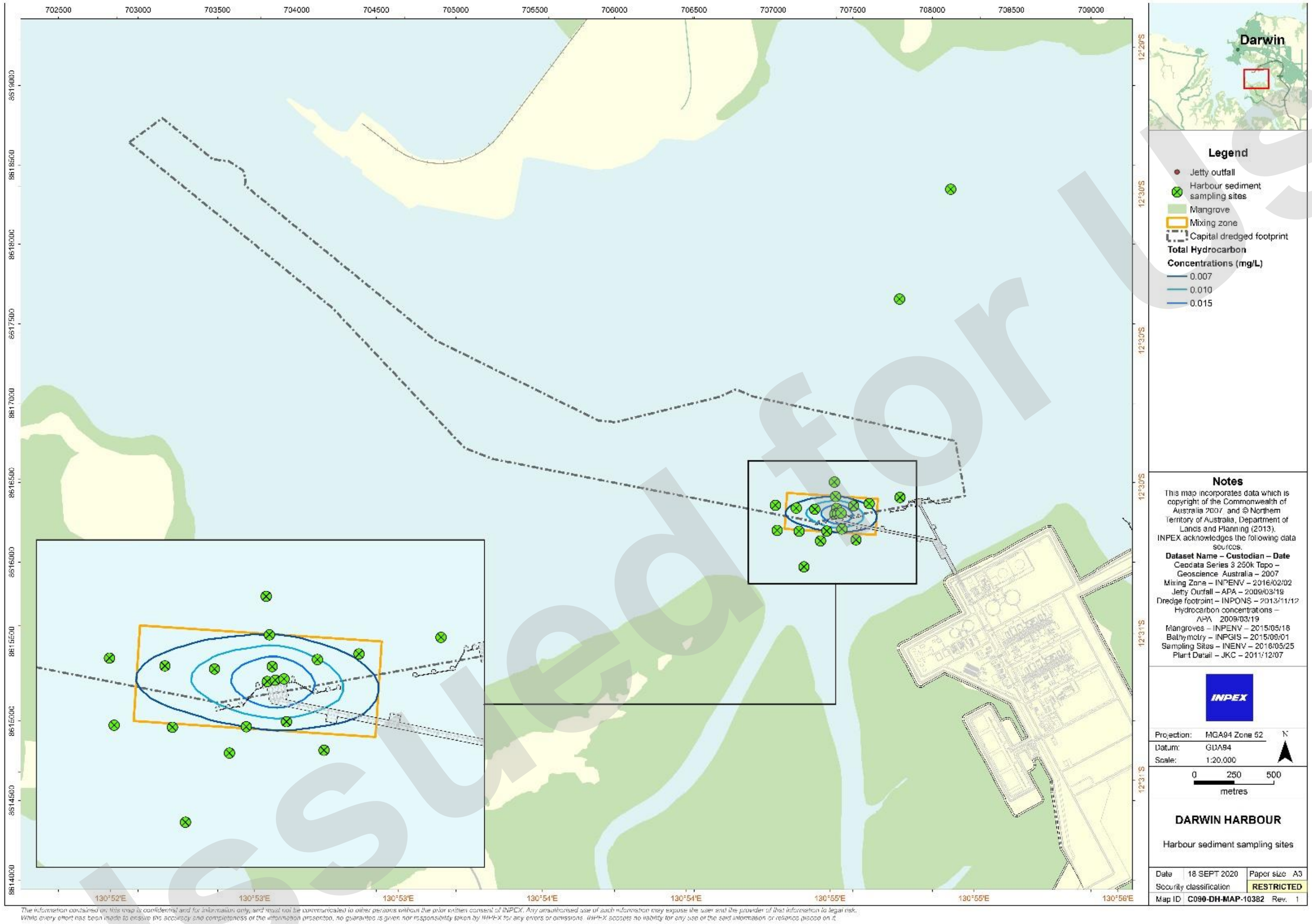

Figure 7-2: Indicative marine sediment quality monitoring sites

7.3 Discharges to Land

7.3.1 Bladin Point Groundwater Quality

During the operations phase, there are no planned discharges directly to groundwater, other than clean rainfall and NCW water (flowing to the NCW drainage network); however, there is potential for groundwater to become contaminated as a result of an accidental spill, leak or rupture during Ichthys LNG operations. Therefore, a groundwater monitoring program has been implemented to monitor whether adverse impacts have occurred from Ichthys LNG operations.

Monitoring and analysis occurred quarterly for the first 12 months following first start-up of LNG Train 1 and 2. Following a review of the first year's monitoring data the program reverted to biannual groundwater sampling events following the July 2019 monitoring event.

Groundwater is sampled at 15 locations in and around Ichthys LNG as illustrated in Figure 7-3. Routine groundwater quality monitoring and laboratory analysis are undertaken for the parameters listed in Table 7-8. All groundwater samples collected are analysed at a NATA-accredited laboratory, either onsite or externally. An interface meter is used to assess for the presence of light non-aqueous phase liquid at each of the sampling locations, during each survey.

Table 7-7: Groundwater monitoring parameters

Parameter	Unit	Monitoring frequency
Temperature	°C	Biannual (twice yearly)
pH	-	
Electrical conductivity	µS/cm	
Redox (oxygen reduction potential)	mV	
Dissolved oxygen	mg/L	
Total dissolved solids (TDS)	mg/L	
Nutrients (Oxides of nitrogen, Ammonia, TN, TP, FRP)	µg N/L µg P/L µg/L	
*E. coli**	cfu/100 mL	
Faecal coliform*	cfu/100 mL	
BOD*	mg/L	
BTEX	µg/L	
TRH[†]	µg/L	

Parameter	Unit	Monitoring frequency
Metals and metalloids‡ (Al, As (total), Cd, Cr (III), Cr (IV), Co, Cu, Pb, Mn, Hg, Ni, Ag, V, Zn)	µg/L	

* Only at locations BPGW27A and BPGW19A – down-gradient of the sewage treatment plant
†Where TRH is detected over the prescribed limits a silica gel clean-up will be undertaken and reanalysed to remove false positive natural oil results.
‡Dissolved fraction only.

The information contained on this map is for information only. Any unauthorised use of such information may expose the user and the provider of that information to legal risk. While every effort has been made to ensure the accuracy and completeness of the information presented, no guarantee is given nor responsibility taken by INPEX for any errors or omissions. INPEX accepts no liability for any use of the said information or reliance placed on it.

Figure 7-3: Groundwater quality sampling locations

Groundwater results are compared against benchmark levels to ascertain whether a trigger exceedance has occurred. The relevant trigger values from the Darwin Harbour WQOs (upper-estuary) and ANZG (2018) for marine waters have been adopted as specified in Table 7-8.

Table 7-8: Groundwater monitoring trigger values

Parameter[1]	Detection method	Trigger value[2]	Reference
pH	In situ	6 lower limit; 8.5 upper limit	Water quality objectives for the Darwin Harbour region - background document (NRETAS 2010)
Ammonia	Laboratory	20 µg/L	Water quality objectives for the Darwin Harbour region-background document (NRETAS 2010)
TN	Laboratory	300 µg/L	
TP	Laboratory	30 µg/L	
Oxides of nitrogen	Laboratory	20 µg/L	
FRP	Laboratory	10 µg/L	
Aluminium	Laboratory	24 µg/L	Golding et al. 2015
Arsenic	Laboratory	2.3 µg/L	Australian and New Zealand guidelines for fresh and marine water quality (ANZG 2018)
Cadmium	Laboratory	0.7 µg/L	
Chromium (III)	Laboratory	10.0 µg/L	
Chromium (VI)	Laboratory	4.4 µg/L	
Cobalt	Laboratory	1 µg/L	
Copper	Laboratory	1.3 µg/L	
Lead	Laboratory	4.4 µg/L	
Manganese	Laboratory	390 µg/L	TBC
Mercury	Laboratory	0.1 µg/L	Australian and New Zealand guidelines for fresh and marine water quality (ANZG 2018)
Nickel	Laboratory	7 µg/L	
Silver	Laboratory	1.4 µg/L	
Vanadium	Laboratory	100 µg/L	

Parameter[1]	Detection method	Trigger value[2]	Reference
Zinc	Laboratory	15 µg/L	
Benzene	Laboratory	500 µg/L	
Ethylbenzene	Laboratory	5 µg/L	
Toluene	Laboratory	180 µg/L	
Xylenes	Laboratory	75 µg/L	
TRH[3]	Laboratory	600 µg/L	Ministry of Infrastructure and the Environment 2013, Groundwater intervention value

1. Metals/metalloids should be analysed for dissolved metals only (not total metals/metalloids). Mercury should be analysed for the total dissolved fraction.

2. Exceedances are screened for seasonal influences by applying the 80th percentile statistical analysis process per ANZG (2018). This includes control charting and calculation of long-term dataset percentiles. Following this, the concentrations that are therefore 'genuine' exceedances can then be identified and any potential impacts examined.

3. Where TRH is detected over the prescribed limits a silica gel clean-up will be undertaken and reanalysed to remove false positive natural oil results. Further interrogation in specific types of hydrocarbons can be undertaken, if needed, through interpretation of the chromatography signatures. Characterisation of specific types of hydrocarbons may be required initially to determine composition and variation in composition, if any.

If a trigger value is exceeded, refer to Receiving Environment Adaptive Management framework outlined in Section 7.5.3. Depending on the nature and scale of the trigger exceedance, the subsequent assessment may include an evaluation of groundwater discharge zones and potential flow on effects to the receiving environment.

An annual review of the AEMR groundwater data is likely to require the following:

- Comparison of operational monitoring data against baseline (construction) to demonstrate no significant difference in monitoring data on a seasonal basis;
- Trend analysis (e.g. Mann Kendall) of construction and operational data to determine suitable triggers for ongoing monitoring at a reduced frequency;
- Demonstration of suitability of new proposed monitoring frequency, including ability to determine impacts from ILNG activities; and
- Requirement for additional monitoring for unplanned discharges at ILNG, based on the adaptive management principles contained in the OEMP.

In the event that a leak is detected from a bulk storage tank, the installation of additional monitoring well/s immediately down-gradient of the source may be considered as an incident response option, depending on the nature and the scale of the incident. If TPH is detected at monitoring location BPGW07 consideration will be given to installing an adjacent well to screen across the water table to detect the presence of LNAPL.

7.4 Cultural and Biological Studies

7.4.1 Cultural Heritage

There are a number of cultural heritage sites located on Bladin Point, outside the battery limits of Ichthys LNG (Section 2.2.2). As outlined in Section 5.9, INPEX personnel are required to stay within Ichthys LNG security fence and are prohibited from accessing heritage sites.

Inspections will be undertaken at a frequency determined by the INPEX Larrakia Advisory Committee. The inspections will look for any signs of damage to, or interference with the heritage sites.

No further monitoring of maritime heritage will be undertaken as INPEX's obligations in this regard are completed.

7.4.2 Marine Pest Species

The most effective marine pest monitoring program is premised on a coordinated, uniform and consistent monitoring approach undertaken by a single authority, as it provides a representative view of the entire Port area. Marine pest monitoring is routinely completed in Darwin Harbour by the NT Aquatic Biosecurity Unit, within the Fisheries Division of DITT (DPIF 2015). INPEX has joined this established program for its operations phase monitoring.

The presence/absence of invasive marine pests is monitored on the Product Loading Jetty using artificial settlement units (also known as settlement collectors or plates). Approximately every four months, the units are recovered for microscopic analysis of settlement for known marine pests and biofouling communities. New settlement units are then deployed to allow for the settlement of more opportunistic biofouling species (DPIF 2015).

Monitoring on the Product Loading Jetty will be undertaken for the first three years following first start-up of LNG Train 1 and 2. Following this, the program will be reviewed to assess adequacy and determine whether or not future monitoring is warranted.

7.4.3 Introduced Terrestrial Fauna Species

INPEX will undertake an annual survey using a third-party licenced pest control contractor if introduced terrestrial fauna species are deemed to be a nuisance on site.

The survey will involve visual inspections for introduced terrestrial fauna species and will identify and implement any required control methods. A brief report will be produced to indicate the pest species recorded, where they are found and control methods that were used.

7.4.4 Weeds

An annual visual inspection for weeds is conducted by qualified contractors at the end of wet season (nominally April). The inspection assesses the distribution and abundance of weeds species on site (including along the GEP corridor), changes in known weed populations and identification of new emergent weeds, especially in areas susceptible to weed invasion, i.e. known locations for weeds and cleared areas.

A weed map is produced following the inspection, to indicate the distribution of weeds at the site, and any control methods applied are recorded. The effectiveness of the weed-control method is reported on in the annual weed management report to assist in identifying opportunities for continual improvement and to measure the effectiveness of the measures.

Routine weed monitoring is undertaken for the parameters listed in Table 7-9.

Table 7-9: Weed monitoring

Parameter	Units / descriptor	Monitoring frequency
Weed names	Scientific and common names	Annual (end of wet)
Physical locations	GPS coordinates	
Abundance	Individual numbers and/or percentage cover	
Control methods	Description of control methods used	

7.4.5 Vegetation Rehabilitation and Erosion

Rehabilitation monitoring is undertaken of areas that were cleared during the construction phase of the Ichthys Project, that are not required during steady-state operations and subsequently have been rehabilitated. This includes areas along the GEP corridor and temporary laydown areas around Ichthys LNG.

Rehabilitation monitoring is undertaken by suitably qualified contractors. The frequency of the monitoring is determined on a case-by-case basis for rehabilitation sites. Currently, monitoring is undertaken biennial (every two years) .

The monitoring uses standard botanical methodologies to assess the whether the establishment of native vegetation has been successful. Monitoring also checks for signs of erosion and weed species within the rehabilitated areas.

This rehabilitation and monitoring program focuses on areas rehabilitated after construction, but does not include areas that will be rehabilitated at the end of Ichthys LNG operations when Ichthys LNG will be decommissioned. Vegetation rehabilitation and monitoring at the end of Ichthys LNG operations will be addressed in a separate decommissioning plan.

7.4.6 Mangrove Health and Intertidal Sediment Monitoring

There are no planned wastewater discharges, other than clean NCW runoff, to the mangrove communities. Nevertheless, mangrove health, intertidal sediments and bio-indicators are monitored to detect adverse changes in mangrove community health as an indirect result of Ichthys LNG operations, such as surface water runoff from the NCW perimeter drain system or changes in groundwater chemistry and level due to unplanned discharges.

The objectives of the mangrove health and intertidal sediment monitoring are to:

- informatively monitor mangroves adjacent to the Ichthys LNG Plant
- detect changes in intertidal sediment quality attributable to Ichthys LNG Plant operations

Mangrove community health monitoring was undertaken annually (at a similar time each year) for the first 36 months following first start-up of LNG Train 1 and 2. Following a review of these results, the monitoring program frequency was reduced to biennial (every two years).

Mangrove monitoring sites already established during the construction phase are used to ensure data continuity. Nine monitoring sites have been retained; seven impact and two control sites. The impact sites retained were selected based on their proximity to groundwater sampling locations and their location downstream of potential contamination sources such as condensate storage tanks and flare pads (Figure 7-4). Two control sites used during construction are also retained.

At each site, a transect from the landward margin of the Hinterland assemblage to the seaward margin of the Tidal Creek assemblage was established during construction phase monitoring. The transects traverse each of the three main Darwin Harbour mangrove assemblages where present; Hinterland Margin, Tidal Flat and Tidal Creek. Fixed quadrats (10 m × 10 m; 100 m^2) were then established adjacent to the transects in the most landward assemblage present along each transect at sites surrounding Ichthys LNG and in all three assemblages at reference sites. A summary of the mangrove monitoring locations and associated area/assemblages monitored is provided in Table 7-10 and depicted in Figure 7-4.

Table 7-10: Proposed mangrove monitoring sites following on from construction site monitoring

#	Mangrove site	Function; Monitoring area
1	BPMC11	Impact; Landward assemblage only
2	BPMC26	Impact; Landward assemblage only
3	BPMC16	Impact; Landward assemblage only
4	BPMC17	Impact; Landward assemblage only
5	BPMC25	Impact; Landward assemblage only
6	BPMC09	Impact; Landward assemblage only
7	BPMC10	Impact; Landward assemblage only
8	CMSC03	Control; All assemblages
9	CSMC01	Control; All assemblages

Figure 7-4: Indicative mangrove health, intertidal sediment and bio-indicator monitoring sites

Sampling Techniques - Mangrove Health Monitoring

Mangrove canopy cover is measured at each site using established fixed quadrats using a Stickler's modified spherical densitometer (Stickler 1959) to provide an estimate of foliage cover. Three replicate foliage cover measurements are taken within each 5 m × 5 m (25 m^2) subplot formed by the fixed quadrat four corner posts and a centre post in the assemblage adjacent to Ichthys LNG and a subset of transects in high risk areas. The canopy cover for each quadrat is calculated by averaging the mean of the foliage cover readings from each subplot.

A known limitation of densitometers is that they are slightly subjective and known to potentially produce observer bias (Cook et al. 1995; Korhonen et al. 2006). However, consistent and reliable results can be achieved if the same scientist is used. To eliminate potential future bias, INPEX is currently trialling a digitised method for measuring canopy cover (e.g. Percentage Cover [%Cover] application). Percentage Cover combines photography and smart device technology to allow rapid assessment of canopy cover, while also providing a digital archive of canopy cover in a vertical direction, which is a 'true' measurement of canopy cover (Jennings et al. 1999). The first trial was undertaken at CSMC01 (at all three monitoring sites; hinterland, tidal flat and tidal creek) during monitoring event no. 3 in April 2021. A limitation of this method is that is requires the use of an iOS device. As the INPEX intrinsically safe devices are Android, application of the method was restricted to CSMC01, which is outside of the Ichthys LNG Facility boundary.

The results of this first trial indicated a significant difference in canopy cover when compared with the spherical densitometer (Stickler 1959) method. Noting the small sample size, the %Cover method will continue to be trialled at CSMC01 during the next monitoring event. Outcomes of the trial will be included in the 2020/20212021/2022 AEMR, and, if successful, will be adopted for future surveys.

Mangrove surveillance photo-monitoring is also be undertaken in quadrats adjacent to Ichthys LNG to provide a visual record of the communities' appearance and condition (e.g. leaf colour). Repeatable photos are captured facing away from the quadrat centre post towards each of the four corner posts.

Visual inspections are also undertaken by the Environmental Advisor/s during ad hoc site inspection to confirm continued mangrove health adjacent to Ichthys LNG.

Sampling Techniques - Intertidal Sediment Monitoring

A single surficial sediment sample (top 20 mm) is collected in proximity to quadrats directly adjacent to the Ichthys LNG Plant only. Samples are analysed using NATA accredited methods. The intertidal sediment parameters analysed are listed in Table 7-11. A portable instrument is also used to measure in situ sediment pH, temperature and redox (oxygen reduction potential) in quadrats following mangrove health assessment.

Table 7-11: Intertidal sediment monitoring

Parameter	Units / descriptor	Monitoring frequency
TPH	mg/kg	Biennial (every two years)
TOC	mg/kg	
Metals (Al, Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	mg/kg	
pH	pH units	

Sediment results are compared against benchmark levels to ascertain whether a trigger exceedance has occurred. An exceedance of a benchmark level occurs when:

- a measured analyte exceeds the SQGVs described in ANZG (2018), and
- a measured analyte exceeds background levels for Darwin Harbour intertidal sediments.

Where measured metal or metalloids exceed SQGVs, results where possible will be normalised for aluminium concentrations based on the methods described in Munksgaard (2013) and Munksgaard et al. (2013) and compared to background levels (i.e. baseline or reference levels).

If a trigger value is exceeded, refer to Receiving Environment Adaptive Management framework outlined in Section 7.5.3.

7.5 Receiving Environment Adaptive Management

Receiving environment monitoring is a key component of the adaptive management framework described in Section 6.6. The monitoring component is illustrated in Figure 7-5 and includes:

- analysis of results for the potential for bioaccumulation to occur in Darwin Harbour sediments in proximity to the jetty outfall (Section 7.2.2)
- monitoring to detect changes in water quality within the harbour due to the commingled wastewater stream discharge, specifically near the outfall (Section **Error! Reference source not found.**).
- monitoring to detect changes in mangrove community health as an indirect result of Ichthys LNG Plant operations such as surface water runoff from the NCW perimeter drain system or changes in groundwater chemistry and level due to unplanned discharges (Section 7.4.6).
- monitoring to detect changes in groundwater quality due to unplanned leaks and spills (Section 7.3.1).

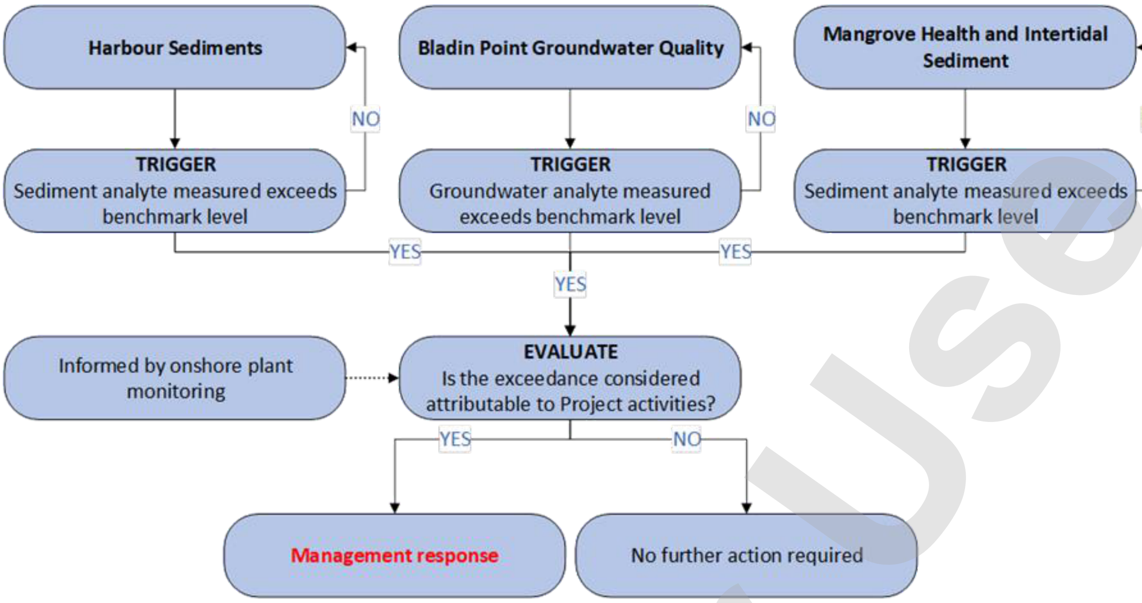

Figure 7-5: Receiving environment adaptive monitoring framework

7.5.1 Triggers

A series of triggers have been selected for the receiving environment monitoring as described in the Harbour Sediment (Section 7.2.2), Bladin Point Groundwater Quality (Section 7.3.1) and the Mangrove Health and Intertidal Sediment (Section 7.4.6) monitoring programs. Where possible, triggers have been chosen to align with long-term construction monitoring program, as described in the Ichthys On-shore LNG Facilities Environment Impact Monitoring Program (L290-AH-PLN-10013). The triggers also include reference to background levels to reduce the number of Type I (false positive) trigger exceedances, noting that Darwin Harbour contains naturally occurring high concentrations of some contaminants (e.g. arsenic in sediments, see Section 2.3.9).

7.5.2 Evaluate

The evaluation aspect of the adaptive management framework (Figure 6-1) comprises an investigation into the source of the exceedance to determine whether it is attributable to Ichthys LNG activities. A management response is only triggered where the exceedance is found to be attributable, as illustrated in Figure 7-5.

In order to determine if a trigger exceedance is attributable to Ichthys LNG activities, a multiple lines of evidence approach is used to assess and interpret results as recommended in ANZG (2018). This includes the analysis of operating conditions and interrogation of the Ichthys LNG Plant monitoring data, in addition to control site data, for example, checking equipment operational records, reviewing in-pipe monitoring data related to the liquid effluent stream discharged from the jetty outfall diffuser or the incidence of a non-routine spill.

7.5.3 Management Response

Management responses considered are specific to the circumstances of the trigger exceedance and outcomes of the attributability assessment. One of the key operational considerations is to confirm that the Ichthys LNG Plant systems, as relevant to this exceedance, are operating within the required parameters (Figure 6-1).

In regard to the receiving environment monitoring, an investigation as to whether the exceedance is considered to be ecologically significant (e.g. bioavailable fraction, receiving environment characteristics etc.) will be completed, and the outcome of the investigation will inform the monitoring term. For example, if groundwater quality criteria are assessed to be above the background historical construction baseline data range or published groundwater quality guidelines, the exceedance will be investigated. The investigation may involve:

- an assessment of the risk of associated with parameter(s) exceedance, including impact to the beneficial uses
- identification of the cause of the exceedance
- review of the groundwater monitoring program to further evaluate the groundwater quality.

If required, a management response will identify and assess management options to reduce the impact pathway if evaluation demonstrates an ecologically significant risk.

7.5.4 Annual Review of Monitoring Program

Results of the monitoring activities outlined in this OEMP are compiled annually in the AEMR. The AEMR provides an overview of monitoring activities completed, results of monitoring and the outcomes of any investigations. As part of the AEMR process, each monitoring program is reviewed to ensure:

- the monitoring program is effective at determining project-attributable impacts to the environment
- review of the appropriateness of the monitoring program based on project activities and associated impact pathways (i.e. reduced or new)
- whether activities completed under the monitoring program are still relevant and applicable to potential project impacts (i.e. the types of analytes monitored may change over time as project activities change).

Results of this review are reported in the AEMR and reviewed by a Qualified Professional.

Following submission of the AEMR, the OEMP will be updated to reflect the proposed amendments to the monitoring program. In accordance with EPL228 requirements, the updated OEMP (inclusive of a Qualified Professional review) will be submitted to the NT EPA at least ten (10) business days prior to any changes being implemented.

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APPENDIX A: INPEX POLICIES

Environmental Policy

Objective

INPEX is a worldwide oil and gas exploration, development and production company committed to conducting each of its activities in a manner that is environmentally responsible.

Our objective is to develop an environment culture that is recognised as amongst "best in industry" that will exceed the performance expectations of our stakeholders.

We recognise our responsibility to adhere to the principles of sustainable development and we acknowledge that we owe a duty of care to both the natural environment and the communities in which we operate.

Strategy

To accomplish this, INPEX will:

- comply with applicable laws and regulations, environmental plans and commitments and apply appropriate INPEX standards
- maintain a culture where people are empowered to intervene to prevent environmental harm
- set, measure and review environmental performance objectives and targets and ensure appropriate management of change processes are followed
- ensure our personnel have the necessary awareness, training, knowledge, resources and support, to meet environmental objectives and targets
- identify, manage and review environmental hazards and risks associated with our current and future business activities and manage these to levels that are 'as low as reasonably practicable' (ALARP)
- implement, maintain and regularly test control measures associated with major environmental events
- maintain and regularly test emergency management processes and procedures, including with industry and government emergency response partners
- engage with and communicate openly on environmental issues with internal and external stakeholders
- provide clearly defined environmental performance expectations for our contractors and suppliers, and work collaboratively with them to attain these
- endeavour to prevent pollution and seek continual improvement with respect to emissions, discharges, wastes, energy efficiency and resource consumption
- actively promote the reduction of greenhouse gas emissions across our operations in a safe, technically and commercially viable manner
- endeavour to protect biodiversity and to contribute to increased understanding of our natural environment
- drive continual improvement in environmental performance through monitoring, auditing and reviews.

Application

This policy applies to all INPEX controlled activities in Australia and related project locations. It will be displayed at all company workplaces and on the company's intranet and it will be reviewed regularly.

Hitoshi Okawa
President Director, Australia

Rev: 3
April 2019
Document No.: 0000-AH-POL-60002

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Electronic Endorsement and Approval

Electronic approval of this document complies with the issued INPEX Electronic Approval Standard (0000-A9-STD-60011) and records evidence that the applicable person has either endorsed and/or approved the content contained within this document. The reviewers of this document are recorded in the DMS.

Name	Title	Date and Time	Action
Neville Carrington	Vice President HSE & Quality	01/08/2019 15:55	Endorsed
Ian Singleton	GM Joint Venture, Strategy & Governance	09/08/2019 14:21	Approved

INPEX

Health and Safety Policy

Objective

INPEX is a worldwide oil and gas exploration, development and production company committed to conducting each of its activities in a manner that is safe and causes no harm to people.

Our objective is to develop a health and safety culture that is recognised amongst the "best in industry", that will exceed the performance expectations of our stakeholders and ensure our facilities are safe for future generations to operate.

Strategy

To accomplish this, INPEX will:

- promote a strong health and safety culture that is supported by visible leadership
- comply with applicable laws and regulations and apply appropriate INPEX standards
- identify health and safety hazards and risks associated with our business and manage these to levels that are demonstrably "As Low As Reasonably Practicable" (ALARP)
- operate each facility in accordance with its accepted safety case
- empower people to intervene to control hazards and prevent hazardous acts
- establish, implement, maintain and regularly test control measures critical to the management of major accident event risks
- establish, maintain and regularly test emergency management processes and procedures
- set, measure and review health and safety performance objectives and targets
- ensure appropriate management of change processes are followed
- ensure health and safety risks are controlled prior to implementing changes
- ensure our personnel have the necessary awareness, training, knowledge, resources and support to meet Health and Safety objectives and targets
- provide clearly defined health and safety performance expectations for our contractors and suppliers, and work collaboratively with them to attain these
- communicate openly on health and safety issues with internal and external stakeholders
- drive improvement in health and safety performance through monitoring, auditing and reviews.

Application

This policy applies to all INPEX controlled activities in Australia and related project locations. It will be displayed at all company workplaces and on the Company's intranet and it will be reviewed regularly.

Hitoshi Okawa
President Director, Australia

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Name	Title	Date and Time	Action
Neville Carrington	Vice President HSE & Quality	01/08/2019 16:20	Endorsed
Ian Singleton	GM Joint Venture, Strategy & Governance	09/08/2019 14:21	Approved

APPENDIX B: EIS COMMITMENTS RELEVANT TO THIS OEMP

ID no.	Environmental commitment	Relevant section of this OEMP
1	**General**	
1.01	The Ichthys Project's HSEQ Management Process will align with the requirements of AS/NZS ISO 14001:2004, Environmental management systems—Requirements with guidance for use and AS/NZS 4801:2001 Occupational health and safety management systems—Specification with guidance for use.	Section 1.6
1.02	Management plan will be publicly available at an appropriate time prior to execution.	INPEX website
2	**Receiving environment monitoring**	
2.01	Wastewater discharge monitoring will be undertaken in the nearshore environment to confirm modelling predictions for wastewater dispersion.	Section **Error! Reference source not found.**
2.02	A Darwin Harbour water-quality monitoring program will be developed and implemented to determine if Project wastewater discharges are adversely impacting on water quality in the Harbour.	Section 7.2
2.10	A groundwater quality monitoring program will be developed to determine if activities in the onshore development area adversely impact on groundwater quality.	Section 7.3.1
2.12	Air-quality monitoring will be undertaken to confirm modelling predictions. EIS Supplement: INPEX will undertake air quality monitoring during the operations phase. This monitoring may include sampling for particulates during the wet season and /or the dry season.	Section 7.1
2.13	Airborne noise monitoring will be undertaken to confirm modelling predictions.	Section 7.1.2
2.14	A marine pests monitoring program will be developed for the nearshore development area. This will be developed in consultation with the relevant agencies.	Section 7.4.2
2.15	A weed monitoring program will be developed to monitor the distribution and abundance of listed weeds species in the onshore development area.	Section 7.4.4

ID no.	Environmental commitment	Relevant section of this OEMP
2.16	A vegetation rehabilitation monitoring program will be developed and periodic surveys of rehabilitated areas will be undertaken to determine the level of success of rehabilitation programs.	Section 7.4.5
2.17	A mangrove health monitoring program will be developed to assess the potential effects of Project activities on mangrove health. Additional commitment within EIS Supplement: mangrove monitoring to be undertaken throughout construction and operations and sediment heights throughout construction.	Section 7.4.6
2.22	INPEX is committed to making information collected from research and monitoring activities available to the public including eco-tourism operators.	INPEX website
5	**Accidental marine hydrocarbon spills**	
5.01	The Project oil spill contingency plan (OSCP) will be revised prior to the commencement of construction and will be periodically reviewed (and updated as required) through the life of the Project.	Section 5.14, addressed in a separate Nearshore Operations OPEP (X060-AH-PLN-60003)
5.02	As part of its OSCP, INPEX will have the capability to initiate real-time oil-spill fate and trajectory modelling so that any spill can be monitored and responses optimised.	
5.13	Periodic internal inspections of the gas export pipeline will be undertaken to assess its integrity.	Section 1.2.2 Section 1.5.1 Section 3.3.1
5.14	Trading tankers will be subject to vetting procedures that will review the technical, operational and maintenance practices on each tanker prior to it being chartered.	Outside of scope of this OEMP
5.15	Offloading operations will be monitored by a terminal representative on board the trading tanker.	Section 5.6
5.16	All valves and transfer lines will be checked for integrity before use, and offloading operations will be continuously monitored.	Section 5.6

ID no.	Environmental commitment	Relevant section of this OEMP
5.18	Appropriate spill response equipment will be available on the CPF, the FPSO, and the supply and pipelay vessels as well as at the onshore and nearshore facilities. Regular pollution response exercises will be undertaken.	Sections 5.13.1 and 5.14, addressed in a separate Nearshore Operations OPEP (X060-AH-PLN-60003)
5.21	During product loading, radio contact will be maintained between the support vessel and the jetty, and collision prevention procedures will be implemented.	Section 5.6
5.22	Dry-break, breakaway couplings or similar technology will be installed and used where practicable during refuelling operations.	Section 5.6
5.23	Maintenance, integrity testing and inspection programs will be undertaken on flowlines and condensate loading hoses.	Section 5.6
5.24	A maintenance and inspection program will be in place for product loading arms.	Section 5.6
5.25	An emergency shutdown interface will be in place between vessels and the onshore gas plant.	Section 5.6
5.27	Approach speeds to the berth will be monitored by a speed-of-approach laser system and the data will be transmitted to the vessel pilot.	Section 5.6
6	**Naturally occurring radioactive materials (NORMs)**	
6.01	Process equipment will be designed to restrict the potential for scale formation and scale inhibition chemicals will be used if required.	Sections 1.5.2 and 3.9
6.02	Should scale be found to contain NORMs, a procedure will be developed for their storage and handling requirements. NORMs disposal will be determined on a case by case basis and will be discussed with the relevant regulatory authorities. The selected disposal method will minimise the potential for environmental impact.	Section 1.5.2

ID no.	Environmental commitment	Relevant section of this OEMP
8	**Marine pests**	
8.01	Quarantine management plans and supporting documentation will be developed and their prescriptions will be implemented in accordance with the requirements of the Australian Quarantine and Inspection Service (AQIS), the NT's Department of Resources (DoR), and the DPC.	Section 5.10
8.02	INPEX will ensure that vessels engaged in Project activities comply with the biofouling requirements of the regulatory authorities.	Section 5.10
8.03	Vessels engaged in Project work will be subjected to a biofouling risk assessment which may result in hull inspections or cleaning.	Outside of scope of this OEMP.
8.04	Relevant Project vessels will be required to maintain satisfactory records of antifouling management, hull-cleaning actions and ballast-water exchange.	Section 5.10 Vessels are Outside of scope of this OEMP. This is addressed in separate vessel procedures
8.05	Opportunistic inspections using remotely operated vehicle (ROV) film footage will be undertaken of submerged surfaces of offshore infrastructure to search for the presence of introduced species.	Section 7.4.2 Although this commitment is primarily for Offshore, it is proposed that marine pests at the jetty will be surveyed by alternative means.

ID no.	Environmental commitment	Relevant section of this OEMP
9	**Marine megafauna**	
9.01	A cetacean management plan and supporting documentation will be developed and their prescriptions will be implemented. EIS Supplement: The cetacean management plan will be extended to include dugongs. Also key management controls reconfirmed in SEIS: management measures to be employed through the cetacean management plan: Vessel masters to be trained in cetacean interaction procedures; vessels will be operated at "no wash" speed when within 50-150m of a dolphin and will not intentionally approach a dolphin.	Vessels are Outside of scope of this OEMP. This is addressed in separate vessel procedures
9.02	Procedures for avoiding interactions between cetaceans and vessels or helicopters will be developed and implemented.	Vessels are Outside of scope of this OEMP. This is addressed in separate vessel procedures
10	**Dredging, trenching and associated earthworks**	
10.2	If mangrove tree deaths result because of sedimentation from the dredging program (and are not attributable to natural causes or activities external to the Project), rehabilitation of the affected areas will be undertaken after the completion of dredging activities through a combination of natural recruitment, facilitated natural recruitment and active planting.	Section 7.4.5
10.5	The final dredging program will be designed so that any changes to the current dredging methodology will not result in significant changes to the predicted environmental and social impacts described in this Draft EIS. EIS Supplement: INPEX has committed to carrying out rehabilitation if mangrove tree deaths occur as a result because of sediment deposition from the Project's dredging program (and are not attributable to natural causes or activities external to the Project).	Not Applicable Maintenance dredging during operations will be addressed in a separate dredging management plan.
11	**Soil erosion**	
11.01	A vegetation clearing, earthworks and rehabilitation management plan and supporting documentation will be produced and their prescriptions will be implemented.	Section 7.4.5

ID no.	Environmental commitment	Relevant section of this OEMP
11.02	A liquid discharges, surface-water runoff and drainage management plan and supporting documentation will be produced and their prescriptions will be implemented.	Section 5.4
11.05	If soil erosion is evident, exposed surfaces at the affected area will be stabilised with mulched vegetation, dust suppressants or slope-stabilisation products.	Section 5.4 and Table 5-4
13	**Alteration to surface water and groundwater**	
13.01	A liquid discharges, surface water runoff and drainage management plan and supporting documentation will be produced and their prescriptions will be implemented.	Section 5.4
14	**Vegetation clearing**	
14.01	A vegetation clearing, earthworks and rehabilitation management plan and supporting documentation will be produced and their prescriptions will be implemented.	Section 7.4.5
14.05	Temporarily disturbed areas such as those in the vicinity of the pipeline shore crossing and the onshore pipeline corridor, as well as areas around the plant that do not need to remain cleared, will be rehabilitated following the completion of construction activities.	Section 7.4.5
14.06	Some topsoil will be stockpiled from cleared areas for future use in rehabilitation.	There will be no stockpiles remaining for the operations phase. Outside of the scope of this OEMP.
15	**Alteration of terrestrial habitats**	
15.01	A vegetation clearing, earthworks and rehabilitation management plan and supporting documents will be produced and their prescriptions will be implemented.	Section 7.4.5
16	**Creation of breeding habitat for biting insects**	
16.01	Natural drainage will be maintained around roads by installing drains and/or culverts, particularly in intertidal areas such as the causeway between Bladin Point and Middle Arm Peninsula.	Section 5.12

ID no.	Environmental commitment	Relevant section of this OEMP
16.02	Surface-water drainage channels throughout the onshore development area will be designed to minimise the creation of breeding habitat for biting insects. Drains will be kept free of vegetation.	Section 5.12
16.03	Regular inspections will be carried out for mosquito larvae in high-risk areas and controls will be implemented as required.	Section 5.12
17	**Introduced species**	
17.01	Quarantine management plans and supporting documentation will be developed and their prescriptions will be implemented in accordance with AQIS, DoR and DPC requirements.	Section 5.10
17.02	A vegetation clearing, earthworks and rehabilitation management plan and supporting documentation will be produced and their prescriptions will be implemented.	Section 7.4.5
17.04	Infestations of listed weeds will be controlled in the onshore development area and along the access road from Wickham Point Road.	Section 5.10
17.08	Inspections of incoming vessels and modules will be undertaken in accordance with AQIS standards.	Section 5.10
18	**Bushfire prevention**	
18.01	A bushfire prevention management plan and supporting documentation will be produced and their prescriptions will be implemented.	Section 5.8
18.02	Firebreaks will be established around Project infrastructure which borders woodlands. Advice will be sought from the NT's Bushfires Council on firebreak requirements for Bladin Point.	Section 5.8
18.03	A firefighting capability will be available and strategically located firefighting stations will be established at the onshore Project site.	Section 5.8
18.04	Firefighting equipment will be available on site at all times, along with accessible supplies of water.	Section 5.8
18.05	Grassy vegetation in the onshore development footprint will be controlled to reduce available fuel loads and prevent wildfire. Control methods may include slashing and spraying.	Section 5.8

ID no.	Environmental commitment	Relevant section of this OEMP
18.07	An internal "hot work" permit system will be implemented for cutting, welding and any other work considered to have a high potential to start a fire.	Section 5.8
18.08	Designated smoking areas will be established for all phases of the Project and receptacles for cigarette butts will be provided.	Section 5.8
20	**Greenhouse gas and air emissions**	
20.01	An air emissions management plan and supporting documentation will be produced and their prescriptions will be implemented.	Section 5.1
20.05	Open-cycle gas turbines will be designed to achieve a low-NOx (low nitrogen oxides) outcome. EIS Supplement: The NOx emissions from the gas turbines will be less than 125 mg/m3 (equivalent to approx. 60 ppm) under normal operating conditions.	Section 3.10
20.06	Residual hydrocarbons and hydrogen sulfide (H2S) will be removed from the emission stream by acid gas removal unit (AGRU) incinerators. In the unlikely event that the AGRU incinerators are shut down, exhaust gases (including H2S and residual hydrocarbons) will be hot-vented through gas turbine exhaust stacks to facilitate the safe dispersion of gases.	Section 3.3.4 and 3.8.2
20.12	Boil off gas- from liquefied natural gas (LNG) storage tanks and LNG offtake tanker loading operations will be recovered by BOG recompression systems and directed to the fuel-gas supply.	Section 3.3.5
21	**Onshore spills and leaks**	
21.01	An onshore spill prevention and response management plan and supporting documentation will be produced and their prescriptions will be implemented.	Sections 5.6 and 5.13
21.03	Material safety data sheets (MSDSs) will be available on the facilities to aid in the identification of appropriate spill clean-up and disposal methods.	Sections 5.6 and 5.7
21.04	Chemicals and hazardous substances used during all phases of the Project will be selected and managed to minimise the potential adverse environmental impact associated with their transport, transfer, storage, use and disposal.	Sections 3.9 and 5.7

ID no.	Environmental commitment	Relevant section of this OEMP
21.05	Spill response materials and equipment (including personal protective equipment) will be available during all phases and will contain equipment to combat both chemical and hydrocarbon spills.	Sections 5.6 and 5.13
21.06	Personnel who routinely handle hazardous materials or wastes (e.g. refuelling personnel, pump operators, mechanics, and stores personnel) will receive training in handling, transporting and storing hazardous materials or wastes; in reporting and documentation requirements; and in spill clean-up techniques and practices.	Sections 5.6 and 5.13
22	**Wastes**	
22.01	A waste management plan and supporting documentation will be developed and their prescriptions will be implemented.	Section 5.7
22.03	Sufficient space will be provided on the FPSO and CPF and at the onshore facility to allow for the segregation and storage of wastes.	Section 3.8.7 and 5.7
22.04	Chemicals and hazardous substances used during all phases of the Project will be selected and managed to minimise the potential adverse environmental impact associated with their disposal.	Section 3.9
22.06	All solid-waste receptacles (e.g. skips and bins) will have covers and be fit for purpose and in good condition. This will prevent scavenging animals from gaining access to putrescible wastes.	Section 5.7
22.07	All hazardous liquid wastes will be stored over a bund in leak-proof sealed containers.	Section 5.7
22.08	Only approved and licensed waste contractors will be engaged for waste disposal.	Section 5.7
22.09	Waste will be stored in the designated waste stations and appropriately segregated into hazardous waste and non-hazardous waste, and, where possible, into recyclable or reusable hazardous waste and recyclable or reusable non-hazardous waste. In the event of the discovery of any unidentified wastes, these will be treated as hazardous waste and stored accordingly.	Section 5.7

ID no.	Environmental commitment	Relevant section of this OEMP
22.10	A baseline calculation of annual waste volumes will be undertaken in the first year of full steady operations (both LNG trains) and total waste reduction targets will be identified for subsequent years.	Section 5.7
22.15	All hazardous and non-hazardous solid wastes generated in the nearshore development area, including food scraps, will be retained on board vessels and transported to onshore facilities for disposal in accordance with the Marine Pollution Act (NT).	Section 3.8.7 and Table 5-7 If vessels are engaged by INPEX for use in NT waters during Operations the waste hierarchy will apply.
23	**Liquid discharges**	
23.01	Liquid discharge monitoring of the combined outfall on the product loading jetty will be undertaken to confirm modelling predictions and to periodically monitor levels of pollutants in the combined outfall.	Section 5.4
23.02	A chemical selection process will be developed and will include consideration of the potential for ecotoxicity.	Section 5.4
23.05	Construction vessels, supply vessels and the mobile offshore drilling unit (MODU) will adhere to the following prescriptions laid down by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and the *Marine Pollution Act* (NT): Sewage will not be discharged within three nautical miles of land. Only treated sewage (macerated to fragment diameters less than 25 mm) will be discharged between three and twelve nautical miles of land. • Untreated sewage may be discharged beyond 12 nautical miles of land.	Section 7.2

ID no.	Environmental commitment	Relevant section of this OEMP
23.11	Antifouling paints containing tributyltin compounds (TBTs) will not be used on any Project vessels or equipment in accordance with the prescriptions of the International Maritime Organization's International Convention on the Control of Harmful Anti-fouling Systems on Ships and the Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 (Cth).	Outside of scope of this OEMP, as GEP maintenance activities are covered under the approved Pipeline Management Plan.
23.12	Drainage at the onshore development area will be designed to isolate areas that could be exposed to hydrocarbon contamination. Wastewater from these areas will be directed to an oily-water treatment system.	Section 5.10
23.17	An on-site treatment facility will be used to treat sewage from the onshore development area during the operations phase, and will produce high-quality wastewater.	Section 3.8.6 and 5.4
23.08	Wastewater streams will be sampled at appropriate frequencies and selected water-quality parameters will be documented.	Section 3.8.6 and 5.4
23.19	Maintenance practices during the operations phase (e.g. drainage of hydrocarbons from tanks and equipment) will avoid discharge of hydrocarbons to the oily-water treatment system.	Section 5.4
23.20	Antifouling paints containing tributyltin compounds (TBTs) will not be used on any Project vessels or equipment in accordance with the prescriptions of the International Maritime Organization's International Convention on the Control of Harmful Anti-fouling Systems on Ships and the Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 (Cth).	Section 5.4
24	**Social integration**	
24.01	INPEX personnel representing the Project will be expected to exhibit professional behaviour standards as required by INPEX's Code of Conduct. Through the Project induction, all Project personnel will be informed of the expectation that they will respect the Darwin community at all times and behave accordingly.	Outside of scope of OEMP

ID no.	Environmental commitment	Relevant section of this OEMP
24.02	Project personnel will be subject to random drug and alcohol testing.	Outside of scope of OEMP
24.05	An ongoing Stakeholder Communication Plan has been developed; this will create an avenue where the broader community can raise Project-related social issues and other matters.	Section 5.16
25	**Housing, social infrastructure and services**	
25.03	A first-aid capability will be available at the onshore facility during both the construction and the operations phases.	Outside of the scope of this OEMP
25.04	INPEX will work in conjunction with the NT Police, Fire and Emergency Services in order to plan effectively for any major emergencies.	Outside of the scope of this OEMP
25.05	A firefighting capability will be available and strategically located firefighting stations will be established at the onshore Project site.	Section 5.13
25.06	Fire-protection systems at the onshore Project site for the operations phase will be designed to enable INPEX personnel to handle fires capably until external help arrives.	Section 5.6 and 5.13
25.07	Appropriate quantities of water will be stored and made available for firefighting purposes during both the construction and operations phases at the onshore Project site.	Section 5.13
25.08	An emergency response plan will be developed and emergency response teams will be established at the onshore Project site for both the construction and the operations phases of the Project.	Section 5.13
25.09	The onshore facilities will be self-sufficient in meeting their power generation requirements during operations.	Section 3.4
25.11	Permanent sewage treatment facilities will be installed at the onshore Project site for the operations phase of the Project.	Section 3.8.6

ID no.	Environmental commitment	Relevant section of this OEMP
27	**Marine traffic**	
27.02	An application will be made to the relevant government and regulatory agencies to implement safety exclusion zones and restricted navigation zones around LNG, LPG and condensate tankers, and around selected construction vessels such as dredging and pipelay vessels.	Outside of the scope of this OEMP
27.03	An application will be made to the relevant government and regulatory agencies to send out a "Notice to Mariners" on the location of offshore infrastructure and the gas export pipeline. These notices will be promulgated through the Australian Maritime Safety Authority.	Outside of the scope of this OEMP
27.04	Shipping traffic schedules during the construction and operations phases will be developed in consultation with the DPC to minimise the impacts of marine traffic on Darwin Harbour.	Outside of the scope of this OEMP
27.05	An application will be made to the relevant government and regulatory agencies to implement safety exclusion zones and restricted navigation zones around LNG, LPG and condensate tankers, and around selected construction vessels such as dredging and pipelay vessels.	Outside of the scope of this OEMP
28	**Heritage**	
28.01	Heritage management plans and supporting documentation will be developed and their prescriptions will be implemented.	Section 5.9
28.02	A Larrakia Heritage Management Committee (LHMC) will be established. It will be made up of representatives of the Larrakia personnel and INPEX and will have a standing agenda.	Outside of the scope of this OEMP
28.08	Monitoring will be undertaken for Aboriginal heritage sites. This will involve inspections by Larrakia representatives prior to and during the construction phase and during the commissioning and operations phases. Photographic records will be maintained for each of the sites.	Section 7.4.1
28.14	During the construction and operations phases, INPEX will periodically assess sediment conditions of Catalina wrecks near to the shipping channel and in consultation with NRETAS determine whether any remedial action is required to address impacts should they arise.	Outside of the scope of this OEMP

ID no.	Environmental commitment	Relevant section of this OEMP
29	**Airborne noise**	
29.05	Buses will be utilised for transporting the majority of workers to and from site to reduce the total number of vehicles on the roads and therefore noise emissions.	Outside of the scope of this OEMP
29.06	Noise mitigation measures will be incorporated into the design and construction of the ground flare to reduce noise emissions. EIS Supplement: INPEX expects noise levels in Palmerston, as a result of process upset flaring from Bladin point, could be 45-55 dB(A) three or four times per year for a few minutes; SEIS confirms that during steady-state and commissioning conditions, the onshore facility should not cause ambient noise levels in Palmerston, or other residential receptors, to rise above 40 dB(A).	Sections 2.3.2, 3.8.3 and 7.1.2
31	**Commercial fishing**	
31.03	A precautionary zone will be applied within 200 m of the gas export pipeline in the nearshore development area, prohibiting dropping or dragging an anchor, or performing an action that could damage the pipeline (according to Section 66(5) of the Energy Pipelines Act (NT)).	Outside of scope of OEMP, managed through Pipeline Management Plan
32	**Public safety**	
32.06	Public risk will be managed in accordance with the National standard for the control of major hazard facilities (2002) and the National code of practice for the control of major hazard facilities (1996) prepared by the National Occupational Health and Safety Commission and issued by Safe Work Australia.	Section 1.5.2
32.07	Marine exclusion zones will be established around the jetty and product tankers. The extent of the marine exclusion zones will be established in consultation with the DPC. EIS Supplement: Preliminary quantitative risk analysis (QRA) indicates that public access to recreational fishing in Lightening and Cossack creeks can be maintained. Exclusion zones are likely to apply to the eastern "fingers" of the creeks subject to the final QRA.	Outside of the scope of this OEMP

ID no.	Environmental commitment	Relevant section of this OEMP
36	**Additional commitments made within the EIS Supplement**	
36.01	The cetacean management plan will be extended to include dugongs. Also key management controls reconfirmed in SEIS: management measures to be employed through the cetacean management plan: Vessel masters to be trained in cetacean interaction procedures; vessels will be operated at "no wash" speed when within 50-150m of a dolphin and will not intentionally approach a dolphin.	Outside of the scope of this OEMP
37	**NRETAS recommendations**	
37.01	Recommendation 1 The proponent shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards: • Identified in the Ichthys Gas Field Development Project's Environmental Impact Statement (draft EIS and Supplement); and • Recommended in this Assessment Report. All safeguards and mitigation measures outlined in the Environmental Impact Statement are considered commitments by INPEX Browse Ltd and its joint venture partners.	This OEMP
37.02	Recommendation 2 The proponent shall advise the Minister of any changes to the proposal in accordance with clause 14A of the Environmental Assessment Administrative Procedures, for determination of whether or not further assessment is required.	Implement as required
37.14	Recommendation 9 INPEX will continue to fund and support research into coastal cetaceans in Darwin Harbour and the wider region to determine the importance of Darwin Harbour for the regional coastal cetacean population and the potential impacts of the Project, particularly drill and blast if it is to be used, on these populations.	Outside the scope of this OEMP; this is managed through INPEX's offsets arrange-ments

ID no.	Environmental commitment	Relevant section of this OEMP
37.16	Recommendation 10 Relevant EMPs are to be amended to include measures for minimising vessel interactions/collisions with dolphins, turtles, dugongs and other large marine fauna. The relevant plans should include: • details on procedures to reduce the risk of vessel strikes on large marine • vertebrates (marine turtles, dugongs and cetaceans) such as speed • limits; • requirements for installation of propeller guards on vessels associated with the Project; • details on procedures for monitoring and reporting of vessel strikes on large marine vertebrates; and • plans to monitor for stranded, injured or dead large marine vertebrates.	Outside of the scope of this OEMP, refer to INPEX's Marine Megafauna Observation and Interaction Specification
37.19	Recommendation 12 An appropriate offset is necessary to compensate for the residual detriment posed by Project activities to the ecological communities and marine fauna within Darwin Harbour. The scale of offset should be commensurate with the scale of residual detriment. If blasting is required, the offset must be increased to compensate.	Outside the scope of this OEMP; this is managed through INPEX's offsets arrange-ments
37.25	Recommendation 14 An offset for loss of monsoon vine forest on Blaydin Point is recommended. All activities associated with offsetting the residual detriment of clearing monsoon vine forests should: • be in perpetuity; and • include a management plan that demonstrates environmental benefits.	Outside the scope of this OEMP; this is managed through INPEX's offsets arrange-ments

ID no.	Environmental commitment	Relevant section of this OEMP
37.27	Recommendation 15 Appropriate controls to mitigate risks from hydrotesting wastewater must be included in the Liquid Discharges, Surface Water Runoff and Drainage Management Plan for Government approval. In preparing the plan, INPEX should also: • investigate options for land-based disposal where practicable; and • select chemical additives that have the lowest practicable risk to the marine environment.	Outside of scope of this OEMP; however maybe applicable in the future if limited hydrotesting is undertaken during maintenance activities
37.32	INPEX has an oil spill contingency plan (OSCP) that will be finalised and submitted to the NT Government for approval under the Disaster Act prior to the commencement of construction, commissioning and operations.	Section 5.14, also addressed in a separate Nearshore Operations OPEP (X060-AH-PLN-60003)
37.34	It is expected that any monitoring activities following an oil spill would include assessment of impacts on marine fauna including mammals, turtles, fish and shore birds. Long-term monitoring of fish populations following an oil spill would be required to determine whether the event caused recruitment failure.	Section 5.14, also addressed in a separate Nearshore Operations OPEP (X060-AH-PLN-60003)
37.35	Recommendation 16 An air monitoring program is required for the life of the Project. The program will be developed as a requirement of the Environment Protection Licence under the WMPC Act. The following point-source emissions testing should be conducted for the program: Quarterly monitoring for the first year of operation and annual thereafter for NO_x (plus temperature, flow, O_2, moisture) at each stack servicing the compressor turbines, power turbines, and hot oil heaters; and Quarterly monitoring for the first year of operation and annual thereafter for SO_2 (plus temperature, flow, O_2, moisture) at each stack servicing the acid gas incinerators.	Section 7.1

ID no.	Environmental commitment	Relevant section of this OEMP
37.41	Recommendation 21 The Bladin Point gas facility must incorporate best-practice water conservation measures into the design. The proponent must commit to continuous improvement in minimising potable water use.	Section 5.5
37.44	Recommendation 23 All Environment Management Plans for the Ichthys Gas Field Development Project are to be submitted to Government for approval prior to commencement of any works for which the plans apply. In preparing each plan, the proponent will include any additional measures for environmental protection and monitoring contained in this Assessment Report and Recommendations. The plans shall be referred to relevant NT Government agencies and key stakeholders for review prior to finalisation. The plans shall form the basis for approvals and licences issued under relevant legislation. The proponent should provide public access to final environmental management plans and a reporting mechanism to inform compliance with the plans.	Submission of this OEMP to NT EPA

APPENDIX C: COMMONWEALTH MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Table C.1 1 provides a list of species identified by the EPBC Protected Matters search tool as matters of national environmental significance that will potentially occur within the vicinity of Ichthys LNG (1 km radius).

Table C.1 1 also includes the false killer whale *Pseudorca crassidensis* which did not register on the EPBC Protected Matters search tool but are known to occur in Darwin Harbour.

Table C.1-1: Protected Marine Species that May be Present Near Ichthys LNG

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Marine mammals						
Blue whale	*Balaenoptera musculus*		✓	Endangered	✓	Unlikely to occur
Bryde’s whale	*Balaenoptera edeni*		✓		✓	Unlikely to occur
Common dolphin	*Delphinus delphis*				✓	✓
Dugong	*Dugong dugon*	✓	✓			✓
Risso's dolphin	*Grampus griseus*				✓	Unlikely to occur
Humpback whale	*Megaptera novaeangliae*		✓	Vulnerable	✓	Unlikely to occur
Killer whale	*Orcinus orca*		✓		✓	Unlikely to occur
Australian snubfin dolphin	*Orcaella heinsohni*		✓		✓	✓
False killer whale	*Pseudorca crassidens*				✓	✓
Indo-Pacific humpback dolphin	*Sousa chinensis*		✓		✓	✓

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Spotted dolphin	*Stenella attenuata*				✓	Unlikely to occur
Spotted bottlenose dolphin	*Tursiops aduncus*				✓	✓
Spotted bottlenose dolphin (Arafura/Timor Sea populations)	*Tursiops aduncus (Arafura/Timor Sea populations)*		✓		✓	Unlikely to occur
Bottlenose dolphin	*Tursiops truncatus s. str*				✓	Unlikely to occur
Terrestrial mammals						
Brush-tailed rabbit	*Conilurus penicillatus*			Vulnerable		Unlikely to occur
Northern quoll	*Dasyurus hallucatus*			Endangered		Unlikely to occur
Northern brush-tailed phascogale	*Phascogale pirata*			Vulnerable		Unlikely to occur
Bare-rumped sheathtail bat	*Saccolaimus saccolaimus nudicluniatus*			Vulnerable		Unlikely to occur
Water mouse	*Xeromys myoides*			Vulnerable		Unlikely to occur
Fawn Antechinus	*Antechinus bellus*			Vulnerable		Unlikely to occur

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Ghost Bat	*Macorderma gigas*			Vulnerable		Unlikely to occur
Black-footed Tree-rat	*Mesembriomys gouldii gouldii*			Endangered		Unlikely to occur
Nabarlek	*Petrogale concinna canescens*			Endangered		Unlikely to occur
Reptiles						
Plains death adder	*Acanthophis hawkei*			Vulnerable		Unlikely to occur
Loggerhead turtle	*Caretta caretta*	✓	✓	Endangered		✓
Green turtle	*Chelonia mydas*	✓	✓	Vulnerable		✓
Leatherback turtle	*Dermochelys coriacea*	✓	✓	Endangered		Unlikely to occur
Hawksbill turtle	*Eretmochelys imbricate*	✓	✓	Vulnerable		✓
Olive ridley turtle	*Lepidochelys olivacea*	✓	✓	Endangered		✓
Flatback turtle	*Natator depressus*	✓	✓	Vulnerable		✓
Saltwater crocodile	*Crocodylus porosus*	✓				

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Freshwater crocodile	*Crocodylus johnstoni*	✓				Unlikely to occur
Dubois' sea snake	*Aipysurus duboisii*	✓				May occur
Spine-tailed sea snake	*Aipysurus eydouxii*	✓				May occur
Olive sea snake	*Aipysurus laevis*	✓				Unlikely to occur
Stokes' sea snake	*Astrotia stokesii*	✓				May occur
Spectacled sea snake	*Disteira kingii*	✓				Unlikely to occur
Olive-headed sea snake	*Disteira major*	✓				May occur
Beaked sea snake	*Enhydrina schistosa*	✓				May occur
Black-ringed sea snake	*Hydrelaps darwiniensis*	✓				May occur
Slender-necked sea snake	*Hydrophis coggeri*	✓				Unlikely to occur
Elegant sea snake	*Hydrophis elegans*	✓				May occur
Plain sea snake	*Hydrophis inornatus*	✓				May occur
No common name	*Hydrophis mcdowelli*	✓				May occur

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Spotted sea snake	*Hydrophis ornatus*	✓				Unlikely to occur
Large-headed sea snake	*Hydrophis pacificus*	✓				Unlikely to occur
Spine-bellied sea snake	*Lapemis hardwickii*	✓				May occur
Northern Mangrove sea snake	*Parahydrophis mertoni*	✓				May occur
Yellow-bellied sea snake	*Pelamis platurus*	✓				Unlikely to occur
Horned sea snake	*Acalyptophis peronii*	✓				
Black-headed sea snake	*Hydophis atriceps*	✓				
Sharks and rays						
Great white shark	*Carcharodon carcharias*		✓	Vulnerable		Unlikely to occur
Northern river shark	*Glyphis garricki*			Endangered		Unlikely to occur
Dwarf sawfish	*Pristis clavata*		✓	Vulnerable		Unlikely to occur
Freshwater sawfish	*Pristis pristis*		✓	Vulnerable		Unlikely to occur
Green sawfish	*Pristis zijsron*		✓	Vulnerable		Unlikely to occur

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Whale shark	*Rhincodon typus*		✓	Vulnerable		Unlikely to occur
Giant manta ray	*Manta birostris*		✓			Unlikely to occur
Narrow sawfish	*Anoxypristis cuspidate*		✓			Unlikely to occur
Reef Manta Ray	*Manta birostris*		✓			Unlikely to occur
Birds						
Red knot	*Calidris canutus*	✓	✓	Endangered		Unlikely to occur
Curlew sandpiper	*Calidris ferrunginea*	✓	✓	Critically Endangered		Unlikely to occur
Bar-tailed godwit	*Limosa lapponica bauera*	✓	✓	Vulnerable		Unlikely to occur
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbieri*			Critically Endangered		Unlikely to occur
Eastern curlew	*Numenius madagascariensis*	✓	✓	Critically Endangered		Unlikely to occur
Pectrol sandpiper	*Calidris melanotos*	✓	✓			Unlikely to occur
Common greenshank	*Tringa nebularia*	✓	✓			Unlikely to occur

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Red goshawk	*Erythrotriorchis radiatus*			Vulnerable		Unlikely to occur
Gouldian finch	*Erythrura gouldiae*			Endangered		Unlikely to occur
Partridge pigeon (eastern)	*Geophaps smithii smithii*			Vulnerable		Unlikely to occur
Australian painted snipe	*Rostratula australis*			Endangered		Unlikely to occur
Masked owl (northern)	*Tyto novaehollandiae kimberli*			Vulnerable		Unlikely to occur
Common noddy	*Anous stolidus*	✓	✓			Unlikely to occur
Streaked shearwater	*Calonectris leucomelas*	✓	✓			Unlikely to occur
Lesser frigatebird	*Fregata ariel*	✓	✓			Unlikely to occur
Greater frigatebird	*Fregata minor*	✓	✓			Unlikely to occur
Red rumped swallow	*Cecropis daurica*	✓	✓			Unlikely to occur
Oriental cuckoo	*Cuculus optatus*		✓			Unlikely to occur
Grey wagtail	*Motacilla cinerea*	✓	✓			Unlikely to occur

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Yellow wagtail	*Motacilla flava*	✓	✓			Unlikely to occur
Oriental reed-warbler	*Acrocephalus orientalis*	✓	✓			Unlikely to occur
Sharp-tailed sandpiper	*Calidris acuminata*	✓	✓			Unlikely to occur
Black-eared cuckoo	*Chrysococcyx osculans*	✓				Unlikely to occur
Fork-tailed swift	*Apus pacificus*	✓	✓			Unlikely to occur
Little tern	*Sterna albifrons*	✓	✓			Unlikely to occur
White-bellied sea eagle	*Haliaeetus leucogaster*	✓				Unlikely to occur
Barn swallow	*Hirundo rustica*	✓	✓			Unlikely to occur
Rainbow bee-eater	*Merops ornatus*	✓				Unlikely to occur
Rufous fantail	*Rhipidura rufifrons*	✓	✓			Unlikely to occur
Common sandpiper	*Actitis hypoleucos*	✓	✓			Unlikely to occur
Magpie goose	*Anseranas semipalmata*	✓				Unlikely to occur
Great egret	*Ardea alba*	✓				Unlikely to occur

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Cattle egret	*Ardea ibis*	✓				Unlikely to occur
Ruddy turnstone	*Arenaria interpres*	✓	✓			Unlikely to occur
Sanderling	*Calidris alba*	✓	✓			Unlikely to occur
Great knot	*Calidris tenuirostris*	✓	✓	Critically Endangered		Unlikely to occur
Greater sand plover	*Charadrius leschenaultii*	✓	✓	Vulnerable		Unlikely to occur
Lesser sand plover	*Charadrius mongolus*	✓	✓	Endangered		Unlikely to occur
Oriental plover	*Charadrius veredus*	✓	✓			Unlikely to occur
Oriental pratincole	*Glareola maldivarum*	✓	✓			Unlikely to occur
Black-tailed godwit	*Limosa limosa*	✓	✓			Unlikely to occur
Whimbrel	*Numenius phaeopus*	✓	✓			Unlikely to occur
Osprey	*Pandion haliaetus*	✓	✓			Unlikely to occur
Grey plover	*Pluvialis squatarola*	✓	✓			Unlikely to occur
Fish						

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Short-keel pipefish	*Hippichthys parvicarinatus*	✓				May occur
Beady pipefish	*Hippichthys penicillus*	✓				Unlikely to occur
Spiny seahorse	*Hippocampus histrix*	✓				Unlikely to occur
Spotted seahorse	*Hippocampus kuda*	✓				Unlikely to occur
Flat-face seahorse	*Hippocampus planifrons*	✓				Unlikely to occur
Hedgehog seahorse	*Hippocampus spinosissimus*	✓				Unlikely to occur
Tidepool pipefish	*Micrognathus micronotopterus*	✓				May occur
Pallid pipehorse	*Solegnathus hardwickii*	✓				Unlikely to occur
Gunther's pipehorse	*Solegnathus lettiensis*	✓				Unlikely to occur
Robust ghost pipefish	*Solenostomus cyanopterus*	✓				Unlikely to occur
Double-end pipehorse	*Syngnathoides biaculeatus*	✓				Unlikely to occur

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Bentstick pipefish	*Trachyrhamphus bicoarctatus*	✓				May occur
Straightstick pipefish	*Trachyrhamphus longirostris*	✓				May occur
Three-keel pipefish	*Campichthys tricarinatus*	✓				Unlikely to occur
Pacific short-bodied pipefish	*Choeroichthys brachysoma*	✓				Unlikely to occur
Pig-snouted pipefish	*Choeroichthys suillus*	✓				Unlikely to occur
Fijian banded pipefish	*Corythoichthys amplexus*	✓				Unlikely to occur
Reticulate pipefish	*Corythoichthys flavofasciatus*	✓				Unlikely to occur
Reef-top pipefish	*Corythoicthys haematopterus*	✓				Unlikely to occur
Bluestripe pipefish	*Doryrhamphus excisus*	✓				Unlikely to occur
Cleaner pipefish	*Doryrhamphus janssi*	✓				Unlikely to occur
Girdled pipefish	*Festucalex cinctus*	✓				May occur

Common name	Scientific name	Listed marine species	Listed migratory species	Listed threatened species	Whales and other cetaceans	Likelihood of occurring in the Onshore Plant battery limits
Tasselled pipefish	*Halicampus brocki*	✓				Unlikely to occur
Mud pipefish	*Halicampus grayi*	✓				May occur
Spiny-snout pipefish	*Halicampus spinirostris*	✓				Unlikely to occur
Ribboned pipehorse	*Haliichthys taeniophorus*	✓				May occur
Blue-speckled pipefish	*Hippichthys cyanospilos*	✓				May occur

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Name	Title

Electronic Endorsement and Approval

Electronic approval of this document complies with the issued INPEX Electronic Approval Standard (0000-A9-STD-60011) and records evidence that the applicable person has either endorsed and/or approved the content contained within this document. The reviewers of this document are recorded in the CDS.

Name	Title	Date and Time	Action
Jake Prout	Environmental Operation	02/02/22 12:14	Endorser
Ben Schmidt	Production Manager	04/02/22 13:02	Endorser
Dave Dann	General Manager Onsho	04/02/22 16:43	Approver