Gorgon Gas Development and Jansz Feed Gas Pipeline:

Reverse Osmosis Brine Disposal via Ocean Outfall Environmental Management and Monitoring Plan

Temporary and Permanent Reverse Osmosis Facilities

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Terminology, Definitions, and Abbreviations

Terms, definitions, and abbreviations used in this document are listed below. These align with the terms, definitions, and abbreviations defined in Schedule 2 of the Western Australian Gorgon Gas Development Ministerial Implementation Statement No. 800 (Statement No. 800) and the Commonwealth Gorgon Gas Development Ministerial Approvals (EPBC Reference: 2003/1294 and 2008/4178).

µg/L	Micrograms per litre
2D	Two dimensions, or two-dimensional
3D	Three dimensions, or three-dimensional
Abiotic	Non-living chemical and physical factors in the environment
ABU	Australasia Business Unit
ACR	Acute to Chronic Ratio
ALARP	As Low As Reasonably Practicable Defined as a level of risk that is not intolerable, and cannot be reduced further without the expenditure of costs that are grossly disproportionate to the benefit gained.
ANZECC and ARMCANZ	Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand.
ARI	Assessment on Referral Information (for the proposed Jansz Feed Gas Pipeline dated September 2007) as amended or supplemented from time to time.
AS/NZS	Australian Standard/New Zealand Standard
ASBU	Australasia Strategic Business Unit
At Risk	Being at risk of Material Environmental Harm or Serious Environmental Harm and/or, for the purposes of the EPBC Act relevant listed threatened species, threatened ecological communities and listed migratory species, at risk of Material Environmental Harm or Serious Environmental Harm.
Avifauna	Birds of a particular region.
Bathymetric	Relating to measurements of the depths of oceans or lakes.
Benthic	Living upon or in the sediment of the sea.
Benthic Habitats	Areas on the sea floor or seabed that support living organisms. Examples include, but are not limited to, limestone pavement, reefs, bare sand and deepwater soft sediments.
Biocide	Any substance that can destroy living organisms.

Bombora	A shallow isolated piece of reef located a distance offshore.
BPP	Benthic Primary Producer; photosynthesising organisms (mangroves, seagrasses, algae) or organisms that harbour photosynthetic symbionts (corals, giant clams).
BTEX	Benzene, toluene, ethylbenzene, and xylene—primary toxins of soils and groundwater associated with petroleum products.
BurrliOZ	A statistical software package, developed by CSIRO for Environment Australia, for use in environmental management of species with regard to understanding the effects of levels of toxins in an environment.
Caisson	A large watertight chamber used for construction under water.
CALM	Former Western Australian Department of Conservation and Land Management (now Parks and Wildlife)
CAMBA	China–Australia Migratory Bird Agreement
Carbon Dioxide (CO_2) Injection System	The mechanical components required to be constructed to enable the injection of reservoir carbon dioxide, including but not limited to compressors, pipelines and wells.
Cetacean	Various aquatic (mainly marine) mammals of the order Cetacea, (including whales, dolphins and porpoises) characterised by a nearly hairless body, front limbs modified into broad flippers and a flat notched tail.
CI	Confidence Interval
CO_2	Carbon dioxide
Construction	Construction includes any Proposal-related (or action-related) construction and commissioning activities within the Terrestrial and Marine Disturbance Footprints, excluding investigatory works such as, but not limited to, geotechnical, geophysical, biological and cultural heritage surveys, baseline monitoring surveys and technology trials.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTD	Conductivity, temperature, depth
Cth	Commonwealth of Australia
DEC	Former Western Australian Department of Environment and Conservation (now Parks and Wildlife).
DEWHA	Former Commonwealth Department of the Environment, Water, Heritage and the Arts (now DotE)
DO	Dissolved Oxygen

DotE	Commonwealth Department of the Environment
EC	Effect Concentration
EC10	Concentration or dose yielding biological effects in 10% of test species.
EC50	Concentration or dose yielding biological effects in 50% of test species.
Ecological Element	Element listed in listed in Condition 14.2 of Statement No. 800 and Condition 11.2 of EPBC Reference: 2003/1294 and 2008/4178.
EIS/ERMP	Environmental Impact Statement/Environmental Review and Management Programme (for the Proposed Gorgon Gas Development dated September 2005) as amended or supplemented from time to time.
EMMP	Environmental Management and Monitoring Plan
EMP	Environmental Management Plan
Environmental Harm	Has the meaning given by Part 3A of the *Environmental Protection Act 1986* (WA).
EP Act	Western Australian *Environmental Protection Act 1986*
EPA	Western Australian Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPBC Reference: 2003/1294	Commonwealth Ministerial Approval (for the Gorgon Gas Development) as amended or replaced from time to time.
EPBC Reference: 2005/2184	Commonwealth Ministerial Approval (for the Jansz Feed Gas Pipeline) as amended or replaced from time to time.
EPBC Reference: 2008/4178	Commonwealth Ministerial Approval (for the Revised Gorgon Gas Development) as amended or replaced from time to time.
EPCM	Engineering, Procurement and Construction Management
EQC	Ecological Quality Criteria
ETC	Chevron Energy Technology Company
$FeCl_3$	Ferric chloride
Flocculent	A substance added to water to make particles clump together in order to achieve better filtration.

Gas Treatment Plant	Includes the following components: Liquefied Natural Gas (LNG) Trains, LNG Tanks, Gas Processing Drivers, Power Generations, Flares, Condensate Tanks and Utilities Area.
Gorgon Gas Development	The Gorgon Gas Development as approved under Statement No. 800 and EPBC Reference: 2003/1294 and 2008/4178 as amended or replaced from time to time.
GPS	Geographic Positioning System
ha	Hectare
Halocline	A strong, vertical salinity gradient; the (sometimes indistinct) border between layers of water that contain different amounts of salt.
HEPA	High Ecological Protection Area
HES	Health, Environment, and Safety
Hydrotest	Method whereby water is pressurised within pipes and vessels to detect leaks.
IMS	Impact Mitigation Strategy
ISO	International Organization for Standardization
ISQG	Interim Sediment Quality Guideline
JAMBA	Japan–Australia Migratory Bird Agreement
Jansz Feed Gas Pipeline	The Jansz Feed Gas Pipeline as approved in Statement No. 769 and EPBC Reference 2005/2184 as amended or replaced from time to time.
kg	Kilogram
KJVG	Kellogg Joint Venture Gorgon
km	Kilometre
LADS	Laser Airborne Depth Sounding (used for bathymetry mapping)
LC	Lethal Concentration
LC_{10}	Concentration or dose found to be lethal in 10% of a group of test species
LC_{50}	Concentration or dose found to be lethal in 50% of a group of test species
LEPA	Low Ecological Protection Area

Littoral	A shore; the zone between high tide and low tide; of, or related to the shore, especially the seashore.
LNG	Liquefied Natural Gas
LOEC	Lowest Observed Effect Concentration
m	Metre
m/s	Metres per second
m^3	Cubic metre
Macroalgae	Algae that can be seen easily, without using a microscope; includes large seaweeds.
Macroinvertebrates	Animals without backbones that are big enough to see with the naked eye. Examples include most aquatic insects, snails and crayfish.
Macrophyte	A large aquatic plant, visible to the unaided eye, which grows in or near water and is emergent, submergent, or floating (e.g. kelp).
Management Triggers	Are quantitative, or where this is demonstrated to be not practicable, qualitative matters above or below whichever relevant additional management measures must be considered.
Marine Disturbance Footprint	The area of the seabed to be disturbed by construction or operations activities associated with the Marine Facilities listed in Condition 14.3 of Statement No. 800, and Condition 11.3 of EPBC Reference: 2003/1294 and 2008/4178 (excepting that area of the seabed to be disturbed by the generation of turbidity and sedimentation from dredging and dredge spoil disposal) as set out in the Coastal and Marine Baseline State Report required under Condition 14.2 of Statement No. 800, and Condition 11.2 of EPBC Reference: 2003/1294 and 2008/4178
Marine Facilities	In relation to Statement No. 800 and EPBC Reference: 2003/1294 and 2008/4178, the Marine Facilities are the: • Materials Offloading Facility (MOF) • LNG Jetty • Dredge Spoil Disposal Ground • Offshore Feed Gas Pipeline System and marine component of the shore crossing • Domestic Gas Pipeline For the purposes of Statement No. 800, Marine Facilities also include: • Marine upgrade of the existing WAPET landing.

Material Environmental Harm	Environmental Harm that is neither trivial nor negligible.
MDF	Marine Disturbance Footprint
MEPA	Moderate Ecological Protection Area
mg/L	Milligrams per litre
MGA 50, GDA 94	Map Grid of Australia Zone 50 (WA); projection based on the Geocentric Datum of Australia 1994.
MOF	Materials Offloading Facility
MSDS	Material Safety Data Sheet
MTPA	Million Tonnes Per Annum
$Na_2S_2O_6$	Sodium metabisulfite
$NaHSO_3$	Sodium bisulfite
NATA	National Association of Testing Authorities
ng/L	Nanograms per litre
NOEC	No Observed Effect Concentration
OE	Operational Excellence
OEMS	Operational Excellence Management System
Oligotrophic	An ecosystem or environment is oligotrophic if it offers little to sustain life. The term is commonly used to describe bodies of water or soils with very low nutrient levels.
Operations (Gorgon Gas Development)	In relation to Statement No. 800 and EPBC Reference: 2003/1294 and 2008/4178, for the respective LNG trains, this is the period from the date on which the Gorgon Joint Venturers issue a notice of acceptance of work under the Engineering, Procurement and Construction Management (EPCM) contract, or equivalent contract entered into in respect of that LNG train of the Gas Treatment Plant; until the date on which the Gorgon Joint Venturers commence decommissioning of that LNG train.
Parks and Wildlife	Western Australian Department of Parks and Wildlife
PC	Protection Concentration; e.g. PC99 is 99% protection concentration, PC95 is 95% protection concentration etc.
PER	Public Environmental Review for the Gorgon Gas Development Revised and Expanded Proposal dated September 2008, as amended or supplemented from time to time.

Performance Standards	Are matters which are developed for assessing performance, not compliance, and are quantitative targets or where that is demonstrated to be not practicable, qualitative targets, against which progress towards achievement of the objectives of conditions can be measured.
PGPA	Policy, Government and Public Affairs
pH	Measure of acidity or basicity of a solution
Photic zone	The depth of the water in a lake or ocean that is exposed to sufficient sunlight for photosynthesis to occur. The depth of the photic zone can be greatly affected by turbidity.
Porites	An important genus of long-lived, reef building corals
Potable water	Drinking water
ppt	Parts per thousand
Practicable	Practicable means reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge. For the purposes of the conditions of EPBC Reference: 2003/1294 and 2008/4178 that include the term ‘practicable’, when considering whether the draft plan meets the requirements of these conditions, the Commonwealth Minister will determine what is ‘practicable’ having regard to local conditions and circumstances including but not limited to personnel safety, weather or geographical conditions, costs, environmental benefit and the current state of scientific and technical knowledge.
Probit	A unit derived from a standard distribution, used in measuring the responses to doses.
PSV	Project Support Vessel; within the context of this Plan, PSVs are limited to the vessels associated with servicing additional water requirements
QC	Quality Control
RO	Reverse Osmosis
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
S&OR	Safety and Operability Review
Seagrass	Unrelated to seaweed, seagrasses are the flowering plants of the ocean, having roots, stems, leaves and inconspicuous flowers with fruits and seeds much like the flowering plants of the land.

Serious Environmental Harm	Environmental harm that is: a) irreversible, of a high impact or on a wide scale; or b) significant or in an area of high conservation value or special significance and is neither trivial nor negligible.
Significant Impact	An impact on a Matter of National Environmental Significance, relevant to EPBC Reference: 2003/1294, 2005/2185 and 2008/4178 that is important, notable or of consequence having regard to its context or intensity.
SIMOPS	Simultaneous Operations
SSD	Species Sensitivity Distribution
Statement No. 965	Western Australian Ministerial Implementation Statement No. 965, issued for the Additional Support Area, as amended from time to time. Statement No. 965 applies the conditions of Statement No. 800 to the Additional Support Area.
Statement No. 748	Western Australian Ministerial Implementation Statement No. 748 (for the Gorgon Gas Development) as amended from time to time [superseded by Statement No. 800].
Statement No. 769	Western Australian Ministerial Implementation Statement No. 769 (for the Jansz Feed Gas Pipeline).
Statement No. 800	Western Australian Ministerial Implementation Statement No. 800 (for the Gorgon Gas Development) as amended from time to time.
Statement No. 865	Western Australian Ministerial Implementation Statement No. 865 (for the Gorgon Gas Development) as amended from time to time.
Stygofauna	Groundwater-dwelling aquatic fauna.
Substrate	The surface a plant or animal lives upon. The substrate can include biotic or abiotic materials. For example, encrusting algae that lives on a rock can be substrate for another animal that lives above the algae on the rock.
TAPL	Texaco Australia Pty Ltd.
TDS	Total Dissolved Salts
TPH	Total Petroleum Hydrocarbons; a measure of concentration or mass of petroleum hydrocarbon constituents present in a given amount of air, soil, or water.
Turbidity	The cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.
WA	Western Australia

WAPET	West Australian Petroleum Pty Ltd.
WAPET Landing	Proper name referring to the site of the barge landing existing on the east coast of Barrow Island prior to the date of Statement No. 800.
Waters Surrounding Barrow Island	Refers to the waters of the Barrow Island Marine Park and Barrow Island Marine Management Area (approximately 4169 ha and 114 693 ha respectively) as well as the port of Barrow Island representing the Pilbara Offshore Marine Bioregion which is dominated by tropical species that are biologically connected to more northern areas by the Leeuwin Current and the Indonesian Throughflow, resulting in a diverse marine biota is typical of the Indo–West Pacific flora and fauna.
WET	Whole Effluent Toxicity
Zone of High Impact	Area within which losses of Benthic Primary Producer Habitat are predicted to occur as a result of dredging and spoil disposal.

Executive Summary

Chevron Australia Pty Ltd (Chevron Australia) is the proponent for the Gorgon Gas Development and proposes to install and operate Reverse Osmosis (RO) facilities in order to supply water to the Gorgon Gas Development for construction and operations. It is proposed that reject RO brine will be discharged to the marine environment via up to two temporary ocean outfalls located south of the Materials Offloading Facility (MOF) and from package RO units located on the Project Support Vessels (PSVs) during construction and the period of simultaneous construction and operations activities (SIMOPS). A permanent ocean outfall located along the northern side of the MOF will commence during construction and be ongoing throughout SIMOPS and operations.

The Revised and Expanded Gorgon Gas Development was approved by the Western Australian State Minister for the Environment on 10 August 2009 by way of Ministerial Implementation Statement No. 800 (Statement No. 800). Condition 30.2.ii of Statement No. 800 states:

> *'Ensure discharges from any wastewater treatment plant, reverse osmosis plant, or other process water are disposed of via deep well injection, unless otherwise authorised by the Minister'.*

On 26 August 2009, the Commonwealth Minister for the Environment, Heritage and the Arts issued approval for the Revised and Expanded Gorgon Gas Development (EPBC Reference: 2008/4178) and varied the conditions for the initial Gorgon Gas Development (EPBC Reference: 2003/1294). Condition 20.2.ii of EPBC Ref: 2003/1294 and EPBC Ref: 2008/4178 states:

> *'Ensure discharges from any wastewater treatment plant, reverse osmosis plant, or other process water are disposed of via deep well injection, unless otherwise authorised by the Western Australian Minister'.*

In April 2009, Chevron Australia obtained Ministerial authorisation to dispose of reject RO brine by temporary ocean outfall during the construction phase via approval of this Environmental Management and Monitoring Plan (EMMP). In December 2013, Chevron Australia expanded this authorisation to include disposal of reject RO brine by permanent ocean outfall, commencing during construction and then ongoing through operations. Chevron Australia is now seeking to expand this authorisation to include disposal of reject RO brine by the PSV ocean outfalls, during construction and SIMOPS, via approval of this updated EMMP.

A number of fresh and saline water source options for the Gorgon Gas Development have been considered (Kellogg Joint Venture Gorgon [KJVG] 2006, 2007). A lack of sustainable freshwater sources available to meet the Gorgon Gas Development requirements necessitates the use of a saline water source together with water processing. Potential shallow and deep well sources of saline water have been investigated and evaluated, and discounted in favour of an ocean seawater intake.

The two main desalination technologies examined for the Gorgon Gas Development were RO and distillation. Although other desalination technologies are available, RO and distillation were considered primary technologies based principally on proven use, competitive availability and reliability. RO has been selected as the most appropriate desalination technology for implementation on the Gorgon Gas Development.

Desalination using RO technology generates a brine reject stream, which requires disposal. A number of brine disposal options for the Gorgon Gas Development have been considered including deep well injection, disposal via shallow beach wells, and an ocean outfall (Helix 2006, 2007, 2007a, 2008; Golder Associates 2008). Given the options available to the Gorgon Gas Development for brine disposal, ocean outfall is considered the most viable due to the reduced implementation uncertainty (i.e. construction and operability of outfall technologies are proven and well supported in Australia), land take is minimised, and the ability to design, monitor and control the treatment and disposal process to reduce environmental impact to As Low As Reasonably Practicable (ALARP).

A number of studies have been undertaken to demonstrate that brine disposal via ocean discharge does not cause Material or Serious Environmental Harm to Barrow Island and its surrounding waters and to ensure that impacts to the marine environment are ALARP. These studies include:

- characterisation and preliminary toxicity assessment of potential brine streams (Chevron Energy Technology Company [ETC] 2007)
- literature review of the effects of saline discharges on the marine environment (RPS Environment 2009)
- Whole Effluent Toxicity (WET) testing and BurrliOZ Species Sensitivity Distribution analysis (RPS Environment 2008a)
- dilution modelling for temporary brine discharges (KJVG 2010)
- dilution modelling for permanent brine discharges (KJVG 2013)
- dilution modelling for brine discharges from package RO units on PSVs (KJVG 2014).

Overall, WET test results indicate that the toxicity of the whole effluent combinations was neither high, nor detectable as different from whole effluents composed of just brine or hypochlorite in sea water. The 95% lower Confidence Interval (CI) estimates of species protection concentrations (PC99) indicates that a 10-fold dilution should provide sufficient dilutions to achieve a 99% species protection level. Applying an alternative, more conservative approach based on minimum No Observed Effect Concentration (NOEC) values with a safety factor of 10, indicates that a 40-fold dilution should provide sufficient dilutions to achieve a 99% species protection level.

Dilution modelling completed for the temporary, PSVs package units and permanent brine discharges indicate that 40-fold dilution can be achieved within their respective mixing zones under a range of potential operating scenarios. In addition, no cumulative impacts are expected from running all plants concurrently as:

- there is sufficient distance between all outfalls to allow 40-fold dilution; therefore, the mixing zones are not expected to overlap
- the MOF creates a physical barrier between the permanent and temporary outfalls/mixing zones.

Based on the studies undertaken, potential impacts to the marine environment as a result of RO brine discharge undertaken in accordance with this Plan, are considered low and acceptable and will not cause material or serious environmental harm to Barrow Island or its surrounding waters.

1.0 Introduction

1.1 Proponent

Chevron Australia Pty Ltd (Chevron Australia) is the proponent and the person taking the action for the Gorgon Gas Development on behalf of the following companies (collectively known as the Gorgon Joint Venturers):

- Chevron Australia Pty Ltd
- Chevron (TAPL) Pty Ltd
- Shell Development (Australia) Pty Ltd
- Mobil Australia Resources Company Pty Ltd
- Osaka Gas Gorgon Pty Ltd
- Tokyo Gas Gorgon Pty Ltd
- Chubu Electric Power Gorgon Pty Ltd

pursuant to Statement No. 800 and EPBC Reference: 2003/1294 and 2008/4178.

Chevron Australia is also the proponent and the person taking the action for the Jansz Feed Gas Pipeline on behalf of the Gorgon Joint Venturers, pursuant to Statement No. 769 and EPBC Reference 2005/2184.

1.2 Project

Chevron Australia proposes to develop the gas reserves of the Greater Gorgon Area (Figure 1-1).

Subsea gathering systems and subsea pipelines will be installed to deliver feed gas from the Gorgon and Jansz–Io gas fields to the west coast of Barrow Island. The feed gas pipeline system will be buried as it traverses from the west coast to the east coast of the Island where the system will tie in to the Gas Treatment Plant located at Town Point. The Gas Treatment Plant will comprise three Liquefied Natural Gas (LNG) trains capable of producing a nominal capacity of five Million Tonnes Per Annum (MTPA) per train. The Gas Treatment Plant will also produce condensate and domestic gas. Carbon dioxide (CO_2), which occurs naturally in the feed gas, will be separated during the production process. As part of the Gorgon Gas Development, Chevron Australia will inject the separated CO_2 into deep formations below Barrow Island. The LNG and condensate will be loaded from a dedicated jetty offshore from Town Point and then transported by dedicated carriers to international markets. Gas for domestic use will be exported by a pipeline from Town Point to the domestic gas collection and distribution network on the mainland (Figure 1-2).

1.3 Location

The Gorgon Gas Field is located approximately 130 km and the Jansz–Io field approximately 200 km off the north-west coast of Western Australia. Barrow Island is located off the Pilbara coast 85 km north-north-east of the town of Onslow and 140 km west of Karratha. The Island is approximately 25 km long and 10 km wide and covers 23 567 ha. It is the largest of a group of islands, including the Montebello and Lowendal Islands.

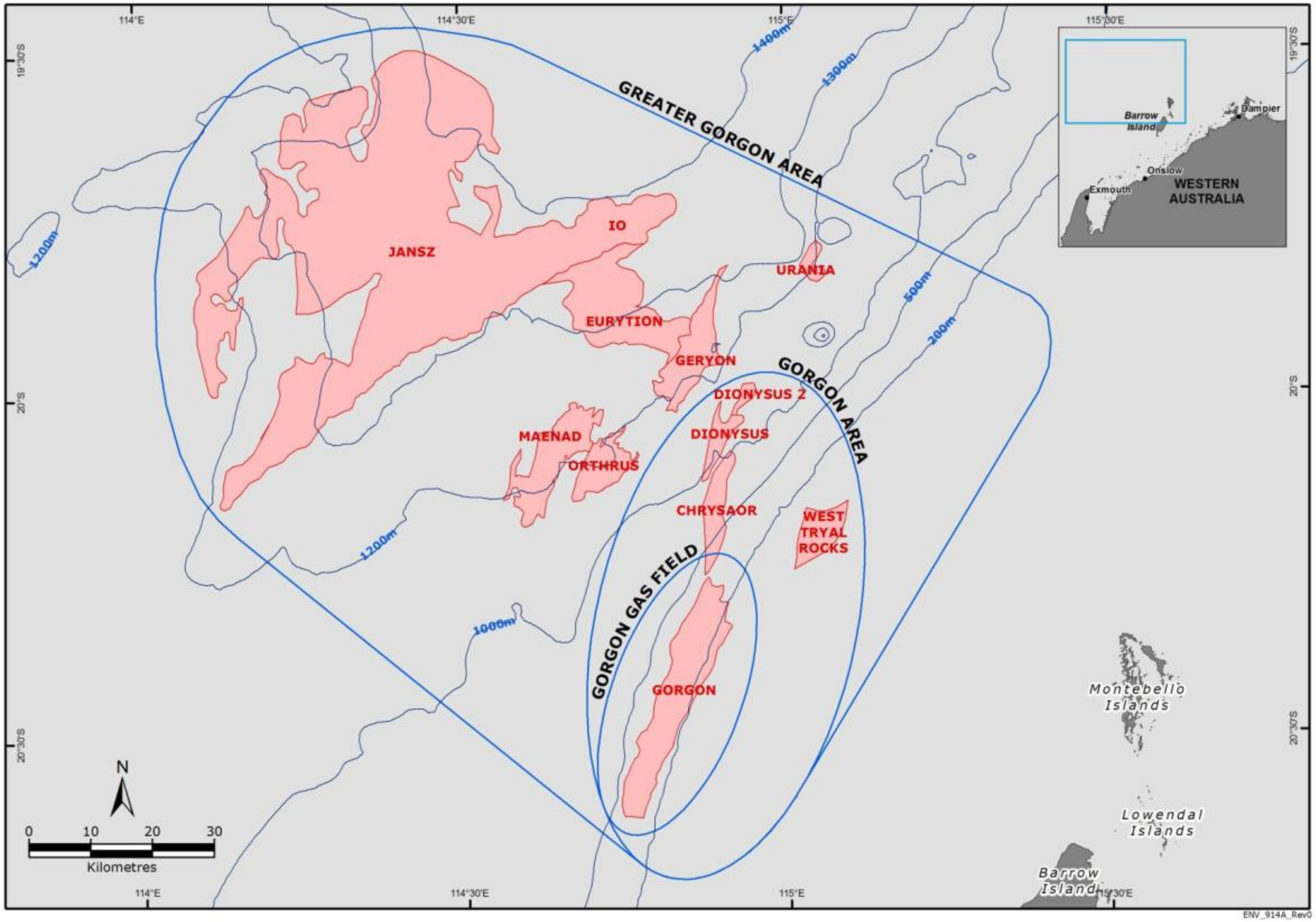

Figure 1-1 Location of the Greater Gorgon Area

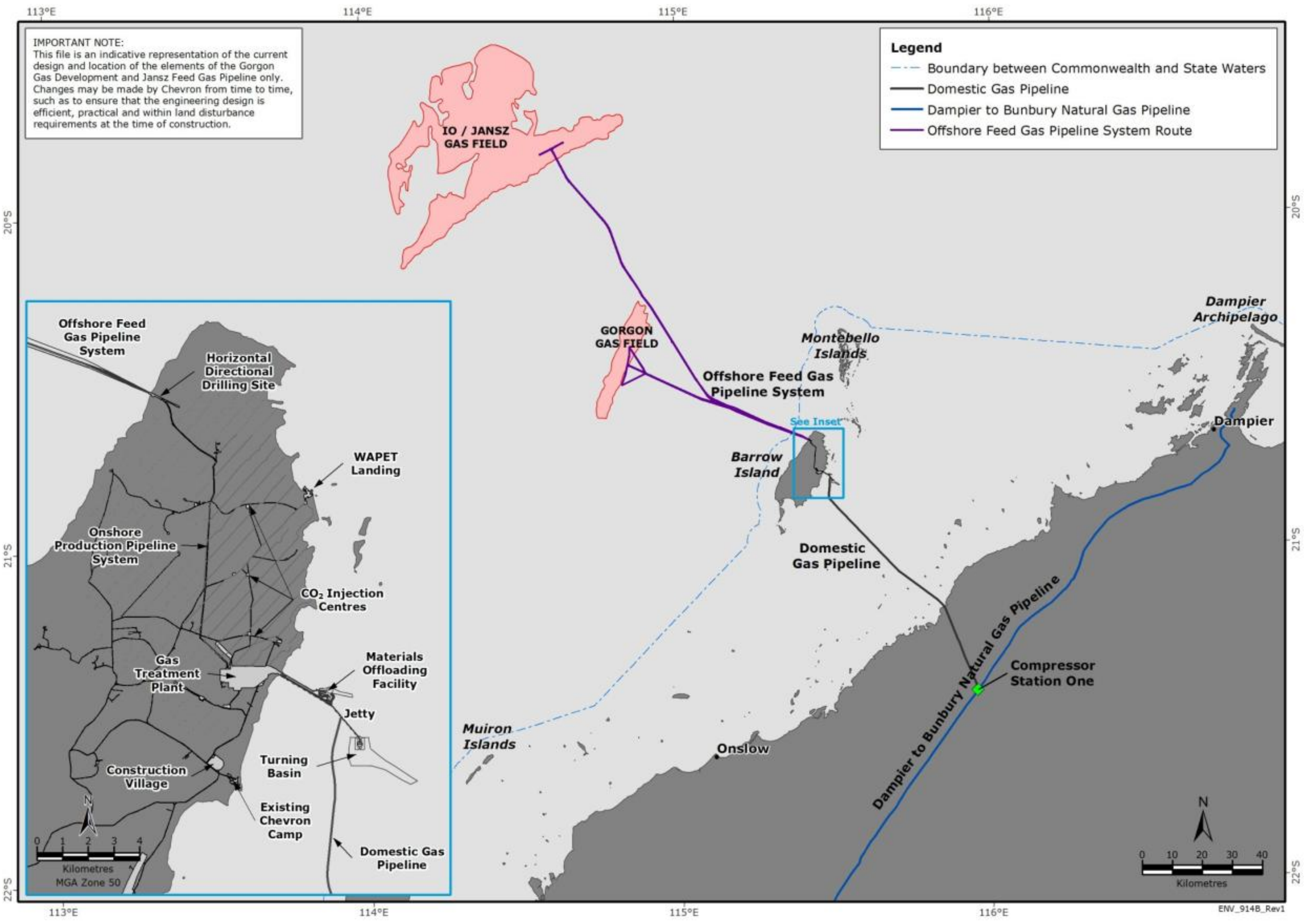

Figure 1-2 Location of the Gorgon Gas Development and Jansz Feed Gas Pipeline

1.4 Environmental Approvals

The initial Gorgon Gas Development was assessed through an Environmental Impact Statement/Environmental Review and Management Programme (EIS/ERMP) assessment process (Chevron Australia 2005, 2006).

The initial Gorgon Gas Development was approved by the Western Australian State Minister for the Environment on 6 September 2007 by way of Ministerial Implementation Statement No. 748 (Statement No. 748) and the Commonwealth Minister for the Environment and Water Resources on 3 October 2007 (EPBC Reference: 2003/1294).

In May 2008, under section 45C of the Western Australian *Environmental Protection Act 1986* (EP Act), the Environmental Protection Authority (EPA) approved some minor changes to the Gorgon Gas Development that it considered 'not to result in a significant, detrimental, environmental effect in addition to, or different from, the effect of the original proposal' (EPA 2008). The approved changes are:

- excavation of a berthing pocket at the Barge (WAPET) Landing facility
- installation of additional communications facilities (microwave communications towers)
- relocation of the seawater intake
- modification to the seismic monitoring program.

In September 2008, Chevron Australia sought both State and Commonwealth approval through a Public Environment Review (PER) assessment process (Chevron Australia 2008) for the Revised and Expanded Gorgon Gas Development to make some changes to 'Key Proposal Characteristics' of the initial Gorgon Gas Development, as outlined below:

- addition of a five MTPA LNG train, increasing the number of LNG trains from two to three
- expansion of the CO_2 Injection System, increasing the number of injection wells and surface drill locations
- extension of the causeway and the Materials Offloading Facility (MOF) into deeper water.

The Revised and Expanded Gorgon Gas Development was approved by the Western Australian State Minister for the Environment on 10 August 2009 by way of Ministerial Implementation Statement No. 800 (Statement No. 800). Statement No. 800 also superseded Statement No. 748 as the approval for the initial Gorgon Gas Development. Statement No. 800 therefore provides approval for both the initial Gorgon Gas Development and the Revised and Expanded Gorgon Gas Development, which together are known as the Gorgon Gas Development. Amendments to Statement No. 800 Conditions 18, 20, and 21 under section 46 of the EP Act were approved by the Western Australian State Minister for the Environment on 7 June 2011 by way of Ministerial Implementation Statement No. 865 (Statement No. 865). Implementation of the Gorgon Gas Development will therefore continue to be in accordance with Statement No. 800 as amended by MS 865.

On 26 August 2009, the Commonwealth Minister for the Environment, Heritage and the Arts issued approval for the Revised and Expanded Gorgon Gas Development (EPBC Reference: 2008/4178) and varied the conditions for the initial Gorgon Gas Development (EPBC Reference: 2003/1294).

Since the Revised and Expanded Gorgon Gas Development was approved, further minor changes have also been made and/or approved to the Gorgon Gas Development and are now also part of the Development. Further changes may also be made/approved in the future. This Plan relates to any such changes, and where necessary this document will be specifically revised to address the impacts of those changes.

Use of an additional 32 ha of uncleared land for the Gorgon Gas Development Additional Construction, Laydown, and Operations Support Area (Additional Support Area) was approved by the Western Australian State Minister for Environment on 2 April 2014 by way of Ministerial Implementation Statement No. 965 and by Variation issued by the Commonwealth Minister for the Environment. Statement No. 965 applies the conditions of Statement No. 800 to the Additional Support Area and requires all implementation, management, monitoring, compliance assessment and reporting, environmental performance reporting, protocol setting, and record keeping requirements applicable to the Additional Support Area under Statement No. 800 to be carried out on a joint basis with the Gorgon Gas Development.

The Jansz Feed Gas Pipeline was assessed via Environmental Impact Statement/Assessment on Referral Information (ARI) and EPBC Referral assessment processes (Mobil Australia 2005; 2006).

The Jansz Feed Gas Pipeline was approved by the Western Australian State Minister for the Environment on 28 May 2008 by way of Ministerial Implementation Statement No. 769 (Statement No. 769) and the Commonwealth Minister for the Environment and Water on 22 March 2006 (EPBC Reference: 2005/2184).

This Plan covers the Gorgon Gas Development as approved under Statement No. 800 and as approved by EPBC Reference: 2003/1294 and 2008/4178, and including the Additional Support Area as approved by Statement No. 965 and as varied by the Commonwealth Minister for the Environment.

In respect of the Carbon Dioxide Seismic Baseline Survey Works Program, which comprises the only works approved under Statement No. 748 before it was superseded, and under EPBC Reference: 2003/1294 before the Minister approved a variation to it on 26 August 2009, note that under Condition 1A.1 of Ministerial Statement No. 800 and Condition 1.4 of EPBC Reference: 2003/1294 and 2008/4178 this Program is authorised to continue for six months subject to the existing approved plans, reports, programs, and systems for the Program, and the works under that Program are not the subject of this Plan.

1.5 Purpose of this Plan

1.5.1 Legislative Requirements

This Plan is required under Condition 30.2.ii of Statement No. 800 and Condition 20.2.ii of EPBC Reference: 2003/1294 and 2008/4178, which is quoted below:

> *'Ensure discharges from any wastewater treatment plant, reverse osmosis plant, or other process water are disposed of via deep well injection, unless otherwise authorised by the (Western Australian) Minister.'*

The sections in this Plan, which meet the conditions of EPBC Reference: 2003/1294 and 2008/4178, shall be read and interpreted as only requiring implementation under EPBC Reference: 2003/1294 and 2008/4178 for managing the impacts of the Gorgon Gas Development on, or protecting the EPBC Act matters listed in Appendix 1 and Appendix 2. The implementation of matters required only to meet the requirements of Ministerial Statement No. 800 (and No. 769) are not the subject of EPBC Reference: 2003/1294 and 2008/4178.

This Plan is also required under Condition 16.2 of Statement No. 769 for periods where personnel working on the Jansz Feed Gas Pipeline are present on Barrow Island. This Condition is quoted below:

> *'The objective of the Plan is to ensure all Proposal-related solid and liquid wastes are either removed from Barrow Island or, if not, that all practicable means are used to ensure that waste disposal does not cause Material or Serious Environmental Harm to Barrow Island or its surrounding waters.'*

Chevron Australia is seeking to expand the current Ministerial authorisation to dispose of reject RO brine by temporary and permanent ocean outfalls to include disposal of reject RO brine by temporary PSV package RO plant ocean outfalls during construction and SIMOPS. This Plan has been prepared in support of that application.

1.5.2 Objectives

The objectives of this Plan are to:

- outline the water source, supply, and disposal options considered for the Gorgon Gas Development and detail the selected system
- demonstrate that brine disposal via ocean outfall undertaken in accordance with this Plan will not cause Material or Serious Environmental Harm to Barrow Island and its surrounding waters.

This Plan has not been prepared to address environmental management during installation of seawater intakes, brine outfalls, and associated pipelines. Potential environmental impacts associated with the installation of these facilities will be managed in accordance with the environmental management strategies outlined in the Marine Facilities Construction Environmental Management Plan (Chevron Australia 2012e), where practicable and to the extent management strategies are relevant to RO facilities installation.

Any matter specified in this Plan is relevant to the Gorgon Gas Development only if that matter relates to the specific activities or facilities associated with that particular development.

Figures have been provided in this Plan to support understanding of the text. Reference to text takes precedence over figures.

1.5.3 Scope

Temporary RO facilities (and associated temporary intakes and outfalls) will be used throughout the construction period. Minor operation of the temporary RO facilities may be required for care and maintenance purposes during operations until the facilities are decommissioned. A permanent RO facility (and associated permanent intake and outfall) will be installed and will commence operations in the latter stages of construction and then continue to be used throughout operations. The previous revisions of this Plan assessed any potential impacts associated with the discharge of brine from temporary and permanent facilities to the marine environment and obtained authorisation for the discharge of brine via associated ocean outfalls. This Plan has now been revised and updated to include the additional package RO facilities located on the PSVs (and associated ocean outfall).

If authorised, Chevron Australia proposes to install and operate the temporary and permanent RO facilities as described in Section 4.2 of this Plan, in accordance with Sections 7.0, 8.0, 9.0, and 10.0 of this Plan.

1.5.4 Hierarchy of Documentation

This Plan will be implemented for the Gorgon Gas Development via the Chevron Australasia Business Unit (ABU) Operational Excellence Management System (OEMS). The OEMS is the standardised approach that applies across the ABU to continuously improve the management of safety, health, environment, reliability, and efficiency to achieve world-class performance. Implementation of the OEMS enables the Chevron ABU to integrate its Operational Excellence (OE) objectives, processes, procedures, values, and behaviours into the daily operations of Chevron Australia personnel and contractors working under Chevron Australia’s supervision. The OEMS is designed to be consistent with and, in some respects, go beyond ISO 14001:2004 (Environmental Management Systems – Requirements with Guidance for Use) (Standards Australia/Standards New Zealand 2004a).

Figure 1-3 provides an overview of the overall hierarchy of environmental management documentation within which this Plan exists. Further details on environmental documentation for the Gorgon Gas Development are provided in Section 9.1 of this Plan.

Other related management system documents that support this Plan include:

- Marine Facilities Construction Environment Management Plan (Chevron Australia 2012e)
- Solid and Liquid Waste Management Plan (Chevron Australia 2012f)
- Coastal and Marine Baseline State and Environmental Impact Report (Chevron Australia 2012b)
- Long-term Marine Turtle Management Plan (Chevron Australia 2012a).

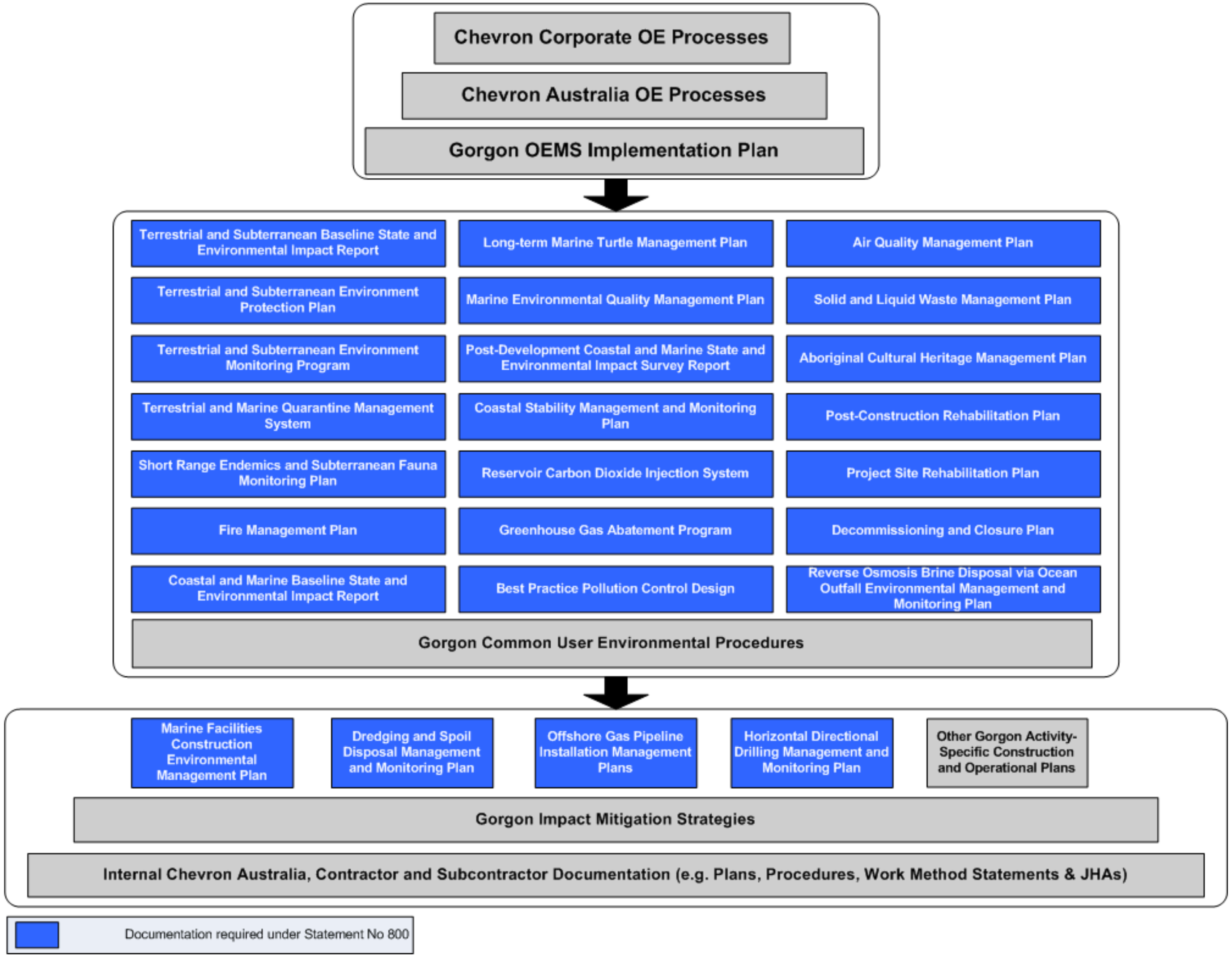

Figure 1-3 Hierarchy of Gorgon Gas Development Environmental Documentation

Note: Figure 1-3 refers to all Plans required for Statement No. 800. The Plans are only relevant to EPBC Reference: 2003/1294 and 2008/4178, if required for the Conditions of those approvals.

1.5.5 Relevant Standards and Guidelines

The following standards and guidelines have been taken into account in the development of this Plan:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand [ANZECC and ARMCANZ] 2000)
- Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and Environmental Quality Objectives (DEC 2006).

1.5.6 Stakeholder Consultation

Regular consultation with stakeholders has been undertaken by Chevron Australia throughout the development of the environmental impact assessment management documentation for the Gorgon Gas Development and Jansz Feed Gas Pipeline. This stakeholder consultation has included engagement with the community, government departments, industry operators, and contractors to Chevron Australia via planning workshops, risk assessments, meetings, teleconferences, and the PER and EIS/ERMP formal approval processes.

This document has been prepared in consultation with:

- The Western Australian Department of Parks and Wildlife (Parks and Wildlife): Workshops and meetings were held involving Parks and Wildlife and Chevron Australia personnel to discuss the scope and content of this Plan during its development. Parks and Wildlife reviewed draft revisions of this Plan along with the feedback of the independent reviewers. Parks and Wildlife's comments have been incorporated or otherwise resolved.
- The Commonwealth Scientific and Industrial Research Organisation (CSIRO) Centre for Environmental Contaminants Research: A peer review of Whole Effluent Toxicity (WET) protocol and results (see Section 6.4) was undertaken by Jenny Stauber.

Figure 1-4 shows the development, review, and approval process for this Plan.

1.5.7 Public Availability

Condition 35 of Statement No. 800, and Condition 22 of EPBC Reference: 2003/1294 and 2008/4178 requires this Plan to be made public as and when determined by the Minister.

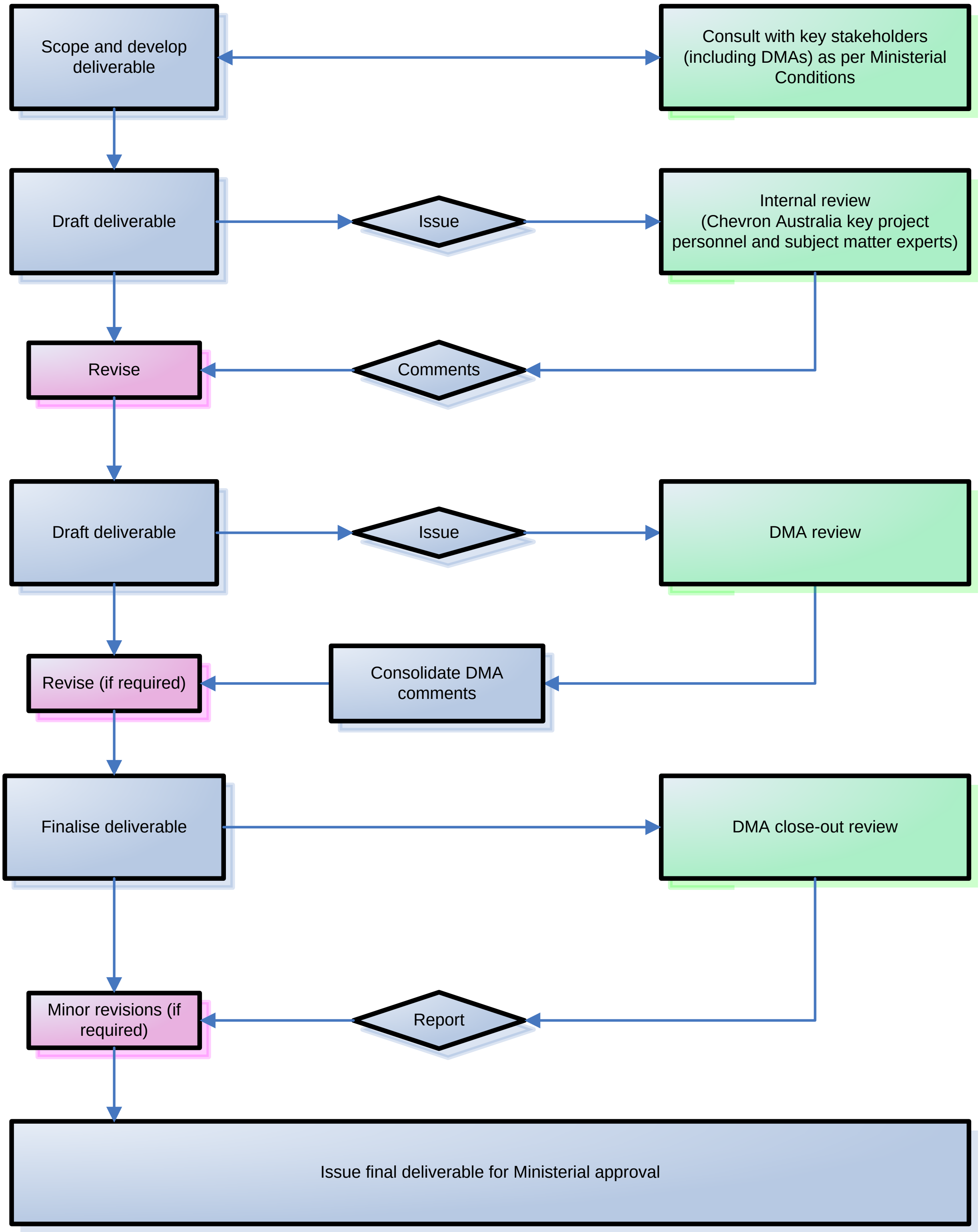

Figure 1-4 Deliverable Development, Review, and Approval Flow Chart

2.0 Overview of the Existing Marine Environment

The existing environment of Barrow Island and scope of the Gorgon Gas Development is described in the EIS/ERMP (Chevron Australia 2006) and PER (Chevron Australia 2008). Additional existing environment information is described in the following documents, as required under Statement No. 800 and EPBC Reference: 2003/1294 and 2008/4178.

Preliminary studies for the EIS/ERMP have been augmented by ongoing surveys conducted in the waters surrounding Barrow Island to establish a pre-construction baseline. These surveys are detailed in the following documents:

- Gorgon Project: Marine Environment – Summary of Baseline Ecological Information (Chevron Australia 2007)
- Coastal and Marine Baseline State and Environmental Impact Report (the Marine Baseline Report) (Chevron Australia 2012b)
- Long-term Marine Turtle Management Plan (Chevron Australia 2012a)
- Coastal Stability Management and Monitoring Plan (Chevron Australia 2009a).

Further to the pre-construction baseline surveys, the Gorgon Post Development Coastal and Marine State and Environmental Impact Survey Report, Year 1: 2011/2012 (Chevron Australia 2012d) and the Gorgon Post Development Coastal and Marine State and Environmental Impact Survey Report, Year 2: 2012/2013 (Chevron Australia 2013b) compare marine ecological elements with the pre-development baseline marine environmental state.

Water quality sampling was also undertaken throughout 2008 to determine baseline concentrations of nutrients, biological parameters, physicochemical parameters, and potential contaminants, notably metals (RPS 2009a).

2.1 Meteorology

The mean wind speed around Barrow Island during the summer period (October through March) is 6.6 m/s and the mean maximum summer wind speed is 16.2 m/s. The dominant direction is from the south-west and west. During winter (April through September) winds approach from the east, south and south-west and have a mean speed of 5.8 m/s and mean maximum speed of 19.4 m/s. Easterly gales occur between May and August, with speeds in the range of 12.5 to 20 m/s (Chevron Australia 2008).

Barrow Island is in a region of high tropical cyclone frequency, with an average of four cyclones passing within 400 nm of the Island each year (MetOcean Engineers 2006). Tropical cyclones usually form in the Timor and Arafura seas between November and April. They initially travel generally in a south-westerly direction, but as they travel further south their tracks become more variable (MetOcean Engineers 2006).

2.2 Bathymetry

Barrow Island lies on the continental shelf, with water depths increasing rapidly to the west of the Island (Figure 2-1). Water depths between the east coast of the Island and the mainland generally do not exceed 20 m; however, depth varies immediately adjacent to the coast due to seabed outcrops and the presence of numerous pinnacles. The water depth in the vicinity of the MOF, LNG Jetty, and turning basin ranges from approximately 5 m to 12 m, and is shallower on the nearshore limestone pavement areas (Chevron Australia 2008).

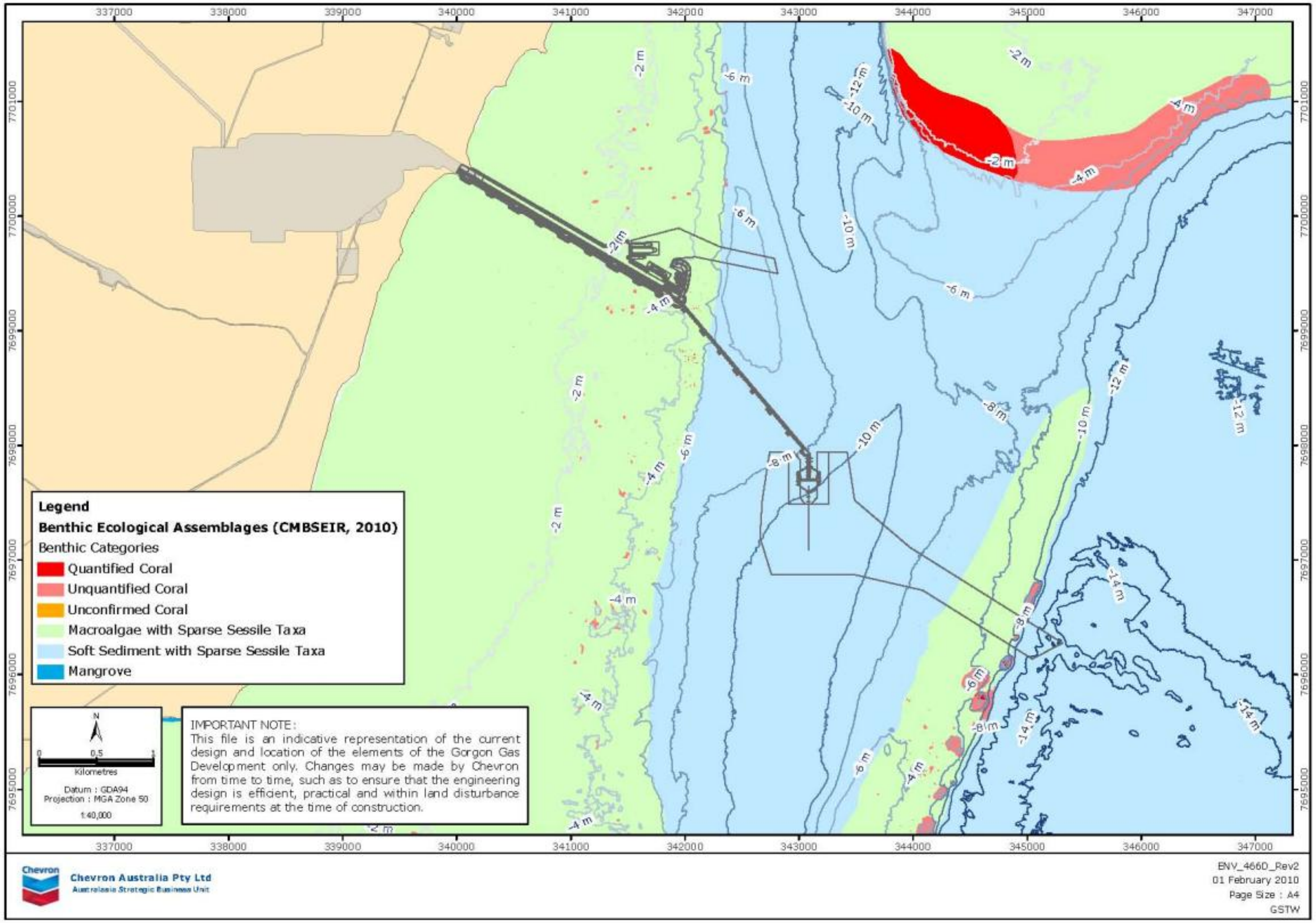

Figure 2-1 Bathymetry of Gorgon Gas Development Area on the East Coast of Barrow Island

2.3 Oceanography

Surface water temperatures around Barrow Island typically vary between 21 °C in winter to 30 °C in late summer. The sea water is generally well mixed with uniform temperatures throughout the water column (Chevron Australia 2008). Generally, temperature stratification of nearshore waters surrounding Barrow Island is infrequent and there is little evidence of salinity stratification at any of the nearshore sites monitored on the east or west coast of the Island (RPS Bowman Bishaw Gorham [BBG] 2006, 2007; RPS 2009a).

The prevailing oceanographic conditions in the Barrow Island area are governed by a combination of sea and swell waves. On the east coast of Barrow Island, periods of greatest wave activity correspond to periods of strong easterly winds during winter (ChevronTexaco Australia 2003). The mean significant wave height at the MOF is 0.47 m, with a mean maximum wave height of 2.11 m. Town Point is largely sheltered from westerly swell by Barrow Island and the shallow reef system to the south (Chevron Australia 2008).

Currents are principally driven by semidiurnal tidal forcing. Near the east coast Marine Facilities, tidal currents run strongly parallel to the eastern shore and funnel through the offshore channel north of the Town Point site. Current measurements at the tanker mooring confirm the tidal nature of these currents, reflecting a distinct spring–neap (14-day) tidal cycle and a semidiurnal pattern. The maximum current measured at this point was 0.62 m/s. The direction of the tidal currents (for both spring and neap) was a flood flow towards the south-west and an ebb flow towards the north-east (ChevronTexaco Australia 2003).

2.4 Water and Sediment Quality

2.4.1 Water Quality

Since development of the EIS/ERMP (Chevron Australia 2005, 2006) three studies (RPS BBG 2006, 2007; RPS 2009a) have been undertaken to assess water quality at targeted locations in and around the marine waters of Barrow Island, including the Marine Facilities on the east coast of Barrow Island. In addition, a number of marine baseline surveys have been undertaken to produce the Coastal and Marine Baseline State Environmental Impact Report (Chevron Australia 2012b).

Higher turbidity levels and light attenuation coefficients indicate that the shallow waters close to Barrow Island are naturally more turbid than deeper offshore waters (RPS BBG 2007). In the waters around Barrow Island, turbidity and concentrations of suspended sediments were generally low (<5 mg/L) and indicative of clear water environments. There were very low levels of sediment deposition over the duration of the Marine Baseline Program (generally below the limits of instrument detection) and any deposition that did occur was temporary and rapidly resuspended by waves and tidal flow.

Background contaminant concentrations detected in samples collected in the vicinity of the Marine Facilities on the east coast of Barrow Island are generally low, although nutrient levels often exceed the ANZECC and ARMCANZ (2000) default trigger values. Total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX), phenol, pesticides and organotin concentrations detected in samples collected from this area were below the laboratory reporting limits at all of the east coast sampling sites (RPS BBG 2007). Oil and grease were detected at low concentrations (5.0 and 12 mg/L) at two east coast sample locations.

Recorded concentrations of all trace metals in samples collected from this area were below laboratory reporting limits and/or ANZECC and ARMCANZ (2000) default trigger values, with the exception of cadmium, copper, zinc and vanadium. Cadmium levels were, on average, double the ANZECC and ARMCANZ (2000) 99% level of protection trigger levels for this metal (0.7 µg/L). Copper levels were recorded at concentrations (2.0 to 12.0 µg/L) above the ANZECC and ARMCANZ (2000) 99% level of protection trigger levels (0.3 µg/L) at three east coast sample locations. Vanadium levels were recorded at concentrations (60 µg/L) slightly above the ANZECC and ARMCANZ (2000) 99% level of protection trigger levels (50 µg/L) at two east coast sample locations.

CSIRO ultra-trace methods were used for water quality sampling over nine sampling events at three sites on the east coast of Barrow Island. The CSIRO ultra-trace analyses provided clear results that concentrations of metals (aluminium, arsenic, barium, calcium, cadmium, total chromium, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, strontium, tin, vanadium and zinc) were consistently below guideline trigger values for 99% species protection, with the exception of cobalt. Background concentrations of cobalt were well above the 99% species protection value, which suggests that the guideline trigger value for cobalt is too low for Barrow Island waters (RPS 2009a).

The nutrient concentrations measured at Barrow Island suggest that the water was generally oligotrophic, with temporal fluctuations in nutrients. Nutrient concentrations were generally below the ANZECC and ARMCANZ (2000) guideline values, with occasional fluctuations of ammonia, mono-nitrogen oxides and orthophosphate well above guideline values (RPS 2009a). Temporary nutrient fluctuations are to be expected in a diverse ecological marine system where nutrient recycling occurs through various dynamic cycles.

2.4.2 Sediment Quality

Preliminary sediment quality data (RPS BBG 2007) collected from sampling sites in the vicinity of the Marine Facilities on the east coast of Barrow Island indicated that nutrient concentrations were low; and concentrations of all metals other than silver were below ANZECC and ARMCANZ (2000) Interim Sediment Quality Guideline (ISQG) low trigger values. Silver levels were recorded at concentrations (1.0 to 4.0 mg/kg) equal to and slightly above the ANZECC and ARMCANZ (2000) ISQG low trigger value (1.0 mg/L) at three sample locations. There are no known sources of silver contamination in the region and thus it could be assumed that the reported silver levels are erroneous. Organotin concentrations were below laboratory detection limits and/or ANZECC and ARMCANZ (2000) ISQG low trigger values at all east coast sample locations (RPS BBG 2007).

Hydrocarbons and BTEX were below laboratory detection limits in all sediments sampled around Barrow Island, although oil and grease was detected at 620 mg/kg at one east coast sample location (RPS BBG 2007).

Further sediment sampling was conducted at eight locations around the end of the MOF in 2009 (Chevron Australia 2012d). Metals (including silver) concentrations in all samples collected were below ANZECC ISQG low trigger levels, and hence it is considered that silver levels recorded in sediment samples collected during previous monitoring were erroneous. Hydrocarbons and BTEX were also below laboratory detection limits in all sediments sampled around the end of the MOF, although oil and grease was detected in all except one of the sediment samples collected around the end of the MOF. Concentrations of oil and grease varied from <100 mg/kg to 490 mg/kg, which were comparable to other samples collected in the area (at the MOF, LNG Jetty and the Dredge Spoil Disposal Ground locations) (Chevron Australia 2012d) as well as preliminary sediment quality data collected (RPS BBG 2007).

2.5 Marine Ecology

2.5.1 Benthic Primary Producers

Marine benthic habitat surveys along the east and west coasts of Barrow Island were conducted between 2001 and 2004 for the EIS/ERMP (Chevron Australia 2005, 2006). Further comprehensive benthic surveys targeting the causeway, MOF, and LNG Jetty on the east coast of Barrow Island were undertaken to produce the Gorgon Gas Development and Jansz Feed Gas Pipeline Coastal and Marine Baseline State and Environmental Impact Report (Chevron Australia 2012b), the Gorgon Post Development Coastal and Marine State and Environmental

Impact Survey Report, Year 1: 2011/2012 (Chevron Australia 2012d) and the Gorgon Post Development Coastal and Marine State and Environmental Impact Survey Report, Year 2: 2012/2013 (Chevron Australia 2013b).

Seagrasses, macroalgae, corals and mangroves are the most important benthic primary producers (BPP) in the tropical marine ecosystems surrounding Barrow Island and on the mainland coast. The marine macrophyte and coral assemblages in the waters surrounding Barrow Island are dominated by tropical and subtropical species that are widely distributed within the Montebello/Lowendal/Barrow Island region and across the Rowley Shelf (Chevron Australia 2008).

In general, Barrow Island is almost entirely surrounded by limestone pavement reef that extends to the subtidal zone. Broad intertidal reef platforms with scattered mud and sand flats are widespread along the east coast of Barrow Island. Sandy beaches are widespread around both the east and west coasts of Barrow Island and typically form above the intertidal reef between rocky headlands (Chevron Australia 2008).

Coral reefs and bombora are restricted to the photic zone and vary greatly in structure and ecology in response to physical disturbance, water clarity and exposure to swell. Corals are abundant around Barrow Island, growing as high profile reefs and on pavement on both the west and east coasts. The most significant coral reefs around Barrow Island are Biggada Reef on the west coast, Dugong Reef and Batman Reef off the south-east coast, and along the southern edge of the Lowendal Shelf on the east side of Barrow Island (Chevron Australia 2008).

2.5.1.1 Benthic Primary Producer Habitats near RO Intake and Outfall Structures

Benthic habitats in the vicinity of the Marine Facilities on the east coast of Barrow Island are shown in Figure 2-2. The limestone pavement reef immediately inshore from the RO intake and outfall structures at Town Point, slopes gently into the lower intertidal and subtidal zones approximately 200 m seaward from the boulder zone. There is a large shallow lagoon surrounding Town Point with a narrow break in the platform open to the sea (RPS BBG 2005).

The marine macrophyte assemblages in the area of seawater intake and brine outfall vary from sparse communities on almost bare exposed rock, to low turf, to dense macroalgae in the rock pools and the lower intertidal area. The upper intertidal pavement is covered in sediment veneers of varying thickness and is mostly bare of macrophytes, apart from low turfing red algae in areas free from sediment. Rock pools support the growth of macroalgae (*Sargassum* sp. and *Cystoseira* sp.) and seagrass in varying densities ranging from occasional plants to small meadows. Seagrasses include *Halophila* sp., *Halodule* sp. and *Thalassia* sp. (RPS BBG 2005).

The lower intertidal rock platform has less sediment cover and supports the growth of macroalgae and seagrass as well as scleractinian corals (stony corals) and octocorals (soft corals). The coral assemblage is dominated by various species of *Goniastrea* sp., with some specimens exceeding 80 cm in diameter (RPS BBG 2005).

The subtidal pavement reef surrounding Town Point is overlain by a thin veneer of sediment and is generally dominated by *Sargassum* sp., with other macroalgae, such as *Cystoseira* sp. and *Dictyopteris* sp., also prominent. Low cover of seagrass is present including the genus *Halodule* sp.

Subtidal coral communities vary from almost exclusively coral-dominated assemblages to areas dominated by macroalgae but with scattered small hard corals (*Acropora* sp. and *Turbinaria* sp.) and soft corals (*Rumphella* sp.). Numerous Porites bombora greater than two metres high are common either interspersed as isolated elements throughout the subtidal reef areas or grouped together to form bombora communities (Chevron Australia 2012b). This habitat is considered to be of local significance but not of regional conservation significance because it is generally very widespread throughout the Pilbara Region (Department of Conservation and Land Management [CALM] 2004).

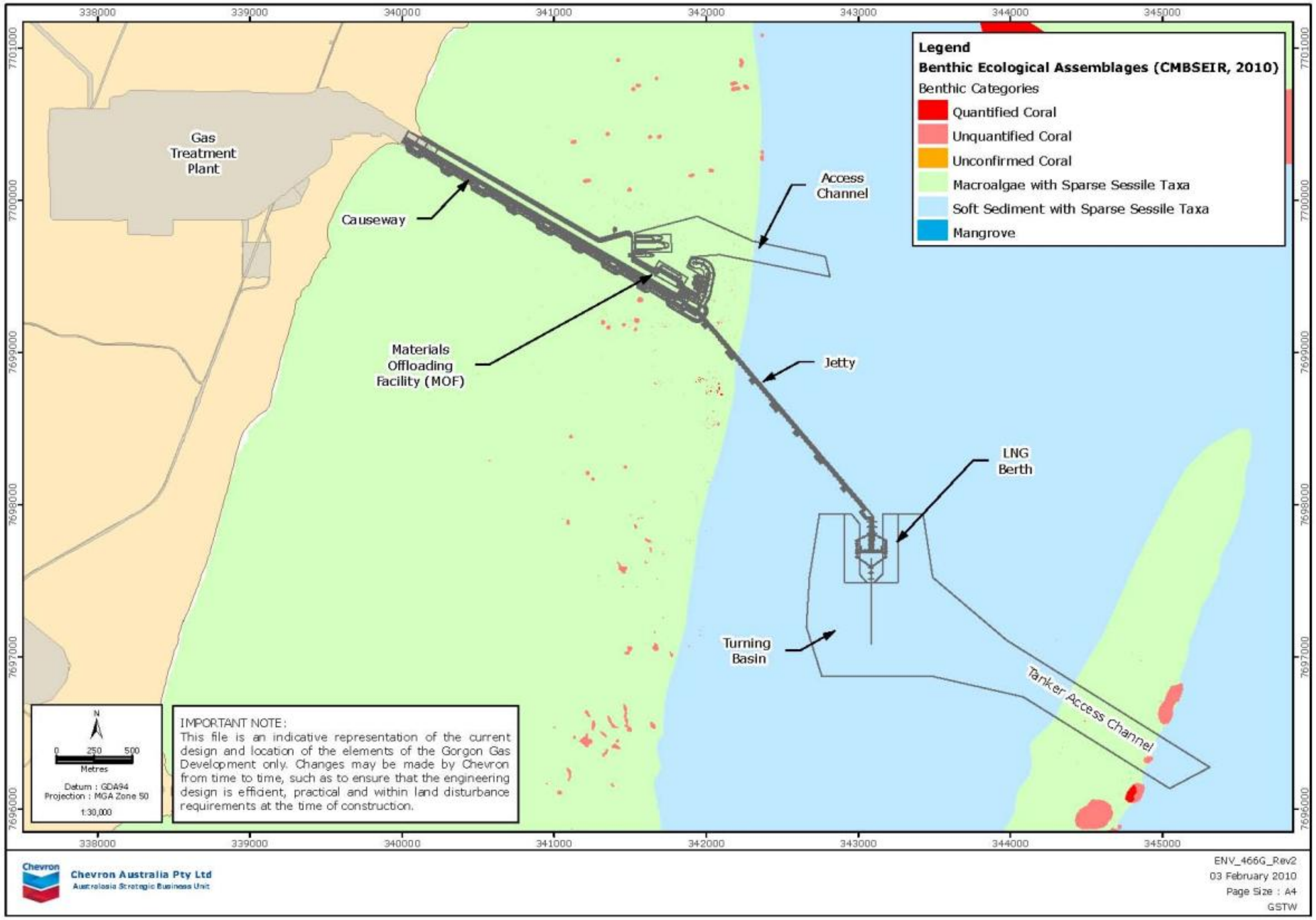

Figure 2-2 Benthic Habitats in the Vicinity of the Gorgon Gas Development Marine Facilities

2.5.2 Marine Fauna

This section focuses on the marine mammals, marine reptiles, fish, and marine avifauna that may occur within the vicinity of the Marine Facilities. Particular attention is paid to species listed under the EPBC Act (Cth) and the *Wildlife Conservation Act 1950* (WA). EPBC Act listed species likely to occur within Barrow Island waters are shown in Table 2-1.

Monitoring programs were not designed to examine the distribution of significant marine fauna, such as dolphins, dugongs, whales, and sea snakes; instead, monitoring programs focused on recording habitats that support these fauna and any opportunistic sightings of marine fauna of significance were concurrently recorded. There are no known species that are endemic to either Barrow Island waters or to the more specific location of the Marine Facilities.

Table 2-1 EPBC Act Listed Threatened Fauna Species and Listed Migratory Species that may occur in the vicinity of the Marine Facilities, Barrow Island

Species	Scientific Name	EPBC Act (Cth) Status
Marine Mammals		
Humpback Whale	*Megaptera novaeangliae*	Vulnerable, Migratory, Cetacean
Blue Whale	*Balaenoptera musculus*	Endangered, Migratory, Cetacean
Bryde's Whale	*Balaenoptera edeni*	Migratory, Cetacean
Killer Whale (Orca)	*Orcinus orca*	Migratory, Cetacean
Dusky Dolphin	*Lagenorhynchus obscurus*	Migratory, Cetacean
Irrawaddy Dolphin	*Orcaella heinsohni*	Migratory, Cetacean
Indo-Pacific Humpback Dolphin	*Sousa chinensis*	Migratory, Cetacean
Dugong	*Dugong dugon*	Migratory, Marine
Marine Reptiles		
Olive Ridley Turtle	*Lepidochelys olivacea*	Endangered, Migratory, Marine
Loggerhead Turtle	*Caretta caretta*	Endangered, Migratory, Marine
Leatherback Turtle	*Dermochelys coriacea*	Vulnerable, Migratory, Marine
Hawksbill Turtle	*Eretmochelys imbricata*	Vulnerable, Migratory, Marine
Flatback Turtle	*Natator depressus*	Vulnerable, Migratory, Marine
Green Turtle	*Chelonia mydas*	Vulnerable, Migratory, Marine
Fish		
Whale Shark	*Rhincodon typus*	Vulnerable, Migratory
Great White Shark	*Carcharodon carcharias*	Vulnerable, Migratory
Grey Nurse Shark	*Carcharias taurus*	Vulnerable

2.5.2.1 Fish

The Montebello/Barrow Islands region supports a rich diversity of fish fauna, most of which are widely distributed throughout the Indo–West Pacific region (DEC 2007). A number of species occurring in the area are protected under Western Australian and Commonwealth legislation. These species include, but are not limited to, the Potato Cod (*Epinephelus tukula*), the Double-headed Maori Wrasse (*Cheilinus undulatus*), and species of syngnathids (*Hippocampus hystrix* and *Phoxocampus belcheri*). Most of these species are regionally widespread (DEC 2007). In addition, numerous commercial and recreationally important fish species such as Spangled

Emperor (*Lethrinus nebulosus*) and Bar-cheeked Coral Trout (*Plectropomus maculatus*) occur around Barrow Island (Chevron Australia 2005). No areas of regional importance to fish were identified during seabed surveys of the development area associated with the east coast Marine Facilities (Chevron Australia 2008).

To date, no protected species of shark or reef fish have been recorded during baseline marine surveys conducted since 2007 in the vicinity of the Marine Facilities (Chevron Australia 2012e). Protected fish species likely to inhabit waters near all intake and outfall structures include *Sygnathids* (pipefish, pipehorses, and sea horses).

2.5.2.2 Marine Mammals

The Pilbara Region supports migratory, transient and resident marine mammals such as whales, dolphins and dugong. The regional distribution of many whale species is not well understood, and while many species may occur in the Pilbara region, most are likely to be transients or occasional visitors (Chevron Australia 2008).

Marine mammals likely to be found in the vicinity of RO intake and outfall structures include baleen whales, toothed whales, inshore dolphins, offshore dolphins, and dugongs.

Most whales are more abundant in deeper waters and are unlikely to visit the shallow, inshore waters in the vicinity of the east coast facilities (Chevron Australia 2008). All whales are protected as listed cetaceans under the EPBC Act.

Dolphins can be expected to occasionally visit all subtidal marine areas of the Gorgon Gas Development. The regional distribution of most dolphin species is poorly known and while many species may occur in the Pilbara region, most are likely to be transients or occasional visitors (Chevron Australia 2008). All dolphins are protected as listed cetaceans under the EPBC Act.

Dugongs occur throughout the shallow waters between the Pilbara offshore islands and the mainland. Dugongs are generally associated with shallow seagrass meadows on which they feed, and have been observed in the shallow waters over the Barrow Shoals, along the east coast of Barrow Island and over the Lowendal Shelf. Dugongs are protected under the *Wildlife Conservation Act 1950* (WA) and are listed as Vulnerable under the EPBC Act (Chevron Australia 2008).

2.5.2.3 Marine Reptiles

Six species of marine turtle are known from the Montebello/Barrow Island region, all of which are protected under the International Bonn Convention, the EPBC Act (Cth), and the *Wildlife Conservation Act 1950* (WA):

- Green Turtle (*Chelonia mydas*)
- Flatback Turtle (*Natator depressus*)
- Olive Ridley Turtle (*Lepidochelys olivacea*)
- Loggerhead Turtle (*Caretta caretta*)
- Hawksbill Turtle (*Eretmochelys imbricata*)
- Leatherback Turtle (*Dermochelys coriacea*).

Barrow Island is a regionally important nesting area for Green Turtles and Flatback Turtles. Hawksbill Turtles nest at low densities around the Island and Loggerhead Turtles have only been recorded from the Island occasionally (Chevron Australia 2012a).

The estimated size of the total Green Turtle reproductive population at Barrow Island is in the order of 20 000 females, with a similar level of nesting in the Montebello Group (Pendoley 2005), and as such is of regional significance (Prince 1994) and potentially of significance to the Western Australian stock. Green Turtles favour the west and north-east coasts of Barrow Island where beaches are characterised by high-energy, deep, steeply sloped, sandy beaches with an unobstructed foreshore approach (Pendoley 2005). Most Green Turtles nest on Barrow Island between December and February, with hatchling emergence occurring from February to March (Chevron Australia 2012a).

Barrow Island supports an estimated 1700 nesting female Flatback Turtles annually. Flatback Turtle nesting is concentrated on the east coast of Barrow Island, on deep, sandy, low-sloped beaches with wide shallow intertidal zones (Pendoley Environmental 2008). Highest nesting densities have been reported on the central east coast beaches, particularly Mushroom Beach, Bivalve Beach, Terminal Beach, Yacht Club Beach North, and Yacht Club Beach South (Chevron Australia 2005). Limited nesting has been reported on the south-west, north, and north-east coasts (Pendoley Environmental 2009). The nesting season for Flatback Turtles on Barrow Island occurs mainly between December and January, with the main hatchling emergence period occurring from February to March (Chevron Australia 2012a).

For further information on the ecology and biology of turtles, refer to the Long-term Marine Turtle Management Plan (Chevron Australia 2012a).

Sea snakes are common inhabitants of the waters around Barrow Island and the shallow Rowley Shelf (Chevron Australia 2005). Storr *et al.* (1986) estimate nine genera and 22 species of sea snakes and kraits occur in Western Australian waters, many of which may frequent Barrow Island. Little is known of the distribution of individual species around Barrow Island; however, most species have generalist habitat associations, are highly mobile, and are likely to be found within the vicinity of the Marine Facilities at some time during the construction program. The most common sightings within the vicinity of the Marine Facilities to date have been of Olive Sea Snakes (*Aipysurus laevis*) (Chevron Australia 2012a).

2.5.2.4 Marine Avifauna

Barrow Island supports numerous species of migratory and resident shorebirds. Many of these species are protected under international treaties—e.g. Japan–Australia Migratory Bird Agreement (JAMBA), China–Australia Migratory Bird Agreement (CAMBA), and Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA)—and Barrow Island is both a staging site and an important non-breeding site for migratory shorebirds. However, the areas of greatest shorebird abundance on Barrow Island are on the south-eastern and southern coasts, a substantial distance from the location of the Marine Facilities.

Migratory shorebird surveys around Barrow Island, including the Town Point area, were conducted in October 2005, and in February and March 2006 (RPS BBG 2006). Bivalve Beach and Terminal Beach, on either side of Town Point, the shoreward site of MOF development where the RO intake and outfall structures are located, were not found to support large aggregations of shorebirds (RPS BBG 2006).

2.5.2.5 Non-coral Benthic Macroinvertebrates

The Montebello/Barrow Islands region has been surveyed by the Western Australian Museum, although information on the invertebrate fauna was limited to measures of species richness (Marsh 1993; Wells *et al.* 1993; RPS BBG 2007).

The area of seabed near temporary intake and outfall structures includes two major substrate types: an expansive soft/sandy bottom area further offshore, and a limestone pavement area inshore. These different abiotic features support a distinct suite of benthic macroinvertebrates, with sparse sponge and sea whips growing on rock protrusions within the sandy substrate further offshore, and mixed assemblages of ascidians, hydroids, sea whips and sponges common on the inshore macroalgae-dominated pavement.

There are no EPBC Act listed species of non-coral benthic macroinvertebrates.

2.6 Social Environment

2.6.1 Socioeconomic Setting

The Gorgon Gas Development is located on Barrow Island and its immediate surrounds, which is within the Shire of Ashburton. There is no resident human population on Barrow Island. The Island has been actively used for petroleum exploration and production since 1964 and access to the Island is restricted to personnel associated with oilfield operations and Parks and Wildlife (Chevron Australia 2008).

A number of Western Australian and Commonwealth commercial fisheries operate in the Montebello/Lowendal/Barrow Island region.

2.6.2 Land and Sea Use and Tenure

In 1966, the Western Australian Government granted a Petroleum Lease (L1H) to WAPET. The lease is held currently by ChevronTexaco Australia, Santos Offshore, and Mobil Australia Resources Company (the Barrow Island Joint Venture) and covers all but two small exploration areas (EP 61 and EP 62) held solely by ChevronTexaco Australia.

A large area off the east coast of Barrow Island is currently a designated port. The Barrow Island Port was created under the *Shipping and Pilotage Act 1967* (WA) and vested under the *Marine and Harbours Act 1981* (WA) in the body corporate Minister for Transport.

2.6.3 Marine and Terrestrial Protected Areas

Barrow Island is reserved under the *Conservation and Land Management (CALM) Act* 1984 (WA) as a Class A nature reserve for the purposes of 'Conservation of Flora and Fauna'. The Class A Barrow Island Nature Reserve was declared in 1910 and the Class A marine conservation reserves were created in 2004. Barrow Island is vested in the Conservation Commission of Western Australia and is managed on its behalf by Parks and Wildlife. The nature reserve is also listed on the Commonwealth Register of the National Estate. Barrow Island is zoned 'Conservation, Recreation and Nature Land' under the Shire of Ashburton Town Planning Scheme No. 7 (Chevron Australia 2008). *The Barrow Island Act 2003* (WA) authorises the implementation of the Gorgon Gas Development and makes provision for land on Barrow Island to be used for gas processing purposes.

The waters around Barrow Island are part of the Montebello–Barrow Island marine conservation reserves. Most of the conservation area is zoned as a Marine Management Area. The conservation area also comprises the Barrow Island Marine Park and Bandicoot Bay Conservation Area, located in waters adjoining the west and south coasts of Barrow Island, respectively (Figure 2-3). The Barrow Island marine area is listed on both the State Register of Heritage Places and the Commonwealth Register of the National Estate. The marine conservation reserves are vested in the Marine Parks and Reserves Authority and managed by Parks and Wildlife.

The Marine Facilities on the eastern side of Barrow Island, including the RO intake and outfall structures, are contained entirely within the Barrow Island Port Area, which is excluded from the Marine Management Area (Chevron Australia 2008).

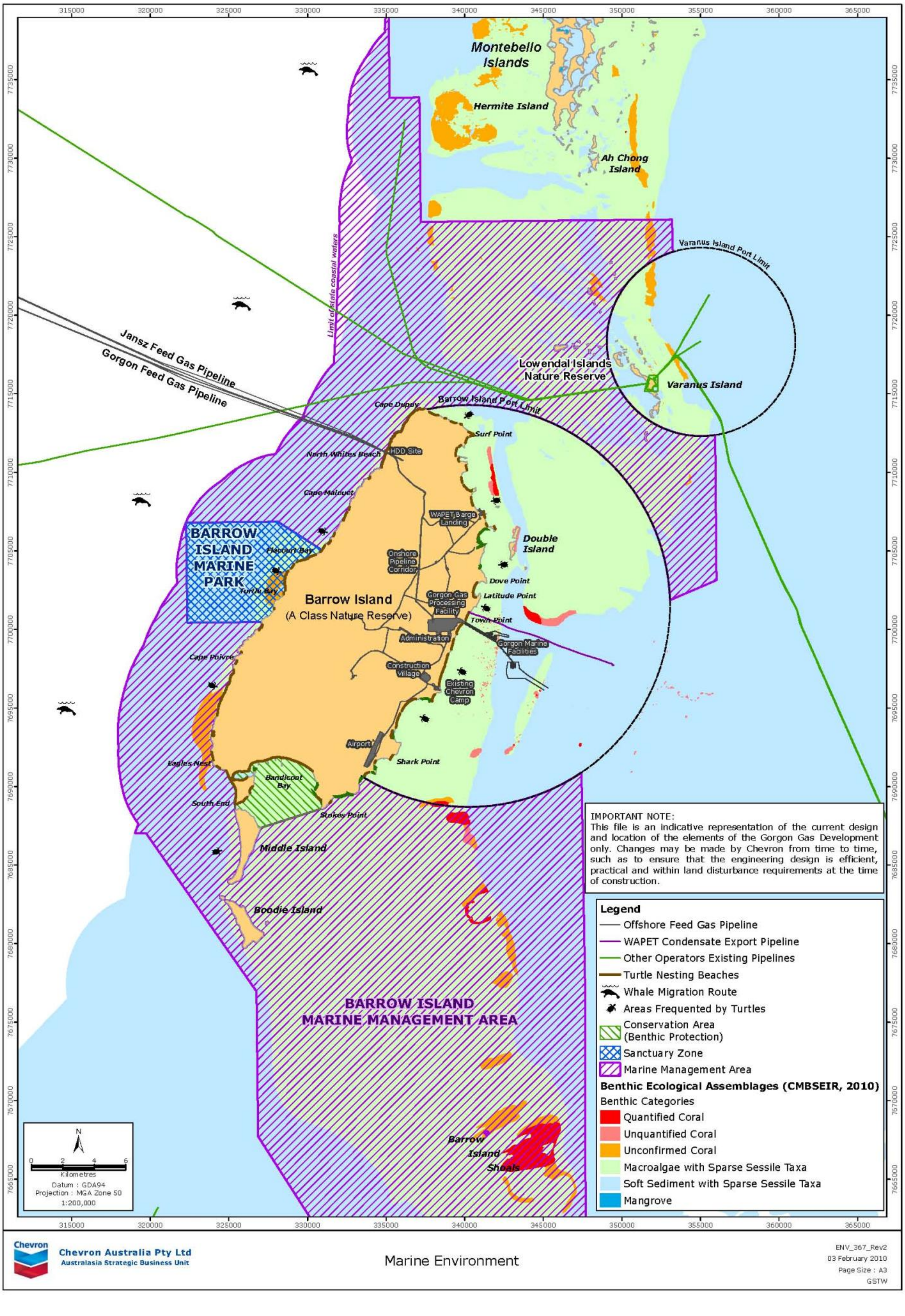

Figure 2-3 Barrow Island Port Area and Surrounding Marine Environment Including Marine Conservation Reserves

3.0 Water Supply, Treatment, and Brine Disposal Options

3.1 Project Water Requirements

Table 3-1 provides an estimate of the Gorgon Gas Development's water demand during construction and operations for the purpose of establishing the necessary capacity of water treatment facilities. These estimates are subject to change and actual water usage may differ.

Approval to re-use treated wastewater on Barrow Island has been obtained via the Solid and Liquid Waste Management Plan (Chevron Australia 2012f). Demand from identified recycled water consumers will exceed the availability of recycled water. Therefore, additional water sources will be required to supplement these consumers (in addition to the identified requirements of fresh/potable water consumers).

Table 3-1 Approximate Water Demand – Construction and Operations

	Approx. Water Demand (m^3/day)	Comment
Construction Phase		
Construction Phase#	4740	Based on: • 60 m^3/h for service water (1440 m^3/day) • 72.5 m^3/h potable water use (accommodation facilities and temporary construction facilities) (1740 m^3/day) • 40 m^3/h to the concrete batch plant (960 m^3/day) • 25 m^3/h for commissioning works (600 m^3/day)
Operations Phase		
Normal Operations	953	Based on: • Butler Park (Construction Village) potable water use for 450 persons • Peak service water use of 27 m^3/h • Nominal plant potable water requirements, including MOF vessels
Major Maintenance	1128	Based on: • Butler Park (Construction Village) potable water use for 950 persons • Peak service water use of 27 m^3/h • Nominal plant potable water requirements, including MOF vessels

The Construction Phase includes the transitional period between Construction and Operations where construction is occurring at the same time as operations (i.e. of Trains 1 and 2).

3.2 Water Supply Options and Selection

A number of fresh and saline water source options for the Gorgon Gas Development have been considered (KJVG 2006, 2006a, 2006b, 2007), including:

Fresh water sources:

- fresh water extraction from groundwater wells
- rainfall catchment on Barrow Island
- fresh water barged in from the mainland.

Saline water sources:

- extract saline water from a new water bore field located close to the Gas Treatment Plant site
- use the CO_2 data bore in the Dupuy Formation to extract saline water
- extract saline water from the Barrow Group Formation through existing oilfield wells
- use produced formation water (separated from feed gas) after appropriate treatment
- sea water from shallow beach wells
- sea water from an ocean intake.

Barrow Island has no sustainable fresh water sources available to supply water in the quantities required for the Gorgon Gas Development. Fresh groundwater sources on Barrow Island are limited and vary depending on rainfall activity.

A high land take, combined with highly variable rainfall, also precludes rainfall catchments as a viable source of fresh water. Barging in fresh water in the quantities required for the Gorgon Gas Development represents not only a safety risk and logistical challenge in terms of marine traffic, but also disproportionate costs and air emissions through the burning of vessel fuel. On this basis, fresh water is not a viable water source option for the Gorgon Gas Development and thus necessitates the use of a saline water source together with water processing.

Potential sources of saline water have been investigated. Well source options were generally discounted based on potential environmental impacts, technical difficulties and/or low reliability, high land take, cost, and/or the requirement for additional water processing.

Shallow groundwater wells and deeper well sources have been evaluated and discounted in favour of an ocean seawater intake. This option provides a reliable supply of saline water, using proven technology, and reduces implementation uncertainty and requires minimal land take, given that associated infrastructure remains within the boundaries of the MOF construction impact zone and Gas Treatment Plant site.

Table 3-2 provides an evaluation summary of the main saline water sources and options.

Table 3-2 Fresh and Saline Water Source Options – Evaluation Summary

Option	Technical, Construction and Operability Considerations	Key Environmental Impacts/Considerations
Extract fresh water from groundwater wells	• Fresh groundwater sources are not available to supply water in the quantities required for the Gorgon Gas Development. • Fresh groundwater sources on Barrow Island are limited and vary depending on rainfall activity.	• Potential impacts on stygofauna. • Land clearing associated with drilling groundwater wells and a pipeline to transport water to the utilities areas (estimated 1.1 ha).
Source fresh water from a rainfall catchment on Barrow Island	• Rainfall on Barrow Island is highly variable and therefore a catchment would not provide a reliable source of fresh water. • Required site area to establishing a catchment is not viable given the area represents approximately 50% of the Gorgon Gas Development land take allowance.	• Significant impacts to flora and fauna associated with land clearing (approximately 170 ha). • Potential change to the ecology of Barrow Island, which has evolved in the absence of a significant surface water body.
Barge fresh water from the mainland	• Increased marine traffic results in safety and logistical challenges arising from frequent docking and undocking. • An estimated 14 vessels per day would be required at peak construction periods and during operations; the Marine Facilities cannot support vessel docking during early phases of the Gorgon Gas Development.	• Increased air emissions through the burning of vessel fuel. • Potential impacts to marine fauna due to increased vessel movements.
Source saline water from a new bore field in the vicinity of the Gas Treatment Plant site (option included in the EIS/ERMP)	• A groundwater exploration drilling program was conducted to examine this option (KJVG 2006a, 2006b). • The result from the program indicated that from approximately 10 to 60 m depth, there is potential for high yields of saline water; however, this option has been precluded from use because of the presence of stygofauna. • The section 60 to 200 m depth covers units of low hydraulic conductivity, which have poor prospects of yielding large supplies of saline water. • Estimated that up to 26 low-yield wells would need to be drilled to meet the Gorgon Gas Development water supply requirements.	• Land clearing associated with drilling up to 26 wells and the subsequent pipeline corridors (estimated >2 ha). • Potential impacts on stygofauna. • Wastes generated from drilling operations (e.g. drilling muds).
Use the CO_2 data bore in the Dupuy Formation to source saline water (option included in the EIS/ERMP)	• Short-term solution only, as the CO_2 data bore will be required for CO_2 monitoring once the Gas Treatment Plant is operating. • Technical and operability considerations also include the high temperature of the extracted water and the ongoing energy and maintenance requirements to pump water from a 2 km depth. • Uncertainty regarding the effect on extracted water quality once CO_2 injection commences (may require pre-treatment prior to delivery to the desalination plant).	• Land clearing associated with a pipeline to transport water to the utilities areas (estimated 1.6 ha). • Uncertainties regarding saline water quality—some water quality parameters may concentrate during RO process and result in an increased toxicity of the brine discharge.

Option	Technical, Construction and Operability Considerations	Key Environmental Impacts/Considerations
Source saline water from the Barrow Group Formation through existing oilfield wells	• Existing oilfield has a ring main water flood network that uses water from the Barrow Group Formation (approximately 1200 m below ground). • This system is fully used for oil production with no spare capacity, hence not a viable option for the Gorgon Gas Development.	• Land clearing associated with a pipeline to transport water to the utilities areas (estimated 1.6 ha).
Use produced formation water (separated from feed gas) after appropriate treatment	• Produced water will only be available during Gas Treatment Plant operation and cannot supply Gorgon Gas Development water requirements during construction. • Uncertainty exists over reliability of supply—the quantity of produced water will be low; i.e. less than 1400 m^3/day—during the initial years of production, and unavailable during periods of Gas Treatment Plant maintenance/shutdown. • Extensive treatment would be required to remove residual process additives (e.g. monoethylene glycol, corrosion inhibitors and hydrocarbons) from the produced formation water to a quality suitable for end users.	• Land clearing associated with the additional treatment facility footprint (estimated 0.1 ha). • Potential solid and liquid wastes generated as by-products from the treatment process to remove residual process additives from the produced formation water.
Source sea water from shallow beach wells	• This option is similar to sourcing saline water from a new bore field in the vicinity of the Gas Treatment Plant site; however, the wells would be drilled quite close to the beach and the well water recharged directly from the ocean. • Location options for these wells would be above the high tide mark, but in front of the primary dune system, within the dune system, or behind the dune system (thus further inland). • Given the potential impacts on turtle nesting, locating wells behind the dune system is favoured (i.e. similar to sourcing saline water from a new bore field in the vicinity of the Gas Treatment Plant site). However, there is uncertainty associated with reliability of water supply given the low yields produced (KJVG 2006a, 2006b) from test/evaluation wells drilled in this area.	• Potential impacts on turtle nesting and coastal dune formations (if wells are located close to the beach). • As wells are located further inland, impacts are the same as those listed for sourcing saline water from a new bore field in the vicinity of the Gas Treatment Plant site.

Option	Technical, Construction and Operability Considerations	Key Environmental Impacts/Considerations
Source sea water from an ocean intake (option included in the EIS/ERMP)	• Involves the supply of water from a seawater intake located within the marine environment and within the MOF and jetty impact zone. • Provides a reliable supply of saline water, using proven technology, reduced implementation and maintenance uncertainty, and requires minimal land take given associated pipelines remain within the boundaries of the MOF construction impact zone and Gas Treatment Plant site. • Provides a short-term solution to meet early Gorgon Gas Development water demand as well as a long-term solution to meet water demand throughout the operations phase.	• Environmental impacts during construction are the same as those identified for the MOF and jetty construction. • Potential for ingress of marine fauna into seawater intake.

3.3 Water Processing Technology Options and Selection

Barrow Island has no sustainable fresh water sources available to supply water in the quantities required for the Gorgon Gas Development. This necessitates the use of a saline water source together with water processing to produce the required potable and service water streams. The two main desalination technologies examined for the Gorgon Gas Development were RO and distillation. Although other desalination technologies are available, RO and distillation were considered primary technologies based principally on proven use, competitive availability and reliability.

Table 3-3 summarises a qualitative comparison of both technologies, in the context of the Gorgon Gas Development.

Table 3-3 Evaluation of Reverse Osmosis vs. Distillation

Evaluation Criteria	Desalination Technology/Process	
	Reverse Osmosis	**Distillation**
Process description	RO is a separation process that uses pressure to force saline water through a semipermeable membrane that traps salt on one side and allows fresh water to pass through to the other side.	Distillation is a phase separation method whereby saline water is heated to produce water vapour, which is then condensed to produce fresh water.
Typical application	Typically suited to small to medium water production applications.	Typically suited to larger water production applications, i.e. greater than the Gorgon Gas Development's requirements.
Energy consumption and atmospheric emissions (associated with fuel combustion)	Energy consumption and emissions are generally less—compared to distillation (Morten *et al.* 1996; Crisp n.d.)—than for efficient operations of typical applications.	Energy consumption and emissions are generally more—compared to RO—(Morten *et al.* 1996; Crisp n.d.) than for efficient operations of typical applications.
Water production	Typical fresh water recovery of 30–45% (Morton *et al.* 1996). This higher rate of recovery will lead to less seawater intake, reduced environmental impact, smaller facilities and reduced land take.	Typical fresh water recovery of 10% (Morton *et al.* 1996). Low recovery rate requires greater seawater intake volume and larger facilities (and potentially land take) to process water volumes.
Reject brine characteristics	• Brine reject stream has a relatively high total dissolved salts (TDS) concentration (due to high recovery) relative to distillation. • Temperature of the brine reject stream is generally the same as inlet (i.e. ambient) seawater temperature (Morton *et al.* 1996). • Volume of brine reject lower relative to distillation.	• Brine reject stream has a relatively low TDS concentration (due to low recovery) relative to RO. • Temperature of the brine reject stream is up to 9 °C higher than inlet (i.e. ambient) seawater temperature (Morton *et al.* 1996). • Volume of brine reject higher relative to RO.
Capital investment costs	Relatively low capital investment costs (Morton *et al.* 1996).	Relatively high capital investment costs (Morton *et al.* 1996).
Installation schedule	Plant delivery and installation time is generally shorter than for distillation plants (Crisp n.d.).	Plant delivery and installation time is generally longer than for RO plants (Crisp n.d.) impacting Gorgon Gas Development execution timing.

Following the evaluation of water processing technologies, and considering that RO membrane technology is well proven with a number of known vendors and locally available expertise for construction and operational support, RO has been selected as the most appropriate desalination technology for implementation on the Gorgon Gas Development.

3.3.1 Overview of Reverse Osmosis Process

RO is a separation process that uses pressure to force saline water through a semipermeable membrane that traps the salt on one side and allows the fresh water to pass through to the other side.

A typical RO system consists of four major components/processes, including pre-treatment, pressurisation, membrane separation, and post-treatment:

- Pre-treatment: The incoming feedwater is pre-treated to avoid membrane fouling and to extend membrane life. Depending on the feedwater quality, pre-treatment may include removing suspended solids, adjusting the pH, adding an inhibitor (antiscalant) to prevent scale formation on the membranes, and adding biocides to control the regrowth of micro-organisms.
- Pressurisation: The pump raises the pressure of the pre-treated feedwater to an operating pressure appropriate for the membrane and the salinity of the feedwater.
- Separation: The feedwater is forced through the semipermeable membranes, which inhibit the passage of dissolved salts while permitting the desalinated product water to pass through, resulting in a freshwater product stream and a concentrated brine reject stream.
- Post-treatment: The product (permeate) water usually requires pH adjustment and/or remineralisation before being transferred to the distribution system for use as drinking water. Chlorine is also added to control the regrowth of micro-organisms and bacteria.

Figure 3-1 illustrates the typical overall RO process, including anticipated process chemicals and liquid waste streams.

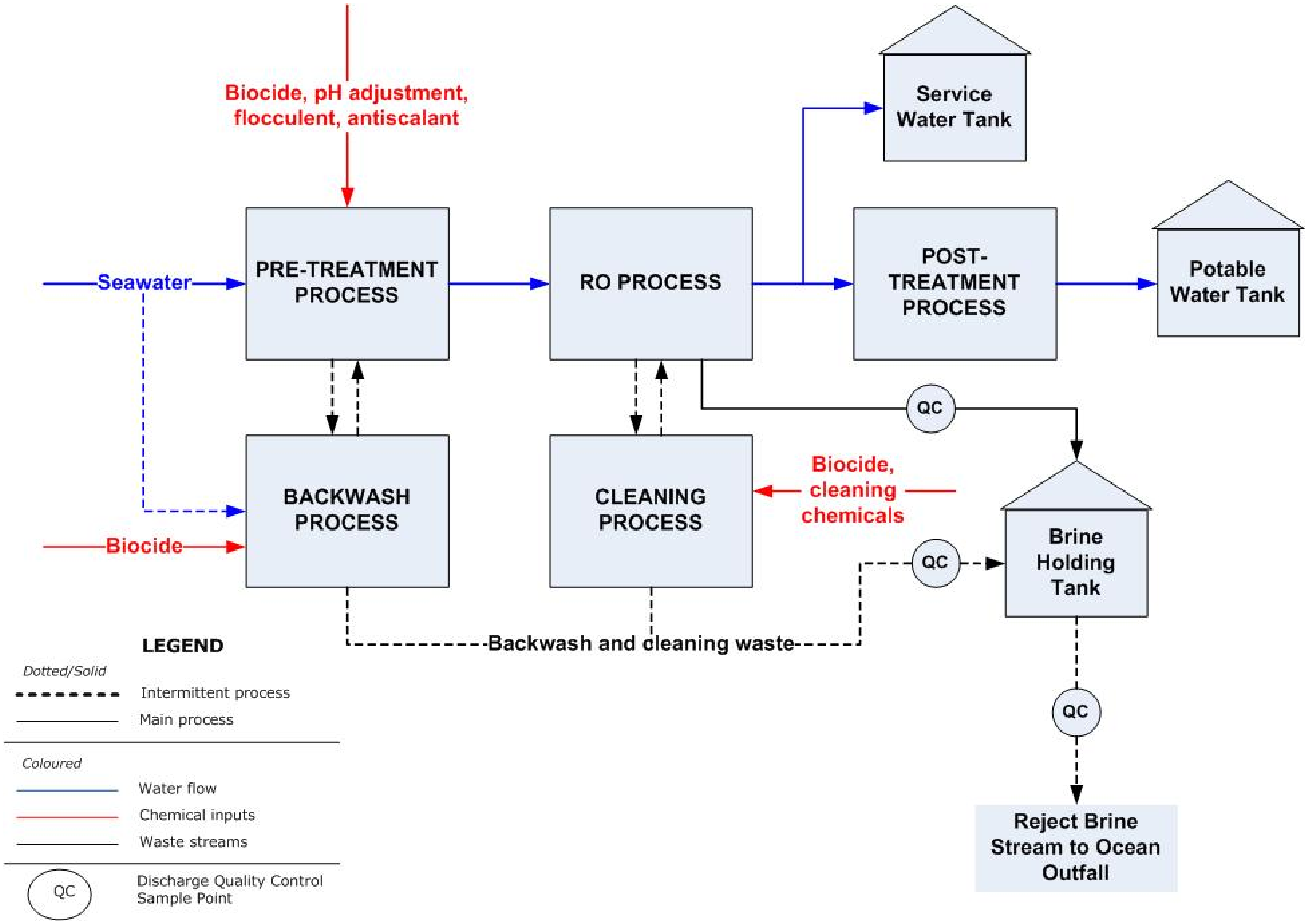

Figure 3-1 Reverse Osmosis Process Diagram

3.4 Brine Disposal Options and Selection

Desalination using RO technology generates a concentrated brine reject stream, which requires disposal. A number of brine disposal options for the Gorgon Gas Development have been considered (Helix 2006, 2007, 2007a, 2008; Golder Associates 2008) including:

- deep well injection (using existing oilfield wells, or drilling new wells)
- shallow beach wells
- ocean outfall.

A summary of the RO brine disposal options and evaluation is provided in Table 3-4.

3.4.1 Deep Well Injection

Deep well injection involves injecting the reject brine stream into the Barrow Group Formation approximately 1 km below the surface. Two options for deep well injection include using existing oilfield injection wells or drilling new wells.

3.4.1.1 Existing Wells

The Barrow Island oilfield group has drilled four produced water injection wells (WDW1–4) into the Barrow Group Formation for its existing operations. The Gorgon Gas Development will use two of these wells (WDW1 and WDW2) to dispose of waste effluents. Figure 3-2 shows the concept to potentially include RO brine disposal.

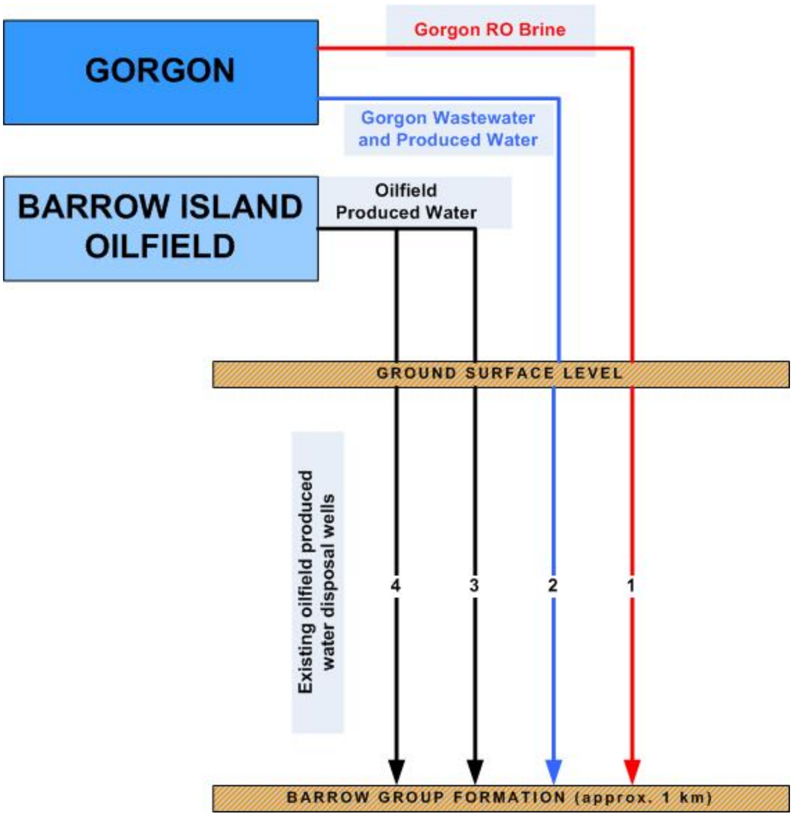

Figure 3-2 Deep Well Injection – Existing Wells

A number of studies were undertaken to address the feasibility of this option (Helix 2006, 2007, 2007a, 2008) specifically considering formation capacity and the compatibility of different waste streams.

The studies concluded that combining the Gorgon RO reject brine (which contains sulfates) with the Barrow Island oilfield produced water (which contains barium) in the Barrow Group Formation is likely to result in barium sulfate scaling throughout the formation, thus resulting in a 'plugging' effect and subsequent reduced injectivity of the wells. Furthermore, the addition of other streams (wastewater, Gorgon produced water), either continuously or at various stages during the development life of the Gorgon Gas Development, is unlikely to reduce the barium sulfate scale risk from the Gorgon RO reject brine. Similar waste stream incompatibility may also exist between RO reject brine and the Gorgon produced water stream, as well as formation water of the Barrow Group.

'Plugging' as a result of scaling and solids generation may be controlled by the use of chemical additives; however, uncertainty exists around the success of such a chemical inhibition program.

As depicted in Figure 3-2, there is no contingency well available for waste stream injection; hence failure of the disposal system (i.e. loss of injectivity) will lead to reduced disposal capabilities and prolonged Gas Treatment Plant shutdown. Additionally, loss of injectivity in the well area has the potential to disrupt the Barrow Island oilfield operator's ability to dispose of produced water, and thus disrupt their operations.

This option would also require construction of a dedicated RO brine disposal pipeline from the Gas Treatment Plant to the well injection site, resulting in an additional land clearing of approximately 0.9 ha.

3.4.1.2 New Wells

This option is similar to the previous 'existing wells' system; however, the RO reject brine would be injected into two new dedicated wells, as shown in Figure 3-3.

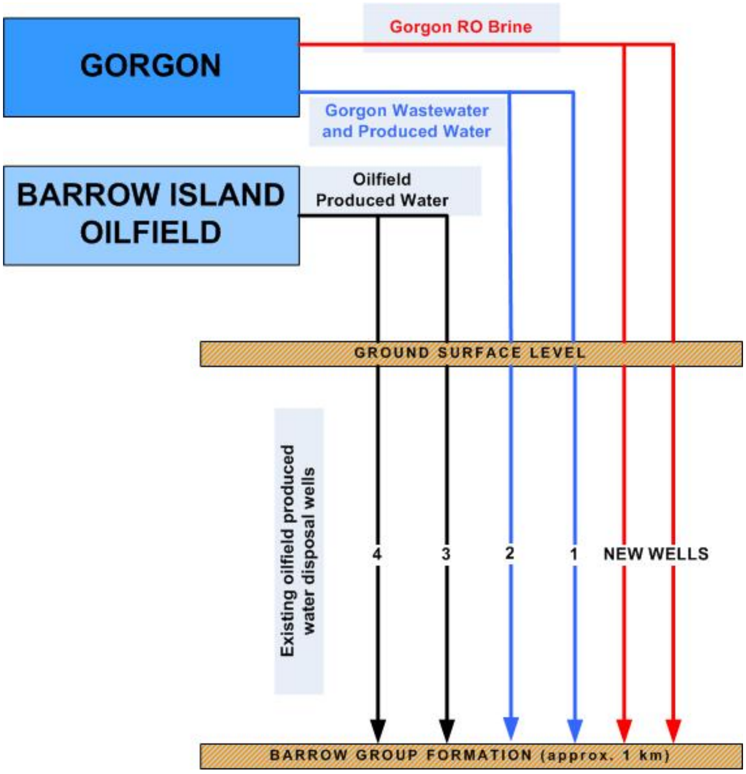

Figure 3-3 Deep Well Injection – New Wells

As with the 'existing wells' option, using new wells for RO reject brine disposal still presents a high risk of scaling when combining Gorgon RO reject brine with formation water of the Barrow

Group, although the risk of injectivity loss is likely to be less than the previous option given the additional contingency that two dedicated wells provides. Whilst this option may reduce the risk of injectivity loss (and subsequent plant shutdown), the drilling and installation of two new wells requires additional land clearing of approximately 2.3 ha. In addition to the problems faced with combining waste streams, uncertainty also exists around the formation characteristics, particularly permeability and the likelihood of the RO reject brine migrating within the formation and causing 'plugging' effects elsewhere in the formation.

In summary, the studies (Helix 2006, 2007, 2007a, 2008) undertaken with regard to disposal of waste streams via deep well injection recommended the separate disposal of RO reject brine (ideally to ocean outfall), with existing injection wells used for disposal of the remaining Gorgon liquid waste streams (i.e. wastewater and produced water).

3.4.2 Shallow Beach Wells

This option involves drilling a series of injection wells of depths between 20 and 150 m into the Lower Limestone (a saline aquifer that has connectivity to the ocean) located along the Barrow Island east coastline in the vicinity of the Gas Treatment Plant site, as shown in Figure 3-4.

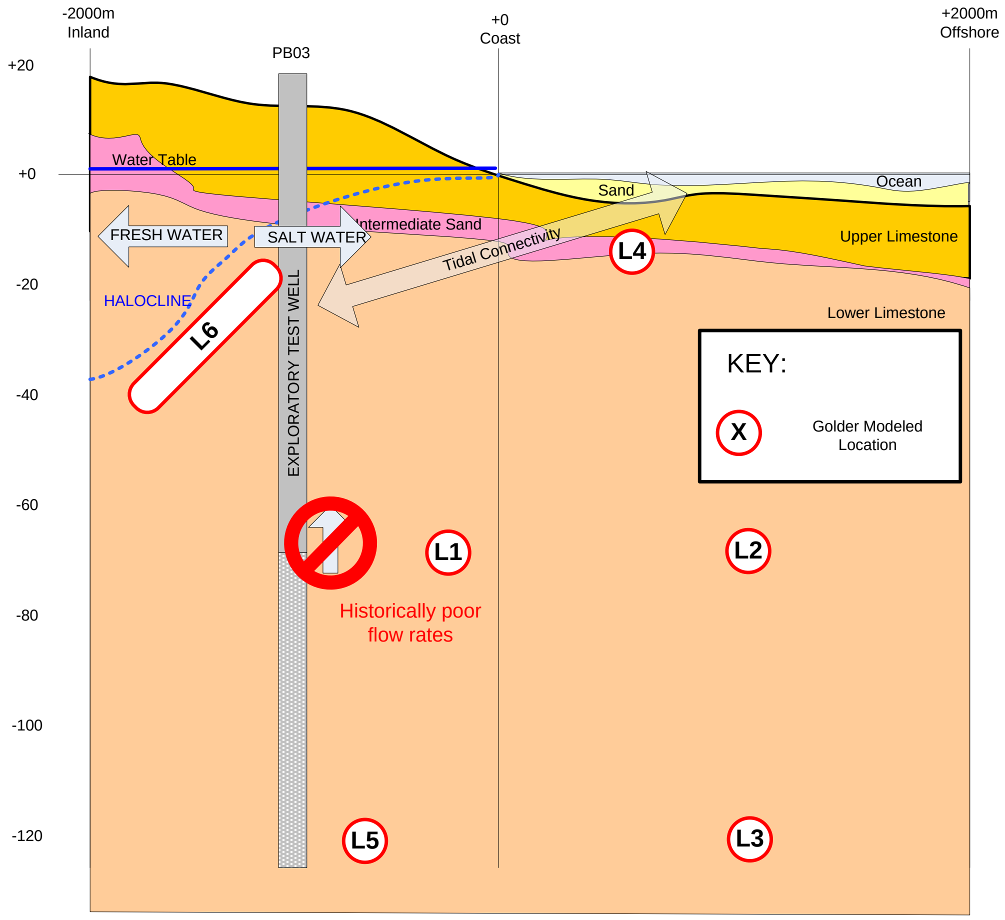

Figure 3-4 Shallow Beach Wells Subsurface Schematic

Source: PowerPoint Presentation: RO Brine Ocean Outfall – Application for Ministerial Approval, 2nd DEC Engagement Meeting, 3 July 2008 (Chevron Australia 2008a)

Along the coastal region of Barrow Island, a subterranean fresh–saltwater interface exists, known as the 'halocline'. Endemic stygofauna reside in the freshwater region.

A hydrology consultant (Golder Associates) was engaged to assess the feasibility of shallow injection of RO reject brine and also to examine potential effects of brine injection on the halocline (Golder Associates 2008). The study included two-dimensional (2D) and three-dimensional (3D) modelling of brine injection for six injection cases, which were then assessed against individual performance criteria. Assessment criteria included:

- no breakthrough of the injected water into the ocean
- no increase of TDS in the vicinity of stygofauna habitat greater than 10%
- no increase in watertable elevations greater than 0.30 m
- no movement of the halocline more than 50 m horizontally
- no movement of the freshwater lens discharge point inland
- no increase of groundwater velocities greater than a factor of two (with the exception of within 50 m of the injection well).

The study concluded that none of the six modelled injection cases adequately met all performance criteria.

Based on predicted daily brine volumes produced by the RO facilities, the study also indicated that an approximately 4000 m long line of up to 50 injection wells would be required at a location to provide the necessary injectivity requirements for the Gorgon Gas Development. Drilling and installing this number of injection wells would involve significant land disruption within the vicinity of the beach, and/or marine environment. Additional land take is estimated to be between 1.2 and 4.8 ha. Uncertainty also exists around the difficulties with well construction and achieving required injectivity (KJVG 2006a, 2006b).

3.4.3 Ocean Outfall

This option involves the disposal of RO reject brine via an ocean outfall and diffuser. A number of studies have been undertaken to assess the impacts of brine discharge to the marine environment, which are discussed in Section 6.0. A summary of RO brine disposal options is included in Table 3-4.

Ocean outfall is considered the most viable option for brine disposal for the following reasons:

- reduced implementation uncertainty (i.e. construction and operability of outfall technologies are proven and well-supported in Australia)
- proven and well-supported technology used
- minimised land take
- ability to design, monitor and control the treatment and disposal process to reduce environmental impact to As Low As Reasonably Practicable (ALARP).

The RO facilities have been designed based on the selected options as discussed in Sections 3.2, 3.3, and 3.4; i.e. ocean seawater intake together with RO desalination technology and an ocean outfall for disposal of reject brine. Further details on the selected water supply system for the Gorgon Gas Development are included in Section 4.0.

Table 3-4 Brine Disposal Options – Evaluation Summary

Option	Technical, Construction, and Operability Considerations	Key Environmental Impacts/Considerations
Deep well injection – use two of the existing oilfield wells	• A number of studies were undertaken to consider the formation capacity and the compatibility of combining the Barrow Island oilfield produced water with Gorgon RO brine (Helix 2006, 2007, 2007a, 2008). • Combining waste streams is likely to result in barium sulfate scaling throughout the injection system, resulting in a 'plugging' effect and subsequent reduced injectivity of the existing wells. • There is no contingency well available for any waste stream injection, so failure of the disposal system (i.e. loss of injectivity) will lead to reduced disposal capabilities and prolonged Gas Treatment Plant shutdown. • Loss of injectivity in the well area has the potential to disrupt the Barrow Island oilfield operator's ability to dispose of produced water and thus disrupt their operations.	Land clearing associated with the pipeline to transport water from the Gas Treatment Plant to the well injection site (estimated 0.9 ha).
Deep well injection – drill two new wells	• Using new wells for RO brine disposal still presents a high risk of scaling when combining Gorgon RO brine with formation water of the Barrow Group, although the risk of injectivity loss is less than the previous option given the additional contingency that two dedicated wells provide. • Uncertainty exists around the formation characteristics, particularly permeability and the likelihood of the RO brine migrating within the formation.	• Land clearing associated with drilling and installing two new wells (estimated 2.3 ha). • Wastes generated from drilling operations (e.g. drilling muds).
Shallow beach wells	• Modelling was undertaken to assess the feasibility of shallow injection of RO brine and examine potential effects of brine injection on the halocline (Golder Associates 2008). Outcomes of the modelling indicated that shallow injection of RO brine is not likely to be a feasible option. • Based on predicted daily brine volumes produced by the RO facilities, the study also indicated that an approximate 4000 m long line of up to 50 injection wells would be required at a location to provide the necessary injectivity requirements for the Gorgon Gas Development. • Uncertainty also exists around the difficulties with well construction and achieving required injectivity (KJVG 2006a, 2006b).	• Potential impacts on stygofauna. • Drilling, installing and operating/maintaining up to 50 injection wells would have significant impacts on the coastal dune formation and nesting turtles. • Wastes generated from drilling operations (e.g. drilling muds). • Land take associated with drilling and installing up to 50 wells (estimated 1.2 to 4.8 ha).

Option	Technical, Construction, and Operability Considerations	Key Environmental Impacts/Considerations
Ocean outfall	• There is significantly less implementation uncertainty compared to deep or shallow injection options. • Construction and operability of outfall/diffuser technologies are proven and well-supported in Australia.	• Potential impacts to marine environment from RO brine discharge. • No additional land take given infrastructure remains within the boundaries of the MOF construction impact zone and Gas Treatment Plant site.

4.0 Overview of the Selected Water Supply System

Temporary RO facilities (using temporary intake and outfall structures) are to be installed in a phased manner to meet water demand during construction. It is anticipated that the temporary RO facilities (using temporary intake and outfall structures) will be operated throughout construction. Minor operation of the temporary RO facilities may be required for care and maintenance purposes during operations until the facilities are decommissioned. Two package RO plants are to be installed on the PSVs and used to service the additional water requirements during construction and SIMOPS. A permanent RO facility (and associated permanent intake and outfall) is to be installed and commence operations in the latter stages of construction and then continue to be used throughout operations.

The description of the permanent RO facility provided in Section 4.3 represents the most likely design scenario and therefore represents the basis for environmental impact assessment and associated management and monitoring described within this Plan. As detailed engineering design advances, the potential for deviation away from the base case scenario may occur; however, any deviation is not expected to significantly alter the outputs of the environmental risk assessment (Section 5.0), environmental impact assessment (Section 6.0), or the proposed monitoring measures (described in Section 7.0). Any significant refinement to engineering design will be assessed and where necessary, this Plan will be updated.

4.1 Mixing Zone

It is accepted practice to apply the concept of a mixing zone, which is an explicitly defined area around a point of effluent discharge, where reduced environmental standards are expected (ANZECC/ARMCANZ 2000).

Dredge and Spoil Zones of Impact associated with dredging and the construction of the east coast Marine Facilities (Figure 4-1) were included in the PER for the Gorgon Gas Development Revised and Expanded Proposal. A reduced level of ecological protection within the Zone of High Impact surrounding the MOF was predicted due to changes in substrate structure, physical disturbance to the seabed and/or declines in water quality due to mobilisation of sediment during dredging associated with the MOF construction. The Zone of High Impact surrounding the MOF was applied as the mixing zone boundary for the temporary RO outfalls and the package plants located on the PSVs.

The mixing zone for the permanent outfall has been set according to the results of the dilution modelling (see Section 6.3). In accordance with the framework proposed by DEC (2006), a Low Ecological Protection Area (LEPA) has been established around the outfall. Within this LEPA, discharged water from the RO plant may temporarily alter water salinity from background levels, and may potentially temporarily alter other parameters, such as temperature and dissolved oxygen. The proposed LEPA is located in the vicinity of the tug pen harbour at the boundary of exchange with ocean water (approximately 90 metres from the outfall) (Figure 4-3). Beyond this LEPA, a Moderate Ecological Protection Area (MEPA) is being proposed in association with the Gorgon Marine Environmental Quality Management Plan (a requirement of Condition 23 of Statement No. 800). This MEPA will extend 250 m from the existing marine infrastructure in accordance with the framework proposed by DEC (2006). Discharge water from the RO brine outfall is predicted to achieve the Ecological Quality Criteria (EQC) for a MEPA within this area, and is predicted to achieve the EQC for a High Ecological Protection Area (HEPA) before it reaches the outer edge of the MEPA boundary (Figure 4-3).

To reduce additional impacts to the marine environment associated with the installation of RO intake and outfall structures, intake and outfall structures will be located within the Zone of High Impact surrounding the MOF. Potential environmental impacts associated with the installation of intake and outfall structures will be managed in accordance with the environmental management strategies outlined in the Marine Facilities Construction Environmental

Management Plan (Chevron Australia 2012e) and to the extent management strategies are relevant to RO facilities installation.

Section 6.0 describes further assessments undertaken to reduce potential impacts from RO brine discharge to ALARP within the relevant mixing zones and to ensure that no material or serious environmental harm to Barrow Island and surrounding waters.

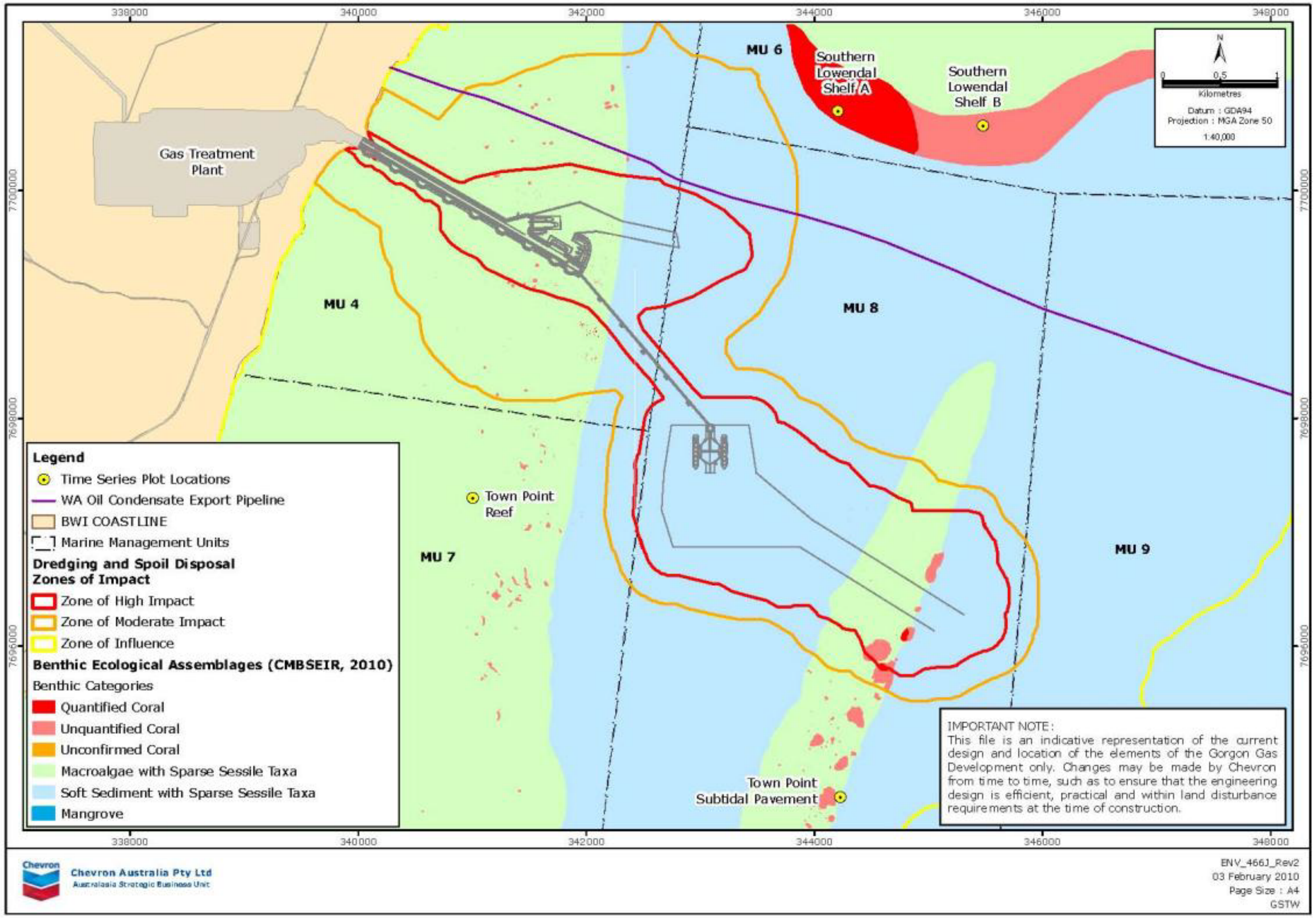

Figure 4-1 Zones of Impact in the Vicinity of Marine Facilities for the Gorgon Gas Development

4.2 Temporary RO Facilities

Temporary RO facilities are to be installed in a phased manner. The first installation, which has now been decommissioned, consisted of RO facilities (Phase 1) located on Town Point. The second and third installations consist of RO facilities (Phase 2, 3, and Bridging) all located within the Bridging Utilities area of the Gas Treatment Plant site.

The Phase 2, 3, and Bridging RO facilities, located within the Bridging Utilities area of the Gas Treatment Plant site, are sized to produce an equivalent of 4800 m^3/day, and are equipped with a pre-filtration system in the form of hydrocyclones, disc filters, and microfiltration units. The RO product water is treated with chlorine and carbon dioxide prior to distribution for construction and potable uses.

The temporary seawater intake system supplying the Phase 2, 3, and Bridging RO facilities consists of a series of pumps mounted on a structure located close to the shoreline within the Zone of High Impact (Figure 4-2). The intake pipes extend approximately 700 m offshore and are secured to the seabed with concrete clump weights. The pumping system is equipped with intake screens limiting the intake velocity at the screen to a maximum of 0.1 m/s to reduce the potential for marine fauna entrainment. Ancillary equipment, such as power generation equipment, control and instrumentation container, and bulk fuel storage, is co-located with the Phase 2, 3, and Bridging RO facilities.

The Phase 2, 3, and Bridging RO facilities discharge brine and backwash water via an outfall (consisting of two diffusers) located up to 900 m from the shore, within the Zone of High Impact (Figure 4-2). The outfall pipes are anchored to the sea floor using concrete clump weights as per the intake lines. The outfall diffusers have been designed to achieve a minimum of 40 dilutions within the Zone of High Impact.

Using only RO produced fresh water for construction purposes, the brine discharge volume from the temporary RO facilities is estimated to peak at nominally 6667 m^3/day during peak construction activities. The brine discharge volume from these temporary RO facilities is estimated to be nominally 210 m^3/day during any period where the facilities are operated in a care and maintenance mode. This volume would be further supplemented by sea water being pumped through the seawater pumping system.

4.3 Project Support Vessel RO Facilities

Water shortages on Barrow Island during the construction and commissioning phase of the project are to be met through package RO plants installed on two PSVs. These plants are different to the integrated vessel RO units as they are stand-alone containerised RO units and used to service demands outside the housing PSV. Both containerised RO units produce up to 500 m^3/day of desalinated water. The brine discharge volume from an individual PSV RO facility is estimated to peak at 750 m^3/day during operation. The intake and outfall systems of the RO plants are located on the vessel.

4.4 Permanent RO Facilities

The permanent RO facility is to be located within the General Utilities area of the Gas Treatment Plant site. The plant is configured with three modular trains, with each train capable of stand-alone operation and sized to produce an equivalent of approximately 700 m^3/day of fresh water. Freshwater demand for operations will normally be met via the use of two RO trains producing approximately 1400 m^3/day of fresh water; however, during upsets and emergencies with higher than normal demand, all three trains may be used to produce approximately 2100 m^3/day of fresh water. These scenarios equate to a maximum brine discharge of approximately 1700 m^3/day and 2550 m^3/day, respectively.

The permanent RO facility is to be supplied with sea water from a caisson installed within the MOF structure approximately 1.3 km from shore and within the Zone of High Impact (Figure 4-3). The inlet holes on the caisson are covered by approximately 10 m of rock armouring, separating the pumps from the open water. The sea water is then pumped via a pipeline to a seawater pre-treatment package located in the General Utilities area. The pumping system is equipped with intake screens limiting the intake velocity to a maximum of 0.1 m/s to reduce the potential for marine fauna entrainment. Fauna entrapment is considered low risk with the combination of the rock armouring, inlet screens, and inflow velocity. Chlorine dosing is to be carried out at the suction pump and caisson to reduce marine growth in the intake line.

The sea water is pre-treated by passing it through disc filter and membrane filtration trains. The resulting RO feed water is then pre-conditioned with antiscalant and sodium bisulfate, before being pumped at high pressure to the reverse osmosis array for separation of dissolved salts from the water. The permeate is then treated with carbon dioxide to adjust pH, passed through calcite media vessels to increase hardness, and dosed with chlorine for disinfection prior to distribution for construction and/or potable uses.

Backwashing of filters and chemical cleaning is required periodically to remove any fouling that accumulates on the filters and RO membranes.

Backwash fluids and reject brine from each RO train are sent to the Reject Buffer Tank for subsequent disposal via ocean outfall. The outfall pipe from the RO plant is to be located within two caissons near the tug pen berth approximately 2 km from the shore and within the Zone of High Impact (Figure 4-3). The diffusers are designed to discharge through the caisson near the surface of the ocean at lowest astronomical tide. The outfall diffusers have been designed to achieve a minimum of 40 dilutions in the near-field.

During the initial stages of commissioning and operation of the permanent RO facility, brine may need to be discharged via the temporary outfall pipe and diffusers. It is envisaged that the brine from the permanent RO facility will displace the existing water/brine production from the temporary facilities; and therefore, there will be no net increase in brine discharge via the temporary outfall.

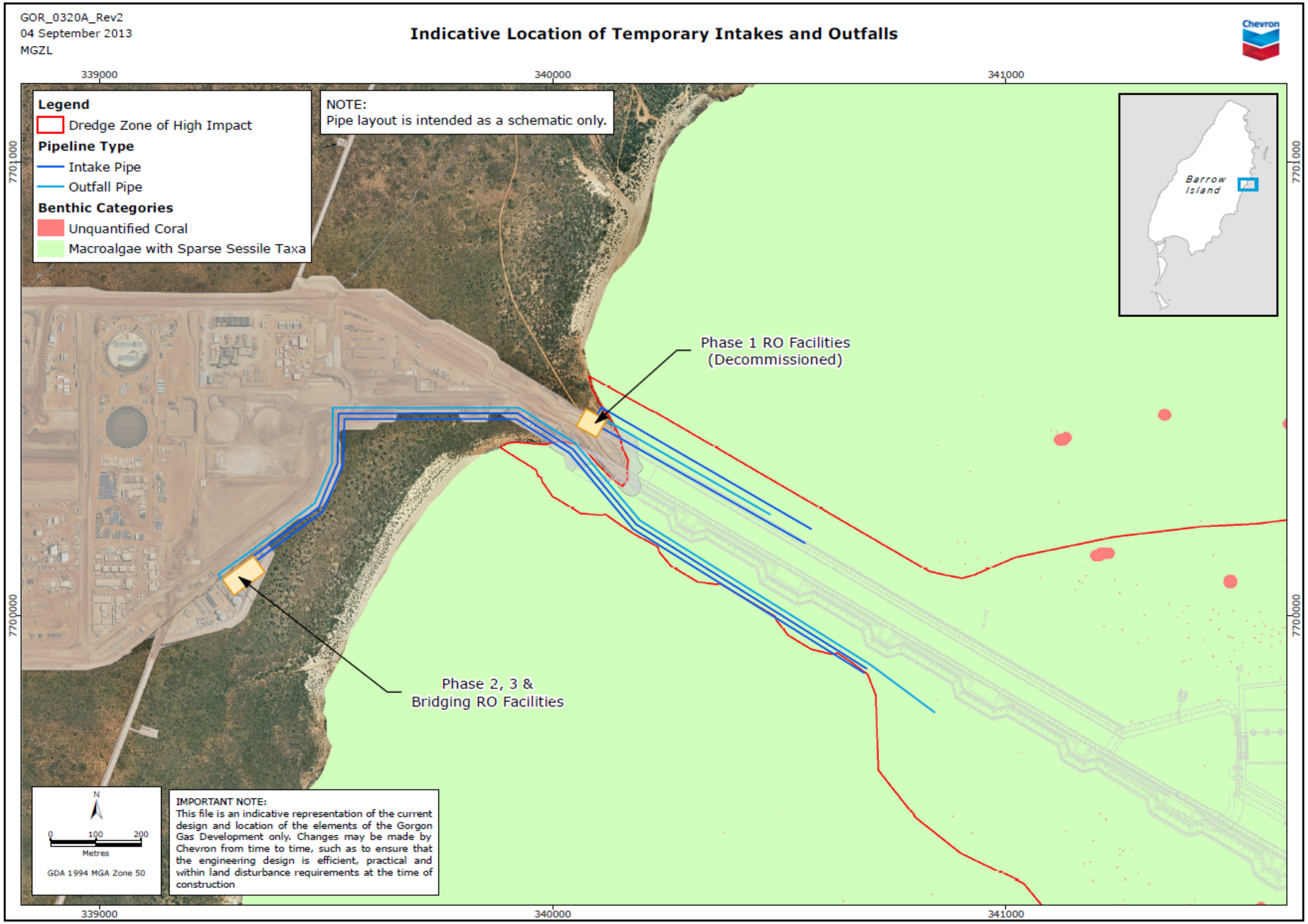

Figure 4-2 Indicative Locations of Temporary Intakes and Outfalls

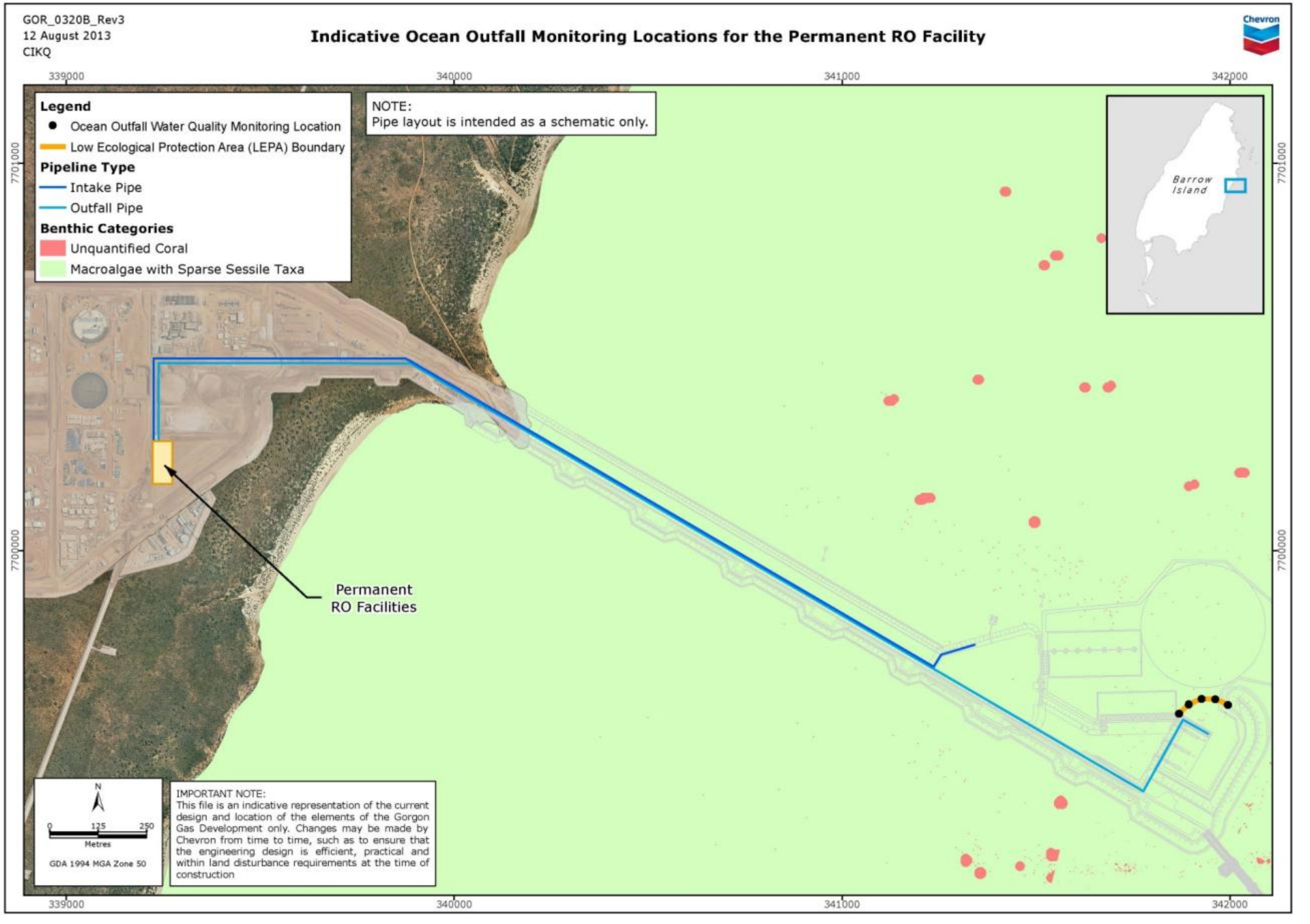

Figure 4-3 Indicative Permanent Intake, Outfall, LEPA, and Ocean Outfall Monitoring Locations

5.0 Risk Assessment

5.1 Overview

Chevron Australia has prepared the HES Risk Management: ABU – Standardized OE Process (Chevron Australia 2012c) to assess and manage health, environment, and safety (HES) risks, which it internally requires its employees, contractors, etc. to comply with.

A number of environmental risk assessments have been completed for the Gorgon Gas Development. A strategic risk assessment was undertaken during the preparation of the Draft EIS/ERMP to determine the environmental acceptability of the Development, and to identify key areas of risk requiring mitigation (Chevron Australia 2005).

This original assessment was reviewed as part of the development of the Gorgon Gas Development Revised and Expanded Proposal PER (Chevron Australia 2008), in light of the proposed changes to the Gorgon Gas Development (described in Section 1.4). The outcomes of these assessments have been reviewed and considered during the preparation of this Plan.

Additional detailed risk assessments have been undertaken for specific scopes of work, using Chevron's RiskMan2 Procedure (Chevron Corporation 2008).

Table 5-1 summarises the risk assessments that have been undertaken to date, and that have provided input into this Plan.

Table 5-1 Risk Assessments Relevant to this Plan

Scope of Risk Assessment	Method(s)	Documentation	Year
Entire Scope of the Approved Development	AS/NZS 4360:2004	Draft EIS/ERMP (Chevron Australia 2005)	2005
Entire Scope of the Revised and Expanded Proposal	AS/NZS 4360:2004	Gorgon Gas Development PER (Chevron Australia 2008)	2008
Safety and Operability Review of the proposed utility systems (including bridging and permanent RO facilities)	RiskMan2	General Utilities FEED Operability & Safety Review Report for the Gorgon Project Barrow Island LNG Plant (KJVG 2008)	2008
Process Hazard Analysis of temporary RO facilities at Town Point	RiskMan2	Town Point Temporary Seawater RO Plant Process Hazard Analysis (Chevron Australia 2010e)	2009
Process Hazard Analysis of permanent RO facility at General Utilities area	RiskMan2	Hazop Study – Water Desalination Plant (KJVG 2011)	2010
Environmental Hazard Analysis of package RO units on the PSVs	RiskMan2	Appendix 3	2014

5.2 Methodology

The methodology for the environmental risk assessments undertaken during the EIS/ERMP assessment process is documented in Chapter 9 of the Draft EIS/ERMP (Chevron Australia 2005).

The risk assessments were undertaken in accordance with the following standards:

- Australian Standard/New Zealand Standard (AS/NZS) 4360:2004, Risk management (Standards Australia/Standards New Zealand 2004b)

- AS/NZS Handbook 203:2006, Environmental Risk Management – Principles and Process (Standards Australia/Standards New Zealand 2006)
- AS/NZS 3931:1998, Risk Analysis of Technological Systems – Application Guide (Standards Australia/Standards New Zealand 1998).

The main components of the RiskMan2 risk assessment methodology include:

- **Hazard Identification**: Identifying potential hazards that are applicable to Gorgon Gas Development activities and determining the hazardous events to be evaluated.
- **Hazard Analysis**: Determining the possible causes that could lead to the hazardous events identified; the consequences of the hazardous events; and the safeguards and controls currently in place to mitigate the events and/or the consequences.
- **Risk Evaluation**: Evaluating the risks using the Chevron Integrated Risk Prioritization Matrix (Appendix 3). The risk ranking is determined by a combination of the expected frequency of the hazard occurring (likelihood) and the consequence of its occurrence. Note that when assessing the consequence no credit is given to the hazard controls; hazard controls are taken into account in determining the likelihood of the event.
- **Residual Risk Treatment**: Reviewing the proposed management controls for each of the risks identified and proposing additional controls or making recommendations, if required.

Using the Chevron Integrated Risk Prioritization Matrix (Appendix 3), identified risks are categorised into four groups, which determine the level of response and effort in managing the risks. The risk-ranking categories have been used in the development of this Plan to determine whether the residual risks were acceptable or whether further mitigation was required.

5.3 Outcomes

The key physicochemical stressors identified (Chevron Australia 2007b) that are associated with RO brine discharge include:

- salinity
- pH
- temperature
- chemical toxicity.

Other physicochemical stressors such as dissolved oxygen (DO) and nutrients were considered in a preliminary environmental impact assessment (RPS Environment 2008); however, they were not considered key stressors given the high-energy and well-flushed nature of the marine environment in the vicinity of the proposed discharges.

The key marine ecological elements, identified within the EIS/ERMP and literature review of the effects of the desalination process on the marine environment (see Section 6.0 of this Plan), potentially at risk from a change in one or more of the identified key stressors include:

- corals
- non-coral benthic macroinvertebrates
- seagrass and algae
- fish
- marine turtles and mammals
- water quality.

Process hazards (with environmental consequences) identified during the Safety and Operability Review (KJVG 2008), Process Hazard Analysis – Temporary Facilities (Chevron Australia 2010e) and Process Hazard Analysis – Permanent Facilities (KJVG 2011) generally related to potential mechanical failure, resulting in uncontrolled release of brine to the marine environment. Other hazards identified included the potential for entrainment of marine fauna into the seawater intake, operator error and physical damage to plant and/or pipelines from an external source or from corrosion.

Given the existing engineering and administrative controls associated with the RO facilities design, the risk of significant impact to the marine environment as a result of the process hazards identified is considered low (i.e. residual risk scores of 7 to 10). A summary of process hazards identified (with environmental consequences) together with specific engineering and management controls to mitigate those risks is included in Appendix 3.

The risk of significant impact to the marine environment as a result of planned (i.e. normal operations) discharge of RO brine is considered tolerable if reasonable safeguards and management systems are confirmed to be in place (i.e. residual risk score of 6). A number of assessments have also been undertaken by Chevron Australia to assess the potential impacts to ecological elements associated with planned (i.e. normal operations) discharge of RO brine to the marine environment. Environmental impact assessments are discussed in Section 6.0 of this Plan.

6.0 Environmental Impact Assessment

A number of studies have been undertaken to assess the potential impacts to the marine environment from RO brine discharges in service during construction and operation. These studies include:

- characterisation and preliminary toxicity assessment of potential brine streams (Chevron ETC 2007)
- literature review of the effects of saline discharges on the marine environment (RPS Environment 2009)
- WET testing and BurrliOZ analysis (RPS Environment 2008a)
- dilution modelling for temporary brine discharges (KJVG 2010)
- dilution modelling for permanent brine discharges (KJVG 2013)
- dilution modelling for brine discharges from package RO units on PSVs (KJVG 2014).

Existing baseline information and data for Barrow Island collected for the Coastal and Marine Baseline State and Environmental Impact Report (Chevron Australia 2012b) have been used to inform the environmental impact assessment process, where relevant.

6.1 Brine Characterisation and Preliminary Toxicity Assessment

The scope of the brine characterisation and preliminary toxicity assessment (Chevron ETC 2007) included:

- consultation with potential RO vendors to characterise the physical and chemical composition of the brine, including salinity, pH, temperature and typical chemicals likely to be used in the desalination process that may be discharged with the brine and/or other liquid waste streams (see Figure 3-1 for waste streams)
- obtaining vendors' Material Safety Data Sheets (MSDSs) for chemicals likely to be present in the brine and other liquid waste streams and to summarise their ecotoxicological properties
- performing a preliminary toxicity assessment of the brine, using computer-based predictive modelling of the salt ion imbalance, pH and temperature.

The typical overall RO process, including process chemicals and the three liquid waste streams (brine effluent stream, filter backwash stream and the spent cleaning stream) is illustrated in Figure 3-1. The backwash and cleaning processes produce waste streams, which are combined with the brine and directed to the ocean outfall. Process chemicals typically used in the RO process include:

- Biocides – added immediately after the intake and during membrane backwash to control the regrowth of micro-organisms. Common biocides include chlorine (usually sodium hypochlorite solution), chloramines and hydrogen peroxide.
- Dechlorinators – free chlorine is neutralised using reducing agents such as sodium metabisulfite ($Na_2S_2O_6$) or sodium bisulfite ($NaHSO_3$) prior to moving through the RO membranes.
- Sulfuric acid – added during pre-treatment for pH adjustment. Sulfuric acid, hydrochloric acid and citric acid are also commonly used to clean scale from membranes during the cleaning process.
- Coagulants – added during pre-treatment to remove suspended solids and turbidity. The most common coagulant used is ferric chloride ($FeCl_3$). Polyelectrolytes, such as polyacrylamide, polyacrylate or polyphosphates, are also used to aid coagulation.

- Antiscalants – added immediately before the RO system to prevent scale formation derived from calcium salts on the membranes. Some of the chemicals used for this purpose are: polycarboxylic acid, polyacrylic acid, polymaleic acid, organo-phosphonates, polyphosphates and polymer-based antiscalants.

A review of the chemicals proposed for the permanent RO facility confirmed that they were consistent with the chemicals assessed during the brine characterisation and preliminary toxicity assessment.

The brine composition and preliminary toxicity assessment undertaken as part of the feasibility study suggested that a 100-to-1 dilution of the RO reject brine stream would likely ensure a high level of ecological protection; however, it was recommended that WET testing with local Australian species be performed to determine actual acute and chronic toxicity effects of the combined brine effluent. The feasibility study based the dilution recommendation on a study of published ecotoxicological data (MSDSs and other publicly available ecotoxicity, biodegradability and bioaccumulation data) with safety factors incorporated to ensure relevance to a suite of marine biota.

Since the preliminary toxicity assessment, actual acute and chronic effects have been established via WET testing, and the respective dilutions recalculated (see Section 6.4). The composition of the simulated whole effluents subject to WET testing is presented in Section 2.4 of the WET test report (Appendix 8).

6.2 Literature Review of the Effects of Saline Discharges on the Marine Environment

A literature review (RPS Environment 2009) of the effects of saline discharges on the marine environment was undertaken and included in this Plan (see Appendix 4). The review focused on quantitative references that specify measured impacts of saline discharges on the physical, chemical or biological characteristics of the marine environment. A summary of the key findings is provided in the following sections.

6.2.1 Physical and Chemical Impacts of Waste Brine

Much of the literature reviewed included many model-based predictions about what the dilution rates of brine should be when released into the sea. However, there were limited quantitative field-based measurements of how the brine actually dilutes once released.

Recorded measurements of physical parameters (temperature, salinity, pH and dissolved oxygen) and chemicals added during the RO process (antiscalants, coagulants, biocides, heavy metals and nutrients) were reviewed for three desalination facilities located in the Canary Islands and north-west Mediterranean Spain. These facilities were significantly larger than both the temporary and permanent RO facilities, and yet rapid dilution of salinity, temperature, pH and chemicals to near-ambient levels was generally recorded in the near-field region (i.e. 10–20 m) around the outfalls.

Hence, considering the high-energy location of the proposed discharge location and the relatively small volume of waste brine proposed for release from the temporary and permanent RO facilities on Barrow Island, it would be expected that near-ambient seawater levels of salinity, temperature, pH and chemicals are also likely to be achieved in the near-field from the outfall. This inference is further supported by dispersion modelling undertaken (see Section 6.3) for the temporary and permanent outfalls.

The literature review also looked at existing literature relating to marine fauna collision with, or entrainment into, seawater intakes. The review indicated that screens of approximately 5 mm mesh width are generally used to avoid marine debris and large marine animals from entering the water intake, and that flow rates of 0.1 m/s do not affect movement of larger fish and animals. Green Turtle hatchlings, for example, swim at an average speed of 0.4 m/s and so should be able to swim away from an intake flow rate of 0.1 m/s.

6.2.2 Toxicity Studies

The review of published sources found limited information on the direct toxicity of desalination waste brine on marine species. In addition, although whole effluent ecotoxicology research is being conducted in association with the construction of a number of desalination plants across Australia, at present little WET test information is available in the public domain. WET testing of brine from the Perth desalination plant found very different levels of toxicity of waste brine between the two years of testing (see Appendix 4 for further details).

6.2.3 Assessment of Ecosystem Vulnerability

Coral, macroalgae, and seagrass occur at Barrow Island and in the vicinity of the temporary and permanent outfalls. The review therefore considered the likely impact of waste brine on these ecosystem types. The review indicated that coral reef systems are sensitive to minor increases above ambient seawater temperatures. Less research is available regarding the impacts of long-term increases in salinity on coral reef systems, although corals are known to survive in environments with elevated salinity, and some species will tolerate gradual increases in salinity. Available literature indicates that salinity tolerances in coral species depend on a number of factors including: the speed, magnitude, and duration of the salinity increase; ambient salinities before the change; individual species tolerance levels; acclimatisation abilities; and whether salinity changes are occurring simultaneously to other stressors such as temperature or turbidity fluctuations. The literature review also highlights coral species where salinity tolerances are available in the literature and the applicability of the literature to corals found around Barrow Island in the vicinity of the RO facilities' outfalls. Coral assemblages at many locations within the vicinity of the outfalls are dominated by *Porites* spp., which available literature indicates as the most highly tolerant genus to saline conditions.

In addition to coral reefs, seagrass habitats are also considered potentially sensitive to impacts from RO waste brine. A large body of research exists relating to the impact of temperature and salinity changes on seagrass. The literature review found that most species of seagrass were tolerant to moderate increases in salinity and temperature.

The literature review also looked at available information relating to potential impacts to fish, turtles and marine mammals from RO waste brine. Impacts to fish were largely attributable to the physical impacts of entrainment, as discussed in Section 6.2.1. These impacts can be mitigated via the installation of intake screens and minimising intake flow velocity.

The review also concluded that there have been no studies into the impact of increased salinity, reduced dissolved oxygen or increased turbidity on marine turtles. Ocean intakes located in areas of high turtle density pose a risk of entrainment to adults, hatchlings and juveniles; however, as discussed in Section 6.2.1, these impacts can be mitigated via the installation of intake screens and minimising intake flow velocity.

Similarly, the review concluded that the effects of desalination plant brine upon cetaceans have not been studied and there is currently no information that suggests brine discharge will have a negative effect on cetacean health.

6.2.4 Summary

The literature review concluded that although little direct experimental work has been published on the impacts of desalination plants on the marine environment, there is little evidence to date to suggest that impacts from RO plants are significant or widespread. As both the temporary and permanent RO facilities will produce a relatively small volume of waste brine compared to many desalination plants in operation, this supports the view that near-ambient levels of salinity, temperature, pH and chemicals are likely to be achieved very close to the outfall. Hence, it is unlikely that the outfalls will have a significant impact on the coral, seagrass, fish, marine turtles and marine mammal populations of Barrow Island. Furthermore, the implementation of screens, combined with low flow rates, can mitigate impacts associated with entrainment of marine fauna into the seawater intake.

6.3 Dispersion Analysis and Dilution Modelling

Preliminary two-dimensional (2D) dispersion analyses were initially undertaken to establish potential operating scenarios (i.e. discharge flow rates) and to provide an initial indication as to whether the spatial dispersion of the temporary brine discharge would be contained principally within the Zone of High Impact surrounding the MOF. Dispersion analyses included the use of a dilution formula for a point source discharge to approximate the spatial extent of the RO brine for three operating scenarios.

Three-dimensional (3D) dilution modelling was also undertaken for the temporary (KJVG 2010), permanent (KJVG 2013), and PSV (KJVG 2014) outfalls. The key objective of the modelling was to illustrate and quantify the likely temporal and spatial evolution of the brine once it has been released into the marine environment. Performance criteria for the diffusers is based on WET test results (see Section 6.4). Hence, an additional objective of the dilution modelling was to demonstrate that dilution levels specified from the WET tests (i.e. 40-fold dilutions) can be reasonably achieved within the respective mixing zones for a range of potential operational scenarios.

The results of the modelling are summarised in the following sections.

6.3.1 Modelling Methodology

Two key steps were undertaken during modelling to establish the key processes affecting the fate of the discharged brine once it has been released into the marine environment. These steps were:

- review of relevant forcings
- establishment of criteria to select an appropriate oceanographic model and associated steps in oceanographic modelling.

The primary forces used in the hydrodynamic model were tides (which generate currents). Atmospheric heat was also used as an input force to simulate mixing in two seasons. Wind forcing was excluded from the model due to the observation that tidal forces dominate. The absence of wind represents an environment with reduced mixing. Hence it is more conservative.

Key input data used to establish the model included: seabed bathymetry, a computational grid, meteorological conditions, tidal elevations, seawater quality, outfall geometry, and the initial effluent discharge parameters.

Model verification was also undertaken to ensure that the model replicated the observed ocean currents when driven by changes in tide. A comparison of measured currents with currents extracted from the model simulation showed a good correlation, indicating the model adequately captures long-shore and cross-shore currents. It was also observed that the modelled current velocities generally slightly under-predict measured values, thus applying a conservative force to mixing within the water column.

Further details regarding modelling methodology and assumptions are included in Appendix 5, Appendix 6, and Appendix 7.

6.3.2 Temporary Outfalls

6.3.2.1 Simulation Cases and Diffuser Design

Given the number of possible operating scenarios for the temporary outfalls, oceanographic modelling was based on the worst-case operating scenario (i.e. all temporary outfalls discharging at the same time, with the MOF present), to ensure that modelling encompassed any likely final operating configuration in terms of outfall locations and flow rates. Table 6-1 summarises simulation conditions as well as diffuser designs.

Table 6-1 Simulations Cases and Outfall Diffuser Design

Diffuser	Current Design	Water Depth Range at Diffuser Location during Operation (min – max) [m]	Flow (m^3/s)
Phase 1	Number of ports: 10 Port diameter: 40.4 mm	0.6 – 4.7	0.074
Phase 2 and 3	Number of ports: 10 Port diameter: 32.3 mm	1.8 – 5.9	0.06
Bridging	Number of ports: 8 Port diameter: 26 mm	1.8 – 5.9	0.03

6.3.2.2 Modelling Results and Interpretation: Near-field Dilution

The near-field dilution was estimated for all temporary outfalls (Phase 1, 2, 3 and bridging) using the PLUMES model developed by United States EPA (Frick *et al.* 2001). Table 6-2 lists calculated diffuser dilutions over the range of operating water depths.

Table 6-2 Diffuser Dilutions

Diffuser	Dilution at Minimum Operating Water Depth	Dilution at Maximum Operating Water Depth
Phase 1	40	>50
Phase 2 and 3	44	>50
Bridging	40	>50

6.3.2.3 Modelling Results and Interpretation: Far-field Dilution

Figure 6-1 shows the dilution contours for the 50^{th}, 80^{th}, and 95^{th} percentiles. Percentiles are evaluated by statistically analysing observed dilution levels over the duration of the simulation case. In summary, the modelling results confirm that under the worst-case predicted operating scenario, 40-fold dilutions can be reasonably achieved within the Zone of High Impact. For operating scenarios with increased depth and/or greater discharge rates, dilution rates greater than 40-fold will be achieved within the Zone of High Impact (KJVG 2010).

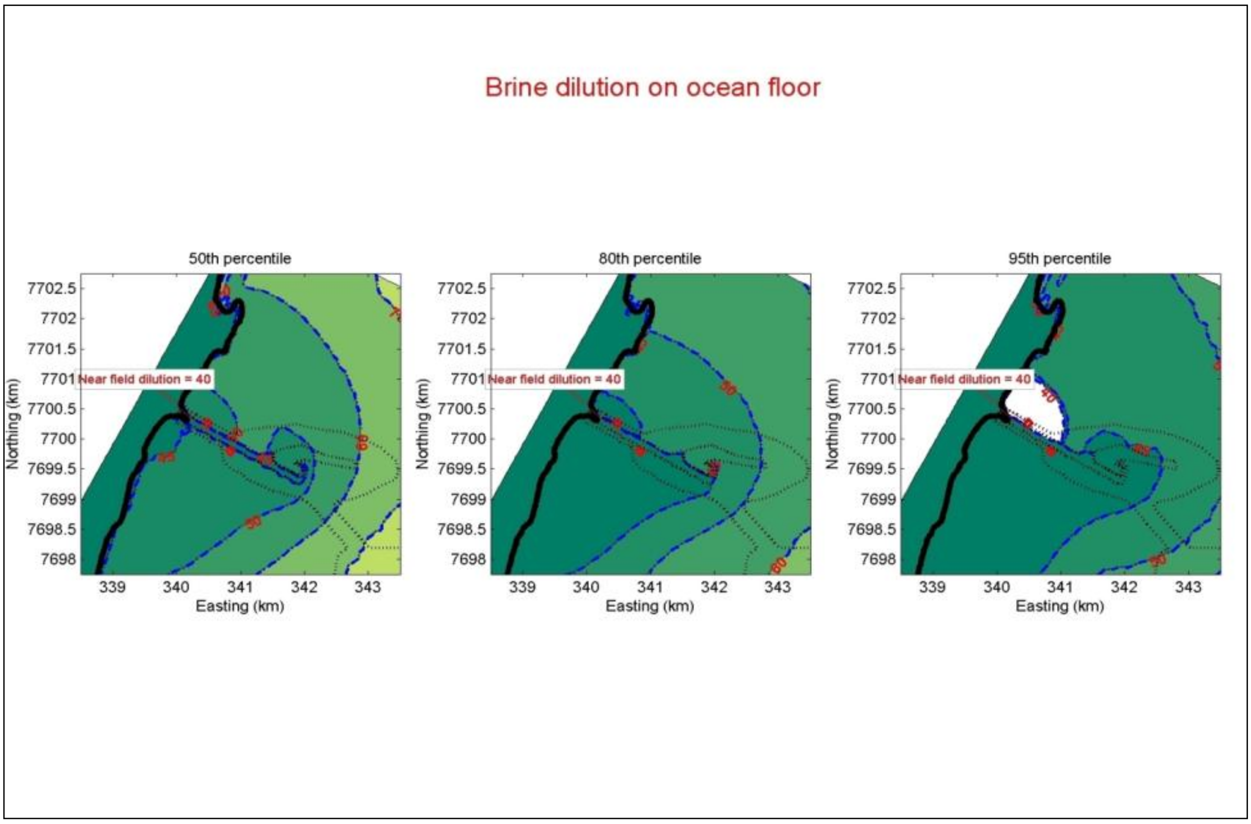

Figure 6-1 Brine Dilution on Ocean Floor

6.3.3 Project Support Vessel Outfalls

6.3.3.1 Modelling Results and Interpretation: Near-field Dilution

The near-field dilution was estimated for PSV outfalls using the Visual Plumes™ model developed by United States EPA (Frick *et al.* 2001). Appendix 7 provides additional details on the monitoring program and modelling input. Figure 6-2 and Figure 6-3 indicate that for ocean current at 0 m/s and 0.1 m/s, 40-fold dilution will be reached within approximately 4 m of the outfall. As the modelling indicated that near-field dilution meets the desired 40-fold dilution factor, far-field modelling was not required.

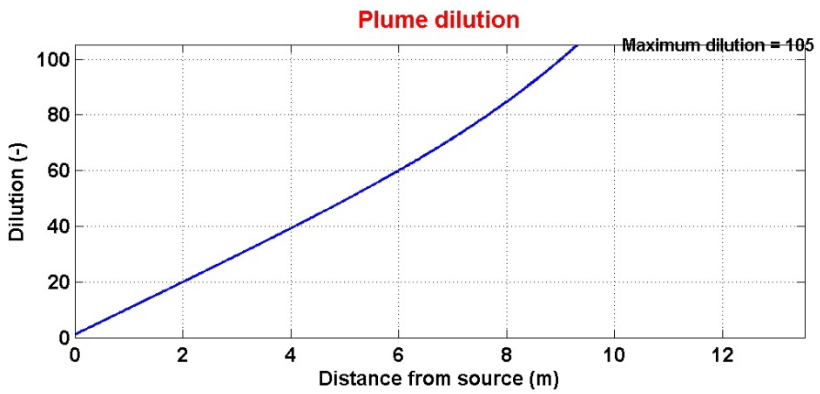

Figure 6-2 Profile View of Brine Dilution, from Source (discharge point) to the Ocean Floor, for a Zero Ocean Current

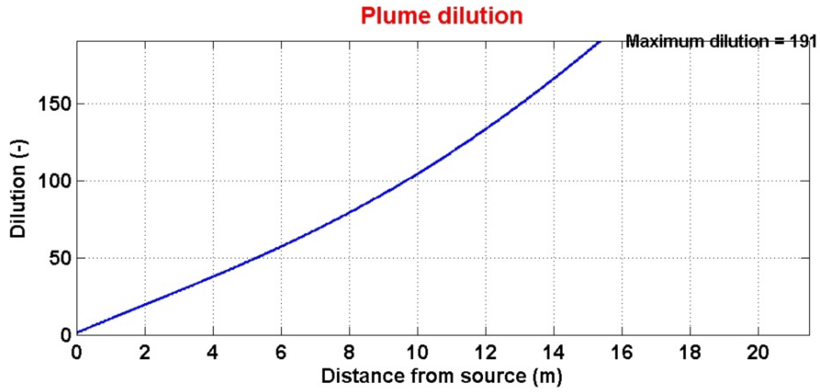

Figure 6-3 Profile View of Brine Dilution, from Source (discharge point) to the Ocean Floor, for a 0.1 m/s Ocean Current

6.3.4 Permanent Outfalls

6.3.4.1 Simulation Cases and Diffuser Design

Modelling for the permanent outfalls used two simulation cases, corresponding to best and worst-case dilution scenarios: brine stream at maximum (0.038 m^3/s) and minimum (0.01 m^3/s) flow rates, respectively.

Outfall diffuser design parameters used in the modelling are shown in Table 6-3.

Table 6-3 Outfall Diffuser Design

Design Parameter	Current Design
Number of ports	6
Port diameter	35 mm
Port depth	0.5 m

6.3.4.2 Modelling Results and Interpretation: Near-field Dilution

The PLUMES model was used to estimate near-field dilution for the permanent outfall. The outcome of the model demonstrated that effective dilution for both simulation cases (i.e. brine stream at maximum and minimum flow rates) were similar, with dilutions of approximately 100-fold achieved in the near field.

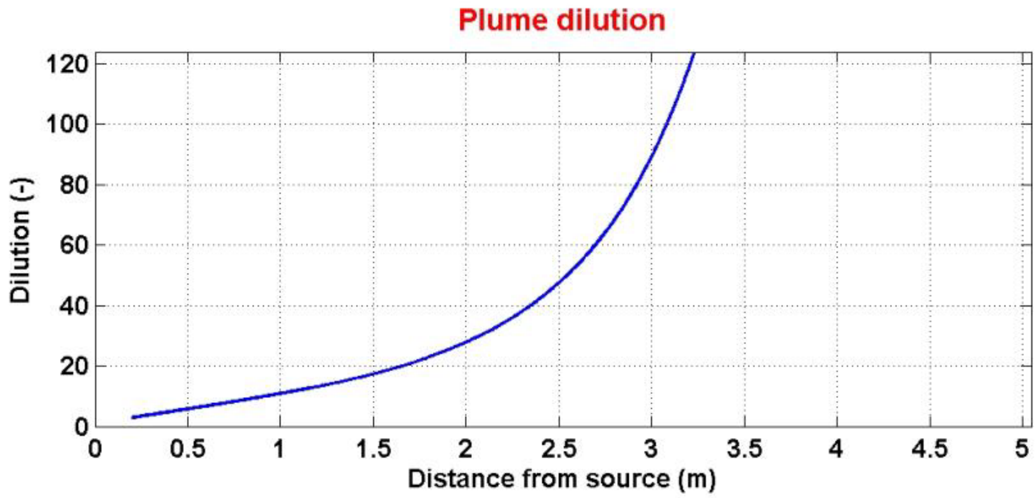

Figure 6-4 Profile View of Brine Dilution, from Source (diffuser) to the Ocean Floor under Minimum Flow Rate

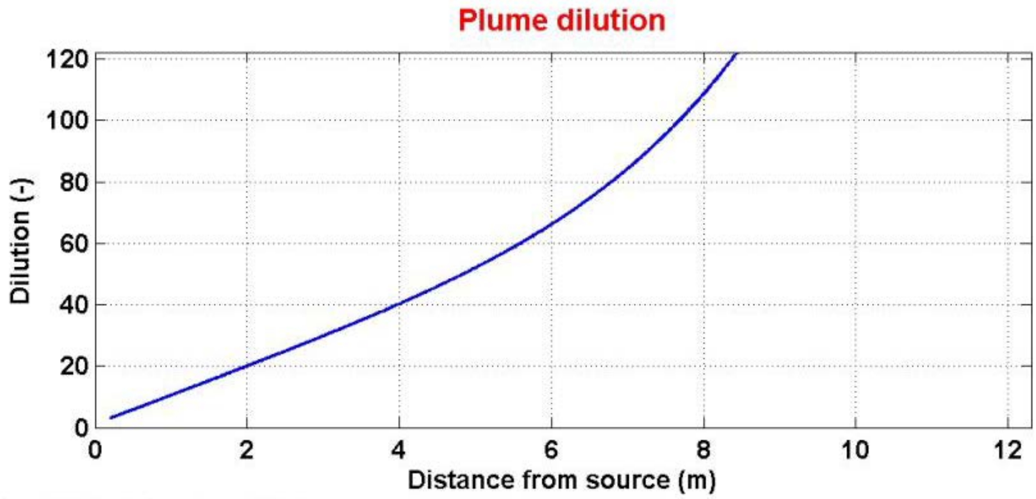

Figure 6-5 Profile View of Brine Dilution, from Source (diffuser) to the Ocean Floor under Maximum Flow Rate

6.3.4.3 Modelling Results and Interpretation: Far-field Dilution

Based on the investigation of near-field dilution through the PLUMES model, effective dilution in the near-field region is 100-fold. Therefore, calculated brine salinity of 35.9 PSU in the near-field region was used to further simulate for dilution in the far-field using DELFT3D. In summary, far-field modelling results confirm there was no build-up of salinity in the area of interest under the worst-case scenario and therefore the dilution achieved in the near-field region is maintained (KJVG 2013).

6.3.5 Cumulative Impacts from Additional Discharges Located in the Vicinity of the Permanent RO Outfall

During the latter stages of construction the temporary, permanent, and PSV RO facilities will run concurrently. In addition, the *Pacific Installer* offshore support and accommodation vessel will be discharging brine and treated wastewater. The *Pacific Installer* (including its seawater intake) will be located within the MOF tug pen. The vessel's discharge line will run across the tug pen breakwater so that it discharges on the eastern seaward side of the tug pen.

As outlined in Sections 6.3.2 and 6.3.3, the temporary RO outfall is expected to achieve 40-fold dilution by the edge of the Zone of High Impact (approximately 70 m from the outfall) and the PSV RO outfall is expected to achieve 40-fold dilution within approximately 4 m from the outfall. The permanent RO outfall attains 100-fold dilution in the almost enclosed berthing area near the diffuser. Modelling undertaken for the *Pacific Installer* Works Approval application (Aurecon Australia 2013) indicates that this vessel's treated effluent should achieve the required dilution within a 10 m mixing zone and its brine is expected to achieve a minimum of 100 dilutions by the time the brine reaches the seabed. As the mixing zones for each of these outfalls do not overlap (see Figure 6-6 for location of outfalls) no cumulative impacts from these discharges are expected. In addition, the MOF creates a physical barrier between the temporary and permanent outfalls.

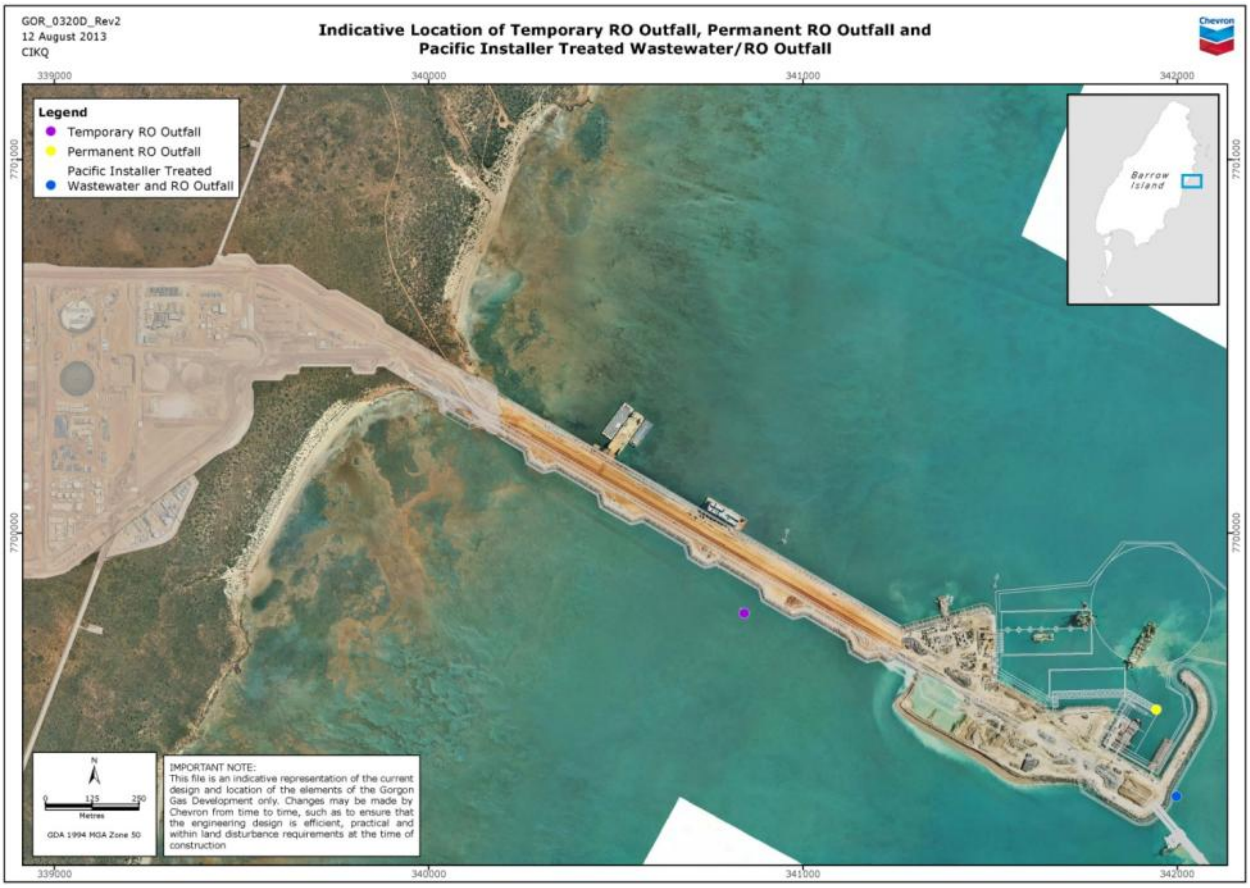

Figure 6-6 Indicative Location of Temporary, Permanent, and PI RO Facility Outfalls

Note: There is no set location for the outfall of the RO units situated on the PSVs. The outfall from these systems will be on the northern side of the MOF structure, within 4 m of the Zone of High Impact (Figure 4-1) and a minimum of 8 m from the permanent RO outfall.

6.4 Whole Effluent Toxicity (WET) Testing

Preliminary toxicity assessments undertaken (see Section 6.1) focused on assessing the toxicity of individual chemical components within effluent streams, as well as a preliminary toxicity assessment of the brine using computer-based predictive modelling. However, to assess the impacts of brine and residual chemicals in combination, a program of ecotoxicological testing of the whole effluents that could potentially be discharged by the temporary RO facilities (Phase 1, 2/3 and bridging) was also undertaken (RPS Environment 2008a).

The ecotoxicological testing program was designed and supervised by an external consultant, RPS Environment, and the WET testing conducted by Ecotox Services Australia in their New

South Wales laboratory. In addition, the WET testing protocol (developed by RPS) and WET test results were peer reviewed by the CSIRO (Stauber 2008).

At the time of initial development of this Plan, a contract had not yet been awarded to a particular RO technology provider; hence WET testing was conducted on a selection of whole effluent combinations that could potentially be produced by temporary RO facilities, based on chemical samples and data provided by four potential RO vendors. The vendor and proposed chemical suite for the permanent RO plant was reviewed and determined to be consistent with the information used in the design of the original WET testing program. Hence, the WET testing is applicable to both the temporary and permanent RO facilities.

The results of the WET testing (RPS Environment 2008a) are included in Appendix 8 and briefly summarised in the following sections.

6.4.1 Designing Simulated Whole Effluents

Given the RO facilities had not been installed at the time the WET testing program was conducted, the actual composition of whole effluents produced by the RO facilities was unknown. Therefore, options for sourcing whole effluents for WET testing included either collecting effluent samples from other operational RO plants, or simulating whole effluents in the laboratory.

The actual composition of an RO plant effluent stream is largely determined by the plant feedwater quality, plant design and specific operational processes such as chemical usage, cleaning and backwash frequencies. Hence, sourcing whole effluents from other operational RO plants would have little relevance in terms of assessing potential toxicological effects at Barrow Island from effluents discharged from the temporary RO facilities (Phase 1, 2/3 and bridging). It was determined more appropriate that whole effluents be simulated in the laboratory.

Samples of proprietary chemicals, estimates of chemical use (for normal operating conditions, backwash and cleaning processes) and expected chemical concentrations within effluent streams, was provided by four potential vendors. Simulated whole effluents were then created by adding a selected combination of chemicals to a brine solution. The brine was created from sea water collected within the vicinity of the proposed MOF at Barrow Island, which was concentrated to 61 ppt via evaporation (based on an assumed RO recovery of 40%).

In all, a total of 26 potential whole effluent combinations were identified, including two control treatments. Given schedule constraints, it was decided to initially test a strategically chosen subset of combinations that were representative of the entire range of whole effluent combinations, and then, based on the results of this subset, a decision would be made regarding the need to test the remaining whole effluent combinations.

Following assessment of all 26 potential effluents, a subset of 12 whole effluent combinations (including two control treatments) were selected for testing. Based on the WET results for these 12 effluents (see Section 6.4.4), it was concluded that no further testing of the remaining whole effluent combinations was required, as the whole effluent combinations tested were no more toxic than just brine. Further details relating to composition of each whole effluent tested are included in Appendix 8.

6.4.2 Test Species

Test species were selected to cover a range of taxonomic groups and trophic levels relevant to Barrow Island. Six marine species were used in seven bioassays to assess the toxicity of 12 simulated whole effluents.

The six major taxonomic groups represented by the species include:

- echinoderms: *Heliocidaris tuberculata*
- molluscs: *Saccostrea glomerata*

- crustaceans: *Penaeus monodon*
- polychaetes: *Diopatra dentata*
- fish: *Lates calcarifer*
- algae: *Isochrysis galbana* (Tahitian isolate).

These species also covered a range of trophic levels:

- primary producers: (*I. galbana*)
- grazers (*H. tuberculata*)
- filter feeders (*S. glomerata*)
- predators (*P. monodon, D. dentata, L. calcarifer*).

Further detail relating to the selection of test species and bioassay preparation is included in Appendix 8.

6.4.3 Statistical Analyses

The statistical analyses undertaken on test data are discussed in detail in Appendix 8. The summaries are listed in the following sections.

6.4.3.1 Estimates of Lethal Concentration (LC)/Effect Concentration (EC)$_{50}$ and LC/EC$_{10}$

The concentration of each simulated whole effluent resulting in 50% mortality or effect in each bioassay (LC_{50} or EC_{50}) was determined by the probit or trimmed Spearman-Karber method in TOXCALC V5.0 software. Similarly, the LC_{10} or EC_{10} estimates (10% mortality or effect) were determined using the probit analysis in the TOXCALC V5.0 software. LC and EC are defined as:

- LC_{50} – Concentration found to be lethal in 50% of a group of test species
- LC_{10} – Concentration found to be lethal in 10% of a group of test species
- EC_{50} – Concentration found to cause a biological effect on 50% of a group of test species
- EC_{10} – Concentration found to cause a biological effect on 10% of a group of test species.

The highest concentration where toxicity was not observed (No Observed Effect Concentration (NOEC)—and the lowest concentration observed causing toxicity (Lowest Observed Effect Concentration (LOEC)—were also determined. However, in line with current practice and the ANZECC and ARMCANZ (2000) guidelines, LC_{10}/EC_{10} estimates were used in the BurrliOZ Species Sensitivity Distribution (SSD) analysis rather than NOEC or LOEC.

As there were no significant differences in toxicity detected among the whole effluent treatments (results are discussed in Section 6.4.4), each whole effluent treatment was treated as one of twelve replicate tests for each bioassay, and the LC_{10} or EC_{10} estimates were averaged within each bioassay. These averages were used in the BurrliOZ Species SSD analysis, following the application of an acute to chronic ratio (ACR).

6.4.3.2 BurrliOZ Species Sensitivity Distribution (SSD) Analysis

The BurrliOZ computer program was used to determine median 99%, 95% and 90% species protection concentrations (PC)—i.e. estimates of PC99, PC95 and PC90—based on fits of the cumulative distributions of species sensitivity with varying concentration of simulated whole effluent to a Burr type III distribution.

The 95% Confidence Interval (CI) estimates for the median PC99, PC95 and PC90 estimates were then determined (Table 6-4).

6.4.4 Results

The WET test results indicate that although there were clear differences in the variation in estimates of LC_{50} or EC_{50} among simulated whole effluents for the different bioassays, there was no indication that any one of the 12 simulated whole effluents was more toxic consistently across bioassays (see Figure 6-7). Thus, the results support the hypothesis that the whole effluent combinations were no more toxic than either of the two control treatments, which consisted of just brine (61 ppt; whole effluent '1' shown in Figure 6-7) or hypochlorite (0.53 mg/L; whole effluent '12' shown in Figure 6-7) in sea water. Therefore, no further testing was undertaken on the remaining possible whole effluent combinations identified.

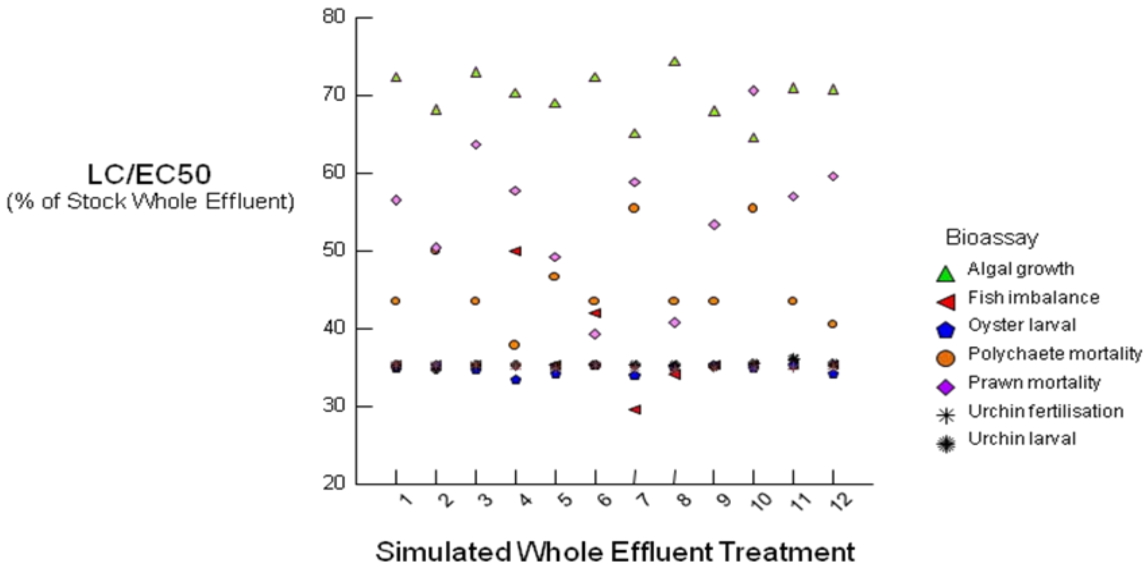

Figure 6-7 Estimates of LC/EC_{50} for Twelve Whole Effluents across Seven Bioassays

The 95% CI estimates of species protection concentrations, calculated with an ACR of both one and two, are included in Table 6-4.

When an ACR of two was applied to the acute LC_{50} data in accordance with ANZECC and ARMCANZ (2000) guidelines, the lower 95% CI estimate of PC99 was 14.2% of the stock whole effluent, meaning that a one-in-seven dilution should provide sufficient dilutions to achieve a 99% species protection level.

When an ACR of two was applied to the acute LC_{10} data, the lower 95% CI estimate of PC99 was 10.3% of the stock whole effluent solution, meaning that a one-in-10 dilution should provide sufficient dilutions to achieve a 99% species protection level.

Table 6-4 95% CI Estimates of Species Protection Concentrations

Species Protection Level	Lower 95% CI Estimate (% of stock whole effluent)			Dilutions Required		
	ACR = 1	ACR = 2*	ACR = 2#	ACR = 1	ACR = 2*	ACR = 2#
PC99	16.2	10.3	14.2	6.2	9.7	7.0
PC95	23.6	12.9	18.0	4.2	7.8	5.6
PC90	24.5	14.1	19.4	4.1	7.1	5.2

Notes:

* *LC_{10} data adjusted by ACR = 2 correction factor*
\# *LC_{50} data adjusted by ACR = 2 correction factor*

An alternative approach for determining protection concentrations was suggested by CSIRO (Stauber 2008) whereby the minimum NOEC is determined and a safety factor of ten applied. Minimum NOEC values (as a percentage of stock whole effluent) for test species are shown in Table 6-5. Applying a safety factor of ten suggests that a 40-fold dilution should provide sufficient dilutions to ensure 99% species protection.

Table 6-5 Minimum NOEC Values

Species	Minimum NOEC
H. tuberculata	25%
S. glomerata	25%
P. monodon	25%
I. galbani	25%
L. calcarifer	25%
D. dentata	25%

6.5 Environmental Impact Assessment – Summary

Based on the results of dilution modelling (Section 6.3) and WET testing (Section 6.4), potential impacts to the marine environment as a result of RO brine discharge from the Gorgon Gas Development temporary and permanent RO facilities are considered low.

WET test results indicate that overall the toxicity of the whole effluent combinations were neither high, nor detectable as different from whole effluents that were composed of just brine or hypochlorite in sea water. The 95% lower CI estimate of PC99 indicates that a 10-fold dilution should provide sufficient dilutions to achieve a 99% species protection level. Applying an alternative approach suggested by CSIRO (Stauber 2008) based on minimum NOEC values with a safety factor of ten indicates that a 40-fold dilution should provide sufficient dilutions to achieve a 99% species protection level.

Additionally, analysis of the potential dilution and spatial dispersion of the temporary, PSV, and permanent outfalls indicates that for the worst-case discharge scenario, the discharged fluid should achieve 40-fold dilution within their respective mixing zones, and thus potential impacts to the marine environment as a result of RO brine discharge undertaken in accordance with this Plan, are considered low and acceptable and will not cause material or serious environmental harm to Barrow Island or its surrounding waters.

7.0 Monitoring Program

Management Triggers have been applied to the monitoring program described in the following sections and are used to inform whether further actions, such as monitoring or management, are required. Management Triggers are not a compliance issue; exceedance of a Management Trigger does not amount to non-compliance with this Plan.

7.1 Baseline Water Quality Monitoring

Water quality in the vicinity of the RO outfalls has been monitored as a part of a number of baseline monitoring programs (Chevron Australia 2012a, RPS 2009a). Baseline monitoring of salinity and water chemistry was completed across seasons during 2008 at three sites (Figure 7-1) – ROWQ1 is located adjacent the MOF in the vicinity of the permanent outfall; ROWQ2 is located in deeper water adjacent to the Lowendal Shelf; and ROWQ3 is located near the turning basin (RPS 2009a).

The concentrations of trace metals in water samples collected were low and predominantly met the environmental quality guidelines for a very high level of ecological protection (99% species protection), as defined by ANZECC and ARMCANZ (2000), with the exception of cobalt. Background concentrations of cobalt were well above the 99% species protection value, which suggests that the guideline Management Trigger for cobalt is too low for Barrow Island waters (RPS 2009a).

A summary of baseline metals concentrations, together with ANZECC and ARMCANZ (2000) Management Trigger values, is included in Table 7-1.

Nutrient concentrations were generally below the ANZECC and ARMCANZ (2000) guideline values, with occasional fluctuations of ammonia, mono-nitrogen oxides and orthophosphate well above guideline values (RPS 2009a).

Salinity of water in the area was fairly consistent through time, ranging from an average of 35.1 to 35.6 ppt (Chevron Australia 2012a, RPS 2009a). There was also very little evidence of stratification, with the difference between surface and bottom measurements differing by at most 0.1 ppt, but often less than this.

Dissolved oxygen (DO) was also fairly consistent, with average values from 6.9 to 8.5 mg/L (RPS 2009a). The difference between DO in surface waters compared to bottom waters was also not great, from 0 to 0.7 mg/L, with most values tending towards the lesser end of this scale. The difference also tended towards showing slightly greater DO in bottom waters, the opposite pattern as predicted under bottom water deoxygenation through stratification (Kelly and Doering 1999, Buzzelli *et al.* 2002, Park *et al.* 2007). The one exception was during November 2008, where surface waters (to about 2 m depth) had greater DO than previously recorded, although the rest of the water column was similar to that previously recorded (RPS 2009a).

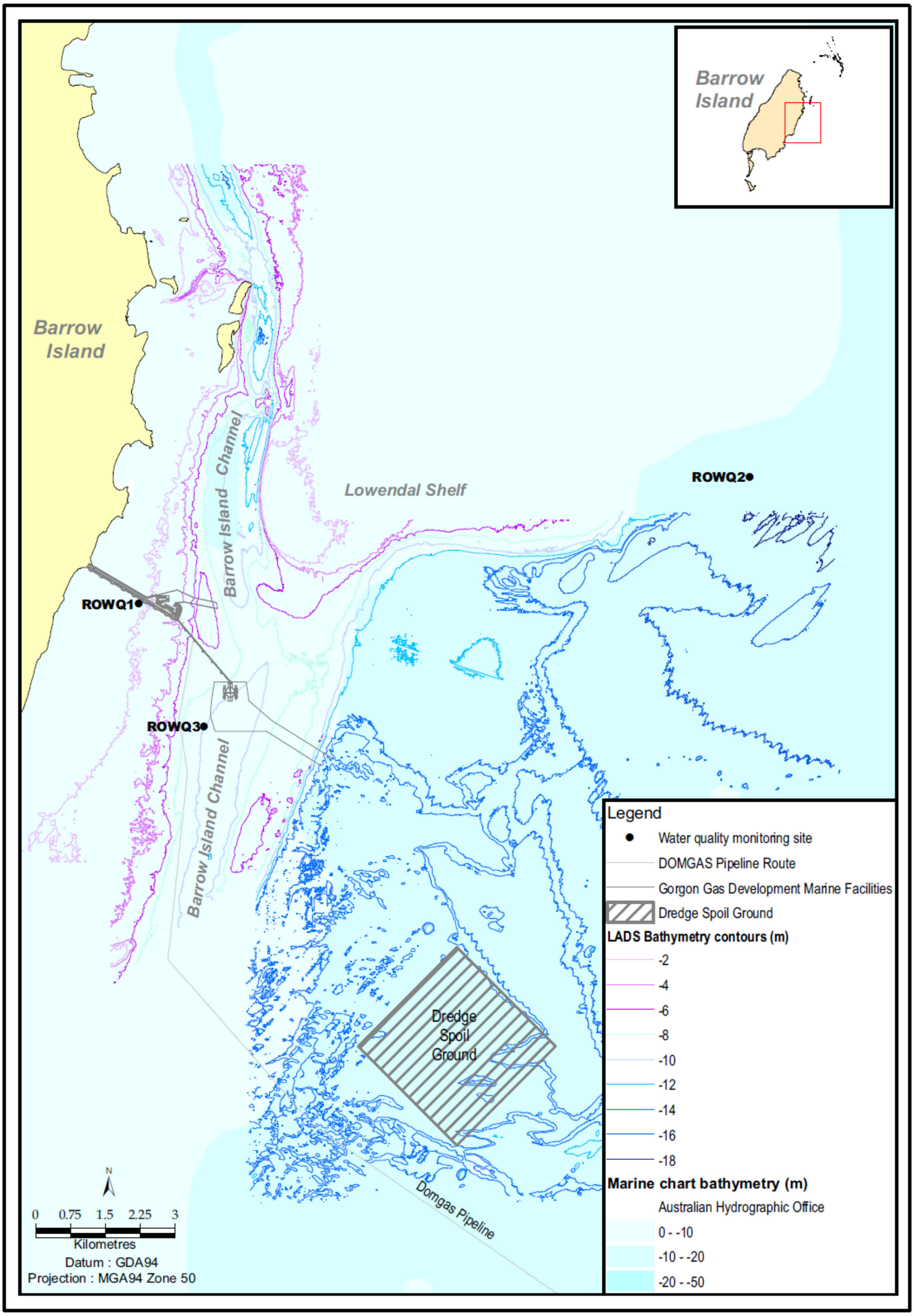

Figure 7-1 Location of Baseline Monitoring Sites for Salinity and Chemical Composition of Sea Water

Table 7-1 Summary of Baseline Water Quality with Management Trigger Values for Toxicants and Alternative Levels of Protection

Analytes	Unit	99% Species Protection#	95% Species Protection#	Limit of Reporting (CSIRO)	Annual Mean	Standard Deviation
Aluminium	µg/L	ID	ID	1	1.4	0.5
Arsenic	µg/L	ID	ID	0.11	1.4	0.2
Barium	µg/L	NA	NA	0.05	6.3	0.1
Calcium	mg/L	NA	NA	1	480.0	0.0
Cadmium	ng/L	700[B, H]	5500[B, C, H]	0.1	3.0	0.6
Total Chromium	µg/L	7.7, 0.14	27.4, 4.4	0.1	0.2	0.0
Cobalt	ng/L	5	1000	1	15.0	4.8
Copper	ng/L	300[H]	1300[H]	3	74.8	1.3
Iron	µg/L	ID	ID	1	1.0	0.2
Lead	ng/L	2200[H]	4400[H]	11	13.2	8.8
Magnesium	mg/L	NA	NA	1	1600.0	0.0
Manganese	µg/L	ID	ID	0.04 – 0.20	0.3	0.1
Mercury	ng/L	100[B]	400[B]	0.1	0.3	0.1
Molybdenum	µg/L	ID	ID	0.14	9.7	1.4
Nickel	ng/L	7000[H]	70000[C, H]	5	155.9	12.2
Potassium	mg/L	NA	NA	1	510.0	0.0
Selenium	µg/L	ID[B]	ID[B]	0.03	0.0	0.0
Silver	ng/L	800	1400	0.3-2	1.3	0.8
Strontium	mg/L	NA	NA	0.1	8.9	0.1
Tin	µg/L	ID	ID	0.002 – 0.02	0.1	0.0
Vanadium	µg/L	50	100	0.03	1.6	0.2
Zinc	ng/L	7000[H]	15000[C, H]	43	108.3	136.3

 # Source: From Chapter 3, Table 3.4.1 in ANZECC and ARMCANZ (2000)

Notes:

NA denotes trigger value not available for chemical analysis

ID denotes insufficient data to derive a reliable trigger value (ANZECC and ARMCANZ 2000)

B chemicals for which possible bioaccumulation and secondary poisoning effects should be considered

C value may not protect key test species from chronic toxicity (this refers to experimental chronic values or geometric mean for species)

H chemicals for which algorithms have been provided in Table 3.4.3 of ANZECC and ARMCANZ (2000) to account for the effects of hardness. The values have been calculated using a hardness of 30 mg/L $CaCO_3$. These should be adjusted to the site-specific hardness.

Trigger values for mercury are for inorganic mercury. Insufficient data for methyl mercury trigger value.

7.2 Temporary RO Facility Ocean Outfall Monitoring

The previous revision of this Plan outlined requirements for temporary ocean outfall monitoring. The key objective for monitoring the temporary outfalls was to validate the brine dilution modelling completed for the temporary RO outfall and determine whether the expected dilution of brine is achieved at the edge of the Zone of High Impact surrounding the MOF, over a range of operating conditions. This objective was achieved through the fortnightly collection of water quality parameters (salinity, dissolved oxygen, temperature, and pH) through the water column. Monitoring was completed at ten routine monitoring sites (prior to installation of the MOF) and five routine monitoring sites (after installation of the MOF) on the boundary of the Zone of High Impact and at two reference sites (each with three separate stations) located 5 km north and south of the ocean outfall (Figure 7-3).

Figure 7-2 shows the maximum salinity values recorded at routine and reference sites since the commencement of operation of the Phase 2/3 and Bridging RO facilities. The data indicates that the brine is consistently achieving the target dilution level (i.e. 40-fold dilution). Most of the instances where salinity at the routine monitoring sites exceeds the salinity trigger level (36.1 ppt) appear to be related to a seasonal trend, as elevated values were recorded at both routine and reference sites on these occasions (generally November-December each year).

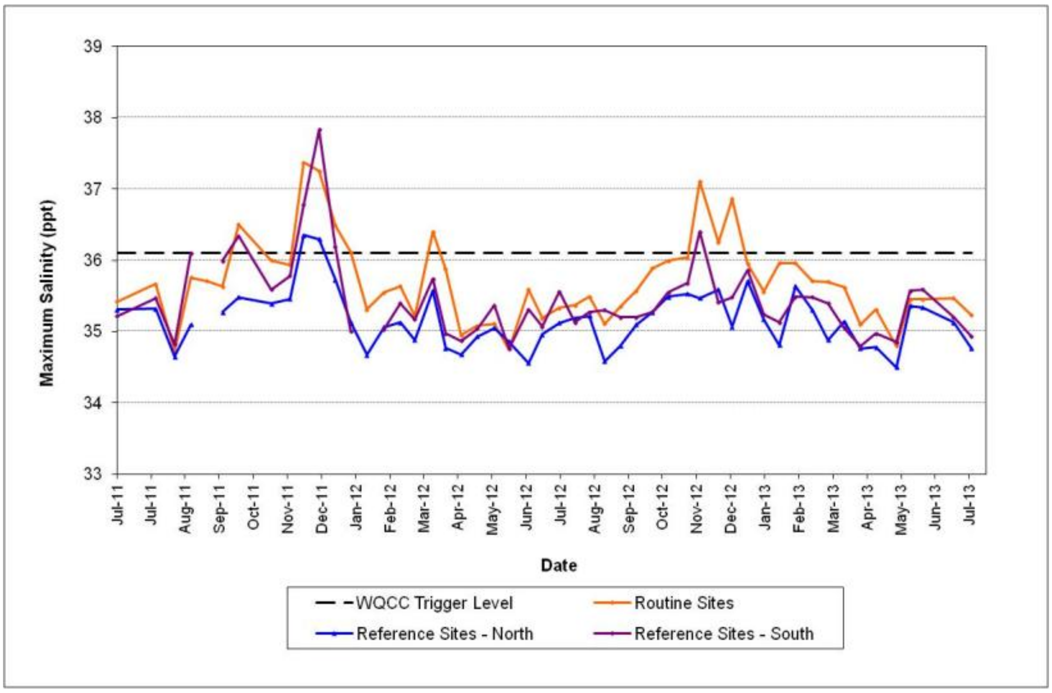

Figure 7-2 Maximum Salinity for Routine and Reference Sites Recorded via the Temporary RO Facility Ocean Outfall Monitoring Program (July 2011 to July 2013)

The ocean outfall monitoring data shown in Figure 7-2 validates the brine dilution modelling completed for the temporary RO outfall, and confirms that the constructed outfall achieves 40-fold dilution. As a result, ocean outfall monitoring for the temporary outfall is no longer required. See Sections 7.4 and 7.5 for details of the ongoing monitoring of brine quality to be completed at the temporary RO facilities.

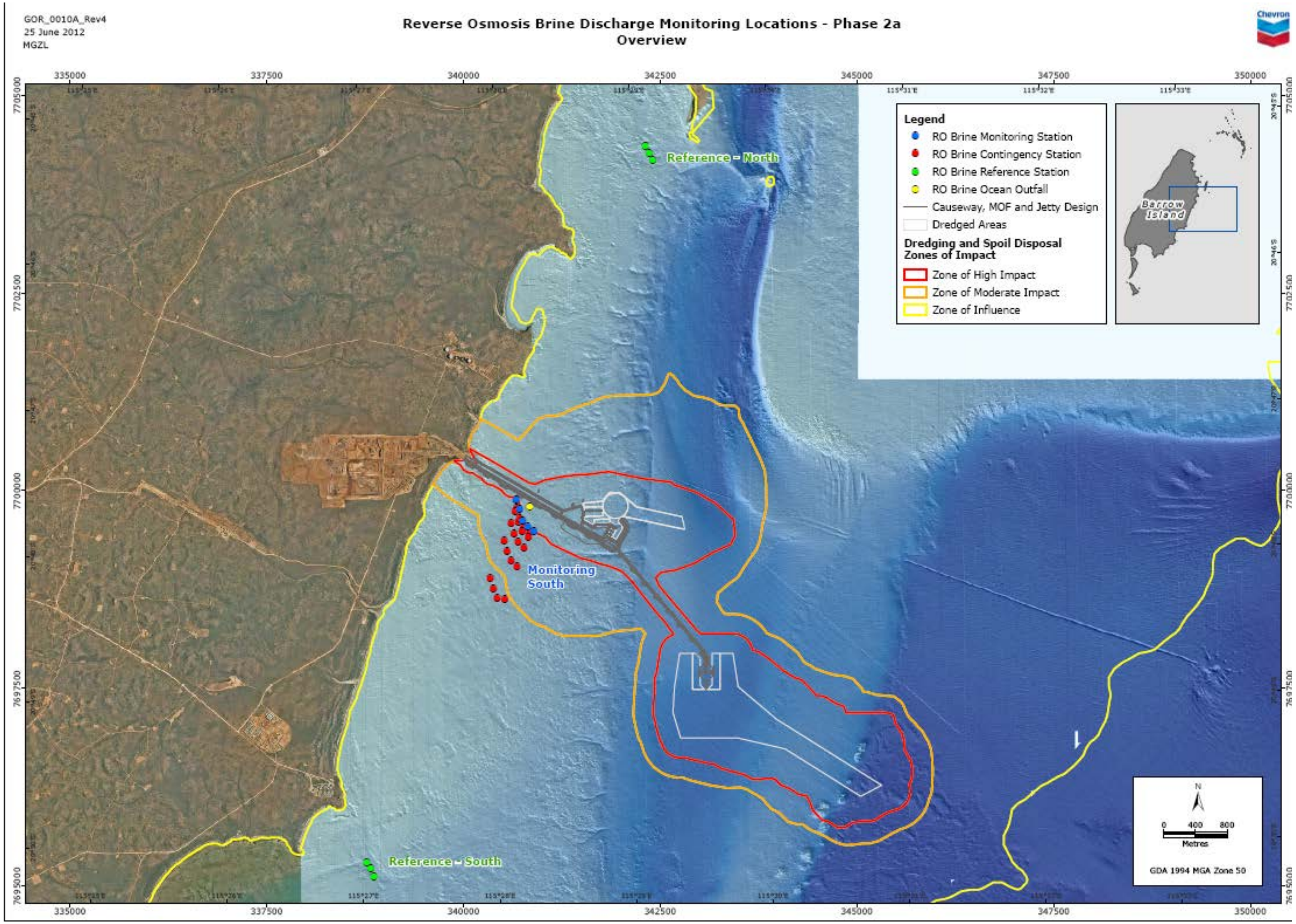

Figure 7-3 Location of Temporary Ocean Outfall Monitoring Sites (after installation of the MOF)

7.3 Seawater Intake Monitoring

Visual inspection of the Temporary and PSV seawater intakes for injured or dead marine fauna trapped within an intake will be undertaken where practicable, with due consideration of other marine activities occurring in the area, and associated safety and logistical considerations applicable to an active construction and/or operational site. It is anticipated that visual inspection of the Temporary and PSV seawater intakes will be undertaken during regular maintenance inspections of intake structures, which are expected to occur at least quarterly.

Records of inspections, including the presence or absence of any injured or dead marine fauna trapped within an intake, will be maintained. Records of seawater intake inspections will be made available to Parks and Wildlife and DotE, upon request.

In the event that injured marine fauna are observed to be trapped within an intake, a nominated Chevron representative will be advised and action strategies will be aligned with those for marine fauna as detailed in the Fauna Handling and Management Common User Procedure (Chevron Australia 2013), as amended from time to time. Removal of entrained fauna from an intake will be undertaken, where practicable, so as to avoid trapped or distressed fauna acting as an attractant for other marine fauna.

Incident reporting requirements for marine fauna (including marine turtles) mortalities are included in Section 10.2.4 of this Plan.

7.3.1 Management Triggers

Adaptive management responses that relate to marine turtle incidents (injury or mortality) associated with operation of seawater intakes will follow an incident investigation and action process aligned with a series of tiered response principles as presented in Section 10.4.4 of the Long-term Marine Turtle Management Plan (Chevron Australia 2012a), as amended from time to time under that Plan.

Adaptive management responses that relate to other marine fauna (excluding turtles) incidents associated with operation of the seawater intakes will follow an incident investigation and action process as detailed below:

- **Level 1 – An injured or dead marine fauna individual is found that is attributable to operation of a seawater intake.**

  Should it be determined that current management measures are not being followed, appropriate action shall be taken to correct this deficiency. If management measures are being followed, an increased frequency of seawater intake inspections shall be implemented, where practicable.

- **Level 2 – More than one injured or dead marine fauna individual is found on two consecutive inspections that are attributable to operation of a seawater intake.**

  Alternative or additional practical management measures to prevent entrainment of marine fauna will be investigated and implemented, where practicable.

- **Level 3 – A large injured or dead marine fauna individual (e.g. cetacean, dugong) is found that is attributable to operation of a seawater intake.**

  Immediate action shall be taken to implement alternative and/or additional management measures in consultation with Parks and Wildlife to prevent entrainment of marine fauna.

7.4 Temporary and Permanent RO Monitoring of System Performance

RO system performance parameters are available to the facility operator via the package control system and will be inspected as part of routine operator checks. These parameters will include pH, conductivity and temperature, as these are relevant to the environmental impact of brine discharge. Flow meters will also be used to record the volume of brine discharge. Operator checks are expected to occur daily; however, they may occur less frequently (e.g. every two or three days) during periods where ongoing reliable RO facility performance has been established.

7.4.1 Management Triggers

Adaptive management responses for monitoring of RO system performance are detailed below. The expected ranges for the performance parameters are provided in Table 7-2:

- **Level 1 – A performance parameter relevant to environmental impact of brine discharge is observed to be outside the expected range during a single routine operator check of the RO facility.**

  An inspection of the RO facility will be undertaken and adjustments to the facility made as determined appropriate by the operator.

- **Level 2 – A performance parameter relevant to environmental impact of brine discharge is observed to be outside the expected range for five consecutive operator checks of the RO facility.**

  An investigation into the cause of the out of range readings will be undertaken. Where the cause is identified to be related to the operation of the RO facility, appropriate corrective action will be taken. This may include an investigation into the reason for the exceedance, a review of the risks associated with the changed parameter (to understand and mitigate the cause of the change); field monitoring; and/or additional management or mitigation measures.

Table 7-2 Expected Range for RO System Performance Parameters

RO System Performance Parameters	Expected Range
pH	7 – 8.5
Conductivity	<95 ms/cm
Temperature	20 – 34.9 C

7.5 PSV RO Monitoring of System Performance

RO system performance parameters will be recorded routinely, at least monthly, and include pH, conductivity, temperature and flow, as these are relevant to the environmental impact of brine discharge.

7.5.1 Management Triggers

Adaptive management responses for the PSV RO system performance are detailed below. The expected ranges for the performance parameters are provided in Table 7-3:

- **Level 1 – A performance parameter relevant to environmental impact of brine discharge is observed to be outside the expected range during a single check of the RO facility.**

  An inspection of the RO facility will be undertaken and adjustments to the facility made as determined appropriate by the operator.

- **Level 2 – A performance parameter relevant to environmental impact of brine discharge is observed to be outside the expected range for two consecutive checks of the RO facility.**

An investigation into the cause of the out of range readings will be undertaken. Where the cause is identified to be related to the operation of the RO facility, appropriate corrective action will be taken. This may include an investigation into the reason for the exceedance, a review of the risks associated with the changed parameter (to understand and mitigate the cause of the change); field monitoring; and/or additional management or mitigation measures.

Table 7-3 Expected Range for RO System Performance Parameters

RO System Performance Parameters	Expected Range
pH	7 – 8.5
Conductivity	<95 ms/cm
Temperature	20 – 34.9 °C

7.6 Chemical Analysis of Brine

A sample of reject brine will be collected quarterly from each RO facility and analysed for pH, nutrients, and metals to check that brine discharge parameters are within expected discharge values. The brine samples will be collected from the RO facilities just prior to discharge to the outfall (e.g. from the brine holding tank).

Analyses of brine samples will be undertaken by National Association of Testing Authorities (NATA) certified laboratories.

7.6.1 Management Triggers

Adaptive management responses that relate to the chemical analysis of brine are detailed below:

- **Level 1 – A contaminant is outside the expected range of discharge values for a single monitoring event.**

  Undertake initial investigation into the exceedance. This trigger does not preclude immediate management action.

- **Level 2 – A contaminant is outside the expected range of discharge values for two consecutive monitoring events.**

  Take management action, which will include resampling within a month of being notified of the exceedance and investigation into the reason for the exceedance. A review of the risks associated with the changed parameter (to understand and mitigate the cause of the change); field monitoring; and/or additional management or mitigation measures may also be considered.

- **Level 3 – A contaminant is outside the expected range of discharge values for three consecutive monitoring events.**

  Report Level 3 trigger exceedance to Parks and Wildlife and DotE (within seven days of being notified of the exceedance). Continue to take management action, which may include investigating the reason for the exceedance; reviewing the risks associated with the changed parameter with the aim of trying to understand and mitigate the cause of the change; further field monitoring; and/or additional management or mitigation measures identified in consultation with Parks and Wildlife and DotE.

7.7 Permanent RO Facility Ocean Outfall Monitoring

The key objective of monitoring the permanent outfall is to validate the brine dilution modelling completed for the permanent RO outfall and determine whether the expected dilution of brine is achieved at the boundary of the LEPA, over a range of operating conditions. This can be achieved via the regular measurement of water quality at the edge of the LEPA, with salinity used as the key indicator of dilution.

Consistent with the temporary ocean outfall monitoring program, the monitoring of sediments has been excluded from the permanent ocean outfall monitoring program for these reasons:

- Baseline monitoring of water quality indicates very low concentrations of trace metals (RPS 2009a) and it is considered unlikely that metals will be present in significantly elevated levels in brine discharged from the RO facilities.
- During the construction period, other marine activities will be occurring in the area of brine discharge including vessel movements, anchoring, rock dumping, and construction of the MOF. Sediment movement is expected within the LEPA as a result of these construction activities.
- The design of the outfall is based on achieving a minimum of 40-fold dilution within the LEPA, and therefore it is considered unlikely that trace metals would settle out of the discharged brine and accumulate in sediments at significantly elevated levels beyond the LEPA.

7.7.1 Water Quality Parameters

Salinity is the most relevant potential ecological stressor on the local environment (i.e. hypersalinity) as indicated by the WET testing summarised in Section 6.4 (RPS 2008a). Therefore, as a minimum, salinity will be measured and used as the key indicator of whether the expected dilution is being achieved at the edge of the LEPA. Other water quality parameters that may be measured in the field are likely to include dissolved oxygen, temperature, and pH.

7.7.2 Water Quality Management Triggers

The water quality Management Trigger at the edge of the LEPA is presented in Table 7-4.

A flow chart illustrating the process that will be followed in the event of an exceedance of the water quality Management Trigger at the edge of the LEPA is provided in Figure 7-4.

Table 7-4 Water Quality Management Trigger

Water Quality Parameter	Environmental Quality Management Trigger	Location
Salinity	The median salinity measured at each location does not exceed the median salinity at the reference sites by more than 1.2 parts per thousand.	Routine sites located along the edge of the LEPA

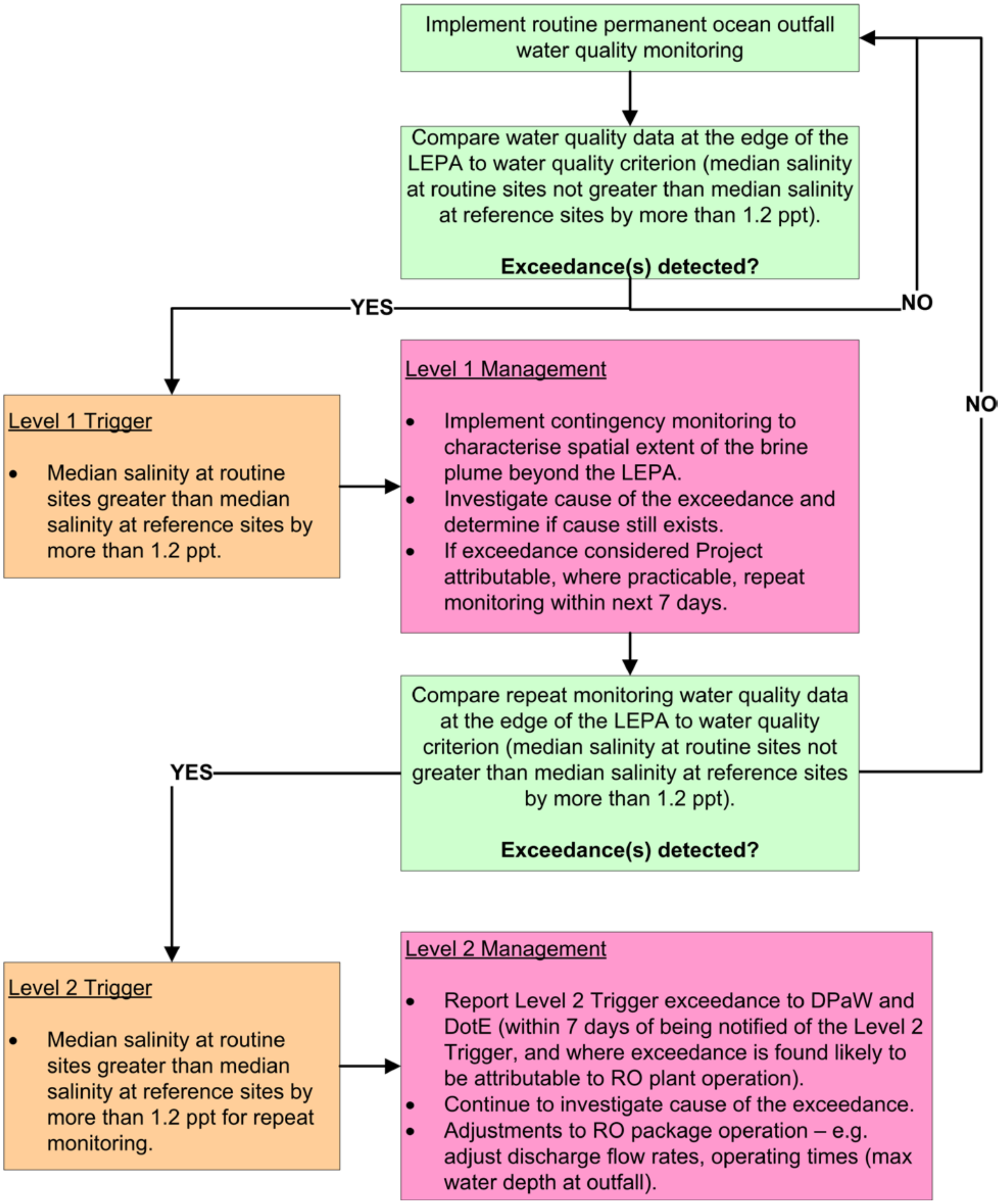

Figure 7-4 Water Quality and Management Flow Chart

7.7.3 Monitoring Methodology

Monitoring of ocean outfalls is to be conducted using a small vessel and water quality meter. It is intended to use a conductivity, temperature, depth (CTD) meter with auxiliary sensors (for dissolved oxygen and pH) to measure the selected water quality parameters (salinity, dissolved oxygen, temperature and pH). Probes are calibrated every six months and are expected to be stable over this period. A computer program that has been calibrated against the probe is used to convert signals from the meter into a data file containing the water quality parameters. This conversion is done automatically and requires no human intervention, thus eliminating potential transcription, or other data handling errors. At each monitoring location, the CTD meter will record measurements through the water column.

7.7.4 Monitoring Locations

Water quality monitoring for discharge of brine via the permanent RO outfall will occur at five locations along the boundary of the LEPA. Indicative monitoring locations are shown in Figure 4-3.

In addition, water quality will be monitored at least two reference sites. The location of reference sites will be based on these criteria:

- located beyond any influence of brine discharge as indicated by modelling
- located away from other brine discharges (i.e. vessels with operating RO facilities)
- located in a similar depth to the outfall
- readily accessible by a survey vessel.

As indicated in the water quality and management flow chart (Figure 7-4), in the event that the water quality criterion is exceeded at a monitoring location, water quality will be measured at additional sites moving further away from the LEPA, in order to characterise the spatial extent of the brine plume. The number of locations measured beyond the LEPA may be affected by other marine activities occurring in the area, and associated safety and logistical constraints.

GPS coordinates of all monitored sites will be recorded.

7.7.5 Monitoring Frequency

Water quality parameters (salinity, dissolved oxygen, temperature and pH) will be measured approximately fortnightly at each location for the first year of brine discharge via the permanent RO outfall. Ocean outfall monitoring will cease once there has been a twelve-month period without a Level 2 trigger and a review of the data validates the discharge modelling and confirms that the expected level of dilution is being achieved.

Over this period, it is expected that a variety of RO facility running conditions (e.g. normal running, cleaning) and different tidal regimes (e.g. neap, spring) will be adequately sampled.

8.0 Objectives, Performance Standards, and Relevant Documentation

8.1 Overview

This section summarises the environmental objectives, performance standards, and relevant documentation that have been developed as part of a systematic approach to the management of environmental risks. Specific objectives, performance standards, and documentation will be used to assess the overall environmental performance for the Gorgon Gas Development and Jansz Feed Gas Pipeline against the stated environmental objectives.

Table 8-1 details the objectives, performance standards, and documentation that relate to this Plan.

8.2 Objectives

Chevron Australia is committed to conducting activities associated with the Gorgon Gas Development and Jansz Feed Gas Pipeline in an environmentally responsible manner, and aims to implement best practice environmental management as part of a program of continual improvement. To meet this commitment, objectives have been defined that relate to the management of the identified environmental risks for the Gorgon Gas Development.

Table 8-1 details the objectives specific to this Plan.

8.3 Performance Standards

Performance standards are the measures Chevron Australia will use to assess whether or not it is meeting its objectives. For each objective and element of each objective, Chevron Australia has described a matter (‘description’) that will be measured, and a quantitative target or, where there is no practicable quantitative target, a qualitative target, which is to be measured against when assessing whether the objective has been met. These targets have been developed specifically for assessing performance, not compliance, and so failure to meet the target does not represent a breach of this Plan. Rather, it indicates that an objective may not have been met and there may be a need for management action or review of this Plan.

Table 8-1 details the performance standards specific to this Plan.

8.4 Relevant Documentation

Chevron Australia has defined the relevant documentation that contains information about whether the performance standards have been met.

Table 8-1 details the relevant documentation specific to this Plan.

Table 8-1 Objectives, Performance Standards, and Relevant Documentation

Objectives	Performance Standards		Evidence/Relevant Documentation
	Description	Target	
Demonstrate that brine disposal via ocean outfall undertaken in accordance with this Plan will not cause Material or Serious Environmental Harm to Barrow Island and its surrounding waters.	Implement the design features, management and monitoring measures described in the Reverse Osmosis Brine Disposal via Ocean Outfall Environmental Management and Monitoring Plan (this Plan)	100% implementation of the design features, management and monitoring program, identified in the Plan.	Annual Compliance Assessment Report Monitoring results obtained as per the requirements of the Reverse Osmosis Brine Disposal via Ocean Outfall Environmental Management and Monitoring Plan.
	Detect seawater intake-attributed harm or mortalities of marine fauna	No Level 2 or Level 3 Triggers associated with temporary seawater intakes. 100% reporting of any detected mortality of any marine fauna declared under Section 14 (4) of the *Wildlife Conservation Act 1950* (WA) within 48 hours to Parks and Wildlife. 100% reporting of any detected mortality of any EPBC Act listed marine fauna attributed to seawater intakes within 24 hours to DotE.	Incident reports Annual Compliance Assessment Report Monitoring results obtained as per the requirements of the Reverse Osmosis Brine Disposal via Ocean Outfall Environmental Management and Monitoring Plan.
	Ocean outfall monitoring validates brine dilution modelling and confirms the expected dilution of brine is achieved	Achieve a minimum 40-fold dilution (99% species protection level) of the discharged brine by the edge of the Zone of High Impact/LEPA.	Monitoring results obtained as per the requirements of the Reverse Osmosis Brine Disposal via Ocean Outfall Environmental Management and Monitoring Plan.

9.0 Implementation

9.1 Environmental Management Documentation

9.1.1 Overview

Figure 1-3 in Section 1.5.4 of this Plan shows the hierarchy of environmental management documentation within which this Plan exists. The following sections describe each level of documentation in greater detail.

9.1.2 Chevron ABU OE Documentation

As part of the Chevron ABU, the Gorgon Gas Development is governed by the requirements of the ABU OEMS, within which a number of OE Processes exist. The Gorgon Gas Development will implement internally those OE Processes (and supporting OE Procedures) that apply to the Gorgon Gas Development activities, where those Processes are appropriate and reasonably practicable.

The key ABU OE Processes taken into account during the development of this Plan, with a description of the intent of each Process, are:

- **HES Risk Management Process** (Chevron Australia 2012c): Process for identifying, assessing and managing HES, operability, efficiency and reliability risks related to the Gorgon Gas Development.
- **Environmental Stewardship Process** (Chevron Corporation 2007): Applies during the Operations Phase of the Gorgon Gas Development and Jansz Feed Gas Pipeline. Process for ensuring all environmental aspects are identified, regulatory compliance is achieved, environmental management programs are maintained, continuous improvement in performance is achieved, and alignment with ISO 14001:2004 (Standards Australia/Standards New Zealand 2004a) is achieved.
- **Hazardous Communication Process** (Chevron Australia 2006a): Process for managing and communicating chemical and physical hazards to the workforce.
- **Management of Change Process** (Chevron Australia 2008a): Process for assessing and managing risks stemming from permanent or temporary changes to prevent incidents.
- **Contractor Health, Environment, and Safety Management Process** (Chevron Australia 2010a): Process for defining the critical roles, responsibilities and requirements to effectively manage contractors involved with the Gorgon Gas Development and Jansz Feed Gas Pipeline.
- **Competency Development Process** (Chevron Australia 2010b): Process for ensuring that the workforce has the skills and knowledge to perform their jobs in an incident-free manner, and in compliance with applicable laws and regulations.
- **Incident Investigation and Reporting Process** (Chevron Australia 2010c): Process for reporting and investigating incidents (including near misses) to reduce or eliminate root causes and prevent future incidents.
- **Emergency Management Process** (Chevron Australia 2010d): Process for providing organisational structures, management processes and tools necessary to respond to emergencies and to prevent or mitigate emergency and/or crisis situations.
- **Compliance Assurance Process** (Chevron Australia 2009b): Process for ensuring that all HES and OE-related legal and policy requirements are recognised, implemented, and periodically audited for compliance.

9.1.3 Gorgon Gas Development Documentation

9.1.3.1 Ministerial Plans and Reports

In addition to this Plan, a number of other plans and reports have been (or will be) developed for the Gorgon Gas Development that are required under State and/or Commonwealth Ministerial Conditions (see Figure 1-3). These documents address the requirements of specific conditions and provide standards for environmental performance for the Gorgon Gas Development.

9.1.3.2 Common User Procedures

The Gorgon Gas Development Common User Procedures support the Ministerial plans and reports, and specify more detailed requirements and relevant considerations for specific environmental issues. The Common User Procedure that supports this Plan is:

- Fauna Handling and Management Common User Procedure (Chevron Australia 2013).

9.1.3.3 Environmental Management Plans

A number of activity-specific environmental management plans (EMPs) are required under Ministerial Conditions (see Figure 1-3); however, other internal work scope EMPs are also being developed to effectively manage specific work scopes for the Gorgon Gas Development. These work scope EMPs will be developed and implemented such that any requirements specified in higher level documents (such as this Plan) are met.

Gorgon personnel, including contractors and subcontractors, involved in a particular scope of work for the Gorgon Gas Development are internally required to comply with the work scope EMP associated with that work scope, where reasonably practicable.

9.1.3.4 Impact Mitigation Strategies

Impact Mitigation Strategies (IMSs) are aspect-based management standards that accompany the activity-specific EMPs (see Figure 1-3). The IMSs document the detailed management requirements associated with potential impacts for the Gorgon Gas Development. Each IMS covers a particular environmental aspect that requires management (e.g. light, noise and vibration, atmospheric emissions, etc.).

Personnel (including contractors and subcontractors) involved in that particular scope of work are internally required to comply with the IMSs where reasonably practicable. The IMSs also document requirements for contractors to develop internal work scope EMPs for the Gorgon Gas Development, which include work procedures (such as step-by-step procedures and work method statements) to mitigate their impacts.

9.1.3.5 Contractor and Subcontractor Documentation

A variety of internal Chevron Australia, contractor and subcontractor documentation will be developed, including documents such as task-specific work instructions, procedures, work method statements, and Job Hazard Analyses. These detailed documents will specify the way activities shall be performed in a step-by-step manner.

These procedural documents are specific to the Gorgon Gas Development (where required) and include any environmental requirements that are detailed in higher level documentation relevant to a specific scope of work (i.e. the IMSs and EMPs described in the previous sections).

9.2 Training and Inductions

All personnel (including contractors and subcontractors) are required to attend environmental inductions and training relevant to their role on the Gorgon Gas Development. Training and induction programs facilitate the understanding personnel have of their environmental responsibilities, and increase their awareness of the management and protection measures required to reduce potential impacts on the environment.

Chevron Australia has prepared the ABU OE Competency Development Process (Chevron Australia 2010b) to deal with the identification and assessment of required competencies for environmental roles, which it internally requires its employees, contractors, etc. to comply with.

Environmental training and competency requirements for personnel, including contractors and subcontractors, are maintained in a Gorgon Gas Development HES training matrix or the Competency Management System for operations personnel.

10.0 Auditing, Reporting, Review

10.1 Auditing

10.1.1 Internal Auditing

Chevron Australia has prepared the internal ABU Compliance Assurance Process (Chevron Australia 2009b) to manage compliance, and which it internally requires its employees, contractors, etc. to comply with. This Process will also be applied to assess compliance of the Gorgon Gas Development against the requirements of Statement No. 800, and EPBC Reference: 2003/1294 and 2008/4178 where this is appropriate and reasonably practicable.

An internal Audit Schedule has been developed and will be maintained for the Gorgon Gas Development and (with input from the Engineering, Procurement and Construction Management [EPCM] Contractors) that includes audits of the Development's environmental performance and compliance with the Ministerial Conditions. A record of all internal audits and the audit outcomes is maintained. Actions arising from internal audits are tracked until their close-out.

Under EPBC Reference: 2003/1294 and 2008/4178, Condition 24 also requires that the person taking the action must maintain accurate records of activities associated with or relevant to the conditions of approval and make them available on request by DotE. Such documents may be subject to audit by DotE and used to verify compliance with the conditions of approval.

Any document that is required to be implemented under this plan will be made available upon request to the relevant Parks and Wildlife and/or DotE auditor.

10.1.2 External Auditing

Audits and/or inspections undertaken by external regulators will be facilitated via the Gorgon Gas Development and Jansz Feed Gas Pipeline's Regulatory Approvals and Compliance Team. The findings of external regulatory audits will be recorded and actions and/or recommendations will be addressed and tracked. Chevron Australia may also undertake independent external auditing during the Gorgon Gas Development and Jansz Feed Gas Pipeline Project.

Under EPBC Reference: 2003/1294 and 2008/4178, Condition 23 also requires that upon the direction of the Minister, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.

10.2 Reporting

10.2.1 Compliance Reporting

Condition 4 of Statement No. 800 and Condition 2 of EPBC Reference: 2003/1294 and 2008/4178 requires Chevron Australia to submit a Compliance Assessment Report annually to address the previous 12-month period. A compliance reporting table is provided in Appendix 9 to assist with auditing for compliance with this Plan for Statement No. 800, and EPBC Reference: 2003/1294 and 2008/4178.

10.2.2 Environmental Performance Reporting

Condition 5.1 of Statement No. 800 and Condition 4 of EPBC Reference: 2003/1294 and 2008/4178 require that Chevron Australia submits an annual Environmental Performance Report to the Western Australian Minister for the Environment and to the Commonwealth DotE respectively, for the previous 12-month period.

In addition, under Condition 5.3 of Statement No. 800, and Condition 4.2 for EPBC Reference: 2003/1294 and 2008/4178, every five years from the date of the first annual Report, Chevron Australia shall submit to the Western Australian Minister for the Environment an Environmental Performance Report covering the previous five-year period.

Specific details on the content of the Environmental Performance Report are defined in Condition 5.2 and Schedule 3 of Statement No. 800, and Schedule 3 of EPBC Reference: 2003/1294 and 2008/4178.

The information in the Environmental Performance Report will also partly meet the requirements of Condition 3.7 of EPBC Reference: 2003/1294 and 2008/4178.

10.2.3 Routine Internal Reporting

The Gorgon Gas Development will use a number of routine internal reporting formats to effectively implement the requirements of this Plan. Routine reporting is likely to include daily, weekly, and/or monthly HES reports for specific scopes of work on the Development. These reports include information on a number of relevant environmental aspects, such as details of environmental incidents (if any), environmental statistics and records, records of environmental audits and inspections undertaken, status of environmental monitoring programs, tracking of environmental performance against performance indicators, targets, and criteria, etc.

10.2.4 Incident Response and Reporting

Chevron Australia has prepared the ABU Emergency Management Process (Chevron Australia 2010d) and Incident Investigation and Reporting Process (Chevron Australia 2010c), which it internally requires its employees, contractors, etc. to follow in the event of environmental incidents. These processes will also be applied internally to environmental incidents identified in this Plan, where this is appropriate and reasonably practicable.

Table 10-1 lists the environmental incidents, reporting requirements and timing specific to this Plan. The external reporting requirements for marine turtle incidents (injury or mortality) are included in Section 10.4.4 of the Long-term Marine Turtle Management Plan.

Note that under Condition 3.2.7 of EPBC Reference: 2003/1294 and 2008/4178, reports will be made in respect of significant impacts detected by the monitoring programs under this Plan, whether or not the impact is caused by the Gorgon Gas Development.

Table 10-1 Incident Reporting Requirements

Incident	Reporting to	Timing
Material or Serious Environmental Harm detected outside the Marine Disturbance Footprint	Parks and Wildlife/DotE	Within 48 hours of detection or as soon as reasonably practicable
Significant Impacts detected by the monitoring program for matters of National Environmental Significance (attributable to the Gorgon Gas Development)	DotE	Within 48 hours of detection

10.3 Review of this Plan

Chevron Australia is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that Chevron Australia will review this Plan every five years or more often as required (e.g. in response to new information).

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions, and any relevant emerging environmental issues.

If the Plan no longer meets the aims, objectives or requirements of the Plan, if works are not appropriately covered by the Plan, or measures are identified to improve the Plan, Chevron Australia may submit an amendment or addendum to the Plan to the State Minister for Environment for approval under Condition 36.2 of Statement No. 800.

If Chevron Australia wishes to carry out an activity other than in accordance with the Plan, Chevron Australia will update the Plan and submit it to the Commonwealth Minister for Environment for approval in accordance with Condition 25 of EPBC Reference: 2003/1294 and 2008/4178. The Commonwealth Minister for Environment may direct Chevron Australia to revise the Plan under Condition 26 of EPBC Reference: 2003/1294 and 2008/4178.

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Appendix 1 Identification of Terrestrial and Subterranean Matters of National Environmental Significant (NES) and their Habitat

Appendix 2 Identification of Marine Matters of National Environmental Significance (NES) and their Habitat

Appendix 3 Chevron Integrated Risk Prioritization Matrix and HAZID Results

Chevron

Chevron Integrated Risk Prioritization Matrix

For the Assessment of HES & Asset Risks from Event or Activity

Legend

Legend applies to identified HES risks
(see guidance documents for additional explanations)

1, 2, 3, 4 - Short-term, interim risk reduction required. Long term risk reduction plan must be developed and implemented.

5 - Additional long term risk reduction required. If no further action can be reasonably taken, SBU management approval must be sought to continue the activity.

6 - Risk is tolerable if reasonable safeguards / management systems are confirmed to be in place and consistent with relevant requirements of the Risk Mitigation Closure Guidelines.

7, 8, 9, 10 - Manage risk. No further risk reduction required. Risk reduction at management / team discretion.

Likelihood Descriptions & Index (with confirmed safeguards)

Likelihood Descriptions	Likelihood Indices		Decreasing Likelihood						
Consequence can reasonably be expected to occur in life of facility	1	Likely		6	5	4	3	2	1
Conditions may allow the consequence to occur at the facility during its lifetime, or the event has occurred within the Business Unit	2	Occasional		7	6	5	4	3	2
Exceptional conditions may allow consequences to occur within the facility lifetime, or has occurred within the OPCO	3	Seldom		8	7	6	5	4	3
Reasonable to expect that the consequence will not occur at this facility. Has occurred several times in industry, but not in OPCO	4	Unlikely		9	8	7	6	5	4
Has occurred once or twice within industry	5	Remote		10	9	8	7	6	5
Rare or unheard of	6	Rare		10	10	9	8	7	6

Decreasing Consequence/Impact

Consequence Descriptions & Index (without safeguards)

Consequence Indices		6	5	4	3	2	1
		Incidental	Minor	Moderate	Major	Severe	Catastrophic
Consequence Descriptions	**Safety**	**Workforce:** Minor injury such as a first-aid. *AND* **Public**: No impact	**Workforce:** One or more injuries, not severe. *OR* **Public**: One or more minor injuries such as a first-aid.	**Workforce**: One or more severe injuries including permanently disabling injuries. *OR* **Public**: One or more injuries, not severe.	**Workforce:** (1-4) Fatalities *OR* **Public**: One or more severe injuries including permanently disabling injuries.	**Workforce**: Multiple fatalities (5-50) *OR* **Public**: multiple fatalities (1-10)	**Workforce**: Multiple fatalities (>50) *OR* **Public**: multiple fatalities (>10)
	Health (Adverse effects resulting from chronic chemical or physical exposures or exposure to biological agents)	**Workforce:** Minor illness or effect with limited or no impacts on ability to function and treatment is very limited or not necessary *AND* **Public:** No impact	**Workforce**: Mild to moderate illness or effect with some treatment and/or functional impairment but is medically managable *OR* **Public**: Illness or adverse effect with limited or no impacts on ability to function and medical treatment is limited or not necessary.	**Workforce**: Serious illness or severe adverse health effect requiring a high level of medical treatment or management *OR* **Public**: Illness or adverse effects with mild to moderate functional impairment requring medical treatment.	**Workforce** (1-4): Serious illness or chronic exposure resulting in fatality or significant life shortening effects *OR* **Public**: Serious illness or severe adverse health effect requiring a high level of medical treatment or management.	**Workforce** (5-50): Serious illness or chronic exposure resulting in fatality or significant life shortening effects *OR* **Public** (1-10): Serious illness or chronic exposure resulting in fatality or significant life shortening effects.	**Workforce** (>50): Serious illness or chronic exposure resulting in fatality or significant life shortening effects *OR* **Public** *(>10)*: Serious illness or chronic exposure resulting in fatality or significant life shortening effects.
	Environment	Impacts such as localized or short term effects on habitat, species or environmental media.	Impacts such as localized, long term degradation of sensitive habitat or widespread, short-term impacts to habitat, species or environmental media	Impacts such as localized but irreversible habitat loss or widespread, long-term effects on habitat, species or environmental media	Impacts such as significant, widespread and persistant changes in habitat, species or environmental media (e.g. widespread habitat degradation) .	Impacts such as persistant reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.	Loss of a significant portion of a valued species or loss of effective ecosystem function on a landscape scale.

The above legend applies only to HES risks, where risk levels 1-6 are actionable and mandatory.
For risks that may result in facility damage, business interruption, loss of product, the "Assets" category below should be used.
Asset risk reduction is at the discretion of management. Under no circumstances may a direct or indirect translation of Asset loss to HES consequences, or between any discrete categories of HES consequences be inferred.

Consequence Descriptions & Index (without safeguards)

Consequence Indices		6	5	4	3	2	1
		Incidental	Minor	Moderate	Major	Severe	Catastrophic
Consequence Descriptions	**Assets** (Facility Damage, Business Interruption, Loss of Product)	Minimal damage. Negligible down time or asset loss. Costs < $100,000.	Some asset loss, damage and/or downtime. Costs $100,000 to $1 Million.	Serious asset loss, damage to facility and/or downtime. Costs of $1-10Million.	Major asset loss, damage to facility and/or downtime. Cost >$10 Million but <$100 Million.	Severe asset loss or damage to facility. Significant downtime, with appreciable economic impact. Cost >$100MM but <$1billion.	Total destruction or damage. Potential for permanent loss of production. Costs >$1billion

This matrix is endorsed for use across the Company.
It is not a substitute for, and does not override any relevant legal obligations.
Under no circumstances should any part of this matrix be changed or modified, adapted or customized.
This matrix identifies health, safety, environmental and asset risks and is to be used only by qualified and competent personnel.
Where applicable it is to be used within the Riskman2 structure and governance of an OE Risk Management Process. If applied outside of these Processes, it is also mandatory to manage identified intolerable risks and comply with the Risk Mitigation Closure Guidelines.

Temporary and Permanent HAZID Spreadsheet

Activity	Hazard Event	Consequences	Safeguards (Prevention/Detection/Control Measures)	Risk Evaluation C	L	R	Notes
Intake of sea water (normal operations)	Ingress of marine fauna into seawater intake	Injury/death of marine fauna.	• Pumps will be located in caissons with screens to prevent ingress of marine fauna. • Pump caissons will be designed with low velocity at intakes (<0.1 m/s). • Inspection and maintenance program.	5	3	7	S&OR Item No. 57 (KJVG 2008) – refers to permanent intake.
Discharge of RO brine (normal operations)	Solar heating of RO reject buffer tank and/or reject brine in disposal line to diffuser	• RO reject brine discharged at temperatures above ambient seawater temperature. • Potential impacts to corals, seagrass and algae, marine fauna.	• Disposal pipeline will be routed on seabed, with natural cooling from sea water occurring before reaching the diffuser. • Diffuser designed to achieve high mixing upon discharge. • System instrumentation and monitoring of temperature. • Control philosophy for disposal of RO reject brine to ocean diffuser. • Operator training and procedures. • Ocean outfall monitoring program (including temperature) in the vicinity of the diffuser and mixing zone.	6	6	10	S&OR Item No. 85, 247, and 281 (KJVG 2008) – refers to permanent outfall. Heating effects (where relevant) to be addressed during detailed design, and mitigated to avoid significant temperature increases.
Discharge of RO brine (normal operations)	Discharge of brine – normal operations and/or plant malfunction	• RO reject brine above ambient seawater salinity. • Potential impacts to corals, seagrass and algae, marine fauna.	• WET testing assessed toxicity of increased salinity. • Diffuser designed to achieve high mixing upon discharge. • System instrumentation and monitoring of salinity. • Control philosophy for disposal of RO reject brine to ocean diffuser. • Operator training and procedures. • Monitoring of brine quality (including salinity).	5	2	6	A plant malfunction would likely result in a plant shutdown. RO plants do not produce more concentrated brine if they malfunction; they produce less concentrated brine.

Activity	Hazard Event	Consequences	Safeguards (Prevention/Detection/Control Measures)	Risk Evaluation C	L	R	Notes
			• Ocean outfall monitoring program (including salinity) in the vicinity of the diffuser and mixing zone.				
Discharge of RO brine (normal operations)	Discharge of backwash and chemical cleaning waste streams with brine – normal operations and/or plant malfunction	• RO reject brine discharged at pH above/below ambient seawater pH. • Chemicals toxic to marine ecosystem. • Potential impacts to corals, seagrass and algae, marine fauna.	• Chemical selection process (ALARP risk to personnel and the environment). • WET testing assessed chemical toxicity. • Diffuser designed to achieve high mixing upon discharge. • System instrumentation and monitoring of pH and chemical concentrations. • Control philosophy for disposal of RO reject brine to ocean diffuser. • Specifications for optimal chemical dosing. • Backwash and chemical cleaning flows can be turned off manually in the event of malfunction. • Operator training and procedures. • Monitoring of brine quality (including pH). • Ocean outfall monitoring program (including pH) in the vicinity of the diffuser and mixing zone.	5	2	6	
Discharge of RO brine (normal operations)	Internal and/or external corrosion/erosion or damage of RO reject brine disposal pipeline	• Leak of RO brine from disposal pipeline to the marine environment (without appropriate diffusing). • Potential impacts to corals, seagrass and algae, marine fauna and water quality.	• Pipeline is high density polyethylene and glass reinforced epoxy making external or internal corrosion unlikely. • Inspection and maintenance program. • If corrosion/erosion of pipeline occurs, then volume of leaked RO brine would be minimal (minor leak). • Low-pressure alarm in RO reject brine outfall (major leak).	6	6	10	S&OR Item No. 88 and 99 (KJVG 2008) – refers to permanent outfall

Activity	Hazard Event	Consequences	Safeguards (Prevention/Detection/Control Measures)	Risk Evaluation C	Risk Evaluation L	Risk Evaluation R	Notes
Discharge of RO brine (normal operations)	Flow control valve open, or bypass open too much when it should be closed	• Potential for reduced pressure (and flow rate) on RO reject disposal line to diffuser, resulting in lower brine dilution. • Reduced water quality beyond approved mixing zone. • Potential impacts to corals, seagrass and algae, marine fauna.	• System instrumentation and monitoring of pressure/flow rate. • Flow control valve has position mismatch alarm, isolation valves and manual bypass. • Low-pressure alarm and pump shutdown. • Control philosophy for disposal of RO reject brine to ocean diffuser. • Operator training and procedures. • Ocean outfall monitoring program in the vicinity of the diffuser and mixing zone.	6	6	10	S&OR Item No. 95 and 98 (KJVG 2008) – refers to permanent outfall.
Discharge of RO brine (normal operations)	Minimum flow valve on RO reject disposal pump open, or open too much	• Potential for reduced pressure (and flow rate) on RO reject disposal line to diffuser, resulting in lower brine dilution. • Reduced water quality beyond approved mixing zone. • Potential impacts to corals, seagrass and algae, marine fauna.	• System instrumentation and monitoring of pressure/flow rate. • Control philosophy for disposal of RO reject brine to ocean diffuser. • Operator training and procedures. • Ocean outfall monitoring program in the vicinity of the diffuser and mixing zone.	5	5	9	S&OR Item No. 259 (KJVG 2008) – refers to permanent outfall

PSV Package RO HAZID Spreadsheet

Activity	Hazard Event	Consequences	Safeguards (Prevention/Detection/Control Measures)	Risk Evaluation C	L	R	Notes
Intake of sea water (normal operations)	Ingress of marine fauna into seawater intake	Injury/death of marine fauna	• Intake will be designed with low velocity at intakes (<0.1 m/s) • Inspection and maintenance program • Intake line will be a 4-inch lay-flat hose	6	4	9	
Discharge of RO brine	Solar heating of RO reject brine prior to disposal – normal operations and/or plant malfunction	RO reject brine discharged at temperatures above ambient seawater temperature. Potential impacts to corals, seagrass and algae, marine fauna.	• Diffuser designed to achieve high mixing upon discharge • Control philosophy for disposal of RO reject brine to ocean diffuser • PSV RO System Performance monitoring program (including temperature) • Discharge volume of the individual plant is limited to 750 m^3/day • Discharge within Zone of High Impact (4 m from boundary)	6	6	10	
Discharge of RO brine	Discharge of brine – normal operations and/or plant malfunction	RO reject brine above ambient seawater salinity. Potential impacts to corals, seagrass and algae, marine fauna.	• WET testing assessed toxicity of increased salinity • Control philosophy for disposal of RO reject brine to ocean diffuser • Monitoring of brine quality (including salinity) • Discharge within Zone of High Impact (4 m from boundary) • Discharge volume of the individual plant is limited to 750 m^3/day	5	3	8	

Activity	Hazard Event	Consequences	Safeguards (Prevention/Detection/Control Measures)	Risk Evaluation			Notes
				C	L	R	
Discharge of RO brine	Discharge of backwash and chemical cleaning waste streams with brine – normal operations and/or plant malfunction	RO reject brine discharged at pH above/below ambient seawater pH. Chemicals toxic to marine ecosystem. Potential impacts to corals, seagrass and algae, marine fauna.	• Chemical selection process (ALARP risk to personnel and the environment) • WET testing assessed chemical toxicity • Monitoring of brine pH and chemical concentrations • Control philosophy for disposal of RO reject brine to ocean diffuser • Standard chemical dosing (Antiscalant and SMBS) • Discharge volume of the individual plant is limited to 750 m^3/day • Discharge within Zone of High Impact (4 m from boundary)	5	2	6	
Discharge of RO brine	Internal and/or external corrosion/erosion or damage of RO reject brine disposal pipeline	Leak of RO brine from disposal pipeline to the marine environment (without appropriate diffusing). Potential impacts to corals, seagrass and algae, marine fauna and water quality.	• Pipeline is a lay-flat PVC making external or internal corrosion unlikely • Discharge of RO in situ minimises the length of pipe, thus reducing the potential for corrosion • Inspection and maintenance program • If corrosion/erosion of pipeline occurs, then volume of leaked RO brine would be minimal (minor leak)	6	6	10	

Appendix 4 Review of the Effects of Desalination on the Marine Environment (G1-NT-REPX0001635)

Appendix 5 Technical Note for Temporary Outfall Dilution Modelling (G1-TE-Z-8500-TCN1501)

Appendix 6 Technical Note for Permanent Outfall Dilution Modelling (G1-TE-Z-4500-TCN1502)

Appendix 7 Technical Note for Outfall Dilution Modelling of Package RO Units on PSV (G1-TE-Z-4500-TCN1504)

Appendix 8 Technical Note Toxicity Testing of Simulated Reverse Osmosis Brine Effluents (G1-NT-REPX0001646)

Appendix 9 Compliance Reporting Table

Section	Actions	Timing
4.1	To reduce additional impacts to the marine environment associated with the installation of RO intake and outfall structures, intake and outfall structures will be located within the Zone of High Impact surrounding the MOF.	Design and Construction
7.3	Visual inspection of the Temporary and PSV seawater intakes for injured or dead marine fauna trapped within an intake will be undertaken where practicable, with due consideration of other marine activities occurring in the area, and associated safety and logistical considerations applicable to an active construction and/or operational site. It is anticipated that visual inspection of the Temporary and PSV seawater intakes will be undertaken during regular maintenance inspections of intake structures, which are expected to occur at least quarterly.	All phases
7.3	Records of inspections, including the presence or absence of any injured or dead marine fauna trapped within an intake, will be maintained.	All phases
7.3	Records of seawater intake inspections will be made available to Parks and Wildlife and DotE, upon request.	All phases
7.3	In the event that injured marine fauna are observed to be trapped within an intake, a nominated Chevron representative will be advised and action strategies will be aligned with those for marine fauna as detailed in the Fauna Handling and Management Common User Procedure (Chevron Australia 2013), as amended from time to time. Removal of entrained fauna from an intake will be undertaken, where practicable, so as to avoid trapped or distressed fauna acting as an attractant for other marine fauna.	All phases
7.3.1	Adaptive management responses that relate to marine turtle incidents (injury or mortality) associated with operation of seawater intakes will follow an incident investigation and action process aligned with a series of tiered response principles as presented in Section 10.4.4 of the Long-term Marine Turtle Management Plan (Chevron Australia 2012a), as amended from time to time under that Plan.	All phases
7.3.1	Adaptive management responses that relate to other marine fauna (excluding turtles) incidents associated with operation of the seawater intakes will follow an incident investigation and action process as detailed below: • **Level 1 – An injured or dead marine fauna individual is found that is attributable to operation of a seawater intake.** Should it be determined that current management measures are not being followed, appropriate action shall be taken to correct this deficiency. If management measures are being followed, an increased frequency of seawater intake inspections shall be implemented, where practicable. • **Level 2 – More than one injured or dead marine fauna individual is found on two consecutive inspections that are attributable to operation of a seawater intake.** Alternative or additional practical management measures to prevent entrainment of marine fauna will be investigated and implemented, where practicable. • **Level 3 – A large injured or dead marine fauna individual (e.g. cetacean, dugong) is found that is attributable to operation of a seawater intake.** Immediate action shall be taken to implement alternative and/or additional management measures in consultation with Parks and Wildlife to prevent entrainment of marine fauna.	All phases

Section	Actions	Timing
7.4	RO system performance parameters are available to the facility operator via the package control system and will be inspected as part of routine operator checks. These parameters will include pH, conductivity and temperature, as these are relevant to the environmental impact of brine discharge. Flow meters will also be used to record the volume of brine discharge.	All Phases
7.4.1	Adaptive management responses for monitoring of RO system performance are detailed below: • **Level 1 – A performance parameter relevant to environmental impact of brine discharge is observed to be outside the expected range during a single routine operator check of the RO facility.** An inspection of the RO facility will be undertaken and adjustments to the facility made as determined appropriate by the operator. • **Level 2 – A performance parameter relevant to environmental impact of brine discharge is observed to be outside the expected range during five consecutive operator checks of the RO facility.** An investigation into the cause of the out of range readings will be undertaken. Where the cause is identified to be related to the operation of the RO facility, appropriate corrective action will be taken. This may include an investigation into the reason for the exceedance, a review of the risks associated with the changed parameter (to understand and mitigate the cause of the change); field monitoring; and/or additional management or mitigation measures.	All phases
7.5	RO system performance parameters will be recorded routinely, at least monthly, and include pH, conductivity, temperature and flow, as these are relevant to the environmental impact of brine discharge.	All phases
7.5.1	Adaptive management responses for the PSV RO system performance are detailed below. The expected ranges for the performance parameters are provided in Table 7-3: • **Level 1 – A performance parameter relevant to environmental impact of brine discharge is observed to be outside the expected range during a single check of the RO facility.** An inspection of the RO facility will be undertaken and adjustments to the facility made as determined appropriate by the operator. • **Level 2 – A performance parameter relevant to environmental impact of brine discharge is observed to be outside the expected range for two consecutive checks of the RO facility.** An investigation into the cause of the out of range readings will be undertaken. Where the cause is identified to be related to the operation of the RO facility, appropriate corrective action will be taken. This may include an investigation into the reason for the exceedance, a review of the risks associated with the changed parameter (to understand and mitigate the cause of the change); field monitoring; and/or additional management or mitigation measures.	All phases
7.6	A sample of reject brine will be collected quarterly from each RO facility and analysed for pH, nutrients, and metals to check that brine discharge parameters are within expected discharge values. The brine samples will be collected from the RO facilities just prior to discharge to the outfall (e.g. from the brine holding tank).	All phases
7.6	Analyses of brine samples will be undertaken by National Association of Testing Authorities (NATA) certified laboratories.	All phases

Section	Actions	Timing
7.6.1	Adaptive management responses that relate to the chemical analysis of brine are detailed below: • **Level 1 – A contaminant is outside the expected range of discharge values for a single monitoring event.** Undertake initial investigation into the exceedance. This trigger does not preclude immediate management action. • **Level 2 – A contaminant is outside the expected range of discharge values for two consecutive monitoring events.** Take management action, which will include resampling within a month of being notified of the exceedance and investigation into the reason for the exceedance. A review of the risks associated with the changed parameter (to understand and mitigate the cause of the change); field monitoring; and/or additional management or mitigation measures may also be considered**.** • **Level 3 – A contaminant is outside the expected range of discharge values for three consecutive monitoring events.** Report Level 3 trigger exceedance to Parks and Wildlife and DotE (within seven days of being notified of the exceedance). Continue to take management action, which may include investigating the reason for the exceedance; reviewing the risks associated with the changed parameter with the aim of trying to understand and mitigate the cause of the change; further field monitoring; and/or additional management or mitigation measures identified in consultation with Parks and Wildlife and DotE.	All phases
7.7.1	Salinity is the most relevant potential ecological stressor on the local environment (i.e. hypersalinity) as indicated by the WET testing summarised in Section 6.4 (RPS 2008a). Therefore, as a minimum, salinity will be measured and used as the key indicator of whether the expected dilution is being achieved at the edge of the LEPA.	
Figure 7-4	A flowchart illustrating the process that will be followed in the event of an exceedance of the water quality criterion at the edge of the LEPA is provided in Figure 7-4, which includes: • **Level 1 Trigger – Median salinity at routine sites greater than median salinity at reference sites by more than 1.2 ppt.** Management measures include: As soon as practicable, implement contingency monitoring sites to characterise spatial extent of the brine plume beyond the; Investigate cause of the exceedance and determine if cause still exists; if exceedance considered Project attributable, where practicable, repeat monitoring within next 7 days. • **Level 2 Trigger – Median salinity at routine sites greater than median salinity at reference sites by more than 1.2 ppt.** Management measures include: Report Level 2 Trigger exceedance to Parks and Wildlife and DotE (within seven days of being notified of the Level 2 Trigger, and where exceedance is found likely to be attributable to RO plant operation); Continue to investigate cause of the exceedance; Adjustments to RO package operation – e.g. adjust discharge flow rates, operating times (max water depth at outfall).	All phases
7.7.4	Water quality monitoring for the permanent RO facility will occur at five locations along the boundary of the LEPA.	All phases

Section	Actions	Timing
7.7.4	In addition, water quality will be monitored at least two reference sites. The location of reference sites will be based on these criteria: • located beyond any influence of brine discharge as indicated by modelling • located away from other brine discharges (i.e. vessels with operating RO facilities) • located in a similar depth to the outfall • readily accessible by a survey vessel.	All phases
7.7.4	In the event that the water quality criterion is exceeded at a monitoring location, water quality will be measured at additional sites moving further away from the LEPA, in order to characterise the spatial extent of the brine plume.	All phases
7.7.4	GPS coordinates of all monitored sites will be recorded.	All phases
7.7.5	Water quality parameters (salinity, dissolved oxygen, temperature and pH) will be measured approximately fortnightly at each location, for the first year of operation of the permanent RO facility.	All phases
7.7.5	Ocean outfall monitoring will cease once there has been a twelve-month period without a Level 2 trigger, and a review of the data validates the discharge modelling and confirms that the expected level of dilution is being achieved.	All phases
10.1.1	Any document that is required to be implemented under this plan will be made available upon request to the relevant Parks and Wildlife and/or DotE auditor.	All phases
10.1.2	The findings of external regulatory audits will be recorded and actions and/or recommendations will be addressed and tracked.	All phases
10.2.4	Material or Serious Environmental Harm detected outside the Marine Disturbance Footprint to be reported to Parks and Wildlife/DotE within 48 hours of detection or as soon as reasonably practicable.	All phases
10.2.4	Significant Impacts detected by the monitoring program for matters of National Environmental Significance (attributable to the Gorgon Gas Development) to be reported to DotE within 48 hours of detection.	All phases