Gorgon Project

Carbon Dioxide Injection System Wells Maintenance Environment Plan: Summary

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1.0 Introduction

1.1 Overview

Chevron Australia Pty Ltd (Chevron Australia) is the operator for the Gorgon Gas Development (also known as the Gorgon Project) on behalf of the Gorgon Joint Venture (GJV). Offshore production wells and pipeline infrastructure associated with the Jansz–Io and Gorgon gas fields gathers and transports gas to the Gorgon Gas Treatment Plant (GGTP) on Barrow Island, where it is processed.

Carbon dioxide (CO_2), which occurs naturally in the feed gas, is separated during the production process and injected in a supercritical state into deep rock formations below Barrow Island.

1.2 Location

The CO_2 Injection System Wells on Barrow Island are located within the Pipeline Licence—PL93—Licence Area (Figure 1-1) and are spread across three CO_2 injection drill centres (DC-A, DC-B, and DC-C) and two pressure management drill centres (DC-D and DC-E). The Licence Area (Figure 1-1) encompasses much of Barrow Island, which allows for the potential development and expansion of the CO_2 Injection System.

The scope of this Plan is limited to the petroleum activity (as described in Section 2.0) that occurs within the Operational Area or drill centres (as defined in Figure 1-1).

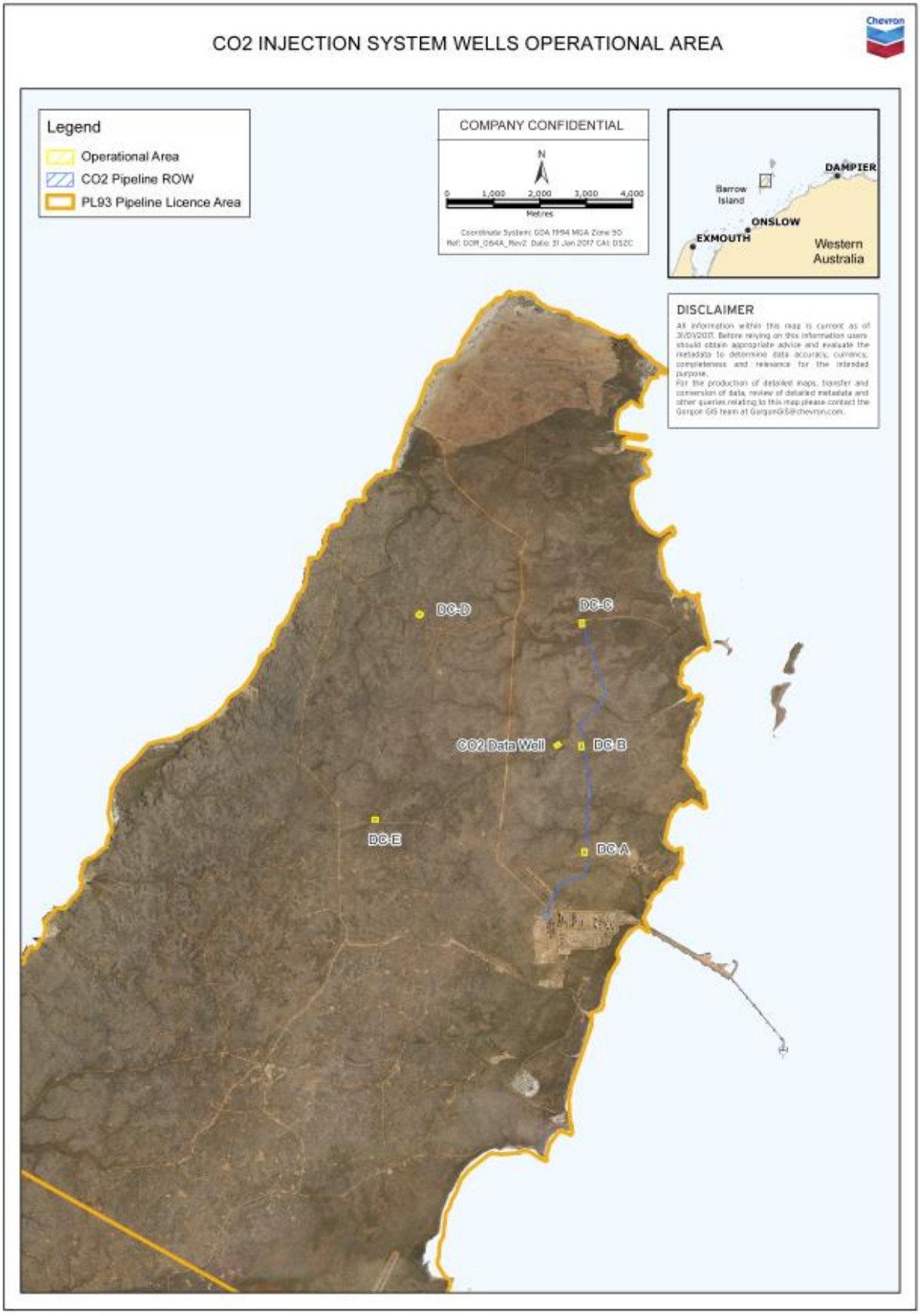

Figure 1-1: Operational Area for CO_2 Injection System Wells

1.3 Scope

The PL93 Licence Area (Figure 1-1) encompasses much of Barrow Island, identified at the licence application stage to allow for the potential development and expansion of the CO_2 Injection System. The scope of the Environment Management Plan (EMP) is limited to the activity as summarised in Section 2.0.

1.4 Licence Holder and Operator Details

Chevron Australia Pty Ltd is nominated as the operator on behalf of the GJV title holders (Table 1-1) for Pipeline Licence PL93, granted under the *Petroleum Pipelines Act 1969* (WA).

Table 1-1: Titleholder Details

Titles	Details	Titleholders	Operator	Address
PL93	CO_2 Injection System Pipeline Licence Onshore	• Chevron (TAPL) Pty Ltd • Shell Australia Pty Ltd • Mobil Australia Resources Company Pty Ltd • Tokyo Gas Gorgon Pty Ltd • Osaka Gas Gorgon Pty Ltd • JERA Gorgon Pty Ltd	Chevron Australia Pty Ltd	QV1, 250 St Georges Terrace, Perth, WA, 6000

In accordance with the Petroleum Pipelines (Environment) Regulations 2012, contact details for the operator, Chevron Australia Pty Ltd, are listed in Table 1-2.

Table 1-2: Operator Contact Details

Company Name	Chevron Australia Pty Ltd
Nominated Liaison Person	John Connor
Position	Drilling and Completions Manager
Business Address	GPO Box S1580, Perth WA 6845
Telephone Number	+61 8 9216 4254
Fax Number	+61 8 9216 4223
Email Address	austdrillingops@chevron.com

1.5 Stakeholder Engagement

Regular consultation with relevant 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 Project.

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 formal environmental approval processes.

1.5.1 Stakeholder Identification

In accordance with Regulation 17 of the Petroleum Pipelines (Environment) Regulations 2012, Chevron Australia completed a scoping exercise to determine which authorities, persons, and organisations were considered to be relevant.

No permanent population resides on Barrow Island. Barrow Island has been actively used for petroleum exploration and production purposes since 1957 and access to Barrow Island is restricted to personnel associated with oilfield operations, Western Australian Department of Biodiversity, Conservation and Attractions (formerly Parks and Wildlife) staff, and Gorgon Gas Development and Jansz Feed Gas Pipeline staff. Therefore, the relevant stakeholders associated with the maintenance of the CO_2 Injection System Wells were identified as:

- Department of Biodiversity, Conservation and Attractions (State)
- Department of Water and Environmental Regulation (formerly Office of the Environmental Protection Agency) (State)
- Department of State Development (State)
- Department of the Environment and Energy (Commonwealth).

1.5.2 Stakeholder Log

Table 1-3 summarises the consultation undertaken specific to this Plan.

Table 1-3: Consultation Summary

Stakeholder	Date	Summary of Consultation	Objections / Claims Raised	Chevron Australia Response
Department of Biodiversity, Conservation and Attractions	16 February 2017	Provision of project-specific information	No response provided	N/a
Department of Water and Environmental Regulation	16 February 2017	Provision of project-specific information	No response provided	N/a
Department of the Environment and Energy	16 February 2017	Provision of project-specific information	No response provided	N/a
Department of State Development	16 February 2017	Provision of project-specific information	None identified	N/a

1.5.3 Ongoing Consultation

Chevron Australia will continue to provide updates regarding Gorgon Operations at regular meetings with these stakeholders.

2.0 Description of the Activity

The well intervention and maintenance activities associated with the CO_2 Injection System Wells includes:

- Well intervention activities (described in Section 2.2):
  - slickline / wireline operations – for purposes of logging, remediation, depth determination and other wellbore services
  - well testing and flowback – may include flowing wells during the Operations phase (not currently scheduled but there is potential for ad hoc short-duration well flowback activities)
  - well workovers – may include removal and replacement of production tubing
- Well maintenance activities (described in Section 2.3):
  - may include valve greasing, function testing, pressure testing, and other maintenance as required.

2.1 Carbon Dioxide Injection System Overview

An overview of the drill centres (DCs) is provided in Table 2-1.

Table 2-1: Overview of Drill Centres and their Purpose

Drill Centre	Purpose
CO_2 injection drill centres (DC-A, DC-B, and DC-C)	The CO_2 injection wells located in DC-A, DC-B, and DC-C receive reservoir CO_2 from the pipeline offtakes for injection into the Dupuy Formation. Each DC comprises a central manifold connected by flowlines to 'Christmas tree' structures on multiple injection wells. DC-A and DC-C each have a reservoir surveillance well to monitor the CO_2 saturation and movement in the injection interval.
Pressure management drill centres (DC-D and DC-E)	Each pressure management DC has two pressure management production wells connected by spools to one water injection well, each capable of pumping up to 3180 m^3 of formation water per day. Pressure management production wells extract water from the Dupuy Formation. This water is then transferred to the injection wells where it is treated and injected into the Barrow Group Flacourt Formation.
CO_2 data well site	An existing CO_2 Data Well has been converted from a geological appraisal well, to a well that can measure pressure in the overlying Barrow Group and also detect microseismic events.

Table 2-2 lists the well identifiers, well types, as-built geographic coordinates, and well depths.

Table 2-2: Well Identifiers, Types, and Locations

DC	DC Footprint	Well	Well Type	Latitude	Longitude
A	1.3488	A-I1	CO_2 injection	-20.774858	115.451294
		A-I2	CO_2 injection	-20.774799	115.451299
		A-RS1	Reservoir Surveillance	-20.774739	115.451303
B	1.4014	B-I3	CO_2 injection	-20.754489	115.450931
		B-I4	CO_2 injection	-20.754431	115.450922

DC	DC Footprint	Well	Well Type	Latitude	Longitude
		B-I5	CO_2 injection	-20.754372	115.450914
		B-I6	CO_2 injection	-20.754314	115.450906
C	1.4012	C-I7	CO_2 injection	-20.730472	115.451228
		C-I8	CO_2 injection	-20.730414	115.451225
		C-I9	CO_2 injection	-20.730356	115.451219
		C-RS2	Reservoir Surveillance	-20.730531	115.451233
D	1.2443	D-WP1	Pressure Management (Production)	-20.728372	115.417386
		D-WP2	Pressure Management (Production)	-20.728294	115.417435
		D-WI1	Pressure Management (Injection)	-20.72845	115.417337
E	0.951	E-WP3	Pressure Management (Production)	-20.768232	115.407745
		E-WP4	Pressure Management (Production)	-20.768231	115.40765
		E-WI2	Pressure Management (Injection)	-20.768233	115.407842
CO_2 Data Well site	1.0184	GDW-1ST1	Reservoir Surveillance	Well site Coordinates -20.754061	Well Site Coordinates 115.445833

2.1.1 Timing

Well intervention and maintenance activities may occur at any time from EP acceptance, and occur for the nominal operational design life (minimum 45 years).

2.2 Well Intervention Activities

Well intervention activities are generally defined as invasive activities or activities that occur within the wellbore. These activities include:

- slickline / wireline operations
- well testing and flowback
- well workovers.

No well interventions are planned to be undertaken; they are generally only required if equipment is underperforming or defective. It is estimated that intervention on a single well may be required once a year; however, it may be more frequent depending on well performance.

2.2.1 Slickline / Wireline Operations

In slickline / wireline operations, a wire (slickline) or braided cable (wireline) is lowered into the well to run tools in and out of the wellbore.

Before conducting these operations and entering the wellbore, pressure control equipment is rigged up and pressure tested to ensure that control of the well is maintained once it is opened. All slickline / wireline operations occur within the contained environment of the wellbore.

Generally, onshore slickline / wireline operations are conducted from a diesel truck (not a workover rig) modified to deploy either slickline and wireline cables. However, in some instances (such as the need to complete a well workover), slickline / wireline operations may be completed by a workover rig.

2.2.2 Well Testing and Flowback

As of publication of this Plan, Chevron Australia has no plan to conduct scheduled well testing or well flowback tasks; however, these tasks may need to be done depending on the results of the maintenance program or well performance. For the purposes of this Plan, the types of tasks associated with well testing and flowback include:

- wellbore clean-up
- venting of CO_2
- production of formation water
- well reinstatement (return to operations).

2.2.3 Well Workovers

Well workovers are required if tubing must be pulled from the well and replaced. For the purposes of this Plan, a workover may be required if:

- there was a failure of the CO_2 tubing resulting in the loss of CO_2 into the annulus
- the upper completion is damaged due to corrosion
- the electrical submersible pumps attached to the water production tubing on the pressure management production wells are damaged or need to be replaced.

If production tubing needs to be replaced, the production packers are detached and the tubing is pulled. Then the well is cleaned using a brine that may include several chemicals (e.g. biocide, surfactant). Once clean, new tubing is installed and various completion equipment (such as downhole gauges, a tubing-retrievable safety valve, production packer to anchor the tubing, gas lift mandrel, or electrical submersible pump) will be run in the production tubing string.

Before reinstating the well, the contents of the wellbore (brine) are recirculated and stored in portable storage tanks.

2.3 Well Maintenance Activities

Well maintenance mainly comprises routine preventative maintenance tasks, which include (but are not limited to):

- greasing valves
- pressure testing valves
- opening and closing valves.

Each well is expected to require annual preventive maintenance. The duration of maintenance activities is estimated to be two days per well, which, given the number of wells, equates to a duration of approximately five weeks per year when maintenance activities covered under this Plan will be undertaken.

If preventative maintenance identifies the need for wellhead components to be replaced, this task may also be undertaken.

3.0 Description of the Environment

The potential extent of the environmental aspects and impacts arising from planned activities during the commissioning, start-up, operation, and IMR of the CO_2 Pipeline and Wells is expected to be limited to the Operational Area (see Section 3.2.4).

However, the potential extent of the environmental aspects and impacts arising from unplanned events or from infrequent and non-routine activities may have a localised effect on the land environment immediately adjacent to the Operational Area, as described and risk assessed in Section 0.

The description of the environment is structured as follows:

- Barrow Island conservation status (Section 3.1)
- the physical environment of Barrow Island (Section 3.2)
- the environment associated with the Operational Area where planned activities occur (Section 3.2.4)
- the environment associated with land adjacent to the Operational Area that may be affected if an unplanned event occurs (Section 0).

3.1 Barrow Island Conservation Status

Barrow Island is reserved under the *Conservation and Land Management Act 1984* (WA) as a Class A Nature Reserve for the purpose of conservation of flora and fauna.

3.2 Physical Environment of Barrow Island

3.2.1 Climate

Barrow Island is characterised by an arid subtropical climate with daytime temperatures ranging from 20 to 34 °C in summer, and from 17 to 26 °C in winter (Ref. 1). Average annual rainfall at Barrow Island is 318 mm with most rain (85%) occurring between January and July (Ref. 1). Rainfall is generally associated with tropical cyclones, which may occur between November and April. Between 1960 and 2003, an average 3.84 cyclones passed within 400 nm of Barrow Island each year (Ref. 2).

3.2.2 Geology, Landform and Soils

The surface geology of Barrow Island generally comprises calcarenite and limestone overlain by alluvium, colluvium, and aeolian sand. Tertiary limestone ridges occur throughout the central upland plateaus of Barrow Island. The terrain ranges from steeper slopes in the west, to flatter, more gentle undulations as the ridges continue east (Ref. 1). Soil types are highly variable, ranging from ‘silty clays’ and ‘clayey loam’ textures in western parts of Barrow Island to coarser ‘clayey sands’, ‘sandy loams’ and ‘sandy clays’ dominating towards the east (Ref. 3).

3.2.3 Hydrogeology

The surface hydrology on Barrow Island is characterised by run-off and short-term standing water after rainfall events, high rates of evaporation, and high infiltration capacities of the surface sands and limestone (Ref. 1). The Operational Area traverses several highly seasonal drainage lines, which generally align in a west-east orientation, but does not cross any permanent watercourses (Ref. 1). All watercourses are ephemeral and typically only flow for short periods following high-intensity rainfall, such as that associated with severe storms or cyclones (Ref. 1).

There is one shallow unconfined potentially fresh water aquifer on Barrow Island. This fresh water aquifer forms a lens of relatively fresh groundwater at depths typically between 9 m and 53 m, and floats upon denser, saline groundwater located

predominantly within the Tertiary Limestone (Ref. 2). Although beneficial uses of this fresh water aquifer are limited, it is an important environment for the stygofauna identified on Barrow Island.

Salinity of the water in this lens varies considerably across Barrow Island. Recharge to the aquifer is from rainfall and occurs most rapidly in areas of highly permeable soils overlying porous karst limestone. Lower salinities occur in areas of more rapid groundwater recharge. Higher salinities occur where recharge is slower, generally in areas where clays and silts are overlying the more porous and permeable limestone.

Salinity of the lens is also higher in coastal areas where seawater influx occurs close to the surface of the water-table.

Several saline ground water systems occur on Barrow Island:

- Tertiary Limestone extending from the mean sea level down to approximately 300 m below mean sea level
- Windalia Sand Member of the Muderong Shale, generally at depths between 650 m and 700 m below mean sea level
- the Barrow Group comprising the Flacourt and Malouet Formations and the Flag Sandstone, generally at depths between 1000 m and 2000 m below mean sea level
- the Dupuy Formation, generally at depths between 2000 m and 2300 m below mean sea level
- the Biggada Formation generally at depths greater than 3000 m below mean sea level.

The Dupuy Formation and Barrow Group systems are described in more detail below.

3.2.3.1 Barrow Group Formation

The Barrow Group Formation is an underground saline aquifer situated at depths between 1200 m and 1900 m below the surface; it is divided into three separate formations—the Flacourt Formation, Malouet Formation, and Basal Barrow Group Shale (Figure 3-1). The Flacourt Formation is the proposed receiving interval for the produced Dupuy Formation water in the pressure management system. The Flacourt Formation is a saline aquifer situated at depths approximately 1200 m in true vertical depth. This Formation comprises sandstone-dominated sandstone/shale sets. Of the core data points taken for the Barrow Group Flacourt Formation, high formation quality was exhibited (Ref. 4).

The underlying Malouet Formation also comprises interbedded sands and shales, although the reservoir quality is not as high as the Flacourt. A pressure baffle within the Malouet Formation hydraulically separates the Lower Malouet Formation from the rest of the Barrow Group. This zone is monitored for pressure changes in the Gorgon CO_2 Data Well. At the base of the Barrow Group is the Basal Barrow Group Shale, which is the top seal (cap rock) for the underlying Dupuy Formation, and hence is the seal for the injected reservoir CO_2.

The components of the upper Barrow Group (Flacourt and Upper Malouet Formations) behave as a single, hydraulically connected unit; however, the Barrow Group Formation is hydraulically separated from the shallow unconfined Tertiary Limestone by a thick sequence (more than 1000 m) of low permeability material (Ref. 4). Water quality is highly alkaline and saline (Total Dissolved Solids [TDS] approximately >30 000 mg/L), and contains hydrocarbons. It is generally characterised as containing stable minerals with a very low proportion of soluble metals.

A thick sequence of low permeability material (Muderong Shale and Gearle Siltstone) hydraulically separates the Barrow Group from the surface groundwater aquifer. The shallow unconfined aquifer forms a lens of fresher groundwater floating upon the denser, more saline sea water. Seasonal fluctuations in rainfall and tidal influence affect

this boundary between the fresh and saline water making it a transition zone, rather than a clear boundary (Ref. 5).

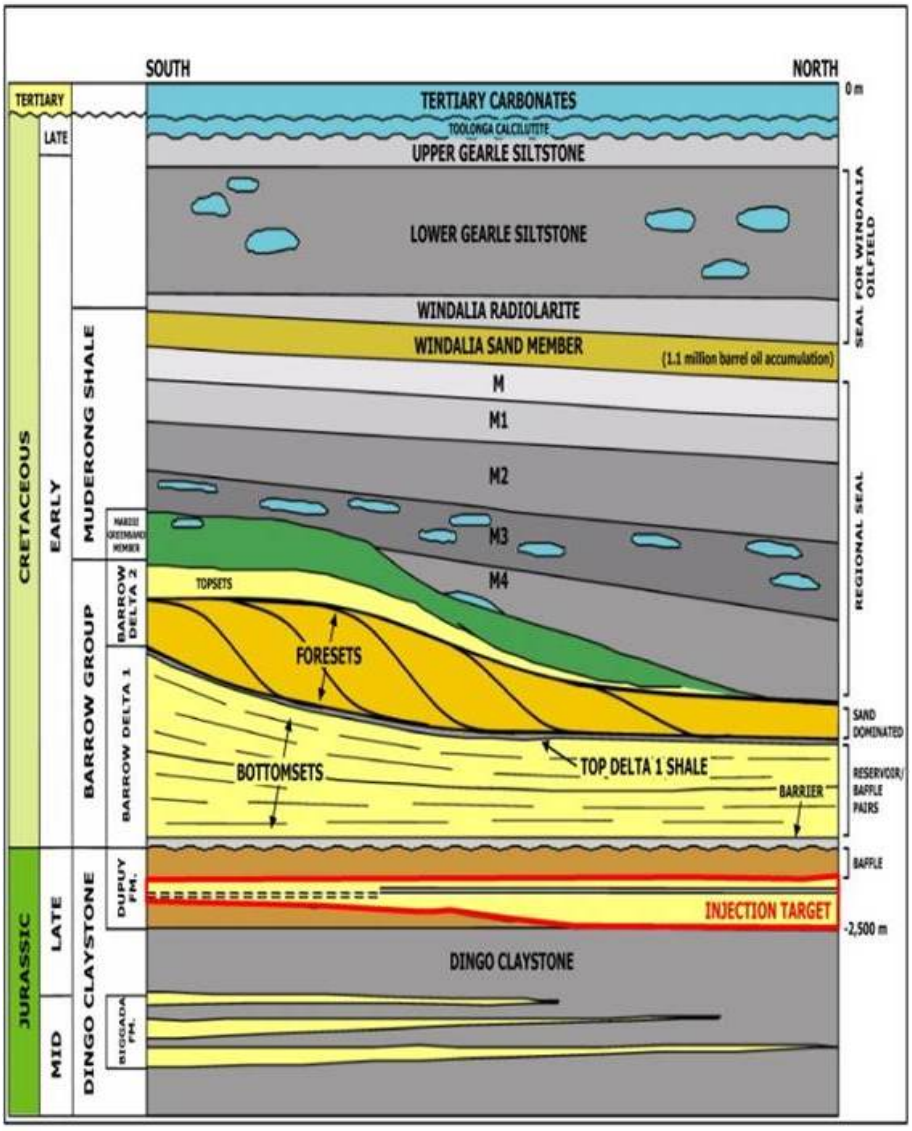

Figure 3-1: Hydrogeological Formations on Barrow Island

3.2.3.2 Dupuy Formation

Water produced from the Dupuy Formation is brackish (approximately 5000–6000 mg/L sodium chloride; 7000–8000 ppm TDS), and may occur at temperatures up to approximately 100 °C upon release (Ref. 6). Trace levels of naturally occurring dissolved hydrocarbons and metals have been identified in the formation water.

3.2.4 Surface water

All drainage lines on Barrow Island are ephemeral and typically only flow for short periods of time following high intensity rainfall such as that associated with storms or cyclones. Operational experience suggests these drainage lines are likely to be inundated between 3-7 days, depending on rainfall.

3.3 Operational Area

The Operational Area comprises land that was cleared and disturbed during construction and installation activities. Consequently, the particular values and sensitivities associated with the Operational Area are limited.

3.3.1 Terrestrial Flora and Vegetation

No particular flora and vegetation values or sensitivities are located within the Operational Area. All flora and vegetation within the Operational Area were cleared during construction. Weed species, including Buffel Grass, have been recorded in various locations on Barrow Island and Chevron Australia has established Weed Hygiene Zones (WHZs) for management purposes, including areas that transect the Operational Area.

3.3.2 Ecological Communities

No Threatened Ecological Community, as listed in the Parks and Wildlife's Threatened Ecological Database (Ref. 7), has been recorded or is known to occur on Barrow Island.

Barrow Island is recognised as being of high conservation significance for subterranean fauna communities, with 19 troglofauna and 63 stygofauna species recorded to date. Ten subterranean fauna species recorded on Barrow Island are listed as specially protected fauna under the *Biodiversity Conservation Act 2016* (WA) and two species, the Blind Gudgeon fish *Milyeringa justitia* (*M. veritas*) and Blind Cave Eel *Ophisternon candidum*, are listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act). Barrow Island subterranean fauna communities are listed by Parks and Wildlife as a Priority 1 Ecological Community ('not adequately defined').

Preliminary geological reviews suggest that strata on Barrow Island (e.g. interbedded sand/limestone) are relatively continuous (Ref. 8), and it is expected that if subterranean fauna occur beneath the Operational Area, it would be of no greater significance to that present elsewhere on Barrow Island. Subterranean fauna is known to exist up to approximately 50 m below ground level. Shallow surface formations and the watertable identified as subterranean fauna habitat are geologically isolated from the deeper formations.

3.3.3 Significant Fauna Habitats

The Operational Area was cleared during construction and does not provide any habitats of particular value or sensitivity.

3.3.4 Terrestrial Fauna

In the absence of fauna habitats of particular value or sensitivity, the Operational Area does not specifically support terrestrial fauna values, although mobile and transient fauna may be encountered in the Operational Area, including mammal, bird, and reptile species.

Four resident mammal species that may be encountered in the Operational Area are listed as specially protected fauna under the *Biodiversity Conservation Act 2016* (WA) or listed as Vulnerable under the EPBC Act. They are Barrow Island Euro *Macropus robustus isabellinus*, Spectacled Hare-wallaby *Lagorchestes conspicillatus conspicillatus*, Barrow Island Golden Bandicoot *Isoodon auratus barrowensis*, and Boodie *Bettongia lesueur*. All these species are widespread across Barrow Island.

Barrow Island supports numerous species of migratory shorebirds as well as resident shorebirds. Many of these species are protected under International treaties (e.g. JAMBA, CAMBA, ROKAMBA). Barrow Island is both a staging site and an important non-breeding site for migratory shorebirds. The highest abundance of shorebirds on Barrow

Island, with over two-thirds of records for most species, is associated with the south-eastern and southern coasts of the Island.

All avifauna with the potential to be encountered in the Operational Area occur widely across Barrow Island. The most common terrestrial avifauna species that have the potential to be encountered are the Spinifex-bird *Eremiornis carteri*, White-winged Fairy-wren (Barrow Island) *Malurus leucopterus edouardi*, Singing Honeyeater *Lichenostomus virescens*, White-breasted Wood Swallow *Artamus leucorhynchus*, and the Welcome Swallow *Hirundo neoxena* (Ref. 1). The White-winged Fairy-wren (Barrow Island) is the only terrestrial bird species on Barrow Island to be listed as Vulnerable under the *Biodiversity Conservation Act 2016* (WA) and the EPBC Act (Ref. 1), but the species is abundant in most habitats on Barrow Island (Ref. 1; Ref. 9) Other listed terrestrial avifauna species with the potential to be encountered in the Operational Area include four vagrant or migratory species protected under international agreements (Oriental Cuckoo *Cuculus saturatus*, Fork-tailed Swift *Apus pacificus*, White-throated Needletail *Hirandapus caudacutus*, and Yellow Wagtail *Motacilla flava*) and the Australian Bustard *Ardeotis australis*, which is listed by Parks and Wildlife as a Priority 4 species (‘rare, near-threatened and other species in need of monitoring’) (Ref. 1).

Reptile species also have the potential to be encountered in the Operational Area, although all species are abundant and widespread on Barrow Island, and none are listed as threatened under the *Biodiversity Conservation Act 2016* (WA) or the EPBC Act (Ref. 1).

3.3.5 Cultural Heritage

Cultural heritage surveys have not identified any cultural heritage sites or materials within the Operational Area.

3.3.6 Petroleum Activities and Infrastructure

Barrow Island has been actively used for petroleum exploration and production activities since 1957 and access is restricted to personnel associated with the oilfield operations, the Gorgon Gas Development, and Parks and Wildlife staff. Infrastructure associated with the Gorgon Gas Development Project, and the Barrow Island oil field road network traverse the Operational Area and adjacent land.

The Barrow Island oil field extracts crude oil, water and gas from the Windalia, Mardie B, M3, Gearle, Jurassic, Malouet and Tunney Formations on Barrow Island. Formation water for pressure management is extracted from Barrow Group Flacourt Formation, processed then injected into the Windalia Formation. Formation water is re-injected into the Windalia reservoir and also disposed of to the Barrow Group Flacourt Formation.

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4.0 Environmental Risk Assessment Methodology

An Environmental Risk Assessment Workshop was undertaken to evaluate impacts and risks arising from the petroleum activities described in Section 2.0. The risk assessment also considered emergency conditions and spill response activities.

The risk assessment was undertaken in accordance with the Chevron Australia Health, Environment, and Safety (HES) Risk Management Process (Ref. 10) and the processes outlined in ISO 31000:2009 Risk Management – Principles and Guidelines and Handbook 203:2012 Managing Environment-related Risk (Ref. 11).

The environmental impact and risk evaluation process comprised these components:

- identification and description of the petroleum activity
- identification of particular environmental values
- identification of relevant aspects
- identification of relevant environmental hazards
- exposure evaluation
- evaluation of impacts and risk
- consequence
- control measures and as low as reasonably practicable (ALARP) evaluation
- likelihood
- quantification of the level of risk
- risk acceptance criteria
- environmental performance objectives, standards, and measurement criteria.

Table 4-1 summarises the environmental impacts, risks, and control measures in place to manage the activity.

Table 4-1: Summary of the Potential Impacts Risks and Control Measures

Source of Environmental Impact or Risk (Hazards)	Potential Environmental Impacts and Risks (Consequences)	Control Measures
Well intervention activities have the potential to result in a leak of reservoir CO_2	A release of CO_2 has the potential to result impacts such as: • localised asphyxiation hazard to terrestrial fauna if CO_2 settles temporarily in low-lying areas • acute impacts to birds if they are exposed to the CO_2 plume.	• Pressure control equipment is in place for all well intervention activities • Pressure control equipment will be tested prior to well entry • A fluids program will be developed for well intervention activities to ensure well control is maintained • WSM and DSM are trained in well control. • Well Intervention Procedure will be developed. • Each 'well program' (program of works for the specified activity) includes a risk assessment that identifies loss of containment from contact with infrastructure.
Well intervention activities have the potential to result in a leak of formation water	A release of higher-temperature brackish Dupuy Formation water has the potential to result in localised impacts to seasonal drainage line vegetation, and to sensitive fauna if present	• Pressure control equipment is in place for all these well intervention activities • Pressure control equipment will be tested prior to well entry • A fluids program will be developed for well intervention activities to ensure well control is maintained. • Well Site Managers (WSM) and Drill Site Managers (DSM) are trained in well control • Well Intervention Procedure will be developed. • Each 'well program' (program of works for the specified activity) includes a risk assessment that identifies loss of containment from contact with infrastructure. • The Gorgon Operations –Procedure for Use of Spill Kits Located in Gorgon Operations Areas (Ref. 12) is used for informing spill clean-up and reporting.
Removal of well cellar coverings to complete well intervention activities has the potential to result in fauna entrapment	Fauna injury or mortality	• Each 'well program' (program of works for the specified well intervention activity) will include a risk assessment that identifies risks associated with fauna entrapment in well cellars • Fauna Handling Common User Procedure (Ref. 13). Specifically: o trained fauna handler o death of EPBC Act listed species reported to Department of the Environment and Energy

Source of Environmental Impact or Risk (Hazards)	Potential Environmental Impacts and Risks (Consequences)	Control Measures
Well testing, flowback, or blowdown will result in the release of CO_2	A release of CO_2 has the potential to result impacts such as: • acute impacts to birds if they are exposed to the CO_2 plume.	• Design of CO_2 vents optimised to increase dispersion
Generation of formation water during flowback or Brine during well clean-up if not managed on site may be accidentally spilled	A release of higher-temperature / brackish water has the potential to result in localised impacts to seasonal drainage line vegetation, and sensitive fauna if present.	• Spill protection will be provided for Portable portable tanks and transfer lines will comprise secondary containment • Each 'well program' (program of works for the specified activity) includes a risk assessment that identifies loss of containment from contact with infrastructure. • The Gorgon Operations –Procedure for Use of Spill Kits Located in Gorgon Operations Areas (Ref. 12) is used for informing spill clean-up and reporting • Wellbore clean-up procedure incorporates fluids management / handling
Well testing, flowback, or blowdown will result in the release of CO_2	Noise generated from the release of CO_2 has the potential disturb sensitive terrestrial fauna during breeding periods.	• Design of CO_2 vents is optimised to reduce noise emissions

Source of Environmental Impact or Risk (Hazards)	Potential Environmental Impacts and Risks (Consequences)	Control Measures
Operating vehicles, equipment, and rigs within the drill centers requires the use and storage of hazardous materials, and chemicals	Contamination within the Operational Area may result in subsequent impacts to stygofauna if these materials reach the groundwater.	• Bulk fuel tanks will have secondary containment • No chemicals and hazardous substances required for well intervention or maintenance activities will be stored within the operational area upon completion of activities under this Plan. • All hazardous liquids will have secondary containment. • All hazardous materials will be stored appropriately. • All hazardous materials will be transferred appropriately. • Stationary equipment (e.g. generators, pumps) will have spill protection • For the bulk transfer of fuel: o transfer hoses are fitted with dry-break couplings o spill protection (e.g. drip trays) is in place before refuelling commences. • Personnel responsible for procuring hazardous materials will complete ABU - ChemAlert HES Reviewer and Authoriser Training • At least one hazardous chemical spill exercise will be conducted during each well program • The Gorgon Operations Procedure for Use of Spill Kits Located in Gorgon Operations Areas (Ref. 12) is used for informing spill clean-up and reporting
Operating vehicles, equipment, and rigs within the drill centers has the potential to create a vehicle strike hazard	Fauna strike may result in injury or mortality	• Traffic Management Common User Procedure (Ref. 14). Specifically: o driver requirements before driving on Barrow Island are met • Fauna Handling Common User Procedure (Ref. 13). Specifically: o trained fauna handler o death of EPBC Act listed species reported to Department of the Environment and Energy

5.0 Management Approach

The implementation strategy in the EMP identifies the systems, practices, and procedures used to ensure the environmental impacts and risks of the activities are continuously reduced to ALARP and the environmental performance outcomes and standards are met. These are predominantly driven through Chevron Australia's Operational Excellence Management System (OEMS).

5.1 Operational Excellence Management System

The implementation strategy of the EMP was developed in line with Chevron Australia's OEMS. Chevron's Operational Excellence Management System is aligned to ISO 14001:2004; Table 5-1lists the key components.

Table 5-1: OEMS Elements Relevant to the Activity

OEMS Element	Element Description	Key Processes Relevant to the Activity
Safe Operations (OE-03)	Operate and maintain facilities to prevent injuries, illness, and incidents	• (OE-03.01.01) ABU HES Risk Management (Ref. 10) • (OE-03.09.01) Marine Safety Reliability and Efficiency – ABU Standardised OE Process (Ref. 15) • (OE-03.06.02) Managing Safe Work – ABU Standardised OE Process (Ref. 16)
Management of Change (OE-04)	Manage both permanent and temporary changes to prevent incidents	• (OE-04.00.01) Management of Change for Facilities and Operations – ABU Standardised OE Process (Ref. 17)
Reliability and Efficiency (OE-05)	Ensure the integrity and availability of wells and facilities, and to prevent incident	• Competency Management System
Incident Investigation (OE-09)	Investigate and identify root causes of incidents to reduce or eliminate systemic causes to prevent future incidents	• (OE-09.00.01) Incident Investigation and Reporting – ABU Standardised OE Process (Ref. 18)
Community and Stakeholder Engagement (OE-10)	Reach out to the community and engage in open dialogue to build trust	• (OE-10.00.01) Community and Stakeholder Engagement – ABU Standardised OE Process (Ref. 19)
Emergency Management (OE-11)	Prevention is the first priority, but be prepared to respond immediately and effectively to all emergencies involving wholly owned or operated Chevron assets	• (OE-11.01.01) Emergency Management Process (Ref. 20) • (ABU-COP-00632) Emergency Response Plan for Barrow Island (Ref. 21)
Compliance Assurance (OE-12)	Verify conformance with OE requirements in applicable company policy and government laws and regulations	• (OE-12.01.19) Compliance Assurance Audit Program ABU Standardised OE Procedure (Ref. 22) • (OE-12.01.18) Compliance Assurance Management of Instances of Potential Noncompliance (Ref. 23)

5.2 Environment Plan Review

Regulation 18 of the Petroleum Pipelines (Environment) Regulations and Condition 7.5 of the Pipeline Licence (PL93) require that Chevron Australia submit a proposed revision of the accepted EMP to the Minister:

- before commencing a new activity
- before any significant modification or change, or a new stage of an existing activity
- before, or as soon as practicable after, any significant new environmental impact or risk occurs, or any significant increase in an existing environmental impact or risk which occurred or is to occur.

Additionally, Regulation 20 of Petroleum Pipelines (Environment) Regulations and Condition 7.6 of PL93 require that Chevron Australia submit a proposed revision of the EMP five years from the date when the EMP is accepted by the Minister.

6.0 Chemical Disclosure

To meet the DMP requirements regarding *chemical disclosure*, this Section details the chemicals and any chemical additives that will be introduced into the CO2 injection system pressure management wells.

1.0 MI SWACO - Inhibited Completion Fluids

1.1 System Details

OPERATOR:	Chevron Australia PTY LTD
PROJECT / WELL:	Barrow Island CO_2 Completions
SYSTEM:	Inhibited Completion Fluids
Total Volume of System	300 m^3

1.2 Product List Details

Trade name	Supplier	Purpose	Product in system fluid (%)	Toxicity & Ecotoxicity Info	MSDS
Water	N/A	Base Fluid	~70		
SAFE-SCAV CA	MI SWACO	Oxygen Scavenger	<0.1%	Acute Toxicity: Bisulfites may cause skin and respiratory sensitization in sulfite sensitive persons. May also cause respiratory sensitization in asthmatics. *Sulfur dioxide:* = 2500 ppm LC50 Inhalation (Rat) 1h Chronic Toxicity: Repeated or prolonged contact may cause allergic reactions in very susceptible persons. EcoToxicity: The product components are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. Biodegradation/Bioaccumulation: Not applicable - Inorganic chemical	Y
Potassium Chloride	M-I Swaco	Brine	~26	Acute Toxicity: = 3 g/kg LD50 Oral (Rat) > 10g/kg LD50 Dermal (Rabbit) > 42 g/m3 LC50 Inhalation (Rat) 1h Ecotoxicity: The product components are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. 5560 - 6080 mg/L LC50 (Lepomis macrochirus) = 96 h 12946 mg/L LC50 (Lepomis macrochirus) = 96 h 4747 - 7824 mg/L LC50 (Oncorhynchus	Y

Trade name	Supplier	Purpose	Product in system fluid (%)	Toxicity & Ecotoxicity Info	MSDS
				mykiss) = 96 h 7050 mg/L LC50 (Pimephales promelas) = 96 h 6420 - 6700 mg/L LC50 (Pimephales promelas) = 96 h 6020 - 7070 mg/L LC50 (Pimephales promelas) = 96 h 340.7 - 469.2 mg/L EC50 (Daphnia magna) = 48 h 1000 mg/L EC50 (Daphnia magna) = 48 h Biodegradation/Bioaccumulation: Degradability not applicable- Inorganic material. Does not bioaccumulate.	
CONQOR 303A	MI SWACO	Corrosion Inhibitor	<1	Acute Toxicity: = 5000 mg/kg LD50 Oral (Rat) > 2000 mg/kg LD50 Dermal Chronic Toxicity: May cause sensitization by skin contact Ecotoxicity: The product components are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. Algae: > 100 mg/L EC50 72h Fish: >100 mg/L LC50 96h Daphnia and other aquatic invertebrates: > 100 mg/L EC50 48h Biodegradation/Bioaccumulation: Product is biodegradable. No bioaccumulation expected due to high molecular weight.	Y
SAFE-LUBE	MI-SWACO	Lubricant	1-3	Acute toxicity: Inhalation Inhalation of vapors in high concentration may cause irritation of respiratory system. Eye contact May cause slight irritation. Skin contact Prolonged contact may cause redness and irritation. Ingestion Ingestion may cause stomach discomfort. Sensitization Not classified. Mutagenic effects This product does not contain any known or suspected mutagens. Carcinogenicity This product does not contain any known or suspected carcinogens. Reproductive toxicity This product does not contain any known or suspected reproductive hazards. Developmental toxicity Not known to cause birth defects or have a deleterious effect on a developing fetus. Routes of exposure None known. Routes of entry None known. Specific target organ toxicity (single exposure) Not classified	Y

Trade name	Supplier	Purpose	Product in system fluid (%)	Toxicity & Ecotoxicity Info	MSDS
				Specific target organ toxicity (repeated exposure) Not classified. Aspiration hazard Not classified Ecotoxicity/Toxicity: This product is not considered toxic to algae. This product is not considered toxic to fish. This product is not considered toxic to daphnia and other aquatic invertebrates Biodegradation/Bioaccumulation: Does not bioaccumulate	
NUOSEPT 78	TROY CORPORATION / Mi Swaco (Renaming of product by MI to NUOSPET 78)	Preservative	<0.05	Acute Toxicity: > 2000 mg/kg LD50 Dermal (Rat) 1009 to 3950 mg/kg LD50 Oral (Rat- female) Chronic Toxicity: Eyes (Rabbit) - Cornea opacity - 21 days - score 59 Skin (Rabbit) - mild irritant Skin (Mouse) - sensitizing Ecotoxicity: 10 - 100 mg/L Acute EC50 (Daphnia) 48 h 10 - 100 mg/L Acute LC50 (Fish) 96 h Biodegradation/Bioaccumulation: Product readily biodegradable. Low Potential to bioaccumulate.	Y
SODA ASH	MI SWACO	pH Modifier	<0.1	Acute Toxicity: = 4090 mg/kg LD50 Oral (Rat) Ecotoxicity: The product components are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. 300 mg/L LC50(Lepomis macrochirus) = 96 h 310 - 1220 mg/L LC50 (Pimephales promelas) = 96 h 242 mg/L EC50 (Nitzschia) = 120 h 265 mg/L EC50 (Daphnia magna) = 48 h Biodegradation/Bioaccumulation: Not applicable - Inorganic chemical	Y
Total			**~100%**		

1.3 Chemical List

Chemicals within products in part 2	CAS Number	Mass Fraction (%)
Water (Including Mix Water Supplied by Client)*	7732-18-5	~ 74
Potassium Chloride Brine	7447-40-7	~ 26
Cocamidopropyl PG-Dimonium Chloride Phosphate	83682-78-4	< 1

Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. residues	68909-77-3	< 1
Sodium carbonate	497-19-8	< 0.1
2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone	6381-77-7	< 0.1
Hexahydro-1,3,5-tris(2-hydroxyethyl)-sym-triazine	4719-04-4	< 0.1
2-aminoethanol	141-43-5	< 0.01
	Total	**~100**

2.0 Contingency Lost Circulation Pill

2.1 System Details Contingency Lost Circulation Pill

OPERATOR:	Chevron Australia PTY LTD
PROJECT / WELL:	BWI CO2 Injection Wells
SYSTEM:	Contingency Lost Circulation pill – approx. 200 bbl (32 m^3)

2.2 Product List Details

Trade name	Supplier	Purpose	Product in system fluid (%)	Toxicity & Ecotoxicity Info	MSDS
Water	N/A	Base Fluid	~80		
Flo-Trol	MI Swaco	Fluid Loss	2- 3%	Acute Toxicity: Inhalation Inhalation of dust in high concentration may cause irritation of respiratory system. Eye contact Dust may cause mechanical irritation. Skin contact Prolonged contact may cause redness and irritation. Ingestion Ingestion may cause stomach discomfort. Unknown acute toxicity Not applicable. Sensitization This product does not contain any components suspected to be sensitizing. Mutagenic effects This product does not contain any known or suspected mutagens. Ecotoxicity/Toxicity: The product component(s) are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. Listed on PLONOR list of OSPAR Toxicity to algae This product is not considered toxic to algae. Toxicity to fish This product is not considered toxic to fish. Toxicity to daphnia and other aquatic	Y

Trade name	Supplier	Purpose	Product in system fluid (%)	Toxicity & Ecotoxicity Info	MSDS
				invertebrates This product is not considered toxic to invertebrates. Biodegradable: Product is biodegradable.	
SAFE-CARB All Grades	MI Swaco	Bridging Agent	8 – 9%	Acute toxicity: Product information This product contains a small quantity of quartz, crystalline silica. Prolonged and repeated exposure to concentrations of crystalline silica exceeding the workplace exposure limit (WEL) may lead to chronic lung disease such as silicosis. Inhalation Inhalation of dust in high concentration may cause irritation of respiratory system. Harmful: danger of serious damage to health by prolonged exposure through inhalation. Repeated or prolonged inhalation of crystalline silica dust can cause delayed lung injury, and other diseases, including silicosis and lung cancer. Eye contact Dust may cause mechanical irritation. Skin contact Prolonged contact may cause redness and irritation. Ingestion Ingestion may cause stomach discomfort. Sensitization Not classified. Mutagenic effects This product does not contain any known or suspected mutagens. Carcinogenicity Crystalline silica dust is listed by IARC in Group 1 as known to cause lung cancer in humans, if inhaled. Aspiration hazard Not applicable. Ecotoxicity/Toxicity: Toxicity to algae This product is not considered toxic to algae. Toxicity to fish This product is not considered toxic to fish. Toxicity to daphnia and other aquatic invertebrates This product is not considered toxic to invertebrates. Biodegradable: Not Applicable - Inorganic chemical	Y
Potassium Chloride	MI Swaco	Base Brine - Weight	6%	Acute toxicity: Inhalation of dust in high concentration may cause irritation of respiratory system. Toxicity/Ecotoxicity: The product component(s) are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. Biodegradation/Bioaccumulation: No data available	Y

Trade name	Supplier	Purpose	Product in system fluid (%)	Toxicity & Ecotoxicity Info	MSDS
SAFE-SCAV CA	MI Swaco	Oxygen Scavenger	<0.1%	Acute toxicity: Inhalation Inhalation of dust in high concentration may cause irritation of respiratory system. Eye contact Dust may cause mechanical irritation. Skin contact Prolonged contact may cause redness and irritation. Ingestion Ingestion may cause stomach discomfort. Unknown acute toxicity Not Applicable The product component(s) are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. The product may affect the acidity (pH-factor) in water with risk of harmful effects to aquatic organisms. Listed on PLONOR list of OSPAR Toxicity/Ecotoxicity: Toxicity to algae This product is not considered toxic to algae. Toxicity to fish This product is not considered toxic to fish. Toxicity to daphnia and other aquatic invertebrates This product is not considered toxic to invertebrates Biodegradable: Not Applicable - Inorganic chemical.	Y
DUO-VIS	MI Swaco	Viscosity	<1%	Acute toxicity: Glyoxal LD50 Oral = 200 mg/kg (Rat) LD50 Dermal = 12700 mg/kg (Rabbit) LC50 Inhalation = 2410 mg/m³, 3-4 hrs Toxicity: Component(s) are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. Glyoxal Toxicity to fish 460 - 680 mg/L LC50 Leuciscuidus 96 h = 215 mg/L LC50 Pimephales promelas 96 h Toxicity to algae <= 348.59 mg/L EC50 Pseudokirchneriella subcapitata 96h > 500 mg/L EC50 Desmodesmus subspicatus 96 h > 500 mg/L EC50 Desmodesmus subspicatus 72 h Toxicity to daphnia and other aquatic invertebrates = 404 mg/L EC50 Daphnia magna 48 h Biodegradation/Bioaccumulation: Not biodegradable/Does not bioaccumulate.	Y
NUO-SEPT 78	Troy	Biocide	< 0.5%	Acute Toxicity: > 2000 mg/kg LD50 Dermal (Rat) 1009 to 3950 mg/kg LD50 Oral (Rat- female) Chronic Toxicity:	Y

Trade name	Supplier	Purpose	Product in system fluid (%)	Toxicity & Ecotoxicity Info	MSDS
				Eyes (Rabbit) - Cornea opacity - 21 days - score 59 Skin (Rabbit) - mild irritant Skin (Mouse) - sensitizing Toxicity/Ecotoxicity: 10 - 100 mg/L Acute EC50 (Daphnia) 48 h 10 - 100 mg/L Acute LC50 (Fish) 96 h Biodegradation/Bioaccumulation: Product readily biodegradable. Low Potential to bioaccumulate.	
Magnesium Oxide	MI Swaco	pH Control	< 0.5%	Acute toxicity: Inhalation Inhalation of dust in high concentration may cause irritation of respiratory system. Eye contact Dust may cause mechanical irritation. Skin contact Prolonged contact may cause redness and irritation. Ingestion Ingestion may cause stomach discomfort. Unknown acute toxicity Not Applicable The product component(s) are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. The product may affect the acidity (pH-factor) in water with risk of harmful effects to aquatic organisms. Listed on PLONOR list of OSPAR Toxicity/Ecotoxicity: Toxicity to algae This product is not considered toxic to algae. Toxicity to fish This product is not considered toxic to fish. Toxicity to daphnia and other aquatic invertebrates This product is not considered toxic to invertebrates Biodegradable: Not Applicable - Inorganic chemical.	Y
Total			**~100%**		

2.3 Chemical List

Chemicals within products in part 2	CAS Number	Mass Fraction (%)
Water	7732-18-5	~ 80
Calcium carbonate	471-34-1	~ 9
Starch, 2-hydroxypropyl ether	9049-76-7	~ 3
Potassium chloride	7447-40-7	~6
Xanthan Gum	11138-66-2	< 1
2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone	6381-77-7	< 1
Magnesium oxide	1309-48-4	< 1
Silica, crystalline, quartz	14808-60-7	< 0.1
Hexahydro-1,3,5-tris(2-hydroxyethyl)-sym-triazine	4719-04-4	< 0.1
Glyoxal	107-22-2	< 0.01
2-aminoethanol	141-43-5	< 0.01
Total		**100.00**

7.0 Acronyms and Abbreviations

Table 7-1 defines the acronyms and abbreviations used in this document.

Table 7-1: Acronyms and Abbreviations

Acronym / Abbreviation	Definition
°C	Degrees Celsius
ABU	Australian Business Unit
ALARP	As low as reasonably practicable
CCR	Central Control Room
Chevron Australia	Chevron Australia Pty Ltd
CO_2	Carbon dioxide
DC	Drill Centre
EMP	Environment Management Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GGTP	Gorgon Gas Treatment Plant
GJV	Gorgon Joint Venture
HES	Health, Environment, and Safety
IMR	Inspection, Maintenance, and Repair
ISO	International Organization for Standardization
km	Kilometre
m	Metre
mg/L	Milligrams per litre
mm	Millimetre
nm	Nautical mile
OE	Operational Excellence
OEMS	Operational Excellence Management System
PEC	Priority Ecological Community
PGPA	Policy, Government and Public Affairs
ppm	Parts per million
PTW	Permit to Work
Q1, Q2,etc.	Three-month quarter of a calendar year
ROW	Right-of-Way
TDS	Total Dissolved Solids
WA	Western Australia
WHZ	Weed Hygiene Zone

8.0 References

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16.	Chevron Australia. *Managing Safe Work (MSW) – ABU Standardised OE Process*. Perth, Western Australia.	OE-03.06.02
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18.	Chevron Australia. *Incident Investigation and Reporting – ABU Standardised OE Process*. Perth, Western Australia.	OE-09.00.01
19.	Chevron Australia. *Community and Stakeholder Engagement – ABU Standardised OE Process*. Perth, Western Australia.	OE-10.00.01
20.	Chevron Australia. *Emergency Management Process– ABU Standardised OE Process*. Perth, Western Australia.	OE-11.01.01

Ref. No.	Document	Document No.
21.	Chevron Australia. *Gorgon Operations – Emergency Response Plan for Barrow Island*. Perth, Western Australia.	ABU-COP-00632
22.	Chevron Australia. *Compliance Assurance Audit Program ABU Standardised OE Procedure*. Perth, Western Australia.	OE-12.01.19
23.	Chevron Australia. *Compliance Assurance Management of Instances of Potential Noncompliance*. Perth, Western Australia.	OE-12.01.18