ENVIRONMENTAL IMPACT REPORT

Cooper Basin Petroleum Production Operations

November 2016

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1 Introduction

1.1 Background

Beach Energy's Cooper Basin production activities currently operate under the *Cooper Basin Petroleum Production Operations Statement of Environmental Objectives* (Beach 2009) which is approved under the *Petroleum and Geothermal Energy Act 2000*.

Under Regulation 14 of the *Petroleum and Geothermal Energy Regulations 2013*, an approved Statement of Environmental Objectives (SEO) must be reviewed at least once in every five years. Beach's production SEO was originally approved in 2003 and was reviewed and updated in 2008-9. Beach undertook a review of the SEO in 2014 and the SEO is subsequently being revised. This Environmental Impact Report (EIR) has been developed to use as the basis for preparation of the revised SEO. It consolidates and updates the information in the existing EIR (Beach 2003) and EIR Addendum (Beach 2009a) for Beach's production operations in the Cooper Basin.

1.2 Beach Energy Company Profile

Beach Energy Limited (Beach) is an Adelaide-based oil and gas exploration and production company which has interests in more than 300 petroleum tenements located in Australia, Egypt, Tanzania, Romania, and New Zealand. Beach is Australia's largest onshore oil producer and currently operates 20 oilfields as well as six gas discoveries and is involved with licences in the South Australian Cooper Basin covering over 50,000 square kilometres. During the financial year 1 July 2013 to 30 June 2014 Beach participated in drilling more than 120 wells of which more than 40 will have been managed by Beach. In the year ending 30 June 2014 Beach produced 9.6 million barrels of oil equivalent and expects to produce 8.6 to 9.4 million barrels in the financial year to 30 June 2015.

In the South Australian section of the Cooper Basin, Beach undertakes oil and gas exploration and production operations under a number of Petroleum Production Licences (PPL), Petroleum Retention Licences (PRL), Associated Activities Licences (AAL) and Petroleum Exploration Licences (PEL). Beach is also a joint venture participant in the Santos-operated Cooper Basin Joint Venture. The locations of Beach's petroleum production operations are shown in Figure 1.

1.3 About this Document

This document has been prepared to satisfy the requirements of an Environmental Impact Report (EIR) under the *Petroleum and Geothermal Energy Act 2000*. It has been prepared in accordance with current legislative requirements, in particular, with Section 97 of the *Petroleum and Geothermal Energy Act 2000* and Regulation 10 of the *Petroleum and Geothermal Energy Regulations 2013*.

This document is based on the EIR for petroleum production operations (Beach 2003) that was prepared by Beach Petroleum in 2003 and reviewed by Beach in 2009 in parallel with the review and update of the SEO, as discussed in Section 2.1 of this document.

In addition, this document uses information sourced from other Cooper Basin EIRs, including:

- *South Australian Cooper Basin Joint Venture Environmental Impact Report: Production and Processing Operations* (Santos 2003)
- *South Australian Cooper Basin Operators Environmental Impact Report: Drilling and Well Operations Santos* (2003a)
- *South Australian Cooper Basin Joint Venture Environmental Impact Report: Waterflood Pilot Project* (Santos 2003b)

- *Senex Energy Cooper Basin Petroleum Production Operations Environmental Impact Report* (Senex 2014).

The South Australian Cooper Basin Joint Venture Production and Processing EIR (Santos 2003) provided background information for this EIR including detailed information on the environment of the Cooper Basin and the environmental risks and consequences gathered over more than 30 years of operations in the Cooper Basin.

1.3.1 Scope

This EIR addresses potential environmental risks and consequences associated with Beach's production activities in the Cooper and Eromanga Basins (which are referred to as the 'Cooper Basin' throughout this document). It has been written to address both current and potential future production activities in all land systems in the Cooper Basin, in order to develop a SEO that will address reasonably foreseeable future activities over the lifetime of the SEO.

Production operations in the future (e.g. production at new sites) will be assessed against this EIR and the revised SEO to demonstrate that the EIR and SEO are applicable as discussed in Section 2.1.3. This assessment will be submitted to the Department of State Development (DSD) as a component of the Activity Notification, as required by Regulations 19 and 20 of the Petroleum and Geothermal Energy Regulations. In some cases it may be necessary to produce a bridging document or brief EIR to supplement this EIR if it does not adequately address associated risks and consequences.

The sites addressed specifically in this EIR are located on pastoral leases and the Innamincka and Strzelecki Regional Reserves. While risks and consequences of production operations are not different inside Regional Reserves, any future production operations inside Regional Reserves will require additional approval of the Petroleum Production Licence from the Minister responsible for the *National Parks and Wildlife Act 1972*.

Beach activities that are specifically covered by this EIR include:

- well operations (after drilling has finished) including completions and workovers, well integrity management, artificial lift and wellhead production equipment, gas well deliquification and downhole abandonment following production
- oil and gas production facility construction, operation, maintenance and abandonment (including extended production test facilities, camps and operational areas such as laydowns)
- produced formation water disposal operations
- waterflood activities (for enhanced oil recovery) and produced water reinjection
- pipeline, trunkline and flowline construction, operation and abandonment
- road construction, maintenance and restoration
- aircraft landing area construction, maintenance and restoration
- oil transport
- waste management, landfill and land treatment unit operations
- decommissioning / rehabilitation.

Well operations (after drilling has finished) have been specifically added to the scope of this EIR and the accompanying SEO. Well operations are managed by the Beach production team (which takes over a well once a well is cased and the drilling rig leaves the site). Coverage of well operations in this document along with the other activities the production team manages, rather than relying on coverage in another SEO, provides a more streamlined and internally consistent approach.

This EIR and the accompanying SEO do not apply to:

- well site and access track construction

- drilling activities
- fracture stimulation
- down hole abandonment following drilling
- restoration of well sites and well access tracks
- seismic operations.

These activities are covered by other EIRs and SEOs. The relevant SEOs in place at the time of preparation of this document are:

- *South Australia Cooper Basin Statement of Environmental Objectives: Drilling, Completions and Well Operations* (Santos 2015).
- *Statement of Environmental Objectives for Geophysical Activities in the Cooper Basin, South Australia* (DSD 2014)
- *Statement of Environmental Objectives: Fracture Stimulation of Deep Shale Gas and Tight Gas Targets in the Nappamerri Trough (Cooper Basin), South Australia* (Beach 2012b).

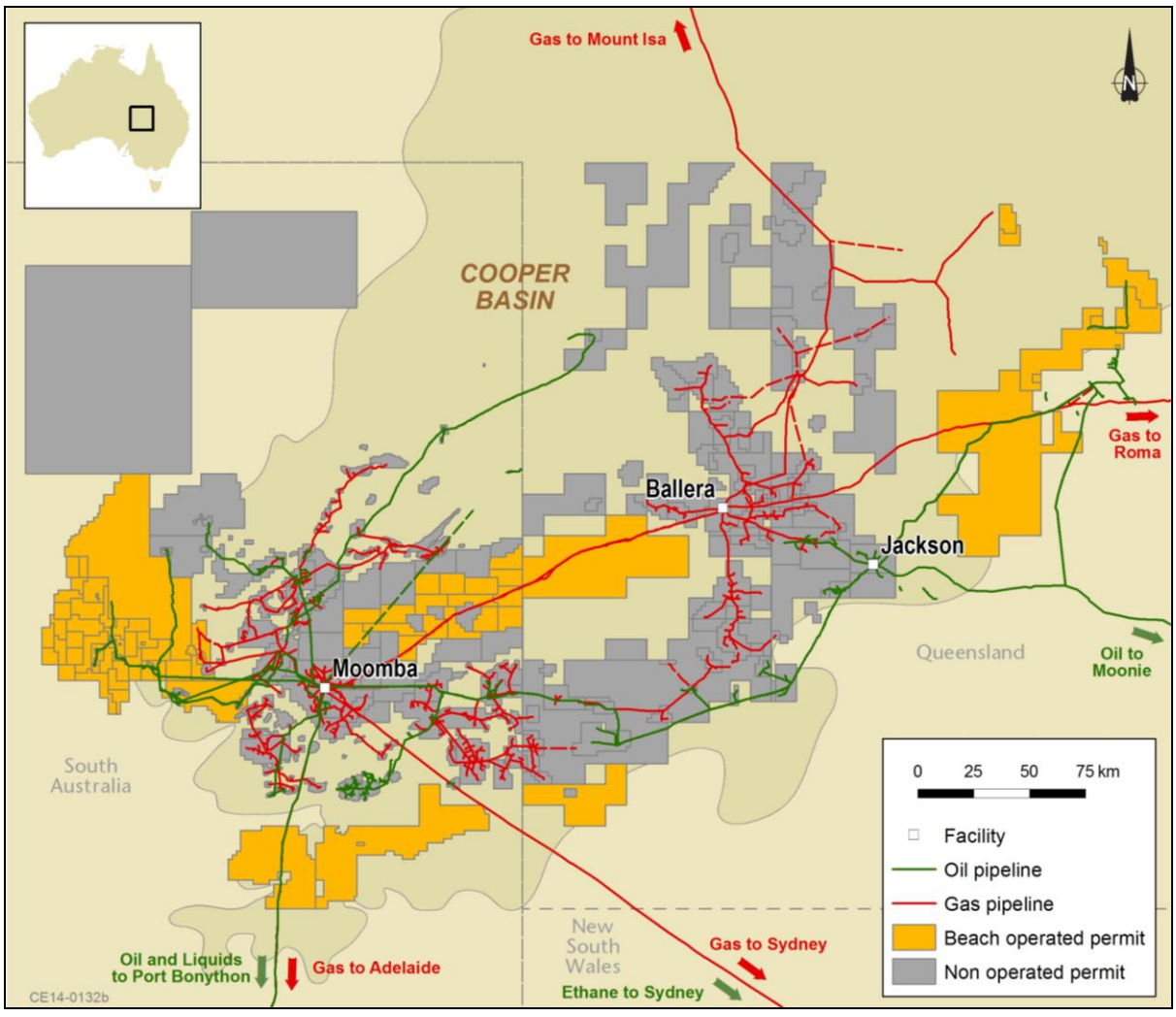


Figure 1: Location of Beach Energy's Cooper Basin operations (February 2015)

2 Legislative Framework

This chapter briefly describes the legislative framework that applies to petroleum activities in South Australia.

2.1 Petroleum and Geothermal Energy Act 2000

Petroleum production activities are governed by the Petroleum and Geothermal Energy Act and the Petroleum and Geothermal Energy Regulations. This legislation is administered by the Department of State Development (DSD).

Key objectives of the legislation include:

- to create an effective, efficient and flexible regulatory system for exploration and recovery or commercial utilisation of petroleum and other regulated resources
- to minimise environmental damage from the activities involved in exploration and recovery or commercial utilisation of petroleum and other regulated resources
- to establish appropriate consultative processes involving people directly affected by regulated activities and the public generally
- to protect the public from risks inherent in regulated activities.

Regulated activities, as defined in Section 10 of the Act, are:

- exploration for petroleum or another regulated resource
- operations to establish the nature and extent of a discovery of petroleum or another regulated resource, and to establish the commercial feasibility of production and the appropriate production techniques
- production of petroleum or another regulated substance
- utilisation of a natural reservoir to store petroleum or another regulated substance
- production of geothermal energy
- construction of a transmission pipeline for carrying petroleum or another regulated substance
- operation of a transmission pipeline for carrying petroleum or another regulated substance.

Statement of Environmental Objectives

As a requirement of Part 12 of the Act, a regulated activity can only be conducted if an approved SEO has been developed. The SEO outlines the environmental objectives that the regulated activity is required to achieve and the criteria upon which the objectives are to be assessed.

Under Regulation 14 of the Petroleum and Geothermal Energy Regulations, an approved SEO must be reviewed at least once in every five years. Beach originally developed the SEO for Beach production operations in the Cooper Basin in 2003. It was reviewed and updated in 2008/9 (Beach 2009).

The SEO has been reviewed (in 2014) and subsequently revised in parallel with the EIR (this document).

2.1.1 Environmental Impact Report

In accordance with Section 97 of the Petroleum and Geothermal Energy Act, an EIR must:

- take into account cultural, amenity and other values of Aboriginal and other Australians insofar as those values are relevant to the assessment
- take into account risks to the health and safety of the public inherent in the regulated activities

- contain sufficient information to make possible an informed assessment of the likely impact of the activities on the environment.

As per Regulation 10 of the Petroleum and Geothermal Energy Regulations, the EIR must include:

- a description of the regulated activities to be carried out under the licence (including their location)
- a description of the specific features of the environment that can reasonably be expected to be affected by the activities, with particular reference to the physical and biological aspects of the environment and existing land uses
- an assessment of the cultural values of Aboriginal and other Australians which could reasonably be foreseen to be affected by the activities in the area of the licence, and the public health and safety risks inherent in those activities (insofar as these matters are relevant in the particular circumstances)
- if required by the Minister – a prudential assessment of the security of natural gas supply
- a description of the reasonably foreseeable events associated with the activity that could pose a threat to the relevant environment (including events during the construction, operational and abandonment stages, atypical events, estimated frequency of events and the basis of predictions)
- an assessment of the potential consequences of these events on the environment (including size and scope, duration, cumulative effects (if any), the extent to which these consequences can be managed or addressed and proposed management actions)
- an explanation of the basis on which these consequences have been predicted
- a list of all owners of the relevant land
- information on consultation undertaken during preparation of the EIR.

2.1.2 Environmental Significance Assessment and SEO Consultation Requirements

The EIR is submitted to DSD and an Environmental Significance Assessment is undertaken to determine whether the activities described in the EIR are to be classified as 'low', 'medium' or 'high' impact. A corresponding SEO is prepared, reflecting the impacts and measures identified in the EIR or other assessments that may be required as determined by the classification.

The classification also determines the level of consultation DSD will be required to undertake prior to final approval of the SEO as follows:

- **Low impact activities** do not require public consultation and are subjected to a process of internal government consultation and comment on the EIR and SEO prior to approval.
- **Medium impact activities** require a public consultation process for the EIR and proposed SEO, with comment sought for a period of at least 30 business days.
- **High impact activities** are required to undergo an environmental impact assessment under the provisions of the *Development Act 1993*.

The level of impact of a particular activity is assessed on the basis of the predictability and manageability of the impacts on the environment. Where the environmental impacts are predictable and readily managed, the impact of the activity is considered low. Where the environmental impacts are less predictable and are difficult to manage, the impact of the activity is potentially high.

Once the approval process is complete, all documentation, including this EIR and its associated SEO, must be entered on an environmental register. This public Environmental Register is accessible to the community from the DSD website.

2.1.3 Activity Notification / Approval Process

Prior to commencing a regulated activity, Section 74(3) of the Petroleum and Geothermal Energy Act provides that:

- The Minister's prior written approval is required for activities requiring high level supervision (as per Regulation 19), and
- Notice of activities requiring low level supervision is to be given at least 21 days in advance (as per Regulation 18).

In order to obtain written approval for activities requiring high level supervision, an application and notification of activities (in accordance with Regulation 20) must be submitted to the Minister at least 35 days prior to the commencement of activities.

The notification of activities must provide specific technical and environmental information on the proposed activity and include an assessment to demonstrate that it is covered by an existing SEO.

Consequently, the activity notification process provides an additional opportunity for DSD to ensure that the proposed activities and their impacts can be effectively managed and are consistent with the approvals obtained in the EIR and SEO approval process. This is particularly relevant for activities that are conducted under an SEO that applies to a broad geographical area, as it provides site-specific detail that is not usually contained in the generic documents.

2.2 Other Legislation

A number of additional environmental approvals may be required under Commonwealth and South Australian legislation. These are outlined in Table 1. (Note that this is not a comprehensive list of all applicable legislation).

It must be noted that not all subsequent approvals are mandatory at the development (or construction) stage, as approvals may be required as circumstances arise (for example cultural artefact finds during construction or operation).

Table 1: Additional environmental legislation and approvals

Agency	Legislation	Issue
Commonwealth		
Department of the Environment and Energy (DEE)	*Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*	Assessment and approval required if activities will significantly impact matters of national environmental significance, including: ▪ National Heritage Places ▪ wetlands of international importance (Ramsar wetlands) ▪ listed threatened species and communities ▪ listed migratory species (for example JAMBA and CAMBA) ▪ a water resource in relation to coal seam gas and large coal mining developments.
Commonwealth	*Native Title Act 1993*	Intersection of registered Native Title claims.
South Australia		
Department of Environment, Water and Natural Resources (DEWNR)	*Heritage Places Act 1993*	Permission required if listed heritage places or related objects are to be destroyed / disturbed.

Agency	Legislation	Issue
DEWNR	*National Parks and Wildlife Act 1972*	'Taking' of protected plant and animal species. Undertaking regulated activities in Regional Reserves.
DEWNR	*Native Vegetation Act 1991*	Removal of native vegetation and achievement of significant environmental benefit (SEB).
DEWNR	*Crown Land Management Act 2009*	Provision for the disposal, management and conservation of Crown Land in South Australia.
DEWNR	*Pastoral Land Management and Conservation Act 1989*	Provides for the management and conservation of pastoral land to ensure that all pastoral land in SA is well managed and utilised to maintain renewable resources and yields sustained.
DEWNR SAAL NRM Board	*Natural Resources Management Act 2004*	Management of pest plants and animals. Water sourcing (e.g. from new bores) and licensing of water extraction. Water affecting activities.
Department of State Development (Aboriginal Affairs and Reconciliation)	*Aboriginal Heritage Act 1988*	Authorisation required if Aboriginal sites, objects or remains are to be damaged, disturbed or interfered with.
Environment Protection Authority (EPA)	*Environment Protection Act 1993* (including all Environment Protection Policies (EPP) e.g. *Environment Protection (Water Quality) Policy 2015*)	General environmental duty to avoid causing environmental harm Protection of water quality Licensing of scheduled / prescribed activities e.g. ▪ establishment of landfill site for waste disposal ▪ transport of prescribed wastes or substances ▪ producing listed wastes ▪ storage or production of large volumes of petroleum (2000 m^3 storage or 20 tonnes per hour production) ▪ fuel burning at a rate of heat release exceeding 5 megawatts ▪ injection of fluid containing antibiotic or chemical water treatments at a rate of more than 50 kL / day.
EPA	*Radiation Protection and Control Act 1982*	Control of activities related to radioactive substances and radiation apparatus, and for protecting the environment and the health and safety of people against the harmful effects of radiation.
SA Attorney General's Department	*Native Title (South Australia) Act 1994*	Matters relating to traditional land rights in South Australia. The Act provides for the registration of native title rights, investigations on native title rights, claims and determinations of native title rights and compensation for acts affecting native title rights.
Safework SA	*Explosives Act (South Australia) 1936*	Regulates the manufacture, carriage, storage, import and purchase or explosives.
Safework SA	*Work Health and Safety Act 2012*	Identifies control measures to be applied to specific work activities and hazards.

Other legislation of particular relevance to the proposed activities includes:

- *Fire and Emergency Services Regulations 2005* – in relation to fire bans and hot work permits.
- *South Australian Public Health (Wastewater) Regulations 2013* – in relation to waste water (sewage) disposal and the operation of septic tank systems with respect to the Department of Health's requirements / approval.

EPBC Act

Approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required for activities that have a significant impact on matters of national environmental significance including World Heritage properties, National Heritage places, Ramsar wetlands of international importance, nationally threatened species and ecological communities, migratory species and water resources in relation to coal seam gas and large coal mining developments.

In regard to petroleum activities in the Cooper Basin, issues that potentially require approval under the EPBC Act are relatively limited and can generally be avoided by site selection and implementation of field procedures (e.g. avoiding impacts to surface drainage and significant wetland areas).

Beach will continue to review proposed activities against the EPBC Act triggers and will submit a referral under the Act for specific activities if necessary. Any future projects involving coal seam gas would need to be referred if they are likely to have a significant impact on a water resource[1].

Native Vegetation Act and Regulations

The South Australian *Native Vegetation Act 1991* and the *Native Vegetation Regulations 2003*[2] apply to vegetation clearance for petroleum operations. Under Regulation 5(1)(zd), petroleum operations are permitted to clear native vegetation, provided that either:

- the clearance is undertaken in accordance with a SEO and the Native Vegetation Council has signified that, as a result of work undertaken in accordance with the SEO, there will be a 'significant environmental benefit' (SEB) at the site of the operations or within the same region of the State, or
- the project makes a payment into the Native Vegetation Fund of an amount considered by the Native Vegetation Council to be sufficient to achieve a 'significant environmental benefit'.

A 'significant environmental benefit' is typically achieved by undertaking works to establish, regenerate, preserve or maintain native vegetation.

Guidelines have been developed for the minerals and petroleum industry to provide a framework for determining the level and method of SEB (DWLBC 2005[2]). These guidelines are administered by DSD, who have delegated authority to approve SEBs.

A requirement to achieve a SEB will be included in the accompanying SEO.

Environment Protection Act

The Environment Protection Act imposes a general environmental duty not to undertake an activity that pollutes, or might pollute the environment unless all reasonable and practicable measures have been taken to prevent or minimise any resulting environmental harm.

[1] South Australia is also a signatory to the National Partnership Agreement on Coal Seam Gas and Large Coal Mining Development. As a consequence, any coal seam gas projects must also be referred by DSD to the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) for advice under the South Australian protocol for the referral of project applications to the IESC.

[2] The Native Vegetation Regulations and Guidelines were under review at the time of writing.

Environmental authorisations are required to undertake activities prescribed under the Act. Beach holds a licence (number EPA31222) for the *Callawonga Oil Field and other Places within the Cooper Basin Region SA* that currently covers the following prescribed activities:

- 1(5)(a) Petroleum Production, Storage or Processing Works or Facilities
- 1(5)(b) Petroleum Production, Storage or Processing Works or Facilities
- 3(4) Activities Producing Listed Wastes.

The Environment Protection Act also imposes an obligation to report incidents causing or threatening serious or material harm to the EPA, where applicable, in accordance with Sections 83 and 83A of the Act.

The Environment Protection Act does not apply to petroleum exploration activity undertaken under the Petroleum and Geothermal Energy Act or to wastes produced in the course of an activity (not being a prescribed activity of environmental significance) authorised by a licence under the Petroleum and Geothermal Energy Act when produced and disposed of to land and contained within the area of the licence.

3 Production Operations

This section provides a description of production operations that are currently being or likely to be carried out by Beach in the Cooper Basin.

Production operations have been grouped into the following categories:

- well operations (including completions and workovers, well integrity management, artificial lift and wellhead production equipment, gas well deliquification and downhole abandonment following production)
- production facilities (including oil and gas production facilities and support infrastructure)
- produced formation water disposal
- waterflood and reinjection activities
- pipelines / flowlines
- road construction and maintenance
- aircraft landing area
- oil transport
- waste management, landfill and land treatment operations
- decommissioning / rehabilitation.

Production operations can be undertaken under a number of different types of licence under the Petroleum and Geothermal Energy Act, including a Petroleum Production Licence (PPL), Petroleum Retention Licence (PRL), Petroleum Exploration Licence (PEL) (e.g. extended production tests), Pipeline Licence (PL) and Associated Activities Licence (AAL) (e.g. for roads or pipelines outside Beach's PELs or PPLs). Figure 2 and Figure 3 provide an overview of Beach's licence areas and production sites in the Cooper Basin.

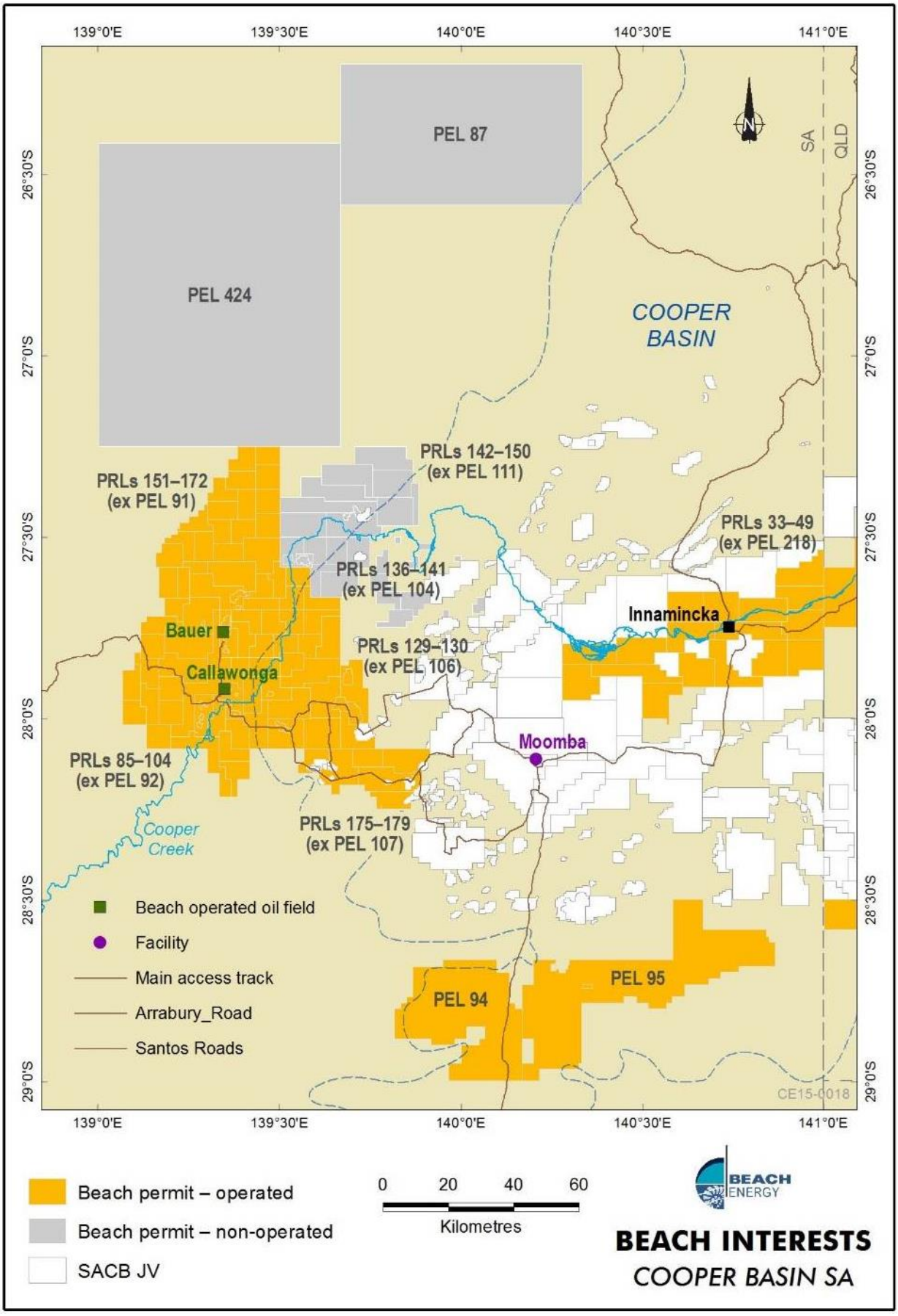


Figure 2: Beach Cooper Basin licence areas (April 2015)

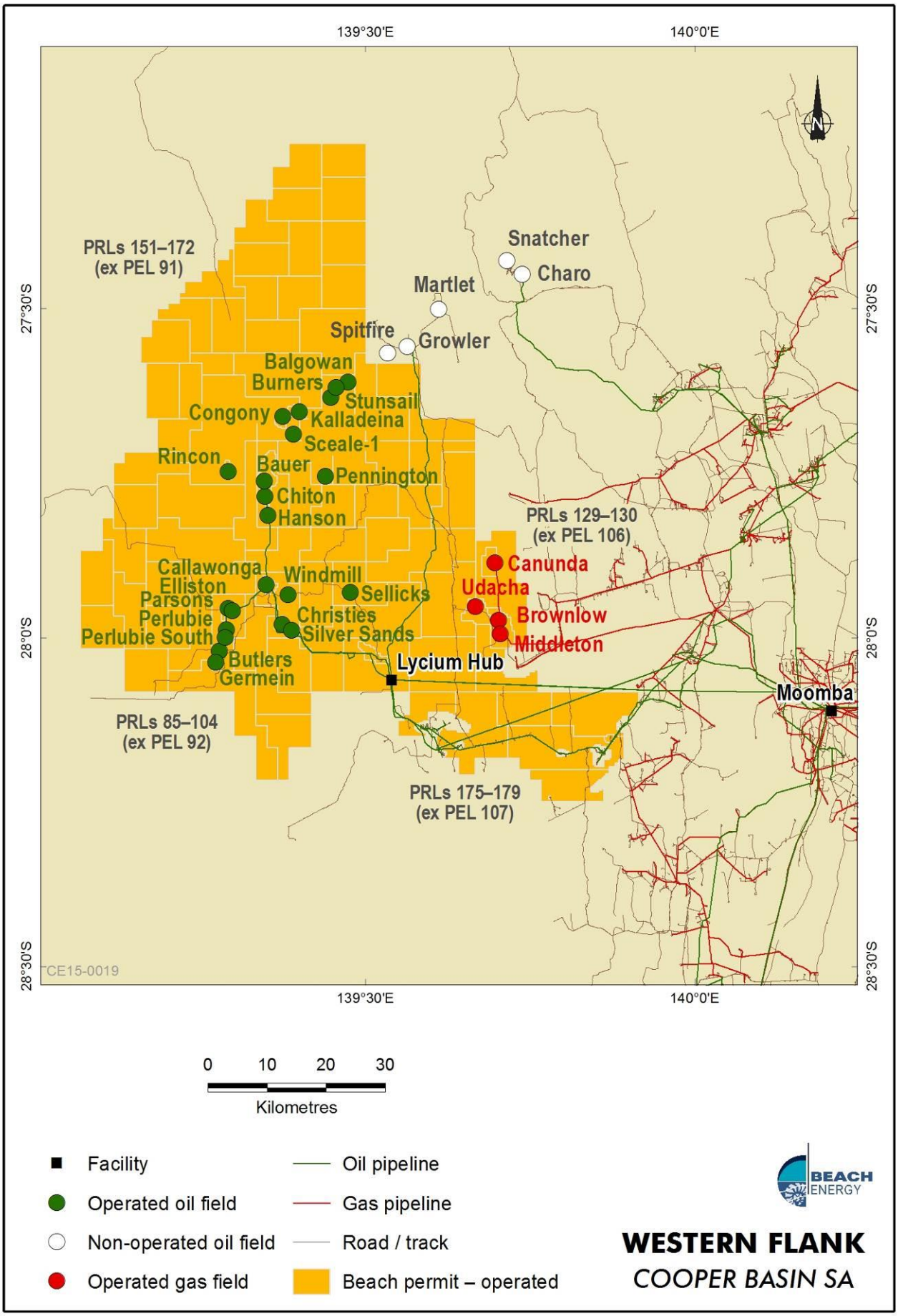


Figure 3: Beach Cooper Basin Western Flank production operations and facilities (April 2015)

3.1 Well Operations

A range of activities related to the operation of wells may be carried out on well sites during the life of a production well. These include but are not limited to completions, workovers, installation and operation of artificial lift, wellhead production skids, gas well deliquification and ongoing well integrity management. These are described in the following sections.

3.1.1 Completions and Workovers

Completion activities to prepare the well for production commence after the well has been drilled, cased and cemented and the wellhead installed. Generally completion activities commence soon after drilling but may be delayed for longer periods (e.g. if the well is cased and suspended for future production). Some examples of completion activities that may be undertaken include:

- cleaning out the casing of any fill, or to confirm wellbore access
- perforating the casing to access the reservoir fluids / gas to be produced
- setting packers downhole for the installation of tubing or plugs to isolate non-commercial reservoir zones
- cased hole logging and gradient / pressure surveys for evaluation of either wellbore construction elements or reservoir property evaluation with time.

Workover operations with a service rig may also be carried out on a well after the initial completion. They may include but not be limited to:

- repairing, replacing or installing artificial lift systems with either like-for-like repairs or upgrading to a different lift system as well parameters change with time
- cleaning sand out of the well from debris / sand / backfill
- isolation of zones, which may be required due to factors such as:
  - watered out zones
  - non-commercial zones
  - in preparation for final abandonment by isolating formations
  - well integrity purposes to reduce risks to as low as reasonably possible
- zone changes in a multi-zone well that has the ability to open and close sleeves to access different formations or combinations of formations
- repairing corrosion by replacement of equipment or engineered patches
- deepening the wellbore to access previously un-accessed formations
- fishing to recover objects from the wellbore and / or milling obstructions in the well
- perforating / re-perforating new or existing zones to improve or increase production.

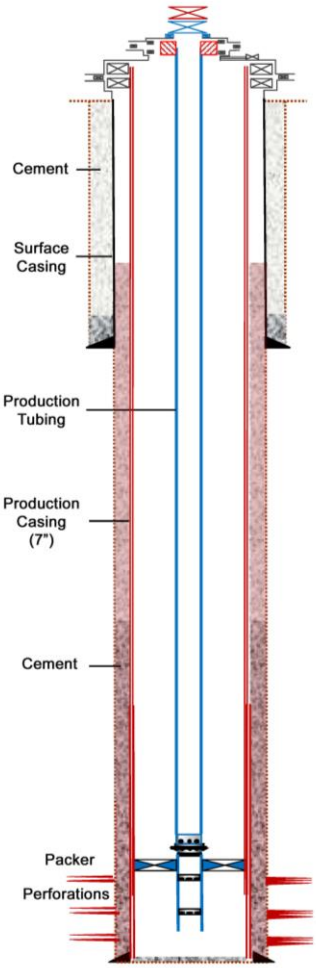
Some well interventions do not need a service rig and require either a smaller unit of slickline and / or wireline equipment to conduct various cased hole operations, such as perforating or setting a plug as mentioned above. In some instances the use of a coiled tubing unit is necessary to enter a live wellbore under pressure to perform an operation similar to that of a service rig, but without having to fill the well full of fluid, which can cause the formation(s) to struggle to produce after the job has been completed. Pumps and storage tanks are used for operations that need to circulate workover fluids in / out of the well.

3.1.2 Well Integrity Management

To assess and maintain the reliability of wells, Beach has implemented a well integrity testing and monitoring program. The intent of this program is to maintain wells in a fit for purpose condition and to protect the environment and people.

The well integrity management process governs the operation and maintenance of wells throughout their lifecycle. The process includes routine visits to evaluate barrier integrity. Following inspection, the asset data is reviewed and wells identified with an elevated risk level undergo a detailed assessment. The outcomes of the risk assessment form the basis of an asset strategy plan, and integrity check frequencies may be modified and scheduled based on the level of risk assigned. Alternately the well analysis may generate recommendations to perform a well repair or suspension and / or abandonment prioritisation. If a high risk issue is identified, repair or abandonment activities are to be undertaken as soon as practicable.

Figure 4 provides a simplified example of a Wellbore Status Diagram, which shows a schematic of a typical gas well and a summary of the integrity status of the barriers in the well.



Well Information	
Well Name	**Gas Well-1**
Well Type	Gas Producer
Well Status	Operational
Date Drilled	Nov 2000
Well Barrier Elements	Verification of Barrier Elements
PRIMARY	
Production packer	Tested on xx/xx/xx to xxx psi.
Production tubing	Tested on xx/xx/xx to xxx psi.
Lower wellhead valve	Tested on xx/xx/xx to xxx psi.
SECONDARY	
7" casing	Tested on xx/xx/xx to xxx psi.
Wellhead Seals	Tested on xx/xx/xx to xxx psi.
7" casing cement	Cement placed as per program. No losses. Cement bond log shows good bond response.
Upper wellhead valve	Tested on xx/xx/xx to xxx psi.
Tbg hanger w/ seals	Tested on xx/xx/xx to xxx psi.

Figure 4: Simplified wellbore status diagram

3.1.3 Artificial Lift and Wellhead Production Equipment

Oil Wells

In the Cooper Basin Western Flank, oil generally 'free flows' to surface under reservoir pressure. In some cases, there may not be sufficient deliverability to produce oil to surface or at an economic rate and artificial lift may be required to increase production. The type of artificial lift installed depends on numerous factors, which include the depth of the well, well deliverability and reserves.

Types of artificial lift used on oil wells include:

- **Jet pumps** which use a small 'nozzle pump' located down the well and circulate a fluid stream known as power fluid between the surface and the downhole nozzle. This creates a suction force which draws in fluid from the oil reservoir and causes it to be lifted up into the well. Above ground the jet pumps consist of a suction header tank, suction manifold and filtration system, power-fluid pumpset, bulk fuel storage tank, power fluid discharge distribution manifold, and connections to deliver power fluid to the jet-pump wellhead(s).

- **Electric submersible pumps (ESP)** which comprise a multi-stage centrifugal pump attached to an electric motor installed downhole. Power is supplied from the surface by a generator and is transferred to the ESP by a cable which is strapped to tubing. Other surface equipment includes a variable speed drive, transformer, junction box and a bulk fuel storage tank.

- **Rod pumps** are deployed in the wellbore and can be operated by either conventional beam pump units, or small skid mounted electro-hydraulic rod-pumping units. These units are typically powered by a diesel motor or generator and may also include a variable speed drive, transformer, junction box and a bunded bulk fuel storage tank.

All artificial lift systems have a high pressure switch which will shut down the unit if the pumping pressure is too high.

Oil wells may also have other equipment located on the well lease, including telemetry equipment or chemical injection skids (which typically include a chemical storage tank and solar-powered pump to inject emulsion-breaker into the flowline downstream of the wellhead).

Plate 1: Rod pump operated by beam pump unit

Plate 2: Jet pump, showing wellhead (foreground) and jet pump engine and fluid tanks (blue, in background)

Gas Wells

Gas wells typically have a wellhead production metering skid and a safety shutdown valve installed on the well lease, immediately downstream of the wellhead.

A wellhead production metering skid may include any or all of the following equipment:

- auto controlled choke
- pressure safety valve
- a meter run and flow recording device
- corrosion inhibitor injection facilities
- telemetry transmission which relays wellhead pressure, flow, temperature and choke position to remote control and monitoring locations.

Additional artificial lift mechanisms may be required in gas wells to assist removal of liquids from the wellbore where excessive liquid production inhibits gas deliverability. These mechanisms, which typically unload water from the well to enable continued gas production, may include:

- plunger lift, which uses bottom hole pressure to lift a plunger from downhole inside the tubing to the surface to push liquid out of the tubing
- velocity string - small internal diameter (ID) tubing, which increases the velocity of the produced fluid moving up hole which can continuously unload the well
- micro-strings, which are a small diameter tube used to inject foamers into a wellbore close to the perforations and help to reduce friction and unload water. Foamer / surfactant selection and dosage rate would be based on the type of the fluids to be foamed, downhole temperature and pressure, the environmental properties of the chemical and corrosivity of the foamer.

Methods such as Nitrogen lifting are usually temporary measures typically associated with a wellbore clean-up post fracture stimulation and are not considered a permanent artificial lift installation. A work program would be issued for these types of operations and fluid returns dealt with as per flowback processes discussed in the Cooper Basin Shale Gas Fracture Stimulation EIR (Beach 2012a).

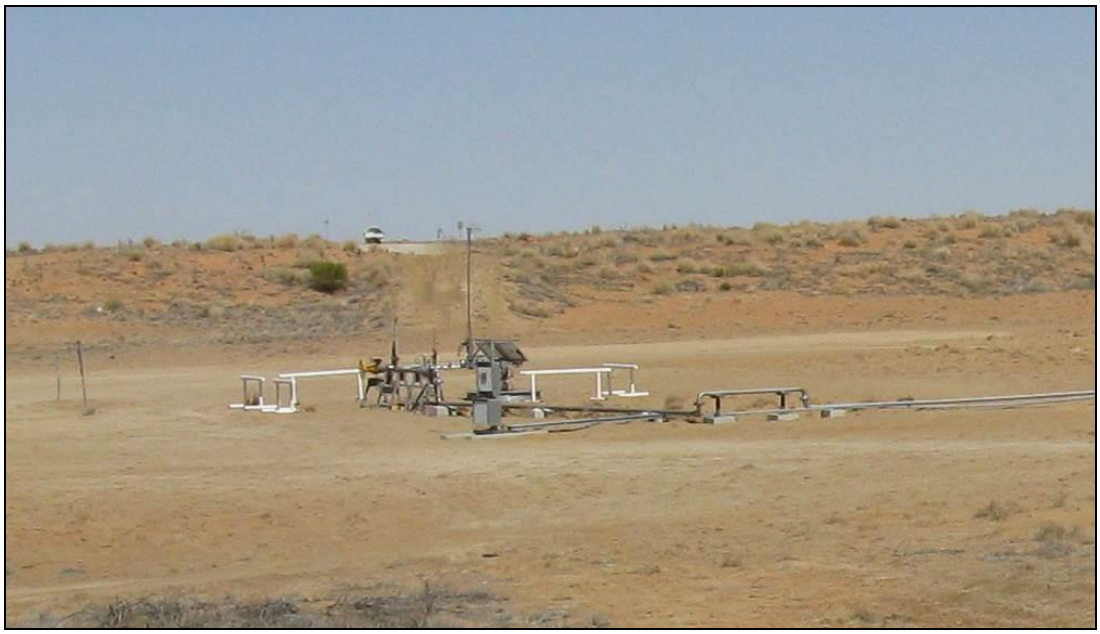


Plate 3: Gas well showing wellhead production metering skid

3.1.4 Gas Well Deliquification

As productivity declines in gas wells, they often require unloading of reservoir fluid (primarily water) that has accumulated in the well and created a static column preventing it from flowing continuously. Deliquification typically involves unloading the liquids in the well's production tubing by expelling the gas and flowing the liquids to a pit or tank. This allows the well to continue to flow for longer periods of time. When a well requires frequent unloading it may become a candidate for a smaller diameter tubing installation or artificial lift (as discussed in Section 3.1.2) depending upon the economics of the project and remaining reserves in place.

Unloading of wet gas streams to a pit are performed in a controlled manner down a blowdown line, for a brief duration until flowline pressure can be simulated, then the well is typically diverted back to inline flow. Where possible the gas stream mix is flared depending on the gas / fluid ratio, however often the stream is too wet to ignite. In this case, the gas vented is negligible and it is mainly a column of fluid being expelled in to an impervious clay lined pit.

3.1.5 Downhole Abandonment Following Production

Once a well has reached the end of its productive life, a decision is made on whether to abandon the cased wellbore or leave it in a suspended state until it can be abandoned. Each well is evaluated individually to design the abandonment program. Abandonment programs are submitted to DSD prior to implementation.

The abandonment program usually involves the following:

- all perforated hydrocarbon zones are isolated with cement plugs and / or mechanical plugs

- bond logs, if conducted, are evaluated to ensure that the cement behind the production casing is adequate to avoid crossflow of aquifers with other aquifers or hydrocarbon producing zones
- if isolation is not present, a decision may be made to perforate and squeeze off the aquifer to ensure that there is no crossflow
- pressure testing and / or negative inflow testing is performed on barrier envelopes / components where feasible
- inhibited fluid is placed between barriers where applicable
- final well abandonment at the surface will involve a surface cement plug and cutting or removing the wellhead to below ground level.

Note: Surface rehabilitation of well sites and downhole abandonment of wells following drilling are governed by the Drilling SEO (Santos 2015) and are not covered by this EIR or the accompanying SEO.

3.2 Production Facilities

Beach's production facilities in the South Australian Cooper Basin at the time of writing of this EIR are summarised in Table 2. All but one of these production facilities (the Middleton gas facility) produce oil. As Beach has recently drilled a number of wells that have resulted in gas discoveries, it is likely that one or more additional gas production facilities will be established within the next few years. Additional oil production facilities are also expected to be installed in the future if ongoing exploration drilling results in further oil discoveries. Consequently, the operation of both oil and gas facilities is discussed in Sections 3.2.1 and 3.2.2.

Table 2: Beach production facilities as at February 2015

Field / Facility	Licence	Type (oil / gas)	Wells	Ponds	EPT / facility	Flowlines
Aldinga	PPL 210	Oil	1	-	Y	1
Bauer	PPL 253	Oil	20	8	Y	19
Butlers	PPL 245	Oil	8	5	Y	8
Callawonga	PPL 220	Oil	9	4	Y	9
Chiton	PPL 253	Oil	3	2	Y	2
Christies / Silver Sands	PPL 205	Oil	8	5	Y	8
Congony / Kalladeina / Sceale	PPL 254 / PPL 256	Oil	3	3	Y	3
Hanson / Snellings	PPL 255	Oil	2	3	Y	1
Kiana (*not operating*)	PPL 212	Oil	1	-	-	-
Lycium Hub	SFL 4	Oil	-	1	N	4 trunk
Middleton / Brownlow / Canunda	PPL 239 / PPL 239 / PPL 257	Gas	3	2	Y	3
Parsons	PPL 224	Oil	5	5	Y	5
Pennington *(under construction)*	PRL 163	Oil	2	3	Y	2
Rincon *(under construction)*	PPL 248	Oil	2	3	Y	1
Sellicks (*not operating*)	PPL 204	Oil	3	3	Y	3
Stunsail *(under construction)*	PRL 172	Oil	2	3	Y	2

Camps to accommodate field personnel, which are located either at production facility sites or at stand-alone sites, are discussed further in Section 3.2.3.

3.2.1 Oil Production Facilities

Oil production facilities may consist of:

- gathering system (flowlines) from the oil well(s)
- well facility and pumping systems
- inlet manifold system
- water separator tank(s)
- skimmer tank
- crude oil separation and oil storage tanks
- pigging facilities (launch and receiver stations)
- oil transfer pumps
- drains and sump
- utilities (instrument air, electric power generation, fuel gas and fuel oil systems) at selected facilities
- control hut / office, amenities and accommodation (at selected facilities)
- bulk storage areas or warehouse
- telemetry and communications system
- emergency shutdown and control systems
- produced water treatment facilities, including interceptor ponds, holding ponds and evaporation ponds
- chemical injection system for corrosion prevention and emulsion breaking
- lined and bunded tanker load-out area
- piping connections to an oil pipeline
- hazardous material storage areas
- wastewater and sewage treatment systems (at selected facilities)
- perimeter fencing.

The area of a production facility (excluding ponds for water disposal) is typically in the order of 150 m x 150 m. Bauer (East and West) is Beach Energy's largest facility at approximately 300 m x 200 m.

Electrical power for the facility and the nearby oilfields is provided by electrical generation equipment at the site.

Artificial lift (e.g. rod pumps, jet pumps and electric submersible pumps) may be used on oil wells (discussed in Section 3.1.3). Consequently, pumps and high pressure flowlines (Section 3.5) may be located both within and outside the boundary of a production facility.

In the event that additional or new facilities are required, the facilities are located where possible on previously disturbed ground. The majority of facilities are usually located on existing drill pads or adjacent to producing wells. This assists in minimising the extent of any additional earthworks and allows existing access tracks to be utilised. However, an additional area may need to be cleared and / or fill imported to provide for facility foundations or bunds.

Facilities are generally located away from areas that are likely to be flooded, but at some sites, minor earthworks (e.g. bunds) may be required to prevent inundation of the facility during flooding. These earthworks are designed and constructed to ensure that surface water drainage patterns in the area surrounding the facility are not significantly altered.

Laydown / storage areas (for stockpiling materials and equipment) are established at selected sites. These are established in existing areas of disturbance where possible, or in areas with little perennial vegetation. They would typically be located adjacent to existing roads or tracks.

Examples of facilities are shown in Plate 4 to Plate 6.

Production Testing Installations

Initial production testing may be performed prior to the construction and installation of permanent production facilities and flowlines. These tests are typically required to assist in the evaluation of the well's productivity in order to justify and/or assist in the design of permanent production facilities. The test duration, and the type and volume of fluids produced are dependent on the characteristics of the well. Tests may range in duration from a few days to up to 6 months.

Installations for initial production testing are typically small-scale, mobile and temporary in nature. They are normally confined to the drilling pad and may consist of one or more separator and storage tanks, with inter-connecting pipework and valving. Testing equipment and personnel may be provided by either a contractor or by Beach Energy in-house, depending on requirements. Over-pressure shutdowns, spill protection and other risk mitigation measures are incorporated in a fit-for-purpose manner. The testing activities may be manned or unmanned, subject to testing requirements and risk assessment.

Produced oil is loaded into tankers and trucked off-site. Produced water may be disposed to either drilling sumps or local ponds for evaporation, or may be trucked off-site.

Plate 4: Bauer oil production facility showing Bauer East and Bauer West tank farms (top) and close-up of Bauer West tank farm (bottom)

Plate 5: Rincon temporary extended production testing (EPT) facility

Plate 6: Callawonga production facility

Processes

Oil production facilities receive fluids from oil producing well(s), separate the gas and water from the oil, and then transfer the processed oil to storage tanks. Oil is then transported from the site to third party facilities either by truck or via pipeline.

The water content of fluid produced from an oil well can vary, with Beach's fields typically varying between nil and 95%. After separation from the oil in separator tanks, produced water flows via pipes to a series of ponds for further separation, as discussed in Section 3.3.

A pressure relief system is installed at sites for both plant venting and emergency relief, and in some cases may also include a flare system.

Management of produced formation water, domestic and other wastes and contaminated soil at oil production facilities is discussed in Sections 3.3 and 3.9.

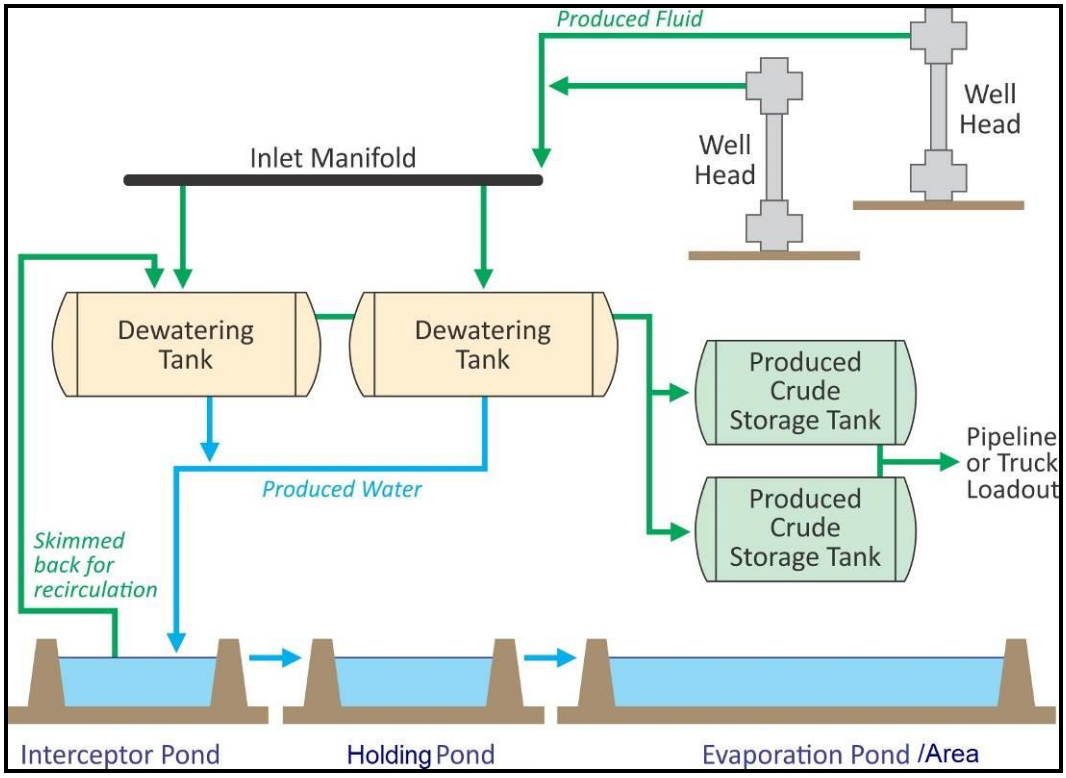


Figure 5: Oil production and water disposal process diagram – free flow, ESP, and rod pump.

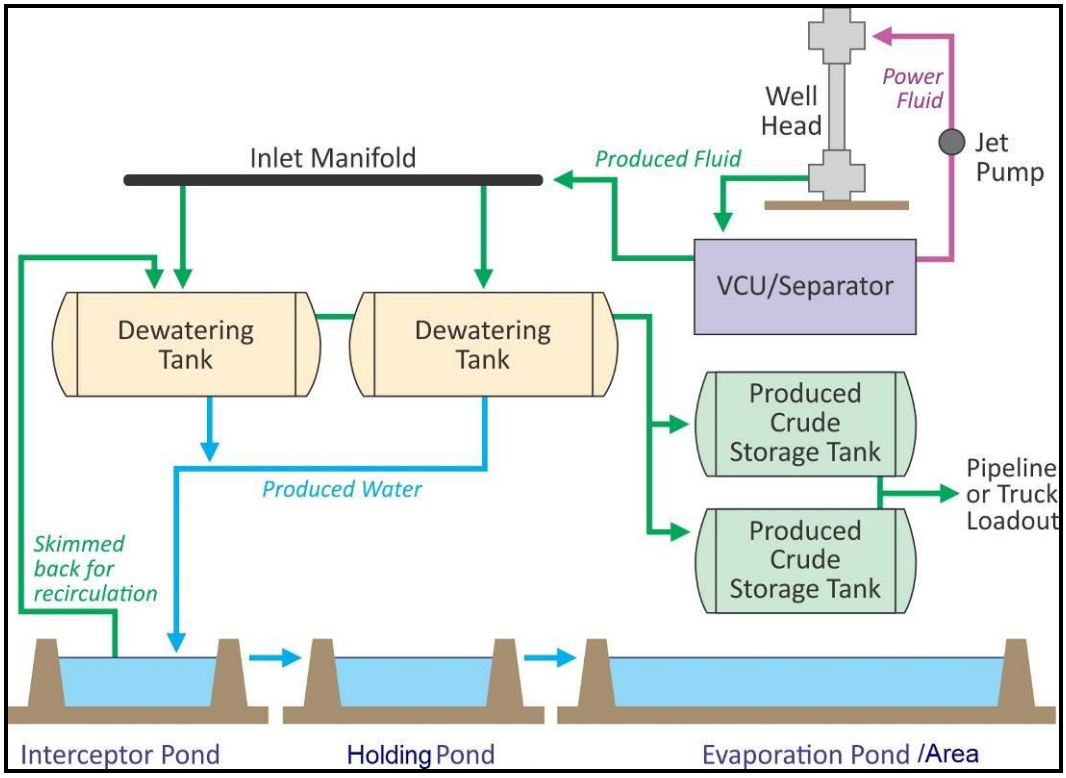


Figure 6: Oil production and water disposal process diagram – jet pump.

3.2.2 Gas Production Facilities

Raw gas is delivered to gas production facilities via pipelines from producing wells. Gas facilities then deliver raw gas (usually pressure-boosted) to the Cooper Basin pipeline network (which feeds the Moomba processing plant).

A typical gas facility incorporates:

- gathering and manifold system from the gas wells
- an inlet header system for raw gas
- gas, liquid hydrocarbon (condensate) and water separation facilities
- gas compression and cooling systems
- gas conditioning (oxygen and CO_2 removal) facilities
- condensate handling facilities
- liquid hydrocarbon recovery
- slug catchers (separation)
- pigging facilities (launch and receiving stations)
- telemetry and communications system
- emergency shutdown and control systems
- utility facilities, including fuel gas system, fire detection, instrument air, evaporative coolers, emergency power generation and wash-down water
- office, amenities and accommodation (at selected facilities)
- produced water treatment facilities, including interceptor ponds and evaporation ponds
- a flare system and vent facilities
- piping connection to a trunkline
- perimeter fencing.

Examples of a small gas production facility (Beach's Middleton facility) and a larger Cooper Basin gas production facility are shown in Plate 7 and Plate 8.

Plate 7: Middleton gas production facility

Plate 8: Example of a larger gas production facility in the Cooper Basin (Source: Santos Dullingari Facility)

Processes

A gas facility generally provides its own fuel gas system. Electrical power is usually generated on-site but may be provided from other sources.

Raw gas enters a gas facility where it is separated into the three component phases - gas, hydrocarbon liquid and water (produced formation water) - inside inlet separator vessels.

Once separated, the natural gas component may then be supplied directly to a third party as raw or compressed gas. Any remaining condensed hydrocarbon liquid in the gas is recovered in separators and generally reinjected into the discharge header or stored and trucked off-site. The gas is transported from the site via a pipeline connection to another gas facility or direct to a third party. Gas and condensate mixture can be piped or trucked but condensate is generally combined with the gas stream for transport via a pipeline connection.

After gas separation in separator vessels, produced water flows via pipes to a series of ponds for further separation, as discussed in Section 3.3. A pressure relief system is provided for both plant venting and emergency relief. During any process anomalies or emergency situation, gas in the plant can be sent directly to the relief system.

During extended production tests that are conducted to evaluate new gas discoveries, gas wells that are not close to an existing gathering network may be flared to allow reservoir parameters and commerciality to be established.

As discussed in Section 3.2, new facilities are located where possible on previously disturbed ground to assist in minimising the extent of any additional earthworks and allow existing access tracks to be utilised.

Management of produced formation water and domestic and other wastes at gas production facilities is discussed in Sections 3.3 and 3.9.

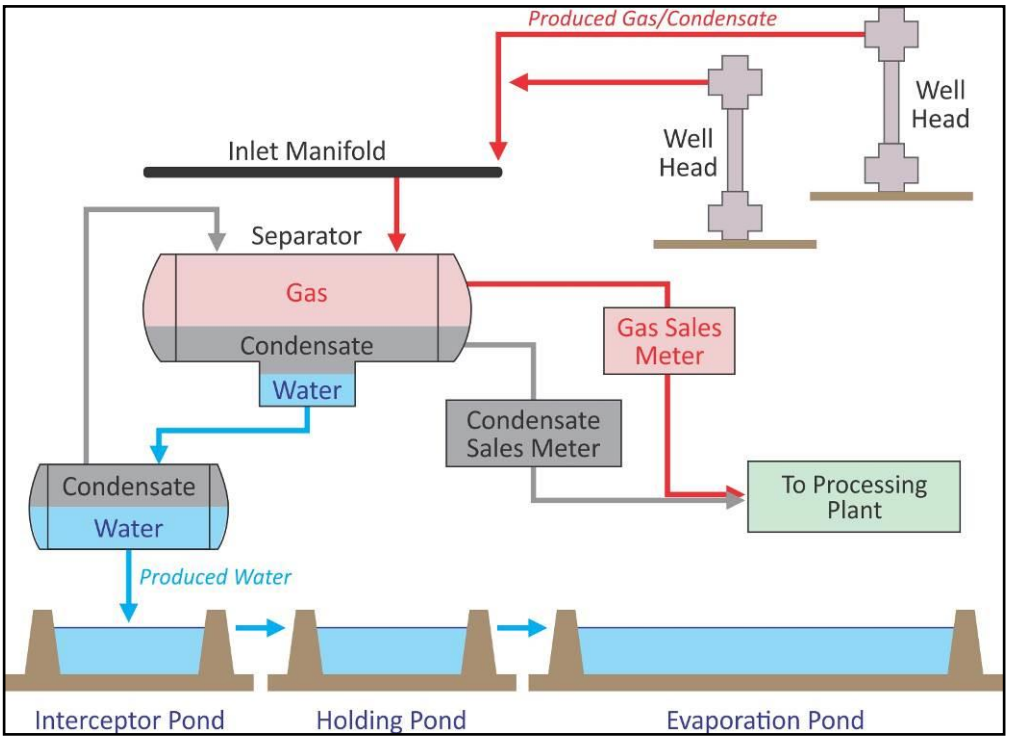


Figure 7: Gas production and water disposal process diagram.

3.2.3 Camps

Camps may be located at production facilities or at stand-alone sites. Camps provide accommodation for personnel working at facilities or surrounding areas, as well as offices and other operations support infrastructure, and may include the following:

- accommodation, offices and amenities
- bulk storage areas or warehouse
- electric power generation
- communications systems
- potable water treatment system (e.g. reverse osmosis system) (at some sites)
- wastewater / sewage treatment system and disposal areas
- fuel storage and refuelling areas
- storage areas for waste and hazardous material
- workshop for maintenance of vehicles, plant and equipment.

Camps are established in existing areas of disturbance where possible, or in areas with little perennial vegetation. A site for a camp would typically be located adjacent to existing roads or tracks.

Beach currently has permanent camp facilities at Callawonga (capacity approximately 50 personnel), Bales (capacity 35) and Habanero (capacity 12) with a small accommodation facility at Middleton (capacity 2) intended primarily for short-term use.

Potable water for use at camps and operational sites may be obtained from third party facilities, or appropriately licensed water bores. Reverse osmosis units may be used to treat bore water to ensure that it is suitable for drinking. For example, the Callawonga camp obtains water from a well

completed in the Great Artesian Basin under a water licence, which is treated by reverse osmosis for potable water supply. This water is also used to supply other nearby camps.

Waste management at facilities and camps is discussed further in Section 3.9.

Plate 9: Callawonga camp

3.3 Produced Formation Water

When oil or gas is produced to the surface it is accompanied by varying quantities of water. This water is known as produced formation water (PFW).

The Minister for Mineral Resources and Energy holds a water licence within the Far North Prescribed Wells Area which allocates 21,900 ML per annum (equivalent to 60 ML/day) for the purpose of taking produced formation water. Industry use of this allocation in 2014 was 41.1 ML/day (DMITRE 2015).

Once PFW undergoes primary treatment at the production facility, it is transferred to a lined interceptor pond. From this point, treatment and disposal of the water is generally achieved using evaporation ponds. Other options that may be used include secondary use (as discussed in Section 3.3.2) or reinjection (as discussed in Section 3.4).

PFW passes via a pipe system into the lined interceptor pond where any entrained hydrocarbons are recovered by manual skimming or vacuum truck. The separated water then passes through a series of ponds (as discussed below in Section 3.3.1) to achieve an oil in water content of:

- less than 30 mg/L if the water is being disposed of via closed (bunded) evaporation ponds; or
- less than 10 mg/L if the water is directed to free-form (unbunded) evaporation areas.

These oil in water content criteria are based on recommended standards that have been provided by the regulator (DSD, formerly PIRSA) for formation water ponds in the South Australian Cooper Basin (Santos 2003). If secondary use of PFW is proposed, water quality criteria for other analytes are also relevant, as discussed in Section 3.3.2.

The formation water produced at Beach's production facilities is reasonably fresh and salinity is typically well below the level (4,000 mg/L) that can be consumed by stock with no adverse effects (ANZECC 2000).

A listing of Beach's PFW disposal facilities is provided in Table 3.

Table 3: Beach PFW treatment facilities as at February 2015

Facility	Approx. area of bunded ponds (m^2)	Indicative free form evaporation area (ha) (nom. max. size)*
Bauer (East and West)	19,280 + 19,280	87
Butlers	28,200	20
Callawonga	10,960	50
Christies / Silver Sands	12,240	39
Chiton	7,035	22
Congony / Kalladeina / Sceale	8,450	20
Hanson / Snellings	7,800	26
Lycium Hub	880	1.4
Middleton / Brownlow / Canunda	560	0.1
Parsons	12,800	39
Rincon	2,085	20

*Note: Nominal maximum size reflects predicted maximum extent. Free form areas change over time due to variation in water production rates and seasonal variation in net evaporation and may be significantly less than this value.

3.3.1 PFW Treatment Process

The PFW treatment process is summarised in Figure 8, and discussed further below.

Primary Treatment

Primary treatment can consist of either physical (gravity) separation or chemical treatment (emulsion breakers) where needed. Chemical treatment enhances PFW separation and aims to maximise hydrocarbon recovery prior to disposal. Primary treatment takes place in vessels and tanks (the separation plant) located in the vicinity of the PFW disposal facility. Water is discharged from the base of the tanks to a lined interceptor pond in the disposal system as shown previously in Figure 5, Figure 6 and Figure 7.

Secondary Treatment - Interceptor Ponds

An interceptor pond is the first pond in any system and is lined with an impervious membrane (e.g. UV stabilised HDPE) and fenced to prevent stock access. The interceptor pond is used as a buffer to ensure that any hydrocarbons carried over from primary separation do not enter the unlined ponds. Hydrocarbons entering the system can be manually skimmed or vacuumed from the surface of the interceptor pond.

Water exits the interceptor pond by an underflow pipe to prevent hydrocarbons on the surface moving further into the system. Water contained in holding ponds should have a concentration of not more than 30 mg/L of total petroleum hydrocarbons.

Tertiary Treatment - Evaporation Systems

The most common means of PFW disposal is the use of a pond system to evaporate water. There are many variables in design of evaporation systems. For example they can be open, closed, bunded or free form. Whether a system is open or closed depends upon water quality considerations and consultation with pastoral lessees and environmental assessment and approval.

Bunded evaporation systems consist of a series of specially constructed shallow ponds to which PFW is discharged, whilst free form water disposal utilises natural landscape features to form the final

evaporation area in the system as described above. Bunded evaporation ponds are typically lined with an impermeable membrane (e.g. UV stabilised HDPE).

Free form evaporation systems usually include at least two specially constructed bunded ponds following primary separation and the lined interceptor pond through which the PFW passes prior to discharge to the free form evaporation area. This acts as a safety mechanism in the event of an oil release to the system. Free form evaporation systems most commonly utilise a dune corridor, with bunds constructed at an appropriate distance apart where required, to form the free form evaporation area.

Residence times in the tertiary treatment system are planned to be sufficient for removal of hydrocarbons to meet the relevant oil in water content criteria.

Free form evaporation systems require increased residence times of the PFW prior to discharge to the free form area, to ensure that the oil in water content is less than 10 mg/L.

Monitoring of pond water quality[3] is carried out regularly (at least every 12 months) to ensure it meets disposal criteria. Monitoring bores may also be installed to monitor potential impacts on groundwater where relevant. Monitoring bores have been installed at older facilities and are currently being installed at all new facilities. Monitoring bores are now a standard component of all new facilities.

Plate 10: Interceptor pond at the Bauer facility

[3] The monitoring suite for freeform evaporation systems typically includes total hydrocarbon, BTEX, PAHs, aluminium, arsenic, beryllium, boron, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, uranium, vanadium, zinc, sulphate, fluoride, calcium, magnesium, TDS, TOC, nitrate, nitrite.

Plate 11: Callawonga West free form area

3.3.2 Secondary Use of PFW

As PFW is a potentially contaminated process by-product, its use for secondary purposes such as drilling, fracture stimulation, road construction, hydrotest water, dust stabilisation or livestock watering is carefully managed.

Prior to secondary use, monitoring results must have shown that the water quality is consistent with relevant guidelines for the intended use and that the concentration of hydrocarbons in the evaporation pond water is consistently lower than 10 mg/L.

The secondary use of PFW as ballast water for oilfield tankers is acceptable provided that the ballast, when not required, is discharged to an approved PFW disposal facility. PFW may occasionally be used as a water source for drilling or fracture stimulation, depending upon proximity to the site and water quality requirements. Ballast water is discharged directly to interceptor ponds to enable any free residual oil to separate from the water and be recovered via surface skimming. Only ballast water is discharged from oilfield tankers to interceptor ponds and under no circumstances is oil, condensate or fluid with greater than 30 mg/L hydrocarbon content discharged from oilfield tankers to interceptor ponds.

PFW may also be used as a water source for waterflood, as discussed in Section 3.4.

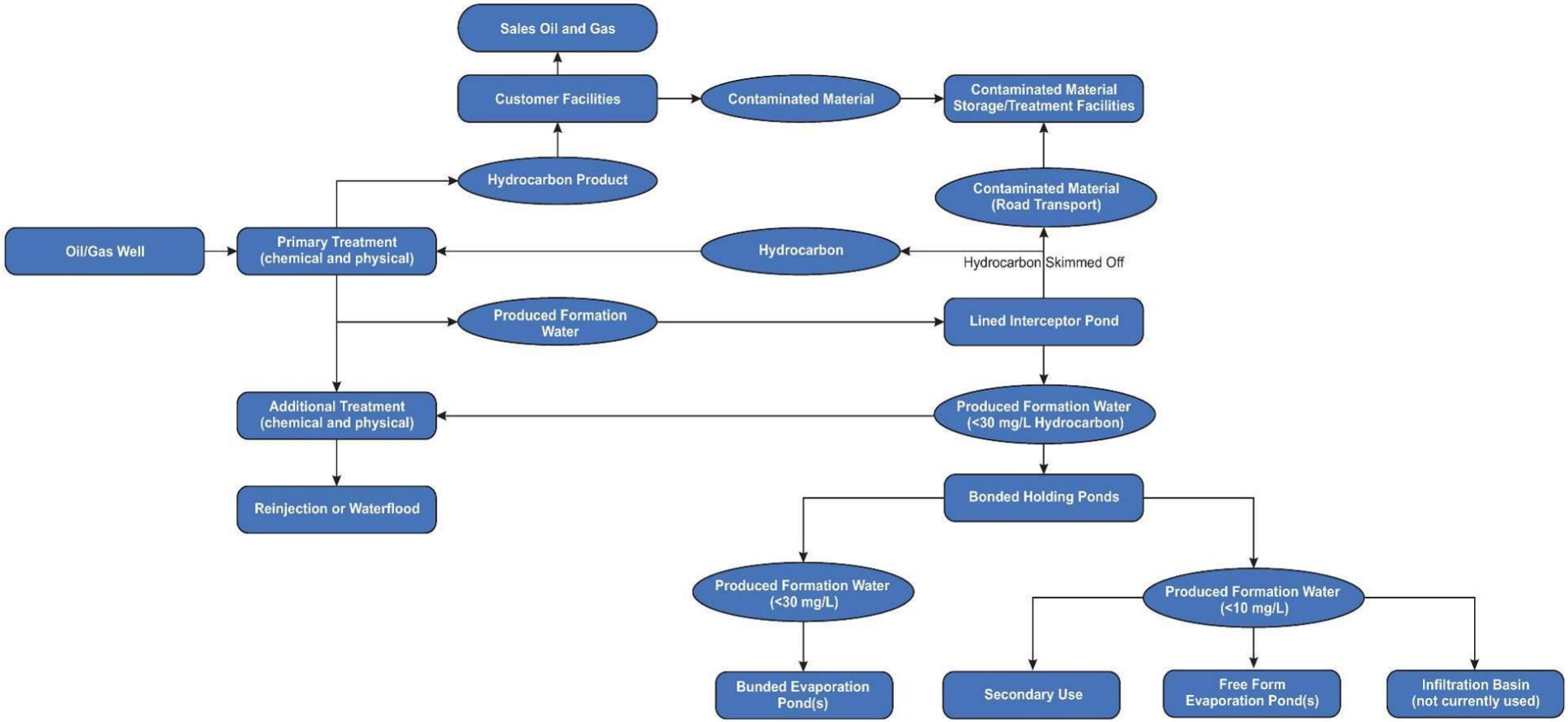


Figure 8: Produced formation water treatment process

3.4 Waterflood and Reinjection

Waterflood

Waterflooding is a means of improving oil recovery by maintaining the pressure in the formation. This is achieved by injecting water back into the formation that it was produced from, or injecting water from other produced wells that have compatible water to the target formation.

Prior to a waterflood scheme being initiated the produced water is tested to ensure it meets certain requirements. The injected water must be clear, stable and be of similar quality to the water in the formation that it is to be injected into. It also must not be severely corrosive and must be free of materials that may plug the formation. In order to achieve this, the PFW may be de-aerated, softened, filtered, chemically treated and / or stabilised.

PFW to be used for waterflood is typically produced into tanks, and further separation is undertaken to ensure that all the oil and sediment have been removed from the water prior to reinjecting into the formation. This is typically done using hydrocyclones, with chemicals and / or heating. Water may also be treated to kill any bacteria residing in the water and other chemicals may be added to eliminate the oxygen content or other components in the water that may cause corrosion of tubulars or incompatibility of the water injected formations.

The water is injected into injection wells using pumps, at pressures high enough to enter the target formation. The injection well may be a production well which has been converted to a water injection well or a well specifically designed and drilled for water injection. The location of injection wells may change over the course of the life of the field to ensure that the oil pool is swept in the most efficient manner. The exact nature of an injection scheme will depend on the objectives of the scheme and the geological environment.

Reinjection

Reinjection of water for disposal is an alternative to surface treatment and evaporation as a means of water management. Reinjection could be into the formation that the water is produced from, or a different formation. The treatment and injection process is similar to waterflood, however injection for water disposal does not aim to enhance the ability of a formation to produce incremental hydrocarbons.

Reinjection has not commonly been undertaken in the Cooper Basin because of the high cost associated with installation and on-going operation of the infrastructure. However, Beach is currently evaluating water reinjection trials as a means of reducing surface water disposal and minimising potential impacts of water production on the Great Artesian Basin.

Beach's preliminary plans for treatment and reinjection involve utilising PFW extracted from holding ponds, filtered and treated to achieve required quality before injection. Water quality monitoring will ensure injected water maintains required quality levels.

3.4.1 Tracers

Tracers may be added to injected water to monitor the direction and effectiveness of the waterflood. Tracers are injected into the water injection well and special lab tests are conducted to pick up extremely low levels of tracer in the produced water.

Tracers are usually non-hazardous chemical or low-level radioactive tracers such as tritium or isotopes of iodine. Tritium tracer, which is effectively tritiated water (HTO), is a weak beta emitting

isotope that has negligible external radiological effect. The radiotracer is typically contained in small volumes (e.g. less than 15 mL) inside approved injection vessels, resulting in negligible internal radiological hazard from possible ingestion of tracer as it is in a sealed system. A beta emitting tracer (e.g. iodine 131) may be added to the vessels to indicate when the tracer has moved through the vessels into the injection well. Tracers such as tritium and iodine tracers are used due to their inherent safety and low cost.

3.5 Pipelines / Flowlines

Pipelines and flowlines are used to connect wellheads to production facilities, and to connect production facilities to the Cooper Basin pipeline network or directly to the Moomba plant. They are typically constructed of steel, glass reinforced epoxy (GRE) or spoolable composite pipe and may be installed above or below ground.

Flowlines generally connect wellheads to facilities. They may carry well fluids extracted from wells via free flow or via artificial lift (e.g. jet pumps or electric submersible pumps - see Section 3.1.3). Flowlines typically range from 3" to 4" (75 mm to 100 mm) in diameter. Above-ground steel flowlines are typically used for oil. Buried flowlines of other materials are sometimes used for crossings and for gas applications. Gas flowlines are generally buried. Above-ground steel flowlines are usually located on supports to minimise contact with corrosive soils.

Buried pipelines that interconnect facilities are usually constructed of composite material (e.g. GRE or spoolable composite pipe). They typically have a larger diameter (in the order of 100 mm to 200 mm or more) and carry larger volumes of fluids than flowlines. Beach generally installs optic fibre cable with buried pipelines, to improve operations and monitoring of upset conditions.

High density polyethylene (HDPE) pipelines can also be used, primarily for transferring water (typically PFW) between facilities and disposal ponds.

A summary of buried pipelines currently operated by Beach is provided in Table 4.

All pipeline design, construction and operation is undertaken in accordance with relevant Australian Standards, in particular:

- AS 4041: Pressure Piping
- AS 2885: Pipelines – Gas and Liquid Petroleum.

Adherence to design standards minimises the risk of pipeline failure, which may have serious environmental implications in sensitive locations such as in floodplains or creek lines. Design standards which aim to protect pipeline integrity and prevent loss of hydrocarbons to the environment include:

- design of the pipeline to have an appropriate diameter and wall thickness for the operating pressure requirements
- application of external interference protection measures, including physical and procedural controls (such as increased depth of burial and increased use of marker signs) to mitigate threats identified in the Safety Management Study undertaken under AS 2885.1
- specification of appropriate threat mitigation measures (such as deeper cover where the pipeline is buried under rivers, creeks and roadways
- on floodplains and under creeks, it may be necessary to use welded lines and / or concrete weighting to counter the buoyancy of the pipeline when the soil is saturated with water
- use of high integrity external coating and cathodic protection devices for buried steel pipe to protect against corrosion
- use of supports for aboveground pipelines to maintain them clear of corrosive soils

- provision of failure detection systems with remote shutdown on major export pipelines
- installation of overpressure protection devices to prevent line rupture which may include some or all of the following:
  - a high pressure shutdown valve to isolate the well from the pipeline
  - a pressure safety valve (PSV) designed to relieve the pressure above design operating pressure of the pipeline
  - liquid pipelines may be equipped with thermal PSVs and check valves to prevent line rupture as a result of temperature induced expansion
- PSVs and pipeline bleed points are provided with sumps or drums of sufficient capacity to contain discharged fluids
- if required, launching and receiving facilities for pipe cleaning devices (referred to as pigs) are constructed to contain minor spills during removal / insertion of pigs and with a sump for draining the receiver / launcher prior to opening. Pigs are typically not used on flowlines due to their short length, smaller pipe diameter and higher temperature well fluids.

Environmental management of pipeline construction and operation is consistent with the guidance provided by the *Australian Pipelines and Gas Association* (APGA) *Code of Environmental Practice: Onshore Pipelines*, which has been incorporated in and expanded on in Beach's environmental management procedures.

Table 4: Beach-operated buried pipelines in the Cooper Basin at February 2015

Pipeline / flowline	Oil / gas	Length (km)	Outside diameter	Design flow
Balgowan – Stunsail *(under construction)*	oil	4.9	132 mm	4,500 bpd
Bauer – Lycium	oil	47	165.1 mm	11,000 bpd
Brownlow – Middleton	gas	2.3	121 mm	15 MMSCFD
Butlers – Parsons	oil	8	132 mm	16,000 bpd
Callawonga – Tantanna	oil	47	132.95 mm	4,000 – 6,000 bpd
Canunda – Middleton	gas	11.2	119 mm	15 MMSCFD
Parsons – Callawonga	oil	8.5	132.95 mm	1000 – 6,000 bpd
Pennington crude export *(under construction)*	oil	1.5	135 mm	5,000 bpd
Pennington well fluids *(under construction)*	oil	5.3	212 mm	40,000 bpd
Perlubie - Parsons	oil	3.8	132.95 mm	20,000 bpd
Coolawang - Canunda	gas	2.0	119 mm	15 MMSCFD
Growler - Lycium	oil	61	165.1 mm	9,000 bpd
Lycium - Moomba	oil	67	210.2 mm	13,000 bpd
Middleton - Moonanga	gas	10.5	121 mm	15 MMSCFD
Stunsail – Bauer *(under construction)*	oil	18	135 mm	1,500 -1,600 bpd
Windmill - Callawonga	oil	4.3	164 mm	25,000 bpd

3.5.1 Route Selection, Survey and Site Preparation

A preferred route alignment is selected according to evaluation criteria, such as constructability, accessibility, environmental and cultural heritage sensitivity, safety and cost. The route alignment selection is initially undertaken as a desktop exercise which is validated and revised in the field during the Work Area Clearance process. Once the pipeline route is selected, the centreline is pegged and Pipeline Alignment Survey drawings are drafted. These drawings are used during the pipeline Safety Management Study to risk assess locational hazards.

For buried pipelines, the right of way (ROW) is cleared, with topsoil and vegetation stockpiled separately. The width of the right of way for a buried pipeline depends on the pipeline diameter, but is typically in the order of 15 – 20 m wide. Large diameter pipe may require the greater width to provide a safe construction area for personnel and equipment. Additional width may be required in some areas to allow room for laydown of pipe and equipment and to allow trucks and vehicles to pass locations where construction is being carried out. Dune crossings may also require a greater width to be disturbed (e.g. up to 100 m or more for large dunes) to achieve sufficient depth of cover without the curvature of the pipe exceeding allowable limits, and to ensure access and construction activities can be carried out safely.

During construction of above ground pipelines the construction easement may be cleared but is not usually graded. Above ground pipelines often require a narrower easement and so result in reduced disturbance to vegetation and topsoil. Above ground pipelines and pipeline stations require ongoing control of vegetation to manage the risk of damage due to fire.

3.5.2 Pipeline Construction

Construction of a buried pipeline involves trenching or ploughing along the alignment after the construction easement is cleared. Trenching to a depth of two metres or more may be necessary in locations where lines pass through sand dunes, areas subject to inundation, wash out areas or under roads. Breaks are left in the trench to facilitate fauna movement across and out of the open trench.

Steel and GRE pipe is transported to the pipeline easement in sections and pipe is typically laid end-to-end adjacent to the trench on raised skids (typically timber blocks) to protect the pipe coating from damage. This process is known as ‘pipe stringing’. In the case of above ground pipelines, sections of steel pipe are laid out on raised skids adjacent to the eventual pipeline supports.

Steel pipes are either screwed together (e.g. for smaller flowlines) or welded in lengths. Welds are subjected to non-destructive testing (NDT), including radiography, to test for construction defects and to comply with specifications. GRE pipes are typically joined by threaded joins with O-ring seals with each pipe screwed to the torque recommended by the pipe manufacturer. Spoolable composite pipe joins typically use proprietary steel joiners.

The joined pipe sections are lowered into the trench or laid on the surface using sideboom tractors. Above ground pipelines are buried under roads, at river and channel crossings and on floodplains where required.

Spoolable composite pipe is supplied on large reels and is transported to locations along the alignment on a carousel located on a truck. Pipe is pulled off the carousel using mobile plant and placed in the trench.

On some pipelines, a ‘spider plough’ may be used to plough composite pipe directly into the ground. This machine ploughs a trench, lays the pipe and refills the trench in one continuous motion, avoiding the need for an open trench.

Where necessary, soil and / or padding from approved borrow pits may be placed into the trench to protect and stabilise the pipe. The trench is then backfilled and compacted with previously excavated trench spoil material.

Watercourses are typically crossed using standard open-cut (trenching) construction. This technique is suited to the dry conditions which prevail in the Cooper Basin. Watercourse crossings are typically completed within the shortest period practicable and the trench is generally not completed through the watercourse channel and banks until immediately prior to pipe installation. Construction is

generally undertaken in dry conditions. If water is present, flow diversion techniques may be employed, such as pumping of water around the work area using barrier dykes or head walls to keep the work area dry, or diverting the flow through a pipe.

Horizontal directional drilling (HDD) can be used to cross watercourses or other infrastructure (e.g. major roads) however it is generally not used in the Cooper Basin. HDD involves drilling a hole at a shallow angle beneath the surface, then pulling the welded pipe string back through the hole. A HDD drilling rig and a variety of associated equipment is required, and excavations are required for a cuttings settlement pit and mud containment pits at the drill entry and exit points.

3.5.3 Pipeline Testing

The integrity of pipelines is verified using hydrostatic testing conducted in accordance with AS 2885. During hydrostatic testing the pipeline is capped with test manifolds, filled with water and pressurised in accordance with the standard. Large sections of the pipeline trench may be kept open during testing to allow identification and repair of any leaks that are detected.

The use of biocides and chemicals with hydrostatic test water may be required under some circumstances to prevent internal bacterial corrosion of the pipeline metal components. Hydrostatic test water may be sourced from existing water bores. Produced formation water may also be utilised as a water source provided that it is adequately treated with biocide to remove potential for bacterial contamination of the pipeline.

Disposal of hydrostatic test water which contains biocide and other chemicals may be to existing lined and fenced interceptor ponds, or to specifically constructed pits sited to prevent the contamination of shallow groundwater and surface waters. Hydrostatic test water that has no biocides or deleterious chemicals added may be disposed of to the land surface (e.g. through road watering) but is not disposed to water or any areas where it is likely to enter waters (including groundwater).

3.5.4 Site Restoration

The easement is reinstated and restored as soon as possible after pipe laying, testing and backfill. This involves removal of all construction generated refuse, re-contouring of the site, re-establishment of natural drainage lines, bank restoration (if necessary), topsoil respreading and respreading of any cleared vegetation.

3.5.5 Operation

Pipeline operation and maintenance is approached in a systematic manner over the life of the assets, in accordance with AS 2885. Inspection and monitoring of pipelines are carried out and operating procedures are followed to ensure that they are operated within their design capability. The Beach Energy management system is outlined in Pipeline Integrity Management Plan (PIMP) and Pipeline Management System (PMS). The Safety Management Study (SMS) and remaining life assessments are periodically reviewed, in accordance with AS 2885 requirements.

3.6 Road Construction and Maintenance

Beach currently maintains approximately 500 km of access roads to production wells and facilities, some of which are also station tracks. The remainder of the road network in the Cooper Basin is maintained by third parties (e.g. Santos, DPTI).

Where possible, existing roads, station tracks and exploration well access tracks are utilised and maintained for production access. However, some road construction or upgrading and realignment will be required for access to future production operations. Within Regional Reserves, the creation of new access tracks is kept to a minimum and where appropriate disused roads will be rehabilitated at the conclusion of activities.

Once surveys are complete and a preferred road alignment is selected, a road is constructed according to the land system(s) it will pass through, in accordance with Beach design standards and procedures. In most cases the easement will be rolled or capping may be laid over the natural surface material (e.g. in gibber plains or where the terrain is naturally flat and susceptible to erosion when disturbed). Alternative road surface preparation methods may also be trialled and used with DSD approval. Table 5 provides information on the road construction methods applied to land systems in the Cooper Basin.

Road construction styles are assessed according to the amount of anticipated use as well as the environmental sensitivity of the area. Roadside borrow pits are used to source material for road fill. Erosion controls are implemented during and after construction and particular attention is given to flood and water flow areas.

Appropriate planning and construction is undertaken for roads in floodplains and watercourses to avoid disturbance to natural drainage patterns. Culverts or other structures may be installed where required to ensure that surface water flows are not impeded by the road and in some circumstances, structures such as raised roads or bridges may be installed (see Plate 12). Detailed hydrological assessment would typically be undertaken for these structures to ensure that there are no significant impacts on surface water flows or aquatic fauna.

Table 5: Road construction methods for land systems in the Cooper Basin

Construction Method	Land System					
	Dunefields	**Floodplains**	**Gibber plains**	**Salt lakes**	**Tablelands**	**Wetlands**
Avoid construction on land system				✓		
Utilise naturally cleared areas	✓	✓	✓		✓	✓
Avoid steep slopes	Susceptible to erosion. Ensure controls are in place		✓		✓	
Weave road between trees and large shrubs	✓	✓	✓		✓	✓
Clear and grade	✓	✓	*			✓
Roll			✓		✓	
Cap road surface with clay or similar borrow material	✓	✓	✓		✓	✓
Bridges, culverts or floodways installed on drainage line crossing as required	✓	✓	✓		✓	✓

*Non-standard practice, which may be undertaken in some circumstances, with adequate erosion controls in place. Detailed site specific assessment, planning, management, monitoring and rehabilitation would be required.

Following construction, rehabilitation is undertaken to ensure that surrounding surface drainage is restored and erosion control structures are installed in erosion prone areas.

Supplies of suitable construction material, such as soil (or occasionally gravel), are usually extracted from sites referred to as borrow pits. Borrow pits are excavated to provide:

- soft earth for trench backfilling
- rubble and clay for upgrading or constructing roads and maintenance of production facilities
- rubble and earth for the construction of above ground pipeline infrastructure.

Borrow pits vary considerably in dimension depending upon the quality and quantity of material contained in them.

Site selection, environmental management and restoration of borrow pits is undertaken in accordance with Beach procedures, guidelines contained in the SEO, and industry-wide standards for borrow pit management developed by DSD[4]. Existing borrow pits are used in preference to new ones where appropriate.

In the event that damage occurs to public roads as a result of Beach's operations, maintenance activities are undertaken to restore and maintain the road at an acceptable standard (as a minimum to pre-existing standard) in consultation with the relevant authority.

Plate 12: Bridge at crossing of channel of Cooper Creek near Callawonga

3.7 Aircraft Landing Area

Beach currently operates an aircraft landing area in PRL 85 south-west of the Parsons facility. Aircraft landing areas near other production facilities may be required in the future to enable personnel to be flown directly to Beach's operational areas. This would facilitate more comprehensive emergency responses by enabling RFDS access, reduce road traffic and driving-related risks, achieve a reduction in overall travel times, avoid rain induced delays due to road closures and enable access to operational areas when road access is restricted by inundation from flood events.

[4] DSD commissioned a review of the Goal Attainment Scaling (GAS) criteria for borrow pit construction and rehabilitation (Jacobs SKM 2014). Following the recommendations of the Jacobs SKM report, GAS tables were developed by DSD in consultation with other relevant government agencies and industry and released in November 2014 for incorporation into relevant Statement of Environmental Objectives.

The design specification for an aircraft landing area would typically meet the CASA Guidelines for Aeroplane Landing Areas (CASA, 1992) and standards published by the RFDS. This would be suitable for aeroplanes such as RFDS PC 12, Saab SF340B aircraft and light twin engine aircraft to land.

To meet CASA requirements, the compacted runway surface component would typically be in the order of 1300 m long and 20 m wide, with the approach, takeoff and adjacent flyover areas (which must be clear of vegetation) totalling approximately 1800 m by 90 m.

Aircraft landing areas are primarily used in the daytime but may be designed to be suitable for night-time helicopter use in case of emergencies. They are fenced to exclude cattle, and gates and signage are also installed to restrict vehicle and personnel movement through the landing strip area.

An aircraft landing area would be located in an area where earthworks and vegetation clearance requirements are limited (e.g. in a flat interdune swale).

Plate 13: Parsons airstrip in PRL 85

3.8 Oil Transport

Oil from Beach's production facilities is transported either by pipeline or tankers, to third party facilities in the Cooper Basin or to other facilities in South Australia or Queensland. There may be several tankers per day travelling from a facility along access roads and in some cases along public roads. Tanker load out areas at the facilities are lined and bunded to contain any spills and are operated in accordance with the Australian Standard (AS) 1940.

Access roads in the Cooper Basin may cross creek beds, including the Cooper and Strzelecki Creeks. These creeks are generally dry; the lower Cooper flows once every 2-5 years on average, and flows in Strzelecki Creek occur even less frequently.

Safe transportation of the oil from the well site to the delivery point is the prime responsibility of the transporters, under the *Dangerous Substances Act 1979* and the *Environment Protection Act 1993*. Suitably licensed, trained and experienced contractors are used to transport oil.

Plate 14: Oil tanker load-out

3.9 Waste Management

Waste management is an important issue and Beach will continue to incorporate appropriate waste management practices into the construction, operation and abandonment phases of its developments.

Beach follows the principles of the waste management hierarchy as far as possible (Avoid, Reduce, Reuse, Recycle, Recover, Treat, Dispose) and has put measures in place to prevent pollution by reducing the use of energy, water, material resources, and recycling waste where possible.

Beach is responsible for the management of all the wastes it generates and for its disposal in accordance with regulatory requirements and industry standards. Waste from operations is generated from two main streams: operational waste and domestic waste (Table 6).

Table 6: Typical waste streams

Waste Type	Disposal
Operational Waste	
Gaseous waste	Flared or vented – gaseous hydrocarbons, CO_2, H_2S, CO Generator and vehicle emissions
Produced formation water	Interceptor ponds and then to evaporation ponds, reinjection or reuse
Waste oil / water (slops) hydrocarbon / water mixtures or emulsions	Directly skimmed from ponds and where possible, returned to the production facilities for processing. Stored in a bunded area for collection and transport off-site by a licensed regulated waste contractor to a licensed regulated waste facility for treatment, recycling or disposal
Pig-receiver / slugcatcher scale	Lime scale and sludge collected for transport off-site by a licensed regulated waste contractor to a licensed regulated waste facility for disposal
Contaminated soil	Soils contaminated with chemicals are to be managed as specified in the Safety Data Sheet (SDS) for the spilt chemical Soils contaminated with hydrocarbons are to be treated in situ or collected and stored in the designated soil containment areas located at Beach sites If not treated in situ or at a Beach soil remediation area, collected for transport off-site by a licensed regulated waste contractor to a licensed regulated waste facility for disposal

Waste Type	Disposal
	Ultimate reuse or disposal of treated soil consistent with the principles of the National Environment Protection Measure for contaminated sites and relevant EPA guidelines
Hydrotest water	Recycled for each hydrotest section Evaporation pond or to ground if consistent with ANZECC and EPA criteria
Empty drums – plastic fuel, lubricant and chemical containers	Drums to be transported off-site by waste contractor for reuse, recycling or disposal
Chemical waste	Stored in accordance with Australian Standards and EPA guidelines in bunded areas for transport off-site by a licensed regulated waste contractor to a licensed regulated waste facility for recycling or disposal
Plastic pond liner (e.g. HDPE)	Transported to a licensed recycling facility (where possible) or sent for disposal at an appropriately licensed facility
Metals – empty steel drums, bulk scrap steel, pipe, bolts, wire / cables, mini rings	Segregate (stored separately from other waste) metals from other wastes and store for recycling
Timber pallets (skids)	Recycled where possible
Batteries	Collected for transport off-site by a licensed regulated waste contractor to a licensed regulated waste facility for treatment, recycling or disposal
Vehicle tyres	Collected for transport off-site by a licensed regulated waste contractor to a licensed regulated waste facility for treatment, recycling or disposal
Workshop waste – filters, rags, grease and lubricants	Recycle where possible and remainder for disposal to EPA licensed landfill Oil and lubricants to be collected and stored in bunded areas awaiting transport off-site by a licensed regulated waste contractor to a licensed regulated waste facility for treatment, recycling or disposal
Domestic waste	
Storm water runoff (camp)	Runoff to vegetation
Sewage and grey water	Treated at facility in septic tank or approved aerobic system in accordance with SA Public Health (Wastewater) Regulations Sludge and residue collected by a licensed contractor as required and disposed of at an appropriately licensed facility
General wastes – food waste, food wrappers, plastic bags, packaging	Securely stored in covered bins (to prevent wildlife access) for regular removal to general landfill. Rubbish contained and controlled to minimise odours and maintain hygiene
Comingled recyclable material – paper and cardboard, timber pallets, plastics and aluminium cans	Segregated and placed in bins or skips for recycling
Grease trap wastes	Collected for transport off-site by a licensed regulated waste contractor to a licensed regulated waste facility for treatment, recycling or disposal

3.9.1 Landfill – Domestic Waste

Beach does not currently operate landfill sites in South Australia. Waste that is to be disposed to landfill is taken to appropriately licensed landfills (e.g. Moomba). However, Beach is undertaking a review of waste management, which may result in changes to the current waste disposal strategy.

If Beach were to establish a landfill site, it would be constructed in accordance with EPA requirements and all necessary approvals would be sought through the EPA and in consultation with DSD.

Beach has previously obtained EPA approval for disposal of putrescible waste to land during extensive Cooper Creek flooding in 2010-11, when road access to the Callawonga camp was extremely limited and access to Moomba to transport waste from the Callawonga camp was not possible. This practice is not preferred, and would only be undertaken (subject to regulatory

approval) on a temporary basis during extreme flood conditions if there were no feasible alternatives.

3.9.2 Sewage Waste Management

Sewage wastes at production facilities are disposed using on-site systems that are approved and managed under the *South Australian Public Health (Wastewater) Regulations 2013* and in compliance with the *South Australian Health On-site Wastewater Systems Code*, or to the satisfaction of the Department of Health. Wastewater effluent is disposed to evaporation ponds or irrigated to land in a location where it will not enter surface waters, to ensure compliance with Clause 17 of the *Environment Protection (Water Quality) Policy 2015*.

3.9.3 Contaminated Soil Treatment / Soil Remediation Areas

Minor spills in lined bunded areas are generally treated in situ in accordance with EPA guidelines. The main method of treatment and disposal of hydrocarbon contaminated soil resulting from spills outside of bunded areas is removal to a Beach production facility for temporary storage in a designated bunded area. The contaminated soil is then transported by a licensed regulated waste contractor to a suitable EPA licensed facility for treatment or disposal.

Beach does not currently have a land treatment area for the bioremediation and treatment of hydrocarbon contaminated soils due to the low volumes generated. If required in the future, a land treatment site would be located away from watercourses, floodplains or areas of shallow groundwater. Establishment of a land treatment site would require approval by DSD and possibly the EPA depending on the volume of material to be treated and any third party materials received. The land treatment site would consist of an impermeable, bunded and fenced area, which would require ongoing management and monitoring. Land treatment would be undertaken in accordance with relevant EPA guidelines, including the EPA Guideline *Environmental Management of On-site Remediation* 2008. The ultimate reuse or disposal of treated soil would be consistent with the principles of the National Environment Protection Measure for contaminated sites and relevant EPA guidelines.

3.9.4 Sludge Treatment

Oily sludge (generally derived from tanks) is currently stored on-site before transport to a suitable licensed facility for treatment and disposal. Beach may, in the future, develop a sludge treatment plant to recover useable hydrocarbons and reduce the amount of solids removed off-site for treatment and disposal. A sludge treatment plant would typically involve physical (e.g. centrifuge, heat) and chemical treatment (e.g. demulsifying agents) to separate out hydrocarbons, water and solids. Hydrocarbons and water would be returned to the production facility provided the quality is suitable. Solids may undergo further treatment (e.g. bioremediation in a land treatment area) and would eventually be transported off-site for reuse or disposal in accordance with relevant EPA guidelines.

A sludge treatment plant would be likely to be located at or adjacent to an existing facility. Installation and operation of a sludge treatment plant would require approval by DSD and EPA.

3.10 Decommissioning / Rehabilitation

Beach will progressively rehabilitate facilities that are no longer required (for example, disused roads, facilities, pipeline routes and borrow pits). The rehabilitation undertaken at these sites will be tailored to the site and the landform, and will typically include:

- removal of all above ground infrastructure and rubbish
- testing for contamination of soil and groundwater (and remediating sites to the relevant regulated standard)
- re-contouring or re-profiling of soils or land surfaces to reinstate natural contours and drainage lines
- ripping compacted areas where appropriate (except in gibber systems) to alleviate compaction and encourage revegetation
- re-spreading of stockpiled topsoil (where available).

Site-specific procedures apply to some facilities. For example, oil pipelines are pigged to remove residual hydrocarbons or sludge, and for buried pipelines, aboveground points are cut off and blinded below the surface.

4 Existing Environment

The Cooper Basin covers a total area of 130,000 km^2 of which approximately 50,000 km^2 lies within north-eastern South Australia. The South Australian sector of the Cooper Basin can generally be described as arid with a uniform climate. It contains a wide diversity of land systems that are defined by geological, geomorphological and hydrological influences.

This section provides an overview of the environment of the Cooper Basin. Detailed information is also available in the South Australia Cooper Basin Joint Venture (SACBJV) Production and Processing EIR (Santos 2003). Where relevant, this section refers to Santos (2003) as a source of additional detail.

4.1 Climate

The region has an arid climate, with low average rainfall and high evaporation. Seasons are generally characterised by hot dry summers and mild dry winters. Rainfall in the area is highly erratic; the annual average being 100 to 200 mm however annual rainfall can be recorded in one event (Arid Areas Catchment Water Management Board 2006). There is no distinct seasonal rainfall pattern with rainfall often associated with thunderstorm activity and as a consequence can be localised and intense. Average annual evaporation is over 3500 mm.

A summary of climate records for Moomba Airport (Station 017123; BOM 2014) is provided in Table 7.

Table 7: Temperature and rainfall records for Moomba Airport

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean Daily Max (°C)	38.8	36.7	33.8	29.2	23.9	19.9	19.7	22.7	27.7	30.5	33.9	36.4	29.4
Mean Daily Min (°C)	24.6	23.5	20.3	15.6	10.7	7.3	6.4	8.1	12.3	15.6	19.4	22.0	15.5
Mean Rainfall (mm)	13.0	32.9	23.7	7.4	9.5	10.3	15.9	5.0	13.5	10.3	21.8	14.1	176.9
Median Rainfall (mm)	3.0	12.6	2.2	1.0	1.0	2.0	1.3	0.8	1.6	4.6	7.2	6.2	157.9
Mean Daily Evaporation (mm)*	15.9	14.4	12.5	8.4	5.2	3.7	3.9	5.5	8.2	10.6	13.2	15.3	9.7

*Evaporation data are from Moomba, Station 017096, for the period 1972-2005

4.2 Bioregions, Landforms and Land Systems

The Cooper Basin falls predominantly within the Channel Country and Simpson Strzelecki Dunefields biogeographical regions, and the far south-western margins of the Cooper Basin are in the Stony Plains biogeographic region[5].

A number of named land systems[6] have been mapped across the Cooper Basin as part of broader land system mapping in the pastoral areas of South Australia (Marree SCB 2004, DWLBC 2007). These land systems and their soil and vegetation characteristics are summarised in Appendix 1.

[5] Biogeographic regions (bioregions) are broad landscape units based on major geomorphic features and are defined by the Interim Biogeographic Regionalisation for Australia (IBRA) Version 7.0.

[6] Land systems subdivide the IBRA bioregions and are areas throughout which there is a recurring pattern of geology, topography, soils and vegetation (DEH 2005).

Six major landforms are found in the Cooper Basin. Table 8 describes these landforms, and indicates the land systems in which they occur. The distribution of these landforms across the Cooper Basin and accompanying photographic examples are shown in Figure 9.

The sensitivity of each landform to disturbance depends upon its basic characteristics of geology, topography, soils, hydrology, flora and fauna. These sensitivities are outlined in this EIR in Table 21 in Section 5.6. Each landform is also discussed in detail with respect to these characteristics in Santos (2003).

Table 8: Cooper Basin landforms and descriptions

Landform	Land system	Description
Dunefields	Bloodwood, Collina, Cooper, Diamantina, Eulpa, Hope, Jeljendi, Ketitoonga, Koonchera, Marqualpie, Mulligan, Simpson. Strzelecki, Tingana, Tirari, Warburton, Wirringina	Generally parallel dunes of red or yellow sands of height 5 – 20 m separated by flat interdune corridors which are often sandy, but also often contain claypans due to limited drainage. Salt lakes are sometimes present in interdune corridors where infiltration is limited. In the Cooper Basin dunes trend approximately north-south. Soils are red-yellow-siliceous sands on dunes and red massive earths or grey self-mulching clays in swales.
Gibber plains	Bloodwood, Koonchera, Lamamour, Merninie, Sturts	An undulating stony plain, sometimes with occasional small dunes or small silcrete capped mesas. Highly polished stones or gibbers are usually embedded in a clayey crust, thereby protecting the underlying soil from erosion. Soils are crusty red duplex soils.
Floodplains	Cooper, Diamantina, Kachumba, Mulligan, Tirari, Warburton	Extensive flood-out areas adjacent to Cooper Creek, Strzelecki Creek, Wilson River and Diamantina River. Floodplains are periodically inundated when creeks and rivers overflow their banks. Characterised by grey sediments which are deposited on plains by floodwaters. In places, dunes are either co-dominant or occasionally present. Soils are grey self-mulching cracking clays and pale sandy clays.
Salt lakes	Blanche, Collina, Wirringina (Note: Small salt lakes are also present in many dunefield land systems)	Terminal lakes or pans of varying sizes where evaporation has resulted in concentration of soluble salts as a surface crust. Are periodically inundated, but are usually dry. Soils are salty overlying grey self-mulching cracking clays.
Tablelands	Lamamour, Merninie, Mumpie, Sturts	Uplifted and eroded gibber plains that have resulted in formation of low but steep silcrete capped hills, escarpments and mesas and extensive gibber covered footslopes. Tablelands are separated by undulating gibber plains. Highly polished stones or gibbers are usually embedded in a clayey crust, thereby protecting the underlying soil from erosion. Soils are crusty red duplex soils and brown self-mulching cracking clays on slopes. Soils on plains are reddish powdery calcareous loams.
Wetlands	Cooper, Diamantina, Mulligan	Channels, waterholes, swamps and lakes associated with Cooper Creek, Strzelecki Creek, Wilson River and Diamantina River. Some waterholes always contain water, but channels, swamps, and lakes are frequently dry. Are located on or close to main watercourses and are therefore inundated more frequently than surrounding floodplain. Soils are predominantly grey self-mulching cracking clays.

Source: Dobrzinski (1998).

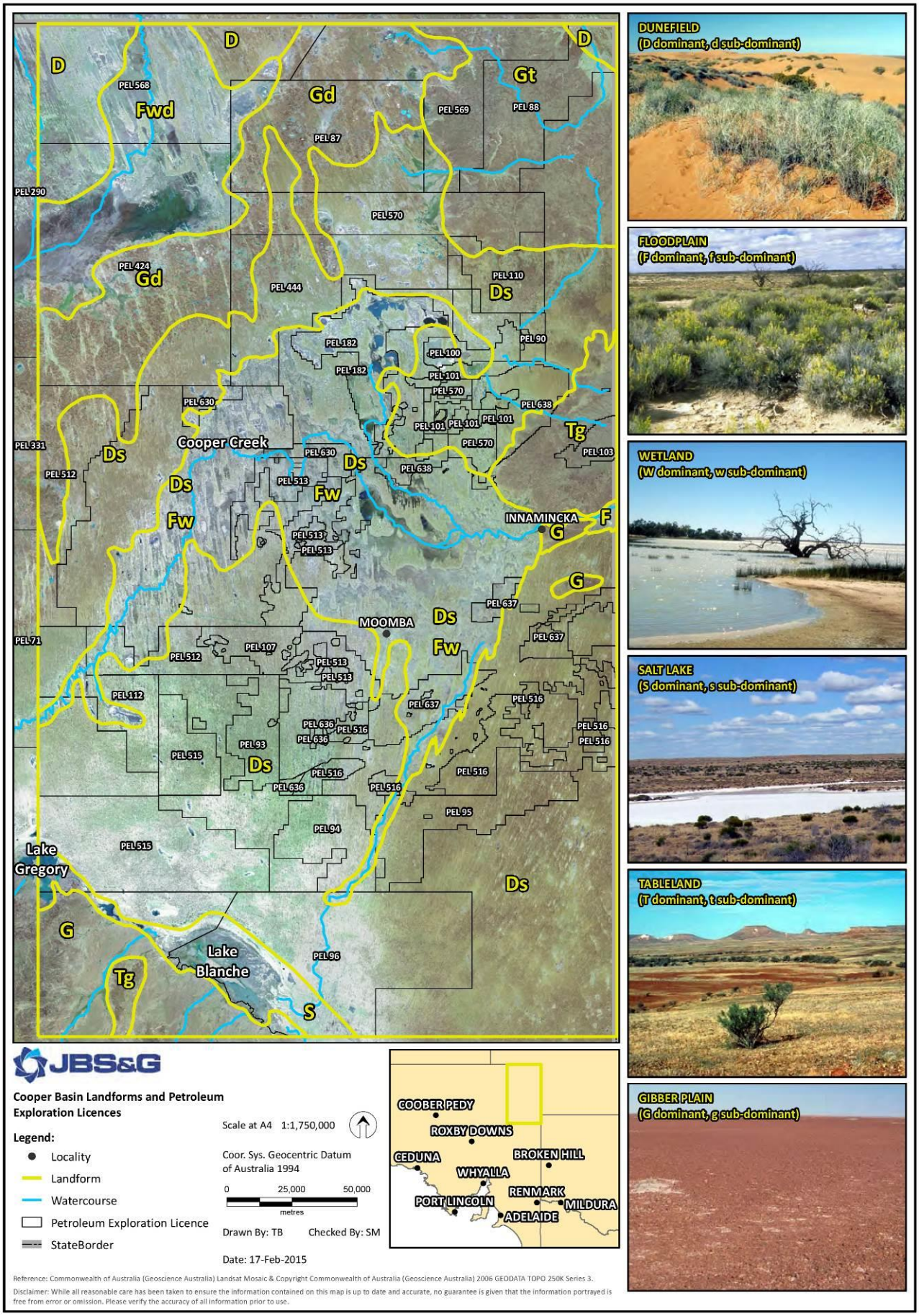


Figure 9: Cooper Basin landforms

Beach's production facilities are predominantly located in dunefield and floodplain land systems. The location of Beach production facilities and the relevant landforms and land systems are set out in Table 9.

Table 9: Beach production facility locations and relevant landforms and land systems (February 2015)

Field / Facility	Licence	Landform	Land system
Aldinga	PPL 210	Dunefield	Tingana
Bauer	PPL 253	Dunefield	Strzelecki
Butlers	PPL 245	Dunefield	Strzelecki
Callawonga	PPL 220	Dunefield / floodplain	Cooper / Strzelecki
Chiton	PPL 253	Dunefield	Strzelecki
Christies / Silver Sands	PPL 205	Dunefield / floodplain	Cooper
Congony / Kalladeina / Sceale	PPL 254 / PPL 256	Dunefield	Strzelecki
Hanson / Snellings	PPL 255	Dunefield	Strzelecki
Kiana (not operating)	PPL 212	Dunefield	Hope
Lycium Hub	SFL 4	Dunefield	Cooper
Middleton / Brownlow / Canunda	PPL 239 / PPL 239 / PPL257	Dunefield	Hope
Parsons	PPL 224	Dunefield	Strzelecki
Pennington (under construction)	PRL 163	Dunefield / floodplain	Strzelecki
Rincon	PPL 248	Dunefield	Strzelecki
Sellicks (not operating)	PPL 204	Dunefield / floodplain	Cooper / Hope
Stunsail (under construction)	PRL 172	Dunefield	Cooper / Strzelecki
Stand-alone camps / warehouse facilities			
Bales	AAL 220	Dunefield	Strzelecki
Habanero	SFL 11	Gibber plain	Merninie

4.3 Flora and Fauna

4.3.1 Flora

The vegetation characteristics of the landforms in the Cooper Basin are outlined in Table 10 and are described for each named land system in Appendix 1. Further detail is also provided in Santos (2003).

Table 10: Typical vegetation characteristics of landforms in the Cooper Basin

Landform	Typical Vegetation Characteristics
Dunefields	Vegetation on dunes includes herbs and ephemeral herbs on dune crests, open shrublands of sandhill wattle, whitewood or hakea and hummock grassland of spinifex and sandhill canegrass. Vegetation in interdune areas is largely dependent on dune spacing and may consist of hummock grassland, chenopod shrubland, open shrubland or low open woodland.
Floodplains	Major intermittent watercourses are characterised by woodlands of river red gum, coolibah or gidgee with a tall shrub layer fringing the floodplains, channels and semi-permanent waterholes. Open coolibah woodland and with an understorey of lignum, chenopod shrubland and grasses is common in frequently flooded areas with outer floodplain areas often consisting of open shrubland. Groundcover on floodplains has a high ephemeral content.
Gibber plains	Vegetation ranges from relatively dense low open shrubland to naturally bare tussock grasslands, or short-lived copperburrs and ephemeral grasses. Low woodland of gidgee and mulga on drainage lines.

Landform	Typical Vegetation Characteristics
Salt lakes	Immediate surrounds usually fringed with samphire grading to low open chenopod shrubland in the outer surrounds.
Tablelands	Low open woodlands, shrublands and low open chenopod shrublands, with more heavily wooded areas of mulga, red mulga and gidgee along drainage lines and more permanent waterholes.
Wetlands	Vegetation similar to floodplains is present, with open woodlands of river red gum or coolibah with an understorey of lignum and chenopod shrubland typically bordering the margins of wetland areas.

4.3.2 Fauna

Terrestrial and avian fauna species present in the area include:

- **Mammals**: Small mammals such as Fat-tailed and Stripe-faced Dunnarts, Giles Planigale, Sandy Inland Mouse and House Mouse are common. Other mammals present include Little Broad-nosed Bat and Lesser Long-eared Bat. Larger mammal species include the Red Kangaroo, Dingo, and non-native species including cattle, cat, rabbit and fox.
- **Reptiles:** Common reptiles include Fat-tailed Gecko, Eastern Brown Snake, Sand Goanna, Sandplain Ctenotus, Ghost Skink, Painted Dragon and Curl Snake.
- **Amphibians**: Ten frog species have been recorded in the Cooper Creek system including several species of burrowing frog (e.g. Trilling Frog, Water-holding Frog) which may be relatively widespread and others (Desert Froglet, Green Tree Frog, Broad-palmed Frog) that would be restricted to areas near water (i.e. the Cooper Creek) except during flooding.
- **Birds**: Bird species present include Australian Magpie, Galah, Brown Falcon, Budgerigar, Black-faced Woodswallow and Little Corella. The region also supports a diverse assemblage of waterbirds, as discussed below.

The Cooper Creek system supports a diverse array of aquatic fauna including waterbirds, fish, frogs and aquatic invertebrates. The wetlands associated with the North-West Branch of the Cooper Creek, including Coongie Lakes, are recognised as a region of exceptional ecological value. They provide a feeding, resting and breeding site for large numbers of migratory and nomadic birds. The most abundant species during flooding include Grey Teal, Pink-eared Duck, Wood Duck, Australian Pelican, Great Cormorant, Black Swan, Eurasian Coot, Black-tailed Native-hen, and Red-necked Avocet. They also support rare or threatened waterbird species such as Freckled Duck, Musk Duck, Little Egret and Intermediate Egret (DEHAA 1998). They are listed as internationally important wetlands under the Ramsar convention, as discussed in Section 4.7.4.

In dry periods, aquatic fauna are concentrated in refuges such as Coongie Lakes and the permanent waterholes on the upstream reaches of the Cooper in South Australia. During flooding, these fauna increase rapidly in abundance and occur across the vast area of channels, waterholes, swamps and floodplains in the Cooper Creek system.

4.3.3 Threatened Species and Communities

A number of species listed under Commonwealth (*Environment Protection and Biodiversity Conservation Act 1999*) and State (*National Parks and Wildlife Act 1972*) legislation are known to occur in the Cooper Basin. Listed rare or threatened species that have been recorded or predicted to occur in the region are listed in Appendix 2.

One threatened ecological community listed under the EPBC Act occurs in the broader region – the community of native species dependent on natural discharge of groundwater from the Great

Artesian Basin. This community occurs at Great Artesian Basin (GAB) springs, which are located outside Beach licence areas and beyond the margins of the Cooper Basin region (see Figure 10).

Five ecological communities identified as threatened in the South Australian Arid Lands Biodiversity Strategy occur in the broader region (DEH 2009a, b, c):

- Coolibah and River Red Gum woodland on regularly inundated floodplains.
- Old-man Saltbush on floodplains.
- Queensland Bluebush shrubland on cracking clay depressions subject to periodic waterlogging.
- Broughton Willow and Coolibah +/- Queensland Bean Tree woodland on drainage lines and floodplains.
- Mulga low woodland on low dunes and sand plains.

The primary threat to these ecological communities is habitat modification or inhibited regeneration associated with total grazing pressure (DEH 2009a, b and c).

Beach is confident that significant impacts to listed threatened species, communities and migratory species that are likely to occur in the Cooper Basin region can be avoided, due to the nature and limited area of production activities and the management measures that are implemented. Site specific assessments are carried out for all sites prior to commencement of operations (as discussed in Section 2.1.3) to ensure that any potential impacts are identified and are minimised or avoided.

4.3.4 Weeds

Introduced plant species recorded in databases as occurring in the region include Buffel Grass (*Cenchrus ciliaris*), Mexican Poppy (*Argemone ochroleuca* ssp. *ochroleuca*), Mimosa Bush (*Acacia farnesiana*), Common Verbena (*Verbena officinalis*), Creeping Heliotrope (*Heliotropium supinum*), Wild Turnip (*Brassica tournefortii*), Common Sow-thistle (*Sonchus oleraceus*), Black Nightshade (*Solanum nigrum*), Wandering Speedwell (*Veronica peregrina* ssp. *xalapensis*), Caltrop (*Tribulus terrestris*), Colocynth (*Citrullus colocynthis*), Grain Sorghum (*Sorghum bicolor*) and Noogoora Burr (*Xanthium strumarium*).

The density of weed species is generally relatively low, and the majority of the introduced plants known to occur in the Cooper Basin are naturalised or widespread species of limited concern to the environmental or pastoral values of the region. Invasive species of particular concern include Buffel Grass (which was proclaimed as a declared weed in January 2015) and Noogoora Burr. Mexican Poppy and Couch Grass (*Cynodon dactylon*) have created localised weed problems, outcompeting native species and reducing habitat (DEWNR 2013).

Pest animals in the region include rabbits, feral cats and foxes, feral pigs, donkeys, horses and camels.

4.4 Surface Water

Wetland and Floodplain Land Systems

The Cooper Creek system is the dominant surface water feature in the region. The Cooper Creek originates in catchments in south-west Queensland. During periods of low flow, most water flows through the North-West Branch of the Cooper Creek into the Ramsar-listed Coongie Lakes and Lake Goyder. If flows are large enough to fill these lakes, additional water flows down the main branch of the Cooper towards Lake Hope and eventually discharges into Lake Eyre.

The main channel of the Cooper Creek is generally well defined and connects a series of ephemeral swamps and permanent and semi-permanent waterholes. During floods, the main channels overflow and floodwaters spill into the vast floodplain via numerous distributory channels.

Significant local rainfall events can also result in shallow inundation of floodplains, interdune claypans and other areas of poorly drained impermeable soil, which can persist for days to weeks or longer. Local rainfall and run-off also results in flow in ephemeral watercourses, most of which drain into either the Cooper or Strzelecki Creeks.

Cooper Creek flows are unregulated and extremely variable. Flow occurs in one or more discrete pulses each year and several months may pass without flow (Puckridge *et al.* 1999). Flow in the Cooper Creek occurs in almost every year, and in most years it reaches the Coongie Lakes (DEH 2008).

The mean annual flow in the Cooper Creek is in the order of 1.5 million megalitres, with a median annual flow (at Cullyamurra Waterhole, near Innamincka) of 399,100 ML (WaterConnect 2014). The highest annual flow was over 14 million megalitres in 1974. Flow can occur in any month, and zero flows have also been recorded in all months of the year. It has been estimated that there is a 98% chance that flow rates will exceed 1m³/s at Innamincka each year (Kotwicki 1986).

During periods of high flow, floodwaters overtop the banks of the Cooper and flow southwards down the Strzelecki and Ooranie Creeks. Cooper Creek floods that are large enough to flow into Strzelecki Creek and its floodplain are relatively rare events. Previous investigations have estimated that floods of this size have an average frequency of approximately one in ten years (Puckridge *et al.* 1999). Flows into Ooranie Creek are more frequent, with an average frequency in the order of 1 in 5 years (SEA 1992, Puckridge *et al.* 1999).

Puckridge *et al.* (1999) developed nine flood classes for the lower Cooper Basin floodplain based on the 25 year Cullyamurra record. Table 11 provides expected frequencies and volumes for each of these flood classes. The predicted extent of flooding for each class is based on satellite imagery of previous flood events in the Cooper Basin region (Puckridge *et al.* 1999).

Table 11: Cooper Creek flood classes, volumes and frequency

Flood class	Daily flow volume (ML / day)	Total volume (ML)	Frequency	Comment
1	600 - 1,200	14,000 - 40,000	Annual	Since 1973 have been Class 1 floods, or larger, every year. All water flows into North-West Branch of Cooper Creek.
2	1,200 - 2,500	40,000 - 130,000	1-2 years	Most water flows into North-West Branch, but a proportion flows into main branch of Cooper Creek.
3	2,500 - 5,400	130,000 - 220,000	1-2 years	Significant part of flows into main branch as far as Embarka Swamp.
4	5,400 - 18,000	220,000 - 400,000	2 years	Significant flow enters main branch, to lower main branch and lower Cooper Creek.
5	18,000 - 40, 000	400, 000 - 1,400,000	2-5 years	Significant flow occurs out of Coongie Lakes into lower Cooper Creek as far as Lake Hope.
6	40,000 - 100,000	1,400,000 - 2,400,000	5 years	Results in flows into Wilpinnie Creek. Flow into this area can disrupt gasfield installations.
7	100,000 - 180,000	2,400,000 - 4,500,000	10 years	Results in flows into Strzelecki Creek but not as far as Lake Blanche. Flows occur along lower Cooper Creek. Class 7 flood was largest in 2005.

Flood class	Daily flow volume (ML / day)	Total volume (ML)	Frequency	Comment
8	180,000 - 450,000	4,500,000 - 10,750,000	20 years	Flow into Lake Eyre North and fill Lake Blanche. Class 8 flood was the largest flood in 1990.
9	> 450,000	> 10,750,000	100 years	A Class 9 flood occurred in 1974, but no satellite images are available to determine flood extent.

Strzelecki Creek is predominantly dry. It can receive some localised inflow from heavy rainfall events but generally only flows during very large Cooper Creek floods, when water flows southwards from Innamincka towards Lake Blanche (a distance of approximately 200 km).

During very large floods, much of the floodplain area within the Cooper land system becomes inundated. However, within this land system, there are areas of dunefield, isolated sand dunes and patches of higher ground that are not subject to flooding.

Dunefield Land Systems

Dunefields are extremely arid, lacking any permanent surface water with significant drainage lines generally absent. Surface water catchments are typically restricted to individual interdune corridors. Surface water ponds in interdune corridors, often collecting in claypans and occasionally salt lakes within the interdune. Infiltration rates are generally low, and surface water may remain in the swales and claypans for a few days to a few weeks or more, depending on the rainfall event and rates of evaporation.

Tableland and Gibber Plain Land Systems

Permanent surface water is scarce in the elevated areas of the tablelands and on the gibber plains, however temporary pools of water often form after rain in gilgais and low depressions. Networks of small, defined drainage lines (which can contain permanent waterholes) typically flow for only a short time (e.g. six to twelve hours) after rainfall has ceased and carry runoff from larger rainfall events.

Salt Lakes

Salt lakes are predominantly dry, but are occasionally filled by floodwaters from the major river systems. During flooding, water may remain fresh and can support abundant fish populations. Lakes become increasingly saline as they dry. The frequency of flooding and inundation is highly variable.

4.5 Geology

This section provides a brief description of the geology of the Cooper Basin. Further details are provided in Santos (2003).

The Eromanga and Cooper Basins are located in central and eastern Australia. The Cooper Basin is a north-east, south-west trending basin that extends over an area of about 153,000 km^2 in north-east South Australia and south-west Queensland (Stanmore 1989). It is unconformably overlain by the Eromanga Basin. The saucer-shaped Eromanga Basin extends over a much larger area of around one million square kilometres in Queensland, New South Wales, South Australia, and the south-east of the Northern Territory. The Eromanga Basin is overlain by the Lake Eyre Basin.

In the north-east of South Australia, the Lake Eyre Basin consists of surface sediments on floodplains, wetlands, tablelands, gibbers, salt pans. At depth, units include the Yandruwantha Sand (medium to coarse grained sand), the Namba Formation (deltaic and lacustrine clay, silt and sand), and the Eyre Formation (sandstone and shale). The thickness of Lake Eyre Basin sediments in the Moomba area is generally in the range 200 – 300 m (Drexel and Preiss 1995).

Below the Lake Eyre Basin section lie the Eromanga Basin sediments which are between 1200 m and 2,700 m thick (Gallagher and Lambeck 1989). These sediments were deposited under fluvial (river), lacustrine (lake) and later shallow-marine conditions, and are broadly continuous across the basin (Vine 1976). These sediments are gently folded in some areas and contain a succession of geographically extensive sandstone formations that serve as oil reservoirs and regional aquifers known as the Great Artesian Basin.

Located underneath the Eromanga Basin section, the total Cooper Basin sediment accumulations exceed 1,500 m in some places and are characterised by fluvial, deltaic, and swamp deposits that include some coal measures (Thornton 1979). These sediments contain petroleum reservoirs (mainly gas) and aquifers.

The tectonic history of the Cooper and Eromanga Basins is complex and has been characterised by several periods of rift-related subsidence and compressional uplift and erosion. This history has resulted in the Cooper Basin being subdivided into a number of large scale sub-troughs separated by fault bounded ridges. The historical evolution of the Cooper and Eromanga Basins is discussed by Kuang (1985), Finlayson *et al.* (1988), Gallagher (1988), Hunt *et al*. (1989) and Stanmore (1989). The Cooper and Eromanga Basins are currently subject to a regionally compressive stress regime. Motion along fault bounded basement blocks results in strong local stress variations. Evidence from wellbore geomechanics shows that conditions for movement on faults are present and that the structural evolution of the area is ongoing.

4.6 Hydrogeology

This section provides a brief description of the hydrogeology of the Cooper Basin based on information provided in Santos (2003) and Beach (2012a).

Regional hydrogeology is dominated by the presence of the Great Artesian Basin, one of the largest multi-layer aquifer systems in the world. The Great Artesian Basin (GAB) comprises Jurassic and Cretaceous sediments of three large sedimentary basins, the Eromanga, Carpentaria and Surat Basins, of which the Eromanga Basin is the largest and most central. Only the south-western third of the Eromanga Basin extends into South Australia, with the Carpentaria Basin located in Queensland and the Surat Basin located in Queensland and New South Wales.

The groundwater flow in the GAB is generally to the south-west; with recharge occurring in northern Queensland and groundwater discharging as spring flow around Lake Eyre. Groundwater travel times can be of the order of 1 to 2 million years. In South Australia recharge also occurs along the western basin margin and a component of groundwater flow also comes from the eastern extension of the basin in New South Wales. Throughout the GAB there are numerous permeable formations and a number of aquifers of regional significance.

The GAB springs are located beyond the margins of the Cooper Basin region, with the closest springs, in the Lake Frome supergroup, occurring near the margins of the southern Cooper Basin (see Figure 10). GAB springs support an EPBC Act listed ecological community, as discussed in Section 4.3.3.

In central Australia the GAB sediments are overlain by the sediments of the Lake Eyre Basin. These sediments consist of Tertiary sands and often contain beds of lignite and clay. The sand units can

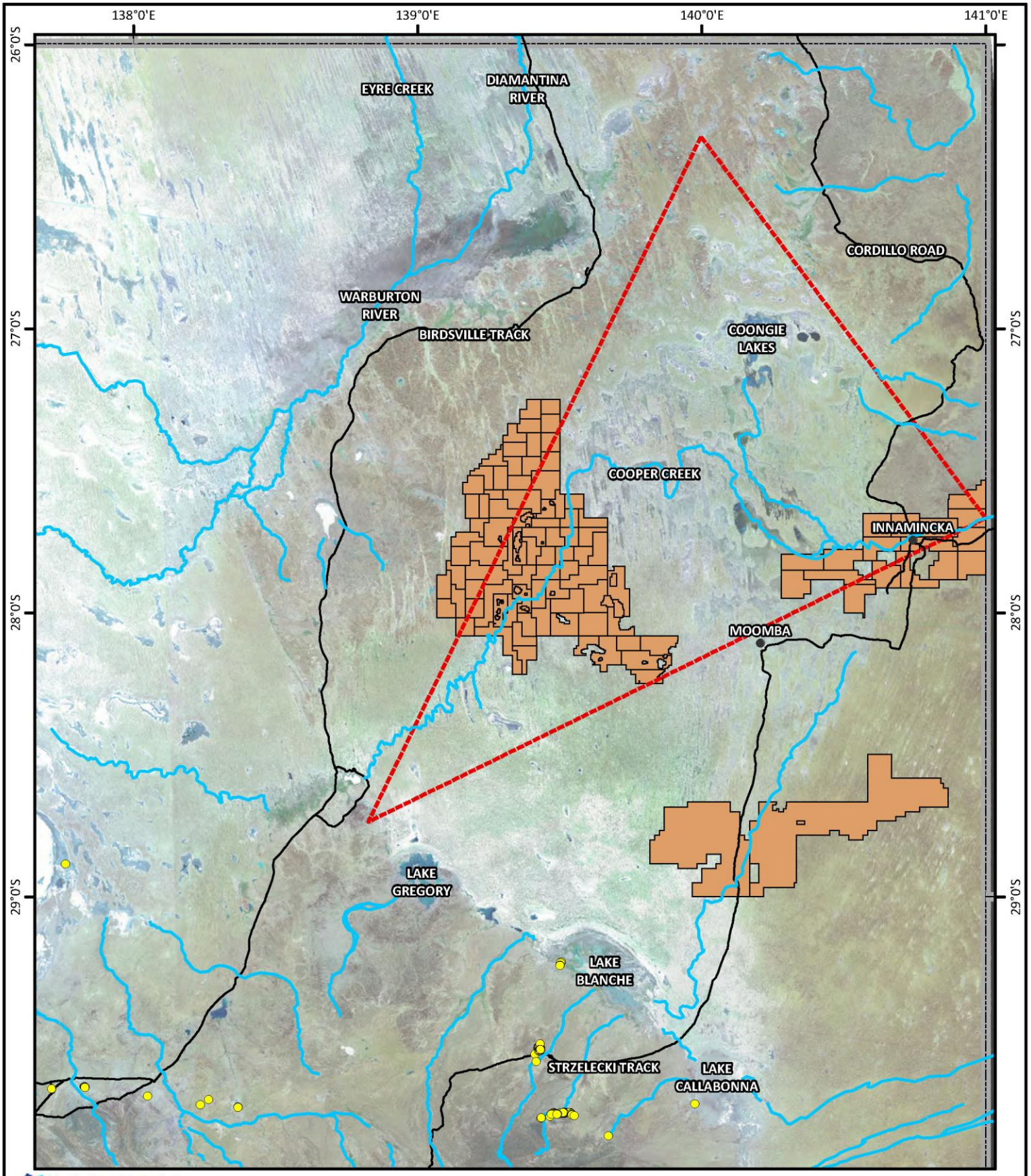
host useful local aquifers that are often exploited for stock water. Localised aquifers can also be found in Quaternary alluvial sands and gravel. Depending on the location in the landscape, groundwater salinity in these shallow aquifers can range from fresh to saline. Shallow groundwater recorded in bores near Beach's facilities on the western flank of the Cooper Basin is generally saline, ranging in salinity from 24,000 to 72,000 mg/L at depths of less than 10 m.

Within the Eromanga Basin itself two major regional aquifer systems are identified, these being the Cadna-owie Formation and Algebuckina Sandstone (Cadna-owie–Algebuckina aquifer), and the upper confined aquifer consisting of sediments of the Winton and Mackunda Formations. The two aquifer systems are separated by the shales of the Bulldog Shale and Oodnadatta Formation. Aquifers of the Winton and Mackunda Formations are generally confined by clays and shale of the Winton Formation and Tertiary sediments of the Lake Eyre Basin. Both aquifer systems can be unconfined near the basin margins.

An intermediate aquifer exists between these two major aquifer systems and is hosted in the Coorikiana Sandstone, which forms a discrete aquifer of high salinity and low permeability in the southern and western Eromanga Basin. Although artesian pressures have been recorded in this aquifer it is generally not exploited due to its poor water quality and low yield. The Winton and Mackunda Formations, while generally confined, are not artesian and are not as widely utilised as the deeper and better quality artesian aquifers of the Cadna-owie–Algebuckina aquifer system.

The Cadna-owie–Algebuckina aquifer comprises the major source of groundwater in the Far North Prescribed Wells Area. To the east of the Birdsville Track Ridge, and overlying the Cooper Basin, the Cadna-owie–Algebuckina aquifer includes sediments of the Murta Formation and the Namur, Adori, Hutton and Poolowanna Sandstones. West of the Birdsville Track Ridge, the confining beds separating these sandstone units pinch out over the ridge and the individual sandstones merge into the Algebuckina Sandstone.

In various locations across the Cooper Basin, erosion of the Cooper Basin sediments and deposition of Eromanga Basin sediments over the top has resulted in contact or mixing between the two formations. As a result, over geologic time, hydrocarbons have migrated from the Cooper Basin into the Eromanga Basin. Indications of trace oil and gas are seen in the Jurassic (GAB) aquifers during drilling across the Cooper Basin because of this migration and in certain areas of the basin, the Eromanga Basin sediments (i.e. the GAB aquifers) are targets for oil exploration and production.



JBS&G

Figure10: Cooper Basin Surface Water Features and GAB Springs

Scale at A4 1:2,000,000

0 25,000 50,000
metres

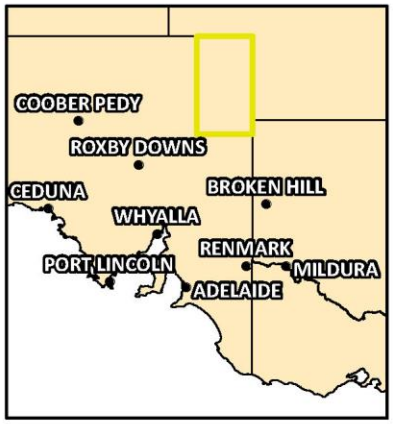
Coor. Sys. Geocentric Datum of Australia 1994

Drawn By: TB Checked By: SM

Version: Rev0 Date: 10-May-2016

Legend:

- Locality
- Roads
- Watercourse
- GAB Springs
- Coongie Lakes Ramsar Wetland
- Beach Permit - Operated



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4.7 Social Environment

4.7.1 Aboriginal Cultural Heritage

The region is culturally significant to the traditional Aboriginal owners. The Cooper Creek region (including the channels and lake shores of the North-West Branch of the Cooper Creek and Coongie Lakes) were an important focus of Aboriginal occupation. Evidence of long term occupation includes rock art, burial sites, trade and ceremonial sites scattered with grinding stones and other artefacts associated with habitation.

Aboriginal sites can still be identified throughout the region and include features of spiritual importance and archaeological sites: for example middens, artefact scatters, rock engravings, arrangement sites, burial sites and quarries (Blackley *et al*. 1996). The eastern section of the Cooper Creek in South Australia has been proclaimed a State Heritage Reserve because of its association with Aboriginal and European history as well as its environmental significance. This area encompasses Innamincka and a one kilometre section either side of Cooper Creek, totalling 120 km^2. It is rich in Aboriginal objects, campsites, quarries and engravings with several unique designs located around Cullyamurra waterhole.

Table 12 summarises the land systems and the archaeological sites and artefacts which may be associated with them.

Table 12: Land systems and Aboriginal heritage

Land types	Artefacts and sites	Location of sites
Floodplains, wetlands, salt lakes	Burial sites	Isolated dunes and sandy rises
	Campsites	Isolated dunes and sandy rises
	Shell middens	Near lakes and rivers
	Rock art	Near lakes and rivers
	Tree scars: rare	Along rivers and creeks
	Stone artefact scatters	Near lakes and rivers
Sand dunes	Burial sites: common	Often in eroding sand dunes
	Shell middens: common	Near sources of permanent water such as Cooper Creek and Coongie Lakes
Tablelands and gibber plains	Cleared pathways	Near stone arrangements
	Stone tool quarries	Mesa caps
	Stone arrangements	Gibber country

Source: Santos (2003)

Work Area Clearances are carried out with the relevant Native Title group in advance of all activities to ensure that cultural heritage values and significant places are not impacted.

4.7.2 Non-Aboriginal Cultural Heritage

Non-indigenous heritage in the region dates back to early exploration of the region in the mid to late 1800's and the expansion of pastoralism. Many of the historical sites in the region are associated with the failed Burke and Wills expedition of 1860-61 (including the Dig Tree and grave sites) and the subsequent settlement of inland South Australia and Queensland and the establishment of transport routes and pastoralism (DPTI 2014, AHPI 2014).

Locations around Innamincka are incorporated within the Innamincka / Cooper Creek State Heritage Area. A number of sites in the region are listed on the State Heritage Register, including the Australian Inland Mission Nursing Home at Innamincka and the Innamincka / Cooper Creek State Heritage Area (a section 1 km either side of the Cooper Creek channel from the Queensland border to 14 km west of Innamincka).

4.7.3 Native Title

There are currently three Native Title Claims in the South Australian Cooper Basin. Details of each claim are presented in Table 13.

Table 13: Native Title claims in the South Australian Cooper Basin (February 2015)

Title	Location	Status / File no.
Dieri Native Title Claim	From Marree in the south to Cameron Corner in the east, to Haddon Corner in the north east, following the Qld border to Lake Teetatobie, south west of Gypsum Cliff, west to Lake Eyre, south to Marree.	Determined SCD2012/001
Wangkangurru / Yarluyandi Native Title Claim	Northern SA and Queensland.	Determined SCD2014/005
Yandruwandha / Yawarrawarrka Native Title Claim	North east corner of South Australia (SA) extending south to Lake Blanche.	Registered* SC1998/001

*Note: The Yandruwandha / Yawarrawarrka Native Title Claim was determined in December 2015 (National Native Title Tribunal file no. SCD2015/003).

Beach has agreements in place for its licence areas with the relevant Native Title claimant groups covering exploration and production. Before Beach conducts activities, work area clearances are undertaken with representatives engaged from the relevant group.

4.7.4 Land Use

The major land uses in the Cooper Basin are pastoralism, oil and gas exploration production, conservation and tourism.

Pastoralism

Pastoralism, mainly in the form of cattle grazing, has a long history in the region, beginning in the late 1800s and continuing today. The floodplains surrounding the Cooper Creek in particular provide pasture and reliable water supplies in the form of permanent waterholes. While stocking rates are relatively low the region continues to support a substantial cattle production operation which is an important contributor to the local economy.

Pastoral leases in the region include:

- Alton Downs
- Bollards Lagoon
- Clifton Hills
- Cordillo Downs
- Gidgealpa
- Innamincka
- Lindon
- Merty Merty
- Mulka

- Mungeranie
- Pandie Pandie

There are a number of properties in the region that have achieved certification for organic beef production. Landholders in Beach's operational regions are also certified under Quality Assurance systems such as the Livestock Production Assurance program, which places emphasis on minimising the risk of chemical contamination, bruising and hide damage and ensuring effective herd management and improvement.

Oil and Gas

Oil and gas exploration in the Cooper Basin commenced in 1954 and the Cooper Basin has become a major supplier of oil and gas in Australia since the discovery of gas reserves at Gidgealpa, near Moomba, in 1963. The actual area of land utilised for gas production is small, but the supporting infrastructure extends throughout much of the central and north eastern portion of the Cooper Basin in South Australia. Producing oil and gas fields are spread through pastoral lands and regional reserves and the Ramsar wetland declared area.

Beach is a major oil producer in the South Australian Cooper Basin, with a number of oil production facilities in the Basin and a strong acreage position on the Cooper Basin's western flank. Beach is also working towards developing a large-scale, cost-competitive unconventional gas resource in the Cooper Basin.

Beach is the second largest petroleum operator in the region and is also joint venture partner in a number of fields operated by Senex Energy and the SA Cooper Basin Joint Venture.

Conservation

The region contains some of South Australia's largest reserves dedicated under the *National Parks and Wildlife Act 1972*. The main parks and reserves of the broader region include the Innamincka Regional Reserve, Strzelecki Regional Reserve, Simpson Desert Regional Reserve and the Coongie Lakes National Park.

Regional Reserves are areas proclaimed for the purpose of conserving wildlife, natural or historical features while allowing responsible use of the area's natural resources (including oil and gas production). Together the Innamincka and Strzelecki Regional Reserves which account for just over two million hectares of land within in the Cooper Basin region while the Simpson Desert Regional Reserve, located on the western margin of the region, is one of the largest protected areas in South Australia and plays an important role for landscape-scale conservation of central Australian arid environments.

In 1987, part of the Cooper Creek system was proclaimed as the Coongie Lakes Wetland of International Importance under the Ramsar Convention. The Ramsar wetland is defined by Lake Moorayepe to the north, the Queensland border at the crossing of Cooper Creek to the east, and a point south-west of Lake Hope (see Figure 10). It is estimated that the Coongie Lakes Wetlands Ramsar area covers 30% of the known oil and gas resources within the South Australian portion of the Cooper Basin (DEHAA 1999).

The Coongie Lakes National Park was proclaimed to conserve significant wetlands, provide tourism experiences and ensure that the core component of the Coongie Lakes system is protected from grazing, petroleum and mining activities. Three special management zones (the No Mining Zone, Walk-In Zone and Controlled Access Zone) have also been established provide additional protection to key riparian and wetland zones adjacent to the Park.

Tourism

The Innamincka, Coongie Lakes and Cooper Creek regions in north-eastern South Australia have increased in popularity over the past 30 years as a destination for tourists seeking a bush exploration experience. It has been previously estimated that annual visitation to the Innamincka region exceeds 34,500 visitors (DEH 2008). Dillons Highway (Strzelecki Track) is a major tourist access route to the region and after connecting with the Adventure Way east of Innamincka, forms part of the outback tourist highway between South Australia and Queensland. The Birdsville Track which connects the towns of Marree in South Australia and Birdsville in Queensland is also a major tourist route in the north-west of the region.

4.8 Socio-economic

The region is located in the unincorporated (i.e. out of councils) area of South Australia. Jurisdiction for the area falls under the responsibility of the Outback Communities Authority which provides limited local government-type support.

As discussed above, the major regional industries are pastoralism, oil and gas production and tourism.

The only township in the region is Innamincka, which has had a resident population in the order of 12 to 18 people (Marree SCB 2004). The Innamincka Progress Association is responsible for managing many of the town's public facilities, including the Town Common camping area, the airstrip and public amenities.

Moomba, Ballera and the satellite production facilities have accommodation and recreation facilities that house the petroleum industry workforce, which operates on a 'fly-in, fly-out' basis.

Infrastructure in the region is minimal. Unsealed roads service the district, with the Adelaide-Moomba Road and Dillons Highway (which are generally referred to as the Strzelecki Track) being the major route through the region. The oil and gas fields in the region are serviced by a network of unsealed roads and tracks, which are generally not available for public access.

Other public roads in the region include the Adventure Way, east of Innamincka, the Cordillo Road and Coongie Lakes track north of Innamincka, Fifteen Mile Track, west of Innamincka and the Walkers Crossing Public Access Route, north-west of Moomba. The Birdsville Track lies on the western edge of the region.

5 Environmental Risk Assessment

This section discusses potential environmental impacts associated with Beach's production operations in the Cooper Basin. The discussion is supported by an environmental risk assessment.

Section 5.1 provides an overview of the risk assessment methodology. Sections 5.2 to 5.11 contain discussions of hazards and tabular summaries of risk assessments and management strategies for Beach's operations and activities in the Cooper Basin. Each risk assessment table outlines:

- environmental hazards associated with the operation or activity
- the potential consequences of the hazard
- an outline of key management measures
- likelihood of occurrence of these consequences, given the management measures in place
- potential severity of the consequences, given the management measures in place, and
- the resultant level of risk.

5.1 Overview of Risk Assessment Process

Environmental risk is a measure of the likelihood and consequences of environmental harm occurring from an activity. Environmental risk assessment is used to separate the minor acceptable risks from the major risks and to provide a basis for the further evaluation and management of the major risks.

The risk assessment process involves:

- identifying the potential hazards or threats posed by the project
- categorising the potential consequences and their likelihood of occurring
- using a risk matrix to characterise the level of risk[7].

The level of risk for Beach's production operations in the Cooper Basin has been assessed based on the assumption that management measures that are discussed in this EIR will be in place. The risk assessment was carried out by JBS&G and Beach environment personnel and relevant members of the Beach Production team, based on knowledge of the existing environment, and experience with production operations in the Cooper Basin undertaken by Beach as well as other companies (e.g. Senex Energy and Santos).

The risk assessment process was based on the procedures outlined in Australian and New Zealand Standard AS/NZS ISO 31000:2009 (Risk Management) and HB 203:2012 (Managing environment-related risk).

The risk assessment uses the risk matrix and definitions for consequences and likelihood outlined below, which use:

- five categories of consequence (Negligible to Critical) to describe the severity, scale and duration of potential impacts
- five categories of likelihood of potential environmental consequences occurring (Remote to Almost Certain). The likelihood refers to the probability of the particular consequences eventuating, rather than the probability of the hazard or event itself occurring.

[7] The risk assessment process may be iterative for some hazards. For example, the risk assessment may initially indicate that risks are unacceptably high, based on minimum or familiar management practices. In such cases, management practices are reviewed to identify additional management options to lower risk and / or improve environmental outcomes (e.g. elimination, substitution, reduction, engineering controls and management controls). The risk is then re-assessed based on these additional management options. This EIR details the final or residual risk after management options have been applied.

- a risk matrix to characterise the risk associated with each hazard as low, medium or high. Risks are generally considered acceptable if they fall into the low category without any further mitigation measures, and 'tolerable' if they fall into the medium risk category and are managed to reduce the risk to a level 'as low as reasonably practicable'. Risk reduction measures must be applied to reduce high risks to tolerable levels.

Definition of Consequences

To describe the severity, scale and duration of potential impacts, the five categories of consequence listed in the following table are used.

Table 14: Consequence definition

		Health and Safety	Natural Environment	Reputation Community / Media	Financial A$
Critical	**5**	Fatality of employees, contractors, or the public	Critical ecological or cultural impact and/or regulatory intervention	Critical impact on business reputation / or international media exposure	Financial loss in excess of $20 Million
Major	**4**	Extensive injury or Hospitalisation of employees, contractors, or the public	Significant ecological or cultural impact and / or regulatory intervention	Significant impact on business reputation and / or national media exposure	Financial loss $2 Million to $20 Million
Moderate	**3**	Medical treatment of employees, contractors, or the public	Significant local environmental impact and / or regulatory intervention	Moderate to small impact on business reputation	Financial loss from $0.5 Million to $2 Million
Minor	**2**	First-aid treatment of an employee, contractor, or a member of the public	Minor local environmental impact and / or regulatory notification is required	Some impact on business reputation	Financial loss from $0 to $0.5 Million
Negligible	**1**	Minimal impact to any issue	Minimal impact to any issue	Minimal impact to any issue	Minimal impact to any issue

Definition of Likelihood

The likelihood of potential environmental consequences occurring is defined using the five categories shown in the following table. The likelihood refers to the probability of the particular consequences eventuating, rather than the probability of the hazard or event itself occurring.

Table 15: Likelihood definition

Likelihood of the consequences selected occurring

A	**Almost Certain**	Is expected to occur in most circumstances	(happens several times a year)
B	**Likely**	Will probably occur in most circumstances	(happens several times a year)
C	**Possible**	Possible that it might occur at some time	(has occurred previously at Beach)
D	**Unlikely**	Unlikely, but could occur at some time	(has occurred previously in the Industry)
E	**Remote**	Highly unlikely, may occur in exceptional circumstances	(never heard of in Industry)

Characterisation of Risk

The risk associated with each hazard was characterised as low, medium or high, using the matrix below.

Table 16: Environmental risk matrix

RISK MATRIX			Consequence				
			Negligible	Minor	Moderate	Major	Critical
			1	2	3	4	5
Likelihood	Almost Certain	A	M	M	H	H	H
	Likely	B	M	M	M	H	H
	Possible	C	L	M	M	H	H
	Unlikely	D	L	L	M	M	H
	Remote	E	L	L	L	M	M

High Risk - Immediate Action Required. **Medium Risk** - Management Attention Needed
Low Risk - Managed by Standard Operating Procedures

Risk Assessment Summary Tables

The following sections contain tables which summarise the results of the risk assessment. The tables present the final or residual risk after management measures have been applied. The tables also provide a cross-reference to the relevant SEO objectives for each hazard.

5.2 Well Operations

Completions and Workovers

Environmental hazards associated with completions and workover activities include well control incidents, loss of containment of workover fluids or the possibility of an explosion or fire. The likelihood of a well control issue during completions activities is low because the well is cased and the wellbore is in a stable condition with known downhole pressures.

The Cooper Basin is geologically well-defined with predictable pressure gradients. Guidelines, procedures, design and safety practices take this information into account which in turn reduces the potential for well control issues. Guidelines and procedures specific to workover operations combined with appropriate certification of trained individuals means that the risk of a well control issue in a cased hole is low.

In the event of a well control issue, Beach employs emergency response procedures which may include wellbore, equipment and / or well site isolation. Beach also has expert well control contractors available for mobilisation to assess and secure the situation.

Well Integrity Management

Hazards relating to well integrity management include a failure of casing or cement, which could result in crossflow and contamination between reservoirs and aquifers, and uncontrolled flows at the

surface. As discussed in Section 3.1.2, Beach uses a well integrity maintenance program to monitor and assess the reliability of sub-surface assets on a routine basis. Hazards relating to downhole abandonment following production are similar, and it has been addressed with well integrity in the risk assessment.

Artificial Lift and Wellhead Production Skids

The main hazards associated with the various wellhead and pumping systems used at well sites include potential spills of hydrocarbon and chemical products that may be stored on-site. Spills and leaks are most likely to be associated with oil well artificial lift installations (e.g. beam pump and jet pump). Stuffing box failure on beam pumps may result in localised contamination of soil and possibly shallow groundwater due to leakage. To minimise the risk associated with spills from stuffing boxes, an Environmental Stuffing Box, a containment device that is fitted above the rod packer and contains any oil / water that has passed by the packer, is installed. In the event that the packing fails to seal, the oil is contained in a receptacle, that once full, initiates beam pump shutdown. Wells are also fitted with impermeable cellars as an additional containment device.

Jet pumps are installed on containment bunds that are connected to a sump which will contain hydraulic fluid leaks, spills during maintenance and / or equipment wash down waters.

Artificial lift systems generally require a generator and associated fuel storage and gas well skids may have storage and injection facilities for production chemicals such as corrosion inhibitor. Spills associated with fuel and chemical storage have the potential to result in localised contamination of soil, surface and / or shallow groundwater and potential for uptake by cattle and loss of beef production certifications. Lease construction (i.e. compaction) and installation of appropriate bunding minimises the risk posed to the environment and reduces the potential for environmental impacts.

Risk assessments are conducted to ensure that the design and installation of production equipment, including artificial lift equipment and wellhead skids, will conform to relevant industry and engineering standards and conventions.

Gas Well Deliquification

The main hazards associated with unloading liquids from gas wells is the handling of water produced and the expulsion of gas. Inappropriate handling of water produced has the potential to result in localised impacts to soils and shallow groundwater, while the expulsion of gas contributes to operations-related emissions and could result in fire or explosion if not appropriately managed. Management procedures and the use of suitable equipment where necessary (e.g. flowback lines connected to impermeable clay and / or lined pits) are used to minimise the level of risk.

Table 17: Well Operations

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Completions and Workovers						
Loss of well control (resulting in uncontrolled release of fluids (liquid or gas) to surface)	Contamination of soil, shallow groundwater and / or surface water Danger to health and safety of personnel, contractors and possibly the public Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat Damage to existing producing infrastructure Generation of greenhouse gas emissions, localised reduction in air quality	3, 6, 7, 8	Periodic well integrity processes in place for whole of life well monitoring and management Workover / completion program in place Fit for purpose equipment used Competent site personnel and contractors on site at all times Blowout preventers (BOP) installed Regular BOP drills, testing, certification, and maintenance Continuous observation during operations to mitigate loss of well control events e.g. trip tanks / gas detection Personnel are trained in the use of spill response equipment Implementation of appropriate emergency / spill response procedures Safety equipment on site appropriate to the anticipated gas composition (e.g. H_2S) such as breathing apparatus and gas detectors Restricted access to site	Moderate	Unlikely	Medium
Explosion or fire at the well site	Contamination of soil, shallow groundwater and / or surface water Danger to health and safety of personnel, contractors and possibly the public Generation of greenhouse gas emissions, localised reduction in air quality Burning of vegetation and habitat Injury to or loss of native fauna	3, 6, 7 8	Fit for purpose equipment used Approved workover / completion program Safety, testing, maintenance and inspection procedures are implemented Establishment of appropriate emergency / spill response procedures for explosion or fire Safety equipment on site appropriate to the anticipated gas composition (e.g. H_2S) such as breathing apparatus and gas detectors Personnel are trained in the use of spill response equipment Erection of signage and, where required, fencing to delineate restricted / hazardous areas Personnel are trained to supervise and instruct individuals entering lease to conduct work Appropriate fire fighting equipment maintained on site Safe work permits must be obtained to ensure only individuals with proper clearance can conduct work on a lease Smoking only in designated areas located away from equipment or activity	Major	Remote	Medium

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Restricted access to site			
Spills or leaks associated with chemical and fuel storage and handling	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat	3, 6	Implementation of appropriate chemical and fuel storage and handling procedures (e.g. bunding and signage) in accordance with relevant standards and guidelines, including AS 1940, EPA guideline 080/12 Bunding and Spill Management and the Australian Dangerous Goods Code (ADG) Regularly educate staff of product, review and monitor chemical and fuel transportation, including signage / labelling, proper packing and tie downs Establish appropriate emergency / spill response procedures for spills or leaks to soil and water Periodic review and exercise of response equipment and procedures to ensure preparedness Appropriate spill containment and clean-up equipment located on site Personnel are trained in the use of spill response equipment Implementation of emergency / spill response procedures Immediate clean-up and remediation to minimise contamination to soil / water Fencing of affected areas if threat is posed to stock or wildlife Monitoring of in situ remediation of spills to confirm that hydrocarbons are decreasing over time Assessment and remediation of uncontained spills with larger scale impact (e.g. any volume to water) undertaken in accordance with the National Environment Protection (Assessment of Site Contamination) Measure Maintain a register of spills and / or leaks and implement corrective actions based on analysis of spill events	Minor	Unlikely	Low
Disposal of hydrocarbon and formation waters	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat	3, 6	Tanks used for on-site storage of fluids generated during completions and workover activities	Minor	Unlikely	Low
Flooding of surrounding floodplain /	Contamination of soil, shallow groundwater and / or surface water	3, 5, 6	Implementation of appropriate chemical and fuel storage and handling procedures (e.g. bunding and signage) in accordance with relevant standards and guidelines, including AS 1940, EPA guideline 080/12 Bunding and Spill Management and the Australian	Minor	Unlikely	Low

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
watercourses	Damage to infrastructure (e.g. roads, well lease, flare pits) Access to contaminants by stock and wildlife Damage to surrounding vegetation by contaminated water		Dangerous Goods Code (ADG) Work programs in floodplain areas scheduled to take into account seasonal conditions and rainfall / flood likelihood Flood management plan activated Measures undertaken to reduce potential impacts of flooding where appropriate (e.g. installation of bunds, removal of liquids prior to arrival of flood event) If deemed at risk, wellheads may be shut in and chemicals removed prior to flood events Fully containerised tanks used for on-site storage Tanks used for on-site storage of fluids generated during completions and workover activities			
Well integrity management						
Cement failure	Communication between formations that are typically hydraulically isolated; or to surface Contamination of aquifers	6	Periodic well integrity processes in place for whole of life well monitoring and management Appropriate controls implemented during well drilling (under the Drilling SEO) including: ▪ Cement slurry and pumping schedule design ▪ Casing centralisation program ▪ QA / QC during cement job execution ▪ Cement bond logs run where appropriate ▪ Remedial cementing undertaken where logs indicate an unacceptable risk ▪ Competent site personnel and contractors on site at all times	Moderate	Unlikely	Medium
Down hole production equipment failure (e.g. casing, packer, seal assembly)	Uncontrolled release of fluids (liquid or gas) to surface Communication between formations that are typically hydraulically isolated Contamination of aquifers Contamination of soil, shallow groundwater and / or surface water Danger to health and safety of personnel, contractors and possibly the public Access to contaminants by stock and wildlife Loss of beef production	3, 6, 7, 8	Appropriate controls implemented during casing installation (under the Drilling SEO) including casing design, running procedures, pressure testing and casing certification Competent site personnel and contractors on site at all times New or certified wellhead and production equipment installed Downhole production equipment and wellhead equipment designed to meet pressure, temperature, operational stresses and loads. Pressure testing, either inflow (negative test) or positive testing to be performed on barrier envelopes / components where feasible Inhibited static packer fluid, where applicable Monitoring programs implemented (e.g. through well logs, pressure measurements / testing and, or corrosion monitoring programs) to aid in the assessment of wellbore barrier conditions Where monitoring identifies potential issues, working within Beach Management Systems, risk assessment undertaken to identify	Moderate	Unlikely	Medium

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
	certification Loss of vegetation and fauna habitat Generation of greenhouse gas emissions, localised reduction in air quality Loss of reserves and reservoir pressure		hazards / scenarios and propose recommendations and mitigation controls where appropriate to reduce or monitor risk Casing annulus pressures are routinely checked and reported, if accessible <u>Downhole abandonment following production</u> Well abandonment program to be submitted to DSD with wireline logs prior to implementation Downhole abandonment carried out to meet worst case expected loads and downhole environmental conditions Appropriate barrier controls put in place to prevent crossflow, contamination or further pressure reduction occurring Pressure testing and / or negative inflow testing performed on barrier envelopes / components where feasible Inhibited fluid placed between barriers where applicable Operational reports for barrier installation and testing submitted and retained			
Artificial lift and wellhead production skids						
Spills and leaks from artificial lift and wellhead production equipment	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat Generation of greenhouse gas emissions, localised reduction in air quality	3, 6, 8	Equipment is fit for purpose and installed in accordance with relevant standards including AS 3000 and AS 60079 series Safety, testing, maintenance and inspection procedures are implemented Over-pressure protection systems, including high-pressure shut downs and environmental stuffing boxes will be installed to suit each type of artificial lift as appropriate Safe work permits must be obtained to ensure only individuals with proper clearance can conduct work on a lease Where appropriate, impervious well cellars are installed at wells Jet pumps are installed with adequately sized containment sumps with floats Containment devices are installed on gas well skids See *Completions and Workovers* section in this table (above) for general controls related to spills or leaks	Minor	Unlikely	Low
Gas Well Deliquification						
Gas / water production during operations	Localised contamination of soil, shallow groundwater and / or surface water Danger to health and safety of personnel, contractors and possibly the public	3, 6, 7, 8	Water produced during gas well unloading is managed based on level of environmental risk (e.g. proximity to surface water bodies and or presence of sensitive shallow groundwater receptors). Measures may include: ▪ impermeable clay and / or lined pit to contain any produced liquids	Minor	Unlikely	Low

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
	Impacts to stock and / or wildlife Loss of beef production certification Ignition of bushfires Loss of fauna vegetation and fauna habitat Generation of greenhouse gas emissions, localised reduction in air quality		▪ tanks ▪ flare stack Assessments undertaken where relevant to identify potential environmental sensitivities and specify required containment measures Wells that are frequently unloaded are reviewed to evaluate whether measures to minimise unloading are appropriate (e.g. installation of small ID tubing or artificial lift installation) Unloading undertaken only when prevailing environmental conditions (e.g. wind speed and direction) are suitable Gas / fluid stream will be flared rather than vented to minimise emissions where possible. This will depend upon fluid ratio in the stream			

5.3 Production Facilities

5.3.1 Facility Construction

Environmental hazards associated with construction of facilities and associated areas such as camps and laydowns include movement of heavy vehicles, earthworks, vegetation clearance, fire, leaks or spills associated with chemical and fuel storage and waste disposal.

The type and severity of potential consequences of earthworks is dependent, to a certain extent, on the land system in which the activities are being carried out. Disturbance of soils in some land systems, such as gibber plains and tablelands, can lead to substantial erosion by water while other systems, such as dunefields, are generally more resilient and less likely to suffer any long-term impacts from soil disturbance. The potential consequences of specific earthwork activities on different land systems in the Cooper Basin are summarised in Table 21.

Production facilities are usually located to avoid sensitive land systems or areas of high ecological value (e.g. salt lakes, wetlands or other areas of significant habitat). Production facilities are also usually located on or adjacent to previously disturbed areas (e.g. drill pads, access tracks) to minimise the need for additional land disturbance and vegetation clearance. Vegetation clearing can result in loss of vegetation and fauna habitat, increased erosion, siltation of natural drainage lines and watercourses, destabilisation of creek crossings, weed invasion and damage to cultural heritage sites. Vegetation clearance may also impede the movement of fauna around the construction site. Care is taken when planning the location of a facility site to ensure that minimal vegetation is cleared.

A potential source of leaks and / or spills during construction is from chemical and fuel storage areas and refuelling depots associated with construction works. The primary consequence of any leak or spill is localised contamination of soil.

Occurrence of flooding or fire during construction works has a number of potential consequences. For flooding these include significant soil erosion in areas that have been subject to earthworks and possibly loss of vegetation. In the case of a fire, loss of vegetation and fauna habitat and production of particulate air emissions are possible consequences.

Facility construction generates some waste. Materials such as metal off-cuts or wooden pallets can generally be reused or recycled.

5.3.2 Facility Operation

There are a number of environmental hazards associated with the operation of oil or gas production facilities. They include production of atmospheric emissions (via fugitive, flare, combustion and venting sources), loss of containment of oil and storage of chemicals and fuels. These are outlined in Table 18.

Emissions of environmental significance (i.e. atmospheric pollutants and / or greenhouse gases) are:

- combustion by-products (e.g. oxides of nitrogen, carbon monoxide and sulphur dioxide)
- methane and organic carbon from fugitive sources
- vented gas
- flared hydrocarbons
- vented CO_2, H_2S, and CO.

Beach reports emissions in accordance with statutory requirements such as the National Pollutant Inventory (NPI) and National Greenhouse and Energy Reporting Act (NGER)[8].

Operation of compressors or generators can result in an increase in background noise levels, which may result in disturbance to wildlife, stock or third parties (e.g. if facilities are inappropriately located near pastoral residences or tourist campsites). The presence of personnel and site activities also has the potential to disturb stock or wildlife, particularly if sites are inappropriately located near yards or significant habitats.

There is the potential for accidental spills or leaks of small amounts of process chemicals (e.g. PFW emulsion breakers), cleaning chemicals or fuels during storage or handling and use. Accidental spills / release of oils may also occur as a result of pipe failure or leaks from equipment such as the inlet header, pipeline connection or plant valves. Other potential causes of spills or leaks include corrosion or material degradation (fatigue), mechanical damage, instrument / component failure or errors in design, construction and operation. There is also a potential for accidental overflow of oil storage tanks at production facilities and for spills to occur during tanker loading activities.

Leaks and spills can potentially lead to localised contamination of soil within the production site and may be a potential ignition source for fire. Leaks or spills also have the potential to reach shallow groundwater, if it is present. Unconfined groundwater across much of the Cooper Basin has high salinity, which means that if a leak or spill reaches shallow groundwater, the risk of impacts to groundwater dependent ecosystems or groundwater users is reduced. Surface water impacts can also potentially occur as a result of leaks or spills and facilities are located, designed, constructed and operated to minimise this risk.

The risks associated with leak or spill hazards are minimised through appropriate storage and containment and implementation of storage and handling procedures. All chemicals and fuels (including oil storage tanks) are stored on impervious bunded surfaces. The design, construction and operation of facilities are carried out in accordance with relevant standards, with appropriate supervision and quality control in place and inspection, testing and maintenance procedures implemented.

Due to the nature of petroleum production operations there is also an inherent risk of explosion or fire. However this risk is reduced to As Low As Reasonably Practical (ALARP) by compliance with relevant standards and implementation of various management measures to minimise the risk, as summarised in Table 18.

Standards of particular relevance to facility design, construction and operation include:

- AS 1940 – The storage and handling of flammable and combustible liquids
- AS 1200 – Pressure equipment
- AS 3788 – Pressure equipment - In-service inspection
- AS 2885 – Pipelines – gas and liquid petroleum
- AS 3000 – Electrical installations
- AS 4041 – Pressure piping
- AS 60079 – Explosive atmospheres.

Process critical shutdowns / fail safes are generally hard wired and regularly function tested. Risk assessments are applied at design and during the life of the asset to identify threats and controls to

[8] Current data is publicly available at the NPI and NGER websites (see http://www.npi.gov.au/npi-data/ and http://www.cleanenergyregulator.gov.au/NGER/). Beach also reports carbon emissions, energy use and NPI data in the annual report to shareholders (available at www.beachenergy.com.au).

mitigate risks. Asset integrity and maintenance is managed through a web based technology to ensure compliance with regulations and scheduled maintenance and safety checks on control systems and monitoring are performed in a traceable manner.

Flooding of production facilities in floodplain areas can lead to contamination of soil and water, particularly if flood levels are high enough to overflow bunded areas. Flooding as a result of low to moderate flows of the Cooper Creek is not expected to affect most Beach facilities, which are located to avoid areas subject to frequent inundation. Flood flows that reach the lower Cooper Creek are estimated to occur once every 2 to 5 years or longer (Santos 2003) and such floods may affect facilities in or near floodplain environments. As these facilities are generally located on higher ground, flooding would generally result in alternative or limited access (both to the facility and within the field) and shutting-in of flood-affected wells rather than inundation of the facility (except perhaps in very large Cooper Creek floods). It is noted that the large 2010 flood, which has been estimated to occur every 20-40 years (Costelloe 2013), significantly restricted operations on the western flank, but did not result in loss of containment from facilities or bunded areas, or contamination of soil or water.

Camp accommodation and offices are located at some facilities and at stand-alone camps to house personnel working at the facilities and in surrounding areas. The primary hazards associated with these facilities are the storage and handling of domestic waste and sewage. These hazards are dealt with in Section 5.10.

The presence of facilities, camps and associated infrastructure can also adversely impact visual amenity, particularly in areas where there are significant numbers of tourists (e.g. parts of Innamincka Regional Reserve). Careful location of infrastructure (e.g. away from significant tourist sites) can significantly reduce this impact. In more isolated areas, such as the western flank of the Cooper Basin where there is little or no public access, visual impact is a less significant issue.

Table 18: Production facility risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Earthworks associated with facility construction (e.g. clearing, grading)	Injury or death of fauna / stock in construction area Disturbance to natural drainage patterns Significant damage to third party infrastructure Soil erosion and siltation of watercourses Inversion of soil profile Dust generation Soil compaction of the easement Impeded fauna movement through construction area Damage to native vegetation Temporary loss of visual amenity Disruption to land use (e.g. grazing and recreation)	1, 2, 3, 5, 8, 10	Minimise environmental impact by appropriate site selection to avoid sensitive land systems, vegetation and cultural heritage sites Use existing disturbed areas where possible Liaise with landowners regarding notification and management of works and site issues including livestock management Observe procedures and guidelines for the identification, management and protection of cultural heritage sites, including obtaining heritage clearances by Native Title groups Minimise vegetation disturbance, and plan construction to avoid vegetated areas Stabilise and control areas where there is potential for or signs of soil erosion or siltation occurring Implement dust control measures where required, using water efficient or waterless techniques where feasible Compliance with the Natural Resources Management Act (e.g. in relation to permits for water affecting activities) Avoid significant or priority[9] vegetation and ensure proposed site has been scouted for significant vegetation and wildlife habitats by appropriately trained and experienced personnel Where possible trim vegetation rather than clearing Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations Records of vehicle inspections and wash down are kept where relevant Minimise consequences to fauna by leaving excavated areas open for as little time as possible Utilise earthen fauna ramps to facilitate the movement of fauna out of excavations Regularly inspect excavations for trapped fauna Reinstate temporary construction areas (e.g. laydown) as soon as possible Restore borrow pits or reuse as evaporation or water storage ponds where appropriate Remove waste to minimise visual impact	Minor	Unlikely	Low
	Disturbance to cultural heritage sites Introduction and / or spread of weeds	4 9		Moderate	Unlikely	Medium

[9] Refer to Appendix 3: Beach Energy Priority Plant List.

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Explosion or fire at the production facility	Danger to health and safety of personnel, contractors and possibly the public Contamination of soil, shallow groundwater and / or surface water Atmospheric pollution Burning of vegetation and habitat Injury to or loss of native fauna Disruption to land use (e.g. grazing) Access to contaminants by stock and wildlife	3, 6, 7, 8	All production facilities are designed, constructed, operated and maintained in accordance with relevant standards (e.g. AS 3000, AS 1940, AS 2885, AS 4041, ASME/ANSI B31.3, AS 1200, AS 3788, hazardous area compliance to AS 60079 series) Safety, testing, maintenance and inspection procedures implemented Risk assessments applied at design and during the asset life to identify threats and controls to mitigate risks Establishment of appropriate emergency / spill response procedures for explosion or fire Erection of signage and, where required, fencing to delineate restricted / hazardous areas Personnel trained to supervise and instruct individuals entering area to conduct work Appropriate fire fighting equipment at all production facilities Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works Smoking only in designated areas located away from equipment or activity Petrol vehicles to be excluded from restricted areas Appropriate firebreaks are maintained Immediate clean-up and remediation of spills to minimise contamination to soil / water	Major	Unlikely	Medium
Flooding of surrounding floodplains / watercourses	Contamination of soil, shallow groundwater and / or surface water Damage to infrastructure (e.g. evaporation ponds) Access to contaminants by stock and wildlife Damage to surrounding vegetation by contaminated water	3, 6	Production facilities located to avoid areas subject to inundation as far as possible Production operations will cease in event of imminent flood inundation of facility. In floodplain land systems, following steps will be undertaken well in advance if there is a risk of facility flooding: ▪ satellite imagery and upstream flood levels used to predict when floodwaters will reach facility (generally take 2-3 months to reach lower Cooper Creek) ▪ construction of bunds around wells where appropriate, to increase protection ▪ additional inspections conducted ▪ storage tanks and flowlines drained, purged and filled with water to reduce buoyancy ▪ interceptor pond (if present) skimmed to remove oil ▪ fuel tanks drained, engines and all hydrocarbons (e.g. fuel and lubricants) removed off-site ▪ office / accommodation units tied down Previous major Cooper Creek floods have inundated Cooper Basin oilfields. With management strategies in place no significant environmental consequences resulted	Moderate	Unlikely	Medium

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Production facilities designed to avoid spread of hydrocarbons during inundation following localised rainfall (e.g. appropriately sized / elevated bunds)			
Spills or leaks associated with chemical and fuel storage and handling	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat	3, 6	See *Completions and Workovers* section in Table 17 for general controls related to spills or leaks	Minor	Unlikely	Low
Tanker Load-out	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife	3, 6	Tanker load-out in lined area, with appropriate bunding to contain spills Construction and operation of filling systems, storage tanks and the tankers in accordance with AS 1940 Spill kit/s located at the load-out Hoses with dry-break couplings Personnel attendance at all times during tanker filling Also refer to controls for spills or leaks in the *Completions and Workovers* section in Table 17	Minor	Unlikely	Low
Fugitive emissions of methane and organic carbon Venting of CO_2, H_2S, and CO Venting of gas	Release of greenhouse gases Localised reduction in air quality	8	All facilities designed, constructed, operated and maintained in accordance with relevant standards (see *Explosion or fire at facility* above) Safety, testing, maintenance and inspection procedures implemented Risk assessments applied at design and during the asset life to identify threats and controls to mitigate risks Continual review and improvement of operations Facilities are routinely inspected for signs of leaks and / or loss of containment Venting activities are managed and minimised with preference to flare rather than vent where feasible Consideration of weather conditions (e.g. wind direction) prior to commencing venting activities Reporting of emissions in accordance with statutory requirements (e.g. NPI and NGER requirements) See also *Explosion or fire at the production facility* in this table (above)	Minor	Unlikely	Low
Flaring or combustion of hydrocarbons	Release of greenhouse gases Atmospheric pollution	8	Facilities designed, constructed, operated and maintained in accordance with relevant standards Continual review and improvement of operations Selection of equipment to minimise emissions Maintenance of plant and equipment in accordance with manufacturer's specifications	Minor	Unlikely	Low

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Flaring activities are actively managed and minimised Appropriate firebreaks are maintained Reporting of emissions in accordance with statutory requirements (e.g. NPI and NGER requirements)			
Loss of containment of oil outside area designed to contain spills (pipe rupture, reliefs, fittings or leaks from plant and other sources)	Danger to health and safety of personnel, contractors and possibly the public Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of vegetation and fauna habitat	3, 6, 7	All facilities designed, constructed, operated and maintained in accordance with relevant standards (see *Explosion or fire at facility* in this table (above)) Safety, testing, maintenance and inspection procedures implemented Risk assessments applied at design and during the asset life to identify threats and controls to mitigate risks Strategies to mitigate threats including high use of corrosion resistant materials, design approach and maintenance systems Construction and operation of filling systems, storage tanks and the tankers in accordance with AS 1940 Use of steel piping and fittings where possible Appropriate areas (e.g. storage tanks) bunded and lined to contain spills in accordance with relevant standards and guidelines including AS 1940, EPA guideline 080/12 Bunding and Spill Management Process critical shutdowns / fail safes generally hard wired and regularly function tested Level control / overfill protection on tanks See *Completions and Workovers* section in Table 17 for general controls related to spills or leaks	Moderate	Possible	Medium
Presence of personnel, site activities and noise emissions	Disturbance to landowners and other third parties Disturbance to stock and wildlife Visual impact	1, 3	Appropriate site selection to avoid site establishment where significant disturbance to wildlife, pastoral residences or tourist sites are likely Liaise with landowners regarding notification and management of works and site issues including livestock management Maintenance of plant and equipment in accordance with manufacturer's specifications Maintain a high standard of 'housekeeping' to minimise visual impact	Minor	Unlikely	Low
Access and activity of personnel outside designated facility area / work areas	Damage to vegetation and habitats	3	Training and induction of all personnel and visitors includes information on restricted areas and activities Vehicle access restricted to designated roads and areas Erection of fencing and signage to delineate restricted areas	Minor	Unlikely	Low
	Damage to cultural heritage sites	9		Moderate	Unlikely	Medium

5.4 Produced Formation Water

One of the most significant hazards associated with the operation of petroleum production facilities is the storage and treatment of large volumes of produced formation water (PFW). PFW can be fresh, brackish or saline and can contain chemicals (both natural and added), residual hydrocarbons and some naturally occurring heavy metals.

Potential contamination of soil and groundwater may result from leaks in separation tanks, interceptor ponds and bunded evaporation ponds. Sub-surface movement of PFW can also lead to upwelling of PFW outside of unlined evaporation ponds. However the likelihood of significant consequences from loss of containment of storage of PFW is considered rare with appropriate control measures and management strategies in place.

A research project conducted by Santos indicated that the principal contaminants of concern in PFW ponds are mercury, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH) and total phenolics (Santos 2003).

The potential environmental consequences associated with PFW disposal include:

- contamination of soil and near surface aquifers by any carried-over hydrocarbon or process chemicals (e.g. emulsion breakers or biocides used to prevent corrosion resulting from sulphur reducing bacteria) or naturally occurring metals
- contamination of soil and associated vegetation with salts and metals naturally occurring, but concentrated in the PFW
- increased soil salinity
- ingestion of contaminants by native fauna or stock.

There is also potential for birds and other wildlife to come into contact with high temperature water, residual hydrocarbons and other contaminants (such as heavy metals) in interceptor ponds. Oiled birds may suffer from restricted movement and distress and often do not survive the effects of ingesting oil and other hydrocarbons.

Access to water in free form evaporation areas by stock can result in increased and ongoing grazing pressure in areas where grazing pressure would otherwise be very low or intermittent. This can lead to changes in vegetation cover, structure and composition, loss of habitat quality, soil disturbance and increased erosion and can directly impact rehabilitation / revegetation efforts. The Native Vegetation Act and Pastoral Land Management and Conservation Act place some restrictions on pastoral landholders regarding artificial waterpoints.

Flooding of PFW ponds can potentially result in impacts to surface water quality. Interceptor ponds and holding ponds are generally located with other facility infrastructure, away from areas subject to inundation and are unlikely to be flooded (see Section 5.3.2). If free form disposal areas are inundated by a large Cooper Creek flood, the large volumes of floodwater involved would cause significant dilution. PFW in free form areas is generally of suitable quality for consumption by stock, and with further dilution, significant impacts to water quality are unlikely.

Co-production of water from oil reservoirs also contributes to the net extraction of water from the Eromanga Basin (which is part of the Great Artesian Basin). Sustainable extraction volumes are set under the Far North Prescribed Wells Area Water Allocation Plan (WAP), which allocates 60 ML/day for taking produced formation water. As noted in Section 3.3, this allocation is managed by DSD on behalf of the Minister for Mineral Resources and Energy, and Beach reports PFW extraction volumes to DSD monthly. The WAP (and the Minister's water licence) also place controls on activities that could impact GAB springs:

- the WAP specifies limits on allowable drawdown near GAB springs and at the boundary of the Southwest Springs Zone (and at the state border)
- the water licence requires that submissions to DSD for taking of PFW from a well in a Petroleum Exploration Licence (PEL), in particular PELs in the Southwest Springs Zone, are to consider potential impacts on GAB springs as part of their submission.

Beach does not currently have any licence areas in the Southwest Springs Zone, and the closest GAB springs (which are in the vicinity of Lake Blanche) are over 50 km from the closest Beach PEL and over 100 km from the closest producing well (Aldinga-1). Current activities are not likely to impact the Southwest Springs Zone or GAB springs. Any future production in proximity to the Southwest Springs Zone would be undertaken in compliance with the WAP and the water licence, and appropriate approvals sought where required.

Table 19: PFW storage and disposal risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Storage and disposal of PFW at production facilities	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Salinisation of operational areas Death of adjacent vegetation Injury to or death of wildlife	3, 6	Site ponds appropriately[10] to minimise potential consequences Construct ponds using appropriate materials and suitable design criteria including adequate freeboard, depths, lining, bunding etc. Site and construct ponds with regard to EPA Guideline *509/14 Wastewater lagoon construction* Ensure that interceptor ponds are appropriately lined with an impermeable liner (e.g. HDPE) Ensure that lining of subsequent ponds is commensurate with the level of environmental risk. Standard Beach practice is to line all new interceptor and holding ponds Surface of interceptor ponds to be regularly skimmed Ensure that tanks are well maintained and regularly emptied Ensure adequate freeboard is maintained on ponds Monitor ponds for surrounding upwelling of PFW Install monitoring bores at all new facilities and other locations where relevant (e.g. where shallow groundwater exists in vicinity of PFW ponds) and conduct regular water quality monitoring Monitor and audit evaporation pond water annually to ensure that relevant oil in water criteria are met Periodic review of PFW and implementation of audit recommendations Minimise use of process chemicals (e.g. biocides, emulsion breakers) and use biodegradable or UV degradable chemicals where available Interceptor holding ponds are contained within the fenced facility area to prevent wildlife and stock access Maintain a register of spills and / or leaks and remediate Breaker siphon installed between interceptor pond and evaporation ponds Record fauna entrapment or deaths if they occur and implement appropriate preventative measures if required Investigate alternatives to surface disposal of PFW (e.g. reinjection)	Minor	Possible	Medium

[10] Appropriately manage means to take into consideration and assess relevant environmental factors (including location of surface water, potential flooding, location of vegetation, etc.) and take measures to reduce the potential impact on these factors through the use of best practice.

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Secondary use of PFW	Contamination of soil and / or groundwater Access to contaminants by stock and wildlife Salinisation of operational areas Death of adjacent vegetation	3, 6	Quality of water analysed prior to secondary use to confirm that it is consistent with relevant guidelines (e.g. ANZECC or EPA guidelines) for the intended site / use Visual monitoring undertaken at secondary use sites as appropriate (e.g. salinity, vegetation health, contamination) Relevant approvals obtained where required (e.g. DSD, landholder)	Minor	Unlikely	Low
	Increased grazing pressure leading to degradation of soils, vegetation and habitat		Liaison with landholder regarding grazing management near PFW facilities Secondary use for road watering or dust suppression avoided in areas where contaminants may enter surface waters	Moderate	Possible	Medium
Flooding of surrounding floodplain / watercourses	Refer to Production Facility Risk Assessment (Table 18)	3, 6				
Production / extraction of water from the GAB	Depletion of GAB water supplies Impact on GAB springs (if co-produced water extracted in close proximity)	5	Reuse PFW where possible to minimise use of other water sources Water extraction in accordance with licences and allocations Monitor well production and minimise water content where possible (when water is co-produced with oil and gas) Co-produced water volumes reported to DSD and total volumes produced are within the industry allocation specified in the Water Allocation Plan Compliance with the Water Allocation Plan and water licence conditions (e.g. regarding the Southwest Springs Zone, GAB springs and state border) Investigate reinjection of PFW to reduce net water extraction from the GAB	Minor	Unlikely	Low

5.5 Waterflood / Reinjection

The major hazards associated with water injection schemes include packer failure or loss of well integrity, injection of non-compatible waters into the aquifer and the potential for spills of saline waters and / or any chemical product that may be used for treating the water prior to injection.

Packer failures are unlikely and injection wells are routinely tested for leaks of the packer or tubulars. If the packer fails there may be little or no hazard to third parties or to the reservoir (e.g. if there are no perforations above the packer). Other downhole issues such as well casing and cementing failure are unlikely as injection pressures will be well below the pressure rating of the casing.

Quality and compatibility testing would be conducted on the injection water to ensure that there is no contamination of the aquifer / reservoir being injected into. The injection water would generally have scale inhibitor and a biocide added to condition the water. The amount added is minute in comparison to the volume of water in the reservoir with which it will be in contact. Water quality testing would be conducted with on-line monitoring to ensure consistency of injection water quality.

Reinjection activities are only undertaken in reservoirs with good containment (i.e. overlying and / or underlying aquitards). This ensures that the injection water will stay within the target formation.

Tracers (if used) are injected into the water injection well under controlled procedures by licensed contractors using a sealed system. The tracers that are typically used (e.g. tritium and iodine) are specifically used due to their safety and low cost. These types of tracers are indicated to have a negligible external radiological effect and are generally not considered to be harmful to people or animals.

The injection water would likely be transferred through new installed polyethylene, steel or composite lines that are rated and tested to meet project requirements. Water injection skids would have high-low shutdowns and be monitored by telemetry. A spill of produced formation water intended for injection would be expected to pose a relatively low hazard.

Waterflood / reinjection programs would be subject to detailed assessment and would require approval from DSD (and possibly EPA and / or DEWNR depending on injection parameters) before commencement.

Table 20: Waterflood / reinjection risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Packer failure or loss of well integrity during injection	Contamination of aquifers	6	Well contents (i.e. injected water) isolated from shallower aquifers by tubing and casing in well Regular pressure measurements undertaken to ensure well integrity is maintained (e.g. to ensure no communication between the tubing and casing) Cement bond logs run to test for poor cement bonds Integrity of the wellbore and packer are routinely tested	Moderate	Unlikely	Medium
Injection of contaminated water into the target or other aquifer zones	Aquifer or reservoir contamination	6	Frequent quality testing of injection waters Compatibility studies conducted prior to injection Filtering of water to promote efficient injection into formation On-line water quality monitoring	Minor	Unlikely	Low
Spill or leak associated with transportation of waters from the production facility to the water injection well	Localised acidification and / or salinisation of soil	6	Equipment designed and operated in accordance with relevant standards and guidelines Water injection skid equipped with shutdowns and injection monitoring New steel, polypropylene or composite piping tested and maintained to design conditions Pipeline monitored for leaks (pressure gauges and visual inspection) Produced water may be treated in a hydro-cyclone to reduce oil in water content where required Maintain register of spills / leaks Immediate clean-up and remediation if any spills or leaks occur	Minor	Unlikely	Low
Spill of radioactive waterflood tracer	Localised contamination of soil Danger to health and safety of personnel and contractors	6, 7	Radiological Safety procedures conducted by specialists hired to conduct work State controls on radiotracer substances followed Conduct of regular inspections, and regular maintenance, follow specific operating procedures for working with tracers. Ensure individuals in areas of responsibility are trained to handle events In the event of a spill or leak follow appropriate emergency response procedures	Minor	Unlikely	Low

5.6 Pipelines / Flowlines

5.6.1 Pipeline Construction

Environmental hazards associated with pipeline construction include movement of heavy vehicles, earthworks, vegetation clearance, fire, spills associated with chemical and fuel storage and waste disposal. Flooding (of the Cooper Creek or Strzelecki Creek floodplain and associated watercourses) may also need to be considered to be as a potential environmental hazard if pipeline construction is required in the vicinity of these areas.

Movement of heavy vehicles (e.g. trucks and side boom tractors) along the construction easement and access tracks is an environmental hazard as there is a possibility that vehicles may inadvertently damage vegetation or existing infrastructure, generate dust and / or compact soil if not appropriately managed. Earthworks can result in similar consequences as well as potentially disturbing sites of cultural significance and exposing soils to wind and water erosion.

The type and severity of potential consequences of earthworks is dependent, to a certain extent, on the land system in which the activities are being carried out. Disturbance of soils in some land systems, such as gibber plains and tablelands, can lead to substantial erosion by water while other systems, such as dunefields, are generally more resilient and less likely to suffer any long-term impacts from soil disturbance. Studies of seismic lines in dunefields in the Cooper Basin have indicated that natural rates of erosion on dunes were not accelerated as a result of disturbance to the soil surface (SEA 1999).

Wetlands are avoided under most circumstances when planning pipeline routes as they are often of high ecological value and sensitivity. Salt lakes are also avoided as rehabilitation is difficult to undertake and they are therefore likely to be severely scarred by pipeline construction activities. The potential consequences of specific earthwork activities on different land systems in the Cooper Basin are summarised in Table 21. Other activities along the construction easement, such as vegetation clearing, can result in loss of vegetation and fauna habitat, siltation of natural drainage lines and watercourses, destabilisation of creek crossings, weed invasion and damage to cultural heritage sites. Vegetation clearance may also impede the movement of fauna within the construction zone. Particular care is taken to ensure that minimal vegetation is cleared in Coolibah woodland during easement preparation. The easement is generally minimised (to approximately 10 m for smaller diameter flowlines) in any heavily wooded areas. Watercourse crossings are typically undertaken in dry conditions and promptly reinstated to minimise the potential for sedimentation of surface water or interruption to water flows.

The presence of an open trench during construction of buried pipelines has the potential to result in fauna entrapment and mortality. The length of time the trench is open is minimised as far as practicable, but for some pipeline installations (e.g. GRE pipe) there may be a need to keep the trench open for long periods (several weeks or more) to allow for identification and repair of any leaks that are detected during hydrostatic testing. Measures such as installation of trench plugs or escape ramps are implemented, and the trench is regularly inspected (by appropriately trained project personnel or fauna monitors where appropriate) to detect and release any trapped fauna.

A potential source of leaks and / or spills during construction is from chemical and fuel storage areas and refuelling depots associated with construction works. The primary consequence of any leak or spill is localised contamination of soil. Discharge of hydrostatic test water to ground surface is another potential source of localised soil and groundwater contamination.

The use of biocides and chemicals in hydrostatic test water is required under some circumstances to prevent internal corrosion of the pipeline. Disposal of hydrostatic test water which contains biocide or other chemicals may be into existing lined evaporation ponds (i.e. produced formation water facilities) or to specifically constructed pits sited to prevent contamination of surface or near surface waters. Test water that is free of additives may be disposed of to land adjacent to the construction zone, away from surface water or any areas where it is likely to enter waters (including groundwater).

Occurrence of flooding or fire during construction works has a number of potential consequences. For flooding these include significant soil erosion in areas that have been subject to earthworks and possibly loss of vegetation. In the case of a fire, loss of vegetation and fauna habitat and production of particulate air emissions are possible consequences.

Pipeline construction generates very little waste. Many materials such as pipe off cuts, rope spacers and timber skids can generally be reused or recycled. Excess soil / fill from pipeline trenching will be respread over pipeline and along the ROW. All remaining waste materials are removed from the work area and disposed of at an appropriately licensed waste facility.

As discussed in Section 3.5, pipeline design and construction is undertaken in accordance with relevant standards, in particular AS 2885.

Table 21: Potential consequences associated with earthworks in various Cooper Basin landforms

Land form	Activity / Event			
	Grading	**Trenching and backfilling**	**Excavation / digging (e.g. borrow pits)**	**Soil stockpiling**
Dunefields	Soil erosion (wind and water erosion) Disturbance to cultural heritage sites (dunefields near waterholes are typically of high cultural significance)	Soil erosion (wind and water erosion) Disturbance to cultural heritage sites (dunefields near waterholes are typically of high cultural significance) Inversion of the soil profile Impeded fauna movement	Soil erosion (wind and water erosion) Disturbance to cultural heritage sites (dunefields near waterholes are typically of high cultural significance) Inversion of the soil profile	Soil erosion (wind erosion) Inversion of the soil profile
Floodplains and wetlands (Note: Wetlands are generally avoided)	Soil erosion (wind and water) Soil compaction Disturbance of natural drainage systems (construction easement typically restricted to less than 10 m at creek crossings on small diameter pipelines) Disturbance to cultural heritage sites (generally low density of sites in floodplains)	Disturbance of natural drainage systems (construction easement typically restricted to less than 10 m at creek crossings on smaller diameter pipelines) Inversion of the soil profile Disturbance to cultural heritage sites (generally low density of sites in floodplains) Impeded fauna movement	Soil erosion (wind and water) Disturbance of natural drainage systems Disturbance to cultural heritage sites (generally low density of sites in floodplains)	Disturbance of natural drainage systems (e.g. siltation) Soil erosion (wind and water)
Gibber plains	N/A	Soil erosion (particularly susceptible to water erosion e.g. severe gullying) Disturbance of natural drainage systems (e.g. siltation) Inversion of the soil profile Disturbance to cultural heritage sites Impeded fauna movement	Soil erosion (particularly susceptible to water erosion e.g. severe gullying) Disturbance of natural drainage systems (e.g. siltation) Inversion of the soil profile Disturbance to cultural heritage sites	Soil erosion (wind and water) Disturbance of natural drainage systems Inversion of the soil profile
Salt lakes	N/A	N/A	N/A	N/A
Tablelands	N/A	Soil erosion (particularly susceptible to water erosion e.g. severe gullying) Soil compaction Disturbance of natural drainage systems (e.g. siltation) Inversion of the soil profile Disturbance to cultural heritage sites Impeded fauna movement	N/A	Soil erosion (wind and water) Disturbance of natural drainage systems Inversion of the soil profile

N/A – not applicable as the activity is not carried out in this land system.

5.6.2 Pipeline Operation

The primary hazard associated with the pipeline operation is the loss of containment of oil or natural gas. Accidental spills and leaks may result from pipeline failure, which may be caused by:

- heavy vehicle traffic (e.g. collision with an above ground pipeline)
- corrosion of steel pipelines (external or internal)
- natural events which stress the pipeline (e.g. flood / earthquake)
- overpressure
- external interference
- pipeline material defects or construction faults.

As discussed in Section 3.5, pipeline operation is approached in a systematic manner over the life of the assets and is carried out in accordance with relevant standards, in particular AS 2885, the Pipeline Integrity Management Plan (PIMP) and Pipeline Management System (PMS). The Safety Management Study process under AS 2885.1 is used to identify threats to the pipeline and identify controls to reduce the risk of a pipeline failure to As Low as Reasonably Practicable, and is regularly reviewed in accordance with AS 2885 requirements.

Regular inspection of pipelines and monitoring of the performance of cathodic protection devices on buried steel pipelines is undertaken, to ensure that protection levels are adequate. Cathodic protection systems are compliant to AS 2832.1.

Corrosion protection on composite pipelines is typically only required for any metal connectors or components, but may also be required for buried end connectors when connecting to an external non-metallic piping system. In addition, connectors are coated to reduce the likelihood of external corrosion. Composite pipelines may also have a HDPE inner layer which provides corrosion resistance that is suitable for the normal chemical and temperature ranges encountered in oil and gas applications. Regular inspection of the corrosion protection devices is undertaken to ensure adequate protection.

Composite pipe is a stress / time dependent material and degradation can occur over time. Testing of material coupons is used to provide data on changes in material properties which may affect remaining life. Degradation of composite pipe can also occur with long term exposure to UV. External protection is provided in areas of exposure to UV and regularly inspected.

Major pipelines in the Cooper Basin are also regularly pigged to remove water and sludge that accumulates at low points within pipelines. Sludge often supports sulphide reducing bacteria that are a significant cause of internal corrosion of pipelines in the Cooper Basin and testing is routinely carried out to detect potential for sulphide reducing bacteria.

Above ground pipelines are regularly inspected to ensure that contact between soil and steel pipe and fittings is minimised. Where contact occurs (e.g. as a result of failure of pipe supports) ‘long line corrosion cells’ can potentially form and result in rapid pitting of the pipe and possible pipeline rupture.

Damage to pipelines as a result of external interference by Beach or third parties has the potential to result in a leak or rupture. The likelihood of such damage occurring is relatively low due to the remoteness of the Cooper Basin, the nature of the pastoral activities that occur and the processes in place (communication, Notice of Entry) to manage petroleum industry activities. Marker signage is installed for all pipelines, and external interference protection measures, including physical and procedural controls (such as increased depth of burial and increased use of marker signs) are used to mitigate threats identified in the AS 2885 Safety Management Study.

A gas or oil leak from a flowline may result in the release of gas to the atmosphere or contamination of soil or groundwater respectively. The potential exists for oil and condensate to be spilt at any point between an oil well and production facility. Many of the consequences associated with oil spills and leaks, such as vegetation loss, soil disturbance and drainage alteration can be minimised if spills or leaks do occur. However, this largely depends on the land system involved.

In dry environments, such as dunefields and gibber, the consequences associated with an oil spill or leak are mainly localised, as oil is easier to contain and recover in dry conditions. Where shallow groundwater is present in these environments it is often saline, which means that if a spill reaches shallow groundwater, the risk of impacts to groundwater dependent ecosystems or groundwater users is reduced. However, the environmental consequences of oil spills in more sensitive wet environments, like the Cooper and Strzelecki Creeks and surrounding floodplains and wetlands, are potentially significant. Of primary concern are flood conditions that can potentially spread oil over large distances and throughout highly sensitive ecosystems. Additional pipeline protection measures are implemented in these areas in accordance with AS 2885 (e.g. increased wall thickness, increased depth of burial, monitoring and leak detection systems). Emergency response plans will be in place and will deal with the response to a spill or leak to surface water.

Fire and explosion are also possible hazards associated with pipeline operation. A fire or explosion along a pipeline can pose a danger to personnel, contractors and possibly the public and can potentially produce significant amounts of atmospheric emissions. The risk is reduced to As Low As Reasonably Practical (ALARP) by management measures. The potential for explosion or fire associated with oil pipelines is considered low due to the low volatility and flammability of oil and therefore the potential severity of the consequence minor. The potential for explosion or fire associated with gas pipelines are considered low as all gas pipelines are designed, installed and operated in compliance with AS 2885 (i.e. with appropriate design features and management measures including wall thickness, depth of burial, pipeline marker signs, cathodic protection, shutdown valves and monitoring, testing, maintenance and inspection procedures).

Table 22: Pipeline construction risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Earthworks (e.g. clearing of construction easement, grading, trenching and backfilling)	Injury or death of fauna / stock in construction zone Long term disturbance to natural drainage patterns Significant damage to infrastructure Soil erosion and siltation of watercourses Inversion of soil profile Dust generation Soil compaction of the easement Temporary disruption to land use (e.g. grazing and recreation) Impeded fauna movement through construction zone Damage to native vegetation Temporary loss of visual amenity Disruption to land use (e.g. grazing and recreation)	1, 2, 3, 5, 8, 10	Minimise environmental impact by appropriate route selection to minimise or avoid sensitive land systems, vegetation and cultural heritage sites Use existing easements where possible Liaise with landowners regarding notification and management of works and site issues including livestock management Stockpile topsoil separately from trench spoil (subsoil) for use in reinstatement Undertake watercourse crossings in dry conditions where possible and complete within the shortest period practicable If crossing flowing watercourses, locate stockpiles (e.g. excavated bank material) and HDD sites (if HDD used) in bunded areas away from watercourse banks Implement erosion and sediment control measures where required Implement dust control measures where required, using water efficient or waterless techniques where feasible Observe procedures and guidelines for the identification, management and protection of cultural heritage sites, including obtaining heritage clearances by Native Title groups Minimise vegetation disturbance, and plan construction to avoid vegetated areas Avoid significant or priority[11] vegetation and ensure proposed routes have been scouted for significant vegetation and wildlife habitats by appropriately trained and experienced personnel Where possible trim vegetation rather than clearing Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations Minimise hazard to fauna by leaving trenched areas open for as little time as possible Utilise trench plugs and fauna ladders to facilitate movement of fauna out of and across trench Regularly inspect open trenches and excavations to detect and release trapped fauna	Minor	Unlikely	Low
	Disturbance to cultural heritage sites Introduction and / or spread of weeds	4, 9		Moderate	Possible	Medium

[11]Refer to Appendix 3: Beach Energy Priority Plant List.

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Backfill trenches or excavations using excavated subsoil (i.e. leave topsoil stockpiles undisturbed for reinstatement) Reinstate construction areas including construction easement as soon as possible Rip areas of compacted soil (except on gibber plains and tableland environments) Respread topsoil Manage and rehabilitate borrow pits in accordance with SEO requirements Restore natural contours to minimise consequences to natural drainage patterns Stockpile cleared vegetation and respread following construction to facilitate revegetation Remove waste to minimise visual impact			
Movement of heavy machinery and vehicles along construction easement and access tracks	Dust generation Soil compaction Soil erosion Damage to native vegetation Injury or death of native fauna Disturbance to cultural heritage sites Introduction and / or spread of weeds Damage to infrastructure Disruption to land use (e.g. grazing and recreation) Increased public access to remote areas	1, 2, 3, 4, 8, 9	Use existing cleared areas for laydowns and turn-arounds. Liaise with landowners regarding notification and management of works and site issues including livestock management Implement dust control measures where required, using water efficient or waterless techniques where feasible Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations Drive only on access tracks and construction easement Rip areas of compacted soil (not on gibber plains and tablelands)	Minor	Unlikely	Low
Spills or leaks associated with chemical and fuel storage and handling	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat	3, 6	See *Completions and Workovers* section in Table 17 for general controls related to spills or leaks	Minor	Unlikely	Low
Ignition of fire along construction easement	Disturbance to cultural heritage sites Loss of vegetation and fauna habitat Release of particulate emissions to the atmosphere Disruption to land use (e.g. grazing and recreation)	3, 7, 8, 9	Smoking only permitted in a designated safe areas away from equipment or activity Personnel are trained to supervise and instruct individuals entering area to conduct work Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works Appropriate fire fighting equipment on-site	Moderate	Remote	Low

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Petrol vehicles to be excluded from construction sites Emergency response procedures should contain bushfire scenario Safety, testing, maintenance and inspection procedures are implemented Immediate clean-up and remediation to minimise contamination to soil / water Maintenance of firebreaks surrounding key infrastructure.			
Disposal of hydrotest water	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of or damage to vegetation and fauna habitat as a result of soil or water contamination Soil erosion / scouring	2, 3, 6	Use of biocides and toxic chemicals are kept to a minimum and if biocides are necessary UV-degradable or biodegradable biocides (e.g. THPS) shall be used where practicable Disposal of hydrostatic test water which contains biocide and other chemicals may be into existing lined and fenced ponds, or to specifically constructed pits sited to prevent the contamination or surface or near surface waters Assessment of hydrotest water prior to disposal to land to ensure that its quality is consistent with relevant guidelines (e.g. ANZECC and EPA) for the disposal site. Discharged water not allowed to flow beyond the intended receiving area or into any watercourses or areas where it may enter surface water Use of aerators / spray bars, geotextile etc. to prevent soil erosion at discharge point where uncontaminated hydrotest water is released to land	Negligible	Unlikely	Low

Table 23: Pipeline operation risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Explosion or fire along a pipeline	Contamination of soil, shallow groundwater and / or surface water Atmospheric pollution Loss of vegetation and fauna habitat Disruption to land use (e.g. grazing) Danger to health and safety of personnel, contractors and possibly the public	3, 6, 7, 8	All pipelines are designed, constructed, operated and maintained in accordance with relevant standards[12] including installation of appropriate warning signage and appropriate external interference protection measures Composite pipelines are buried with increased depth of cover however transitions will be located above ground and protected by steel bollards Separation distances and exclusion zones are maintained Pipeline proximity fire breaks are cleared and maintained Safety, testing, maintenance and inspection procedures are implemented Establishment of appropriate emergency / spill response procedures for explosion or fire Personnel are trained to supervise and instruct individuals entering area to conduct work Safe smoking areas away from equipment or activity	Major	Remote	Medium
Spill or leak associated with pipeline failure to land	Contamination of soil, shallow groundwater and / or surface water Damage to vegetation and habitat Disruption to land use (e.g. grazing) Access to contaminants by stock and wildlife	3, 6	All pipelines are designed, constructed, operated and maintained in accordance with relevant standards[12] including installation of appropriate warning signage and appropriate external interference protection measures Safety, testing, maintenance and inspection procedures are implemented Export lines and high pressure flowlines associated with jet pumps have pressure monitoring / shutdown in case of leak Establishment of appropriate emergency / spill response procedures for spills or leaks to soil and water Spill response equipment maintained on-site Immediate clean-up and remediation of spills to minimise contamination to soil / water Fencing of contaminated areas if threat is posed to stock or wildlife Maintain a register of spills and / or leaks and implement corrective actions based on analysis of spill events	Minor	Unlikely	Low

[12] Relevant standards include AS 2885, AS 2832.1 and associated documentation/processes including Safety Management Study, Pipeline Integrity Management Plan, Pipeline Management System and Remaining Life Review

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Periodic review and exercise of response equipment and procedures to ensure preparedness			
Spill associated with pipeline failure in a watercourse	Contamination of groundwater, surface water and soil at spill site and potentially downstream Damage to vegetation and habitat at spill site and potentially downstream Access to contaminants by stock and wildlife Injury or death of native fauna Danger to health and safety of personnel, contractors and possibly the public	3, 6, 7	All pipelines are designed, constructed, operated and maintained in accordance with relevant standards[12] Flowlines in floodplain areas designed to maintain integrity during inundation Management strategies implemented for spills associated with pipeline failure including: ▪ monitoring of process parameters on SCADA ▪ surveillance patrols ▪ leak detection with remote shutdown on major pipelines and control systems to automate shutdown and isolation Additional protection provided for pipelines traversing floodplains and ephemeral creeks including avoidance of connections, increased burial depth, casing and weighting to overcome buoyancy where appropriate Safety, testing, maintenance and inspection procedures are implemented Establishment of appropriate emergency / spill response procedures for spills or leaks to soil and water Spill response equipment maintained on-site Installation of marker posts near major water courses (e.g. main Cooper Creek Channel) to gauge any pipe movement during times of flooding Immediate clean-up and remediation of spills to minimise contamination to soil / water Fencing of contaminated areas if threat is posed to stock or wildlife Maintain a register of spills and / or leaks and implement corrective actions based on analysis of spill events Periodic review and exercise of response equipment and procedures to ensure preparedness	Major	Unlikely	Medium

5.7 Road Construction and Maintenance

The major hazards associated with road construction are earthworks, vegetation clearance, chemical and fuel storage and waste disposal. Earthworks and vegetation clearance can potentially result in soil erosion, interruption of natural drainage patterns, disturbance to cultural heritage sites, introduction and spread of weeds and loss of vegetation. Waste disposal and chemical and fuel storage associated with road construction activities and mobile earthworks camps can lead to localised soil or water contamination. As indicated in Section 5.6 the type and severity of potential consequences of earthworks is dependent, to a certain extent, on the land system in which the activities are being carried out.

Hazards associated with road maintenance and operation include earthworks (i.e. grading), road watering and introduction of construction material (e.g. fill). Earthworks, including the construction of borrow pits, can potentially disturb natural drainage patterns, introduce or spread weeds, lead to soil erosion and result in the alteration of drainage lines or lead to the capture of water which in turn may attract animals and lead to an alteration in grazing patterns. A recent review of borrow pits in the Cooper Basin (Jacobs SKM 2014) highlighted water retention in borrow pits and the associated indirect impacts of increased grazing and predator pressure as an issue of particular concern. As discussed in Section 5.4, the Native Vegetation Act and Pastoral Land Management and Conservation Act place some approval requirements on pastoral landholders regarding approval of new waterpoints which may be relevant for borrow pits that retain water for long periods.

Introduction of fill material can also result in alteration of drainage patterns and possibly introduction and / or spread of weeds. The presence of roads can also increase the ease of access by third parties to previously inaccessible sites, which has been observed to increase impacts from grazing and tourism visitation (Gillen and Reid 2013).

Public roads will be maintained where impacted by Beach activities to minimise consequences on other public road users.

There are few hazards associated with road abandonment. Hazards include earthworks (i.e. ripping) and removal of road construction material (e.g. clay). Ripping can lead to soil erosion and alteration of drainage patterns. Disposal of road construction material may potentially spread weeds or alter drainage patterns and vegetation cover at the disposal site.

Table 24: Road construction and maintenance risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Earthworks and physical presence of road	Injury or death of fauna / stock in construction zone Long term disturbance to natural drainage patterns Significant damage to third party infrastructure Soil erosion and siltation of watercourses Inversion of soil profile Dust generation Soil compaction Impeded fauna movement through construction zone Damage to native vegetation during construction Temporary loss of visual amenity Temporary disruption to land use (e.g. grazing and recreation) Damage to vegetation and habitats from increased access by third parties (grazing, visitor impact)	1, 2, 3, 4, 5, 8, 9	Use existing roads and tracks where possible Minimise impact on the environment by appropriate route selection to minimise or avoid sensitive land systems, vegetation and cultural heritage sites or areas of high biological significance Observe procedures and guidelines for the identification, management and protection of cultural heritage sites including heritage clearances by Native Title groups Design and construct road with drainage features (e.g. culverts and offtakes) that avoid disturbance to natural drainage and minimise erosion and sedimentation Undertake appropriate planning and construction for roads in floodplains and watercourses to avoid disturbance to natural drainage patterns. This may include: ▪ construction of roads at (or not significantly above) the natural surface level as a minimum standard ▪ hydrological assessment of proposed roads and drainage features to ensure potential impacts are identified and addressed in the design ▪ installation of culverts or bridges across channels or flow paths to ensure flows are maintained ▪ installation of 'fish passages' to enable passage of fish and other aquatic fauna where required ▪ consultation with relevant agencies (e.g. DSD, DEWNR, SAAL NRM Board) where appropriate Liaise with landowners regarding notification and management of works and site issues including livestock management Implement dust control measures where required, using water efficient or waterless techniques where feasible Minimise vegetation disturbance, and plan construction to avoid vegetated areas Avoid significant or priority[13] vegetation and ensure proposed routes have been scouted for significant vegetation and wildlife habitats by appropriately trained and experienced personnel Where possible trim vegetation rather than clearing Undertake environmental assessment and consultation with landowners and DSD where new road construction / stabilisation techniques or materials are proposed	Minor	Unlikely	Low
	Introduction and / or spread of weeds Disturbance to cultural heritage sites			Moderate	Unlikely	Medium

[13] Refer to Appendix 3: Beach Energy Priority Plant List.

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations Remove waste to minimise visual impact Install appropriate signage to deter unauthorised third party access			
Movement of heavy machinery and vehicles along road and access tracks	Dust generation Soil compaction Soil erosion Damage to native vegetation Injury or death of native fauna Disturbance to cultural heritage sites Introduction and / or spread of weeds Damage to third party infrastructure Disruption to land use (e.g. grazing and recreation)	1, 2, 3, 4, 7, 8, 9	Use existing cleared areas for laydowns and turn-arounds Liaise with landowners regarding notification and management of works and site issues including livestock management Implement dust control measures where required, using water efficient or waterless techniques where feasible Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations Drive only on access tracks and road formation Rip areas of compacted soil (not on gibber plains and tablelands) Implement traffic management measures / signage where appropriate for significant transportation movements	Minor	Unlikely	Low
Ignition of fire	Disturbance to cultural heritage sites Loss of vegetation and fauna habitat Release of particulate emissions to the atmosphere Disruption to land use (e.g. grazing and recreation) Danger to health and safety of personnel, contractors and possibly the public	1, 3, 7, 8, 9	Smoking only in safe areas away from equipment or activity Personnel are trained to supervise and instruct individuals entering area to conduct work Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works Petrol vehicles to be excluded from construction sites Emergency response procedures should contain a bushfire scenario Safety, testing, maintenance and inspection procedures are implemented	Moderate	Remote	Low
Spills or leaks associated with chemical and fuel storage and handling	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat	3, 6	See *Completions and Workovers* section in Table 17 for general controls related to spills or leaks	Minor	Unlikely	Low
Presence of borrow pits	Injury or death of stock and wildlife Soil erosion	1, 2, 3, 10	Procedures for operation and restoration of borrow pits are followed Existing unrestored borrow pits are used in preference to establishing new pits, and planning is undertaken to rationalise borrow pit establishment Reworking of pits, or construction of new pits occurs a suitable distance from existing facilities, including stock yards Pits are not to be established in locations which pose an unacceptable hazard to stock or wildlife	Minor	Possible	Medium
	Dispersal of watering points and redistribution of stock / wildlife movements resulting in inadvertent damage to vegetation and habitats			Moderate	Possible	Medium

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Where required bunds are installed to divert overland flow and prevent water ingress Borrow pits are restored to a standard consistent with the surrounding land use, in accordance with SEO requirements Reuse of borrow pits as PFW evaporation or water storage ponds where appropriate Restored pits have topsoil / overburden replaced and pit re-profiled where necessary to prevent erosion and minimise the capture of water Liaise with landholder regarding grazing management near borrow pits			
Movement of road construction material	Introduction and / or spread of weeds	4	Inspect / monitor for weeds during standard inspections of facilities and infrastructure Undertake control measures for weed outbreaks Do not import material from areas of weed / disease infestation Washdown of equipment bought in from high risk areas for weed infestation	Moderate	Unlikely	Medium
Use of roads	Dust generation Injury or death of stock and wildlife Increased public access to remote areas	1, 3, 4, 7, 8	Training, speed restrictions and appropriate signage to reduce speed and increase awareness of hazards Implementation of in-vehicle monitoring system to track and improve driving safety Radio communication between road users and designated radio call points to notify other road users of presence on road Restrictions on night driving Inspect / monitor for weeds during standard inspections Signage to prevent unauthorised access Implement dust control measures where required, using water efficient or waterless techniques where feasible	Minor	Unlikely	Low
	Introduction and / or spread of weeds			Moderate	Remote	Low
	Danger to health and safety of personnel, contractors and possibly the public			Major	Unlikely	Medium

5.8 Aircraft Landing Area

The principal hazards associated with construction of an aircraft landing area are earthworks, vegetation clearance, chemical and fuel storage and waste disposal, as discussed for road construction in Section 5.7.

The major hazards associated with operation of an aircraft landing area are the storage of fuels and the potential disruption or injury to stock or wildlife, particularly birds. Permanent airstrips are fenced to exclude stock or large fauna species.

Table 25: Aircraft landing area risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Earthworks	See *Road Construction and Maintenance* above		See *Road Construction and Maintenance* above.			
Take-off / landing of aircraft	Disturbance to landowners and the public Disturbance to stock and wildlife Injury or death of birds, stock or other wildlife	1, 3	Airstrip located to minimise disturbance to landowners and the public Gates and signage installed to restrict vehicle and personnel movement through the landing strip area Permanent airstrips fenced to exclude cattle and large fauna species Protocols implemented to ensure landing area is clear of stock or wildlife (e.g. pre-landing inspection) Bird numbers monitored and scare methods used if large numbers become established on-site	Minor	Unlikely	Low
Leaks and / or spills associated with chemical and fuel storage and handling	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat	3, 6	If refuelling facilities are required, implementation of appropriate chemical and fuel storage and handling procedures (e.g. bunding and signage) in accordance with relevant standards and guidelines, including AS 1940, EPA guideline 080/12 Bunding and Spill Management and the Australian Dangerous Goods Code (ADG) See *Completions and Workovers* section in Table 17 for general controls related to spills or leaks	Minor	Unlikely	Low

5.9 Oil Transport (by road)

The major hazard associated with the transport of oil on road networks is a leak or spill of oil or fuel (e.g. as a result of a collision or truck rollover). Many of the consequences associated with oil spills and leaks, such as vegetation loss, soil disturbance and drainage alteration, can be minimised by effective emergency response and remediation. However, this largely depends on the land system involved.

Transport personnel will comply with road rules and drive to road conditions to minimise impact on other road users.

In dry environments, such as dunefields and gibber, the consequences associated with an oil spill are mainly localised, as oil is easier to contain and recover in dry conditions. However, the environmental consequences of oil spills in more sensitive wet environments, like the Cooper and Strzelecki Creeks and surrounding floodplains and wetlands, are potentially significant. Flood conditions that can potentially spread oil over large distances and throughout highly sensitive ecosystems are of primary concern and management measures need to minimise the environmental risk in these conditions.

Other hazards associated with oil transport include potential fire hazard and encountering stock or fauna on the roads. Consequences, such as stock or fauna death and vehicle damage or accidents, can be minimised by measures such as reducing the occurrence of night travelling and speed restrictions.

Table 26: Oil transport risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Use of roads	See *Use of Roads* section in Table 24	1, 3, 4, 7, 8	See *Use of Roads* section in Table 24.			
Spill associated with transport of oil / condensate (via truck) to land	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Damage to vegetation and fauna habitat	3, 6	Transportation of chemicals, fuels and oils in accordance with ADG Code Suitably trained, experienced and licensed contractors used to transport oil Ensure roads and causeways are designed to minimise risk of vehicle accident Training and speed restrictions to reduce speed and increase awareness of hazards Vehicles maintained and serviced in accordance with manufacturer's specifications Avoid transportation movements in wet conditions Appropriate communication between trucks, other vehicles and facilities to plan safe transport movements Appropriate signage installed (e.g. at access to public roads) See *Completions and Workovers* section in Table 17 for general controls related to spills or leaks	Minor	Unlikely	Low
Spill associated with transport of oil / condensate (via truck) to watercourse / wetland	Contamination of soil, surface water and shallow groundwater Damage to vegetation and habitats Access to contaminants by stock and wildlife	3, 6	As above, plus: Install signage at creek crossings where appropriate No fording of flowing streams Removal of contaminated soil from spills in watercourses as appropriate Call signs for traffic management at and along creek crossings and roads	Major	Unlikely	Medium

5.10 Waste Management

Waste at Beach production facilities is currently transported off-site to a licensed facility for recycling or disposal. Sewage and grey water is treated in approved wastewater treatment systems on-site and treated effluent irrigated to land or to a wastewater evaporation pond. Untreated sewage may also be stored before being pumped out and trucked off-site by a licensed contractor. Concentrates from reverse osmosis (RO) or desalination are disposed to ponds (e.g. produced water ponds if volumes are suitably low relative to PFW volumes or dedicated lined ponds). There is a potential for localised contamination or salinisation of soil and groundwater as a result of leaks from the sewage treatment system or inappropriate disposal of treated effluent or RO concentrates.

Beach does not currently operate landfill sites for disposal of domestic waste in South Australia. If landfill sites were required to be developed in the future, they would be sited in a suitable, stable area, distant from watercourses or floodplain areas and approved and operated in accordance with EPA requirements, as discussed in Section 3.9.1.

Beach does not currently have a land treatment area for the bioremediation and treatment of hydrocarbon contaminated soils due to the relatively low volumes generated. In the future it is possible that Beach will need to establish a land treatment site for soil remediation, subject to necessary DSD and EPA approvals, as discussed in Section 3.9.3. A land treatment site would treat oily waste by mixing with existing soil, with the aim of breaking down oil by evaporation, photochemical processes and biological action of naturally occurring soil micro-organisms. Once hydrocarbons are broken down, soil would be transported by truck to an appropriate location for reuse or disposal.

Similarly, Beach may construct a sludge treatment plant in the future, subject to DSD and EPA approval, as discussed in Section 3.9.4. The plant would typically involve physical and chemical processes to separate hydrocarbons, water and solids for reuse or disposal.

Potential consequences of these waste management practices include contamination or salinisation of soil or groundwater and the introduction and / or spread of weeds. In the case of a landfill site consequences also include outbreaks of pests and scavenging by wildlife.

Table 27: Waste management risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Storage of waste at camps or facilities and transport to landfill	Localised contamination of soil and / or groundwater Scavenging by native and pest species Pest outbreaks Loss of visual amenity Odorous emissions	1, 3, 6, 10	EPA's Waste Hierarchy model (avoid, reduce, reuse, recycle, recover, treat, dispose) complied with and waste management undertaken with regard to *the Environment Protection (Waste to Resources) Policy 2010*. Covered bins provided for the collection and storage of wastes. All loads of rubbish are covered during transport to an approved waste facility Waste streams segregated on-site and transported to appropriately licensed facilities to maximise waste recovery, reuse and recycling Production of waste minimised by purchasing reusable, biodegradable or recyclable materials where practical Hazardous wastes handled in accordance with relevant legislation and standards Licensed contractors used for waste transport Operational sites are kept free of litter and rubbish	Minor	Unlikely	Low
Disposal and treatment of sewage	Contamination of soil, shallow groundwater and / or surface water Danger to health and safety of personnel, contractors and possibly the public Access to contaminants by stock and wildlife	3, 6, 7	Containment of all untreated sewage wastes within septic tank or treatment system Treated effluent irrigated or disposed to land or ponds in area with appropriate fencing / signage, in a location where it will not enter surface waters All wastewater disposed in accordance with the *South Australian Public Health (Wastewater) Regulations 2013* or to the satisfaction of the Department of Health) and in accordance with the *Environment Protection (Water Quality) Policy 2015*	Minor	Unlikely	Low
Disposal of reverse osmosis concentrates	Salinisation of soil, shallow groundwater and / or surface water	6	Disposal of RO concentrate to PFW pond system, provided that volumes are suitably low relative to PFW volumes and will not result in unacceptable salinity impacts in free form areas Use of lined ponds (e.g. HDPE) for disposal where appropriate	Minor	Unlikely	Low
Domestic waste disposal facility*	Contamination of soil, shallow groundwater and / or surface water Scavenging by native animals and pest species Pest outbreaks Loss of visual amenity Odorous emissions	1, 3, 6	Sited in a suitable, stable area, distant from watercourses or floodplain areas Design and operation in accordance with EPA approval requirements Undertake soil and groundwater monitoring Cover and fence site with an appropriate material to prevent the spread of rubbish from the site by wind and prevent access by stock and wildlife	Minor	Unlikely	Low

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
			Bury rubbish immediately to facilitate degradation and reduce offensive odours and aesthetic consequences Fill in waste pits if flood inundation is imminent			
Storage, treatment and disposal of contaminated soil*	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife	3, 6	Temporary storage of contaminated soil at Beach production facility in designated lined, bunded area prior to treatment or removal off-site by licensed regulated waste contractor to appropriately licensed facility for treatment or disposal Appropriate siting of land treatment site in a suitable, stable area, distant from watercourses or floodplain areas Design and operation of land treatment area in accordance with DSD / EPA requirements and relevant EPA guidelines, including the EPA Guideline *Environmental Management of On-site Remediation 2008* Ultimate reuse or disposal of treated soil consistent with the principles of the National Environment Protection Measure for contaminated sites and relevant EPA guidelines Monitoring of surrounding soil and groundwater for contaminants at least annually Fence off contaminated areas Development of remediation plans for land treatment area	Minor	Unlikely	Low
Sludge treatment*	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of vegetation and fauna habitat	3, 6	Plant and equipment designed, constructed, operated and maintained in accordance with DSD / EPA requirements and relevant standards and guidelines Appropriate areas are bunded and lined to contain spills See *Completions and Workovers* section in Table 17 for general controls related to spills or leaks	Minor	Unlikely	Low

* Landfill, land treatment area and sludge treatment activities do not currently occur but may in the future

5.11 Decommissioning / Rehabilitation

The major hazards associated with decommissioning are earthworks, movements of heavy vehicles, spills and leaks, chemical and fuel storage and waste disposal. Earthworks and vegetation clearance can potentially result in soil erosion, interruption of natural drainage patterns, disturbance to cultural heritage sites, introduction and spread of weeds and damage to vegetation, however the impacts are generally limited as earthworks are generally confined to disturbed infrastructure sites. Spills and leaks during decommissioning, waste disposal and chemical and fuel storage can lead to localised soil or water contamination.

Table 28: Decommissioning / rehabilitation risk assessment

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
Earthworks e.g. grading, ripping and backfilling	Injury or death of fauna in a construction zone Loss of visual amenity Damage to native vegetation Introduction and / or spread of weeds Disturbance to natural drainage patterns Damage to third party infrastructure Soil erosion and siltation of watercourses Inversion of soil profile Dust generation Soil compaction Disturbance to cultural heritage sites	1, 2, 3, 4, 5, 8, 9, 10	Earthworks restricted to the minimum area necessary (typically on existing, disturbed infrastructure sites) Observe procedures for location of services and infrastructure Obtain excavation permits where required Observe procedures and guidelines for the identification, management and protection of cultural heritage sites Rip areas of compacted soil (except on gibber plains and tableland environments) Respread topsoil and stockpiled vegetation Restore natural contours to minimise impacts to natural drainage patterns Minimise vegetation disturbance, and plan works to avoid vegetated areas and significant or priority[14] vegetation Stockpile any cleared vegetation and respread following works to facilitate revegetation Minimise impacts to fauna by leaving excavations open for as little time as possible Undertake vehicle and equipment washdown when operations have been undertaken in areas of known weed infestations Liaise with landowners regarding notification and management of works and site issues including livestock management	Minor	Unlikely	Low
Movement of machinery and vehicles along ROW and access tracks during rehabilitation	Dust generation Soil compaction Soil erosion Damage to native vegetation Injury or death of native fauna Disturbance to cultural heritage sites Introduction and / or spread of weeds Damage to third party infrastructure	1, 2, 3, 4, 8, 9, 10	Undertake vehicle and equipment washdown when operations have been undertaken in areas of known weed infestations Drive only on access tracks and pipeline easement Rip areas of compacted soil (not on gibber plains and tablelands)	Minor	Unlikely	Low

[14] Refer to Appendix 3: Beach Energy Priority Plant List.

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
	Disruption to land use (e.g. grazing and recreation)					
Spills and leaks associated with chemical and fuel storage and handling	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of beef production certification Loss of vegetation and fauna habitat	3, 6	See *Completions and Workovers* section in Table 17 for general controls related to spills or leaks	Minor	Unlikely	Low
Loss of containment of gas or oil (pipeline failure / pigging during decommissioning or leaks from facility equipment)	Contamination of soil, shallow groundwater and / or surface water Disruption to land use (e.g. grazing) Danger to health and safety of personnel, contractors and possibly the public Atmospheric pollution Access to contaminants by stock and wildlife Loss of vegetation and fauna habitat	3, 6, 7, 8	Abandonment programs planned to avoid or minimise hazardous situations, with controls in place to address risks Pipeline decommissioning programs planned to take into account pipeline condition and location and minimise risk of rupture or leak Establish appropriate emergency / spill response procedures for spills or leaks to soil and water Implementation of appropriate emergency / spill response procedures Periodic review and exercise of response equipment and procedures to ensure preparedness Appropriate spill containment and clean-up equipment located on-site Personnel are trained in the use of spill response equipment Immediate clean-up and remediation to minimise contamination to soil / water Fence contaminated areas if threat is posed to stock or wildlife Maintain a register of spills and / or leaks and implement corrective actions based on analysis of spill events	Minor	Unlikely	Low
Disposal of hydrotest water or water used for flushing pipelines	Contamination of soil, shallow groundwater and / or surface water Access to contaminants by stock and wildlife Loss of vegetation and fauna habitat as a result of soil or water contamination	3, 6	See *Disposal of hydrotest water* in Table 22.	Negligible	Unlikely	Low
Explosion or fire at the facility or along the ROW	Danger to health and safety of personnel, contractors and possibly the public Contamination of soil, shallow groundwater and / or surface water Atmospheric pollution (gas)	3, 6, 7, 8	Abandonment programs planned to avoid or minimise hazardous situations, with controls in place to address risks Risk assessments undertaken in line with industry best practice	Major	Remote	Medium

Activity / Event	Potential Consequences	SEO Obj	Management Strategy	Consequence	Likelihood	Residual Risk
	Loss of vegetation and fauna habitat Disruption to land use (e.g. grazing and recreation)		Hazardous area assessment and compliance with AS 3000 Earthing maintained as appropriate to prevent static charges where residual hydrocarbons may be present No smoking or safe smoking areas away from equipment or activity Operation under fire permit requirements where relevant Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works Immediate clean-up and remediation to minimise contamination to soil / water Petrol vehicles to be excluded from gas well / pipeline sites Establish appropriate emergency / spill response procedures for explosion or fire Safety, testing, maintenance and inspection procedures are implemented			
Storage of waste and disposal to licensed landfill	Scavenging by native and pest species Pest outbreaks Localised contamination of soil and / or groundwater Loss of visual amenity Odorous emissions	1, 6, 10	Refer to Table 27.	Negligible	Possible	Negligible

6 Environmental Management Framework

Production activities will be undertaken in accordance with Beach Energy's Health, Safety and Environment Management System (HSEMS) and Production Operations Safety Manual.

Health, Safety and Environment Management System

The HSEMS is a key tool in the management of Beach and associated contractors' environmental responsibilities, issues and risks. The HSEMS also provides a framework for the coordinated and consistent management of environmental issues by ensuring the:

- establishment of an environmental policy (see http://www.beachenergy.com.au/)
- identification of environmental risks and legal and other requirements relevant to the operations
- setting of appropriate environmental objectives and targets
- delineation of responsibilities
- establishment of a structure and program to implement environmental policy and achieve objectives and targets, including the development of procedures or guidelines for specific activities and education and induction programs
- facilitation of planning, control monitoring, corrective action, auditing and review of activities to ensure that the requirements and aspirations of the environmental policy are achieved.

Production Operations Manual

The Production Operations Manual (POM) is the reference manual for Beach Site Supervisors and Production Operators controlling well production operations of land wells. The POM does not replace sound production practices and should reflect industry best practice.

The purpose of the POM is to:

- illustrate the guidelines, procedures and controls required during production of oil wells
- provide sufficient information to ensure that production operations are conducted with environmentally and safety orientated procedures
- provide a guide for relevant personnel on the procedures to be followed to ensure that a consistent, thorough and uniform approach is adopted to facilitate delivery of hydrocarbon product to point of sale
- provide sufficient information to allow a Production Supervisor to supervise and monitor production operation control standards and reporting
- provide sufficient information to allow the Production operator to operate, monitor and report on production operations.

Key components of the HSEMS are discussed in the following sections.

6.1 Environmental Objectives

Environmental objectives have been developed based on the information and issues identified in this document. These objectives have been designed to provide a clear guide for the management of environmental issues and are detailed in the accompanying Statement of Environmental Objectives.

6.2 Responsibilities

Environmental management and compliance will be the responsibility of all personnel and contractors. The indicative organisation and responsibilities for personnel overseeing environmental

management are detailed in Table 29. The exact nature and title of these roles may vary and positions may be amalgamated or the responsibilities shared under a modified arrangement.

The overall responsibility for environmental compliance lies with Beach. Beach will maintain a high level of on-site supervision. The site operators and individuals will also be responsible and accountable through their conditions of employment or contract. The training of all personnel will ensure that each individual is aware of their environmental responsibility.

Table 29: Indicative roles and responsibilities

Role	Responsibility
Beach Energy Management	Licence holders Hold overall responsibility for Beach activities and environmental management Incident notification to Authorities
Beach Energy Project Managers	Responsible for co-ordinating the management of the activities, including all environmental aspects Responsible for overall implementation of HSEMS Responsible for the overseeing and fulfilling of commitments contained in EIR and SEO Overall responsibility for reporting on environmental performance and due diligence
Beach Energy Health, Safety and Environment Personnel	Oversees implementation of HSEMS, EIR and SEO Monitors the activities of construction contractors and assesses compliance with the SEO Coordinates the monitoring and audit program Environmental internal reporting and incident investigation Identification and implementation of corrective actions
Beach Energy Site Superintendents / Supervisors	Directly responsible for on-site management, including all environmental aspects Responsible for the overseeing and fulfilling of commitments contained in EIR and SEO Reports to Beach Production Manager on environmental performance and due diligence Environmental internal reporting and incident investigation Implementation of corrective actions
Beach Landholder Liaison	Landholder liaison
Contractor	Responsible for ensuring that works meet regulatory requirements and all environmental objectives contained in the SEO pertinent to production operations Directly responsible for the overseeing and fulfilling of commitments contained in relevant approvals, HSEMS, EIR and SEO Responsible for ensuring adequate resources are provided for constructing and maintaining environmental controls Inspection of work area to ensure appropriate environmental management Reporting of environmental incidents to Beach Energy Site Superintendent / Supervisor

6.3 Environmental Management Procedure

All Beach employees and contractors are responsible for ensuring compliance with the Beach Environmental Management Procedure (EMP) and associated environmental legislation. The EMP is comprised of a number of levels of documentation (including plans and procedures) that form the framework for the management of the environment in which Beach operates. The EMP covers all activities undertaken by Beach in Australia including exploration, drilling, well operations, and production.

Beach conducts periodic environmental audits to assess the appropriateness of the EMP to meeting Beach's policies, legislative requirements and environmental objective commitments and whether the EMP has been properly implemented and maintained.

6.4 Job Safety Analysis and Permit to Work

Job Safety Analysis (JSA) is a process used to identify hazards associated with a job, by assessing the risks and implementing control measures to ensure the job can be conducted in a safe manner. Beach conducts JSAs for tasks where a work procedure does not exist, where the task has not previously been conducted by the personnel assigned to the task, or where additional hazards are present.

Beach operates a single use, multi-purpose Permit to Work (PTW) system covering all areas of operations. The purpose of this PTW procedure is to summarise the Beach safety control mechanism designed to identify hazards, assess risks and to prevent accidents associated with task specific activities requiring a Permit prior to the work commencing.

6.5 Induction and Training

Prior to the start of field operations all field personnel will be required to undertake an environmental induction to ensure they understand their role in protecting the environment. This induction will be part of a general induction process which also includes safety procedures. Site specific environmental requirements will be documented in the work program or work instruction. Beach field personnel and contractors receive periodic, in-field environmental training. Beach also utilises knowledge sharing bulletins to communicate specific environmental issues.

A record of induction and attendees will be maintained.

6.6 Emergency Response and Contingency Planning

In the course of normal operations, there is always the potential for environmental incidents and accidents to occur. To manage these incidents, emergency response plans will be developed to guide actions to be taken to minimise the impacts of accidents and incidents. Emergency response plans will be reviewed and updated on a regular basis to incorporate new information arising from any incidents, near misses and hazards and emergency response simulation training sessions. These plans will also include the facilitation of fire danger season restrictions and requirements.

Emergency response drills will also be undertaken at regular intervals (e.g. every 2 years in accordance with regulations) to ensure that personnel are familiar with the plans and the types of emergencies to which they apply, and that there will be a rapid and effective response in the event of a real emergency occurring.

6.6.1 Oil Spill Response

Oil spill response procedures are captured under Beach's emergency response plan, which requires spills to be contained, reported, cleaned-up and the cause investigated and corrective and / or preventative action implemented.

Minor spills in lined bunded areas are generally treated in situ in accordance with EPA guidelines. Initial clean-up of spills outside of bunded areas usually involves removal of hydrocarbon contaminated soil to a Beach production facility for temporary storage in a designated bunded area, prior to treatment or disposal (see Section 3.9.3 for discussion).

Assessment of potentially contaminated sites where spills have occurred is undertaken in accordance with the National Environment Protection Measure for contaminated sites. Site remediation (where required) is undertaken in line with relevant EPA guidelines.

6.7 Environmental Monitoring and Audits

Ongoing monitoring and auditing of production operations are undertaken to determine whether significant environmental risks are being managed, minimised and where reasonably possible, eliminated.

Monitoring programs are designed to assess:

- compliance with regulatory requirements (particularly the Statement of Environmental Objectives)
- integrity of bunding and containment systems
- integrity of ponds and pond liners
- site contamination
- groundwater quality
- site revegetation following completion and any restoration
- potential future problems.

6.8 Incident Management, Recording and Corrective Actions

Beach and its contractors have a system in place to record environmental incidents, near misses and hazards, track the implementation and close out of corrective actions, and allow analysis of such incidents to identify areas requiring improvement. The system also provides a mechanism for recording 'reportable' incidents, as defined under the Petroleum and Geothermal Energy Act and associated regulations.

6.9 Reporting

Internal and external reporting procedures will be implemented to ensure that environmental issues and / or incidents are appropriately responded to. A key component of the internal reporting will be contractors' progress and incident reports to Beach.

External reporting (e.g. incidents, annual reports) will be carried out in accordance with Petroleum and Geothermal Energy Act requirements and the SEO. Annual reports are available for public viewing on the DSD website.

The National Pollutant Inventory (NPI) is an internet based database on emissions and transfer of substances (see Section 5.3.2). Several of Beach's production facilities exceed NPI reporting thresholds and the resultant emissions are reported at http://www.npi.gov.au/.

Where applicable, incidents causing or threatening serious or material environmental harm under the *Environmental Protection Act 1993* must be reported to the EPA in accordance with Section 83 of the Act.

As noted in Section 2.2, the Environmental Protection Act and its reporting obligation do not apply to:

- petroleum exploration activity undertaken under the Petroleum and Geothermal Energy Act
- wastes produced in the course of an activity (not being a prescribed activity of environmental significance) authorised by a licence under the Petroleum and Geothermal Energy Act when produced and disposed of to land within the area of the licence.

7 Stakeholder Consultation

The Cooper Basin is a sparsely populated and remote arid region. The local community broadly includes pastoral leaseholders, Innamincka township residents, DEWNR personnel, tourists, petroleum explorers / producers, geothermal explorers and associated contractors.

It is a requirement under the Petroleum and Geothermal Energy Regulations that information on consultation with relevant landowners, Aboriginal groups or representatives, government departments or agencies, or any other interested person or parties is outlined in an EIR.

Stakeholders in the Cooper Basin region include landholders and the local community, native title groups, regulatory agencies, industry groups and environmental organisations.

Beach is committed to maintaining effective communication and good relations with all stakeholders. Beach maintains ongoing contact with landholders and other directly affected parties in relation to all aspects of its operations in the Cooper Basin. Issues raised to date have been integrated into this report.

Extensive consultation with stakeholders was undertaken by Santos and DSD (formerly PIRSA) during production and review of the SACBJV Production and Processing Operations EIR and SEO in 2002/03 (Santos 2003). Petroleum production operations have been conducted in the region for over 40 years. Consequently, key stakeholders are aware of and understand the relevant issues associated with petroleum production operations in the Cooper Basin.

As Beach Energy's operations are very similar in nature to production activities outlined in the Santos EIR (Santos 2003) (although at a much smaller scale) it was not considered necessary to undertake another round of extensive consultation with all stakeholders during the development of the Beach Production EIR in 2003. However, consultation with key stakeholders was undertaken, including landholders directly affected by Beach's activities and relevant government agencies. Beach invited landholders in the Cooper Basin to a public meeting at Innamincka on 11 May 2015 to discuss the draft EIR and SEO which was cancelled due to limited interest.

This draft EIR and accompanying SEO were sent for comment in April 2015 to stakeholders (listed in Table 30) who are directly and indirectly impacted by Beach's production operations in the Cooper Basin. The stakeholders listed in Table 30 incorporate pastoral landholders, government agencies, the Innamincka township, native title claimants, non-government organisations (NGOs) and other petroleum and geothermal companies. Stakeholders were provided with four weeks to comment on the draft documents. Comments have been addressed in this EIR and the SEO and a summary of all comments received and responses is provided in Table 31. A number of government agencies indicated that they would provide comments during the formal Petroleum and Geothermal Energy Act consultation process.

Government agencies were formally consulted by DSD under the Petroleum and Geothermal Energy Act process following formal submission of the EIR and draft SEO in December 2015. Agency comments and Beach responses are contained in Appendix 4.

Following the receipt of agency comments, Beach undertook further liaison with the Dieri Aboriginal Corporation RNTBC and the Yandruwandha Yawarrawarrka Traditional Land Owners (Aboriginal Corporation) RNTBC to clarify for DSD the approaches to Aboriginal heritage site definition and WAC boundaries and confirm wording in the SEO.

Beach aims to continue to engage stakeholders for the duration of its production activities to ensure that all potential concerns are identified and appropriately addressed.

Table 30: Key stakeholders consulted on EIR and SEO by Beach Energy (April 2015)

Government
Department of State Development (DSD)
Environment Protection Authority (EPA)
Department of Environment, Water and Natural Resources (DEWNR)
SA Arid Lands Natural Resources Management Board
Aboriginal Affairs and Reconciliation (AAR)
Department of Planning, Transport and Infrastructure (DPTI)
Outback Communities Authority
Lake Eyre Basin Community Advisory Committee
Great Artesian Basin Coordinating Committee
Non-Government
Conservation Council of SA
Innamincka Progress Association
Wilderness Society
Yandruwandha Yawarrawarrka Traditional Land Owners (Aboriginal Corporation)
Dieri Aboriginal Corporation RNTBC
South Australian Chamber of Mines and Energy
Landholders
Bollards Lagoon
Clifton Hills
Gidgealpa
Innamincka
Lindon
Merty Merty
Mungeranie
Mulka
Innamincka and Strzelecki Regional Reserves
Industry
Clean Energy Australasia Pty Ltd
Geodynamics Ltd
Santos Ltd
Epic Energy Pty Ltd
APA Group
Senex Energy Ltd
Drillsearch Energy Ltd
Strike Energy Ltd
Cooper Energy Ltd

Table 31: Summary of issues raised during stakeholder consultation undertaken by Beach Energy (April 2015)

Stakeholder	Issue / Comment	Response
DEWNR	Need to ensure close liaison with the Senior Ranger, Innamincka regarding road construction and rehabilitation and signage for public safety	Noted
AAR	Presence of registered sites in Beach licence areas (maps provided) and potential for unregistered sites	Noted
	Obligations under Aboriginal Heritage Act including authorisations for site disturbance and reporting	Noted
EPA	Reporting under Section 83A	Reference added
	Compliance with *Environment Protection (Water Quality) Policy 2003* and *EPA Guideline 080/12 Bunding and Spill Management (August 2012)*	Noted. Referred to in EIR and SEO; additional references added
	Contaminated soil treatment / soil remediation areas – take into account EPA guidelines and factors for design	Noted. Factors would be addressed in activity specific information provided with any proposal for a land treatment area
	Risk assessment initial risk levels and controls	EIR details the final or residual risk with controls in place.
	ALARP vs 'as far as reasonably practicable' principles and treatment of 'low' categorised risks in risk assessment	ALARP is standard across the industry and generally considered to be equivalent to 'as far as reasonably practicable' and consistent with the objectives of the PGE Act. Statement that 'low' categorised risks can be acceptable is consistent with PGE Act requirements to 'reduce environmental damage as far as reasonably practicable' and 'eliminate as far as reasonably practicable risk of significant long term environmental damage'
	Correlation of consequence criteria in risk assessment and definition of 'environmental harm' in Environment Protection Act (EP Act)	Criteria do not align directly with definitions of material and serious environmental harm in the EP Act
	Level of detail in risk assessment (high level globalised format) and specifics of hazards, causes, pre-control risk assessment, hierarchy of controls, abating causes vs consequences specific controls, performance of controls, specific risk assessment tools and techniques	EIR presents a deliberately high level and globalised risk assessment for the evaluation of potential environmental impacts. Approach is consistent with risk assessments in other EIRs approved under the PGE Act. Requirement for more specific and detailed risk assessment and management is addressed elsewhere in the PGE Act framework (e.g. Regulation 16 (Operator Assessment Factors) and Regulation 20 (Activity Notification)) and in relevant standards that apply to Beach operations (e.g. AS2885: *Pipelines – gas and liquid petroleum*). This level of detail is not considered necessary or appropriate for the purposes of an EIR.
	One to one relationship between SEOs and EIR risk assessment and traceability between SEO and EIR.	SEOs do not generally have a one-to-one relationship with the EIR risk assessment and are intended to provide higher level objectives and assessment criteria. Controls in the risk assessment are cross-checked with the SEO to ensure they are adequately captured – some directly, many with a broader statement. Cross-references to relevant SEO objectives have been added in the EIR risk assessment.
	Wording in SEO footnotes regarding assessment of compliance taking into account timing of remediation – EPA does not agree that non-complying activities or outcomes 'should not be considered a non-compliance (provided that remediation is planned and undertaken in a timely manner)'	Wording not intended to imply that non-complying activities or outcomes should not be considered a non-compliance; rather that compliance for some issues, particularly erosion, may not necessarily be able to be assessed at a single point in time. Footnotes removed and wording condensed into the soil assessment 'Guide' column for clarity.

Stakeholder	Issue / Comment	Response
	Location, design and operation of production facilities (including ponds) in compliance with the requirements of the *Environment Protection (Water Quality) Policy 2003*, and by having regard to the *EPA Guideline 509/14 Wastewater lagoon construction*.	Noted. Referred to in EIR and SEO; additional references added to SEO.
	Terms 'significant' and 'long term' used in SEO in relation to contamination but not clearly defined	Terms removed and replaced by reference to 'unacceptable risk to human health or the environment, as determined by an assessment in accordance with the NEPM[15], taking into account current and post-activity land uses'
	Waste management objectives can be achieved by compliance with the requirements of *the Environment Protection (Waste to Resources) Policy 2010.* Disposal of waste material such as paper, cardboard and food scraps at itinerant camp sites can be by burial (at an appropriate location and depth), covering and compaction	Noted
	Siting, construction and operation of ponds in line with the *EPA Guideline 509/14 Wastewater lagoon construction*	Added reference in SEO to siting, constructing and operating ponds with regard to *EPA Guideline 509/14 Wastewater lagoon construction.*
	Awareness of requirements under the *Environment Protection (Noise) Policy 2007* in the case of operations in close proximity to potential sensitive receivers	Noted
	Obligation to report emissions to the National Pollutant Inventory (NPI)	Added reference in SEO (also covered in EIR)
	Continuous improvement program as a more effective way of demonstrating compliance with Goal 8.1. Should compare data from year to year to "identify and implement strategies to minimise volumes".	Added reference to SEO regarding comparing data from year to year to identify and implement strategies to minimise volumes if needed
	'Compliance with relevant legislation regarding air quality' includes the *Environment Protection (Air Quality) Policy 1994*	Noted
	EPA is supportive of dust management and control actions and suggests both waterless and water efficient techniques be utilised	Noted

Note: Wording referred to in some of these responses has changed in the final version of the EIR and SEO as a result of formal consultation undertaken following formal submission of the documents in December 2015. See Appendix 4.

[15] *National Environment Protection (Assessment of Site Contamination) Measure (1999)* amended in 2013

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9 Abbreviations and Glossary

AAL	Associated Activities Licence
ADG Code	Australian Dangerous Goods Code
ALARP	As Low as Reasonably Practical
ANZECC	Australia and New Zealand Environment and Conservation Council
AS	Australian Standard
bbls	barrels (1 barrel = 159 litres)
bpd	barrels per day
BoM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
CASA	Civil Aviation Safety Authority
CO_2	carbon dioxide
DEH	Department for Environment and Heritage (now DEWNR)
DoE	Department of the Environment (Commonwealth) (Note: Name changed to Department of the Environment and Energy in July 2016)
DMITRE	Department of Manufacturing, Innovation, Trade, Resources and Energy (now DSD)
DEWNR	Department of Environment, Water and Natural Resources
DPTI	Department of Planning, Transport and Infrastructure
DSD	Department of State Development
EIR	Environmental Impact Report prepared in accordance with Section 97 of the *Petroleum and Geothermal Energy Act 2000* and Regulation 10
EMS	Environmental Management System
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESP	Electric submersible pump
EPT	Extended production testing
GAB	Great Artesian Basin
GRE	glass reinforced epoxy
ha	hectare
H_2S	hydrogen sulphide
HDD	horizontal directional drilling
HDPE	high density polyethylene
hydrotest	hydrostatic testing
ISO	International Standards Organisation
JAMBA	Japan-Australia Migratory Bird Agreement
JSA	Job Safety Analysis
km	kilometre
km^2	square kilometres
LTU	Land Treatment Unit
mg/L	milligrams per litre
MMSCFD	million standard cubic feet per day
NDT	non-destructive testing
NGER	*National Greenhouse and Energy Reporting Act 2007* (Cth)
NPI	National Pollutant Inventory
NPWS	National Parks and Wildlife Service
PAH	polycyclic aromatic hydrocarbon

PEL	Petroleum Exploration Licence
PIMP	Pipeline Integrity Management Plan
PFW	produced formation water
PGE Act	*Petroleum and Geothermal Energy Act 2000*
pigging	use of pipeline inspection gauges or 'pigs' to perform various maintenance operations on a pipeline, including cleaning and inspecting the pipeline
PIRSA	Primary Industries and Resources, South Australia (now DSD)
PMS	Pipeline Management System
PPL	Petroleum Production Licence
PRL	Petroleum Retention Licence
psi	pounds per square inch
PSV	pressure safety valve
PTW	Permit to Work
QA/QC	Quality Assurance / Quality Control
RFDS	Royal Flying Doctor Service
ROW	Right of way
SACBJV	South Australian Cooper Basin Joint Venture
SCADA	Supervisory control and data acquisition
SEB	Significant environmental benefit
SEO	Statement of Environmental Objectives prepared in accordance with the *Petroleum and Geothermal Energy Act 2000*
SFL	Special Facilities Licence
slugcatcher	the unit in which slugs (a quantity of gas or liquid) at the outlet of pipelines are collected or caught
SMS	Safety Management Study
THPS	TetrakisHydroxymethylPhosphonium Sulfate (a biocide)
TPH	total petroleum hydrocarbons
waterflood	injection of water back into the formation to maintain the pressure in the formation and improve the sweep efficiency, thus improving oil recovery

Appendix 1

Land Systems of North East South Australia

Table A1-1: Land Systems of North East South Australia

Land System	Land form	Description
Blanche	Salt lakes	Saltlake country often with pale dunes on lake margins. Lake margins of Bladder Saltbush and Samphire; Cobbler Desert with Nitrebush, Samphire, Native Myrtle and Canegrass.
Bloodwood	Dunefields Gibber	Scattered dunes and sand plains interspersed with gibber gravel flats typical of south eastern Cordillo Downs. Red irregular shaped sand dunes with Sandhill Spider-flower, Sandhill Wattle and Sandhill Canegrass; sandplains with Bloodwood and Lobed Spinifex, plains with fine gibber gravel, Mitchell grass, Neverfail and herbs.
Collina	Dunefields Salt Lakes	Highly eroded and saline dunefield, of truncated parabolic dunes adjacent and north of the Lake Callabonna, Blanche, Gregory complex with predominantly Nitrebush dunes with broad saline flats and small plains and many small saline depressions.
Cooper	Floodplains Wetlands Dunefields	Channels, lakes, swamps and crabhole flats of Cooper Creek floodplain. Main channels with Coolibah, River Red Gum (upstream channels), Beantree, River Cooba, River Emubush, Broughton Willow and Lignum; swamps with Queensland Bluebush, Canegrass, Old Man Saltbush, Samphire and Lignum; lakes lined with Coolibah, River Couch and rushes; crabhole flats with Copperburrs and herbs; pale dunes and sandplains with Whitewood / Sandhill Wattle and Sandhill Canegrass; red longitudinal dunes with Sandhill Wattle and Sandhill Canegrass; interdune flats with variable soils and vegetation.
Diamantina	Floodplains Wetlands Dunefields	Channels and floodplains of Diamantina River. Land units as for Cooper land system; includes the intricately braided channels of Goyder Lagoon with Lignum / Broughton Willow / Queensland Bluebush and Canegrass.
Eulpa	Dunefields	Dunefield in the north east corner of the district on Cordillo Downs. Sand dunes with Sandhill Canegrass and scattered Sandhill Wattle; interdune flats with Copperburrs, Neverfail and annual grasses.
Hope (formerly Strzelecki)	Dunefields	Dunefields of Strzelecki Desert in the south east of the district. Red dunes with Whitewood, Mulga, Sandhill Wattle, Sandhill Canegrass and Lobed Spinifex; sandy interdune flats with Colony Wattle, Straggly Corkbark over Copperburrs and annual grasses; clay swales with Mitchell Grass, Neverfail and Plate Grass.
Jeljendi	Dunefield	Long high dunes of the eastern Simpson Desert with Sandhill Wattle and Waxy Wattle over Sandhill Canegrass and Lobed Spinifex. Alluvial floodouts with Coolibah, Queensland Bluebush, Lignum and Old Man Saltbush; main channels with Coolibah, Broughton Willow and River Cooba.
Kachumba	Floodplains	Alluvial outwash plains and channels of Kachumba and Rainbow Plains on Cordillo Downs. Alluvial plains with Canegrass, Queensland Bluebush and Lignum with Native Millet and Copperburrs; creeklines with River Red Gum
Ketietoonga	Dunefields	Dunefields, swamps and lakes of Pandie Pandie, western Cordillo Downs and northern Innamincka. Long red dunes with Lobed Spinifex, Sandhill Canegrass and scattered Sandhill Wattle and Narrowleaf Hopbush; variable interdune flats with Blackbush, Starbush and Neverfail on clay flats and Lobed Spinifex on sandy flats; swamps with Canegrass and Lignum; lakes fringed with Samphire and Copperburrs on lake beds.
Koonchera	Gibber Dunefields	Gently undulating gibber plains with Mitchell grass, Katoora and Bladder Saltbush. Run on depressions and swamps with Queensland Bluebush, Cottonbush, Canegrass and Neverfail; scattered long red sand dunes with Sandhill Canegrass and Desert Cynanchum; drainage lines with Coolibah, Plumbush, River Emubush and River Cooba.
Lamamour	Tablelands Gibber	Gibber low hills and tableland of Lamamour Plateau on Cordillo Downs. Low hills and undulating plains with Barley and Curly Mitchell Grass, Neverfail and Common Bottlewashers; creeks with River Red Gum and Red Mulga; rocky hills and mesas with Deadfinish and Silvertails.
Marqualpie	Dunefields	Jumbled dunes, sandplains, channels and swampy flats abutting tableland country on Cordillo Downs and Innamincka. Red dunes with Sandhill Wattle, Sandhill Spider flower and Rattlepods over dense Spinifex; a variety of flats with Lignum, Canegrass, Queensland Bluebush, Neverfail, Mitchell Grass and Coolibah on the channels and deeper depressions; sandplains with Mulga, Deadfinish and Bloodwood over Woolybutt, Spinifex and annual grasses.
Merninie	Tableland Gibber	Gibber tableland and mesas of eastern Innamincka. Tableland and low hills with Mitchell Grass, Neverfail and Copperburrs; mesas with Emubushes, Gidgee and Mulga over Bladder Saltbush; drainage lines with Red Mulga, Gidgee and River Red Gum; alluvial plains with Mitchell Grass, Copperburrs and forbs.

Land System	Land form	Description
Mulligan	Floodplains Wetlands Dunefields	Floodplains of Mulligan River which enters South Australia from Queensland on Alton Downs and flows south to Goyder Lagoon on Clifton Hills. Channels with Coolibah, Broughton Willow, River Cooba, Beantree and Lignum; floodout flats with Old Man Saltbush, Cottonbush and Queensland Bluebush; red dunes with Lobed Spinifex, Sandhill Canegrass, Sandhill Wattle and Sandplain Wattle.
Mumpie	Tablelands	Undulating gibber tableland country. Tableland with gilgais supporting Barley and Curly Mitchell Grass, Cottonbush, Samphire, Bladder Saltbush, Neverfail and Bindyis; mesas with scattered Mulga and low Bluebush; larger creeks with River Red Gum, Coolibah, Broughton Willow and River Cooba; minor creeks with Deadfinish and Plumbush.
Simpson	Dunefield	Active longitudinal dunes running generally north south. Sandhills are dominated by Sandhill Canegrass with scattered Mulga, Horse Mulga, Marpoo, Needlebush, Hopbush and Cassias; dune swales support Spinifex with Sandhill Wattle, Sandplain Wattle and various shrubs.
Strzelecki	Dunefield	Dune fields of Strzelecki Desert in the south east of the district. Red dunes with Whitewood, Mulga, Sandhill Wattle, Sandhill Canegrass and Lobed Spinifex; sandy interdune flats with Colony Wattle, Straggly Corkbark over Copperburrs and annual grasses; clay swales with Mitchell Grass, Neverfail and Plate Grass.
Sturts	Gibber plains Tablelands	Southern parts of Sturts Stony Desert with gibber downs and scattered red dunes. Lake Howitt and other saline lakes; the mesa jump ups around Mungerannie Gap; undulating gibber plains with gilgais with Neverfail, Mitchell Grass, Cottonbush, scattered Lignum and Canegrass swamps; sandplains with Bladder Saltbush, Mitchell Grass and Katoora; mesas with Deadfinish, low Bluebush, Blackbush and Shrubby Twinleaf; dunes with Sandhill Wattle overS and Sandhill Canegrass.
Tingana (formerly Della or Strzelecki)	Dunefield	Dune Fields of Strzelecki Desert in the south east of the district. Red dunes with Whitewood, Mulga, Sandhill Wattle, Sandhill Canegrass and Lobed Spinifex; sandy interdune flats with Colony Wattle, Straggly Corkbark over Copperburrs and annual grasses; clay swales with Mitchell Grass, Neverfail and Plate Grass.
Tirari	Dunefields Floodplains	Sandhills and flats of the Tirari Desert east of Lake Eyre often known as Peachawarinna country. Includes channels and floodplains of the lower Cooper, Warburton and Kalakoopah Creeks; dunes with Sandhill Canegrass, Desert Cynanchum and scattered Sandhill Wattle; variable flats with Starbush, low Bluebush and annual grasses; channels with Coolibah and scattered Nitrebush, Goosefoot swamps; saltlakes and claypans with Samphire.
Warburton	Floodplains Dunefields	Channels, floodplain and associated sand dunes of Warburton Creek. Channels with Coolibah, Broughton Willow, River Cooba and Lignum; swamps with Queensland Bluebush, Old Man Saltbush and Lignum; sand dunes with Canegrass, Desert Cynachium and Sandhill Wattle.
Wirringina	Dunefields Salt lakes	Red sandplains, dunes and sand accumulations on stony country. Salt lakes including Lake Harry; sand plains and dunes with Needlewood, Sandhill Wattle, Sandhill Canegrass and Starbush; saltlakes with samphire, Tangled Poverty Bush and Water Weed; kopi lunettes with Blackbush, Bladder Saltbush and Tates Bindyi; creeks with Coolibah, River Cooba and Old Man Saltbush.

Appendix 2

Threatened Species Recorded in the Region

Table A2-1: Listed plant species recorded or predicted in the area[1]

Species	Common Name	Conservation Status[2]	
		AUS	SA
*Acacia carneorum**	Needle Wattle	V	V
Acacia confluens	Arkaroola Wattle		V
Acacia georginae	Georgina Gidgee		R
Acacia loderi	Nealie		R
*Acacia menzelii**	Menzel's Wattle	V	V
*Acacia peuce**	Waddy, Waddi, Waddy-wood, Birdsville Wattle	V	
Acacia pickardii	Pickard's Wattle	V	R
Acacia tenuissima	Slender Wattle		R
Atriplex eichleri	Eichler's Saltbush		R
Atriplex kochiana	Koch's Saltbush		V
Austrostipa pilata	Prickly Spear-grass		V
Bergia occultipetala			V
Brachyscome eriogona			R
Bulbostylis turbinata			R
Calandrinia stagnensis			R
Callitriche sonderi	Matted Water Starwort		R
*Codonocarpus pyramidalis**	Slender Bell-fruit, Camel Poison	V	E
Cyperus bifax	Downs Flat-sedge		R
Cyperus concinnus			R
Cyperus dactylotes			V
Cyperus nervulosus			R
Eleocharis papillosa	Dwarf Desert Spike-rush	V	R
Eleocharis plana	Flat Spike-rush		R
Eragrostis lacunaria	Purple Love-grass		R
Eremophila gibbifolia	Coccid Emubush		R
Eremophila polyclada	Twiggy Emubush		R
Eriocaulon carsonii ssp. carsonii	Salt Pipewort, Button Grass	E	E
Eryngium vesiculosum	Prostrate Blue Devil		R
Frankenia cupularis			R
Frankenia plicata		E	V
Frankenia subteres			R
Gilesia biniflora	Western Tar-vine		R
Gratwickia monochaeta			R
Mimulus prostratus	Small Monkey-flower		R
Neurachne lanigera	Woolly Mulga-grass		R
Nymphoides crenata	Wavy Marshwort		R
Ophioglossum polyphyllum	Large Adder's-tongue		R
Orobanche cernua var. australiana	Australian Broomrape		R
Osteocarpum acropterum var. deminutum	Wingless Bonefruit		R
Osteocarpum pentapterum	Five-wing Bonefruit		E

Species	Common Name	Conservation Status[2]	
		AUS	SA
Phlegmatospermum eremaeum	Spreading Cress		R
Pimelea penicillaris	Sandhill Riceflower		R
Podolepis muelleri	Button Podolepis		V
Ptilotus sp. Cordillo Downs (B.Lay 1487) (NC)			V
Sauropus ramosissimus			V
Sclerolaena blackiana	Black's Bindyi		R
Stylidium desertorum			V
Swainsona fuscoviridis	Dark Green Swainson-pea		R
Swainsona leeana	Lee's Swainson-pea		R
Swainsona microcalyx	Wild Violet		R
Swainsona oligophylla			R
Swainsona procumbens	Broughton Pea		V
Tecticornia cupuliformis			V
Wurmbea deserticola	Desert Nancy		R
Zygophyllum humillimum	Small-fruit Twinleaf		R
Zygophyllum hybridum			R

[1]Search area is 26°S-30°S, 138°E-141°E. Database records and species ratings were current at the time of searching (late 2014) (see DEWNR 2014, DoE 2014).

[2]Conservation status under the SA *National Parks and Wildlife Act 1972* & Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*: R – Rare, V – Vulnerable, E – Endangered, EX – Extinct

* Indicates the species has been predicted to occur by the protected matters search tool (DoE 2014) but has not been recorded in the BDBSA (DEWNR 2014).

Table A2-2: Listed fauna species recorded or predicted in the area[1]

Species	Common Name	Conservation Status[2]	
		AUS	SA
Birds			
Actitis hypoleucos	Common Sandpiper		R
Amytornis barbatus	Grey Grasswren	V	R
Amytornis modestus	Thick-billed Grasswren	V	
*Amytornis merrotsyi merrotsyi**	Short-tailed Grasswren (Flinders Ranges)	V	
Anas rhynchotis	Australasian Shoveler		R
Anhinga novaehollandiae	Australasian Darter		R
Anseranas semipalmata	Magpie Goose		E
Aphelocephala pectoralis	Chestnut-breasted Whiteface		R
Aprosmictus erythropterus	Red-winged Parrot		R
Ardea ibis	Cattle Egret		R
Ardea intermedia	Intermediate Egret		R
Ardeotis australis	Australian Bustard		V
Arenaria interpres	Ruddy Turnstone		R
Biziura lobata	Musk Duck		R

Species	Common Name	Conservation Status[2]	
		AUS	SA
*Botaurus poiciloptilus**	Australasian Bittern	E	V
Burhinus grallarius	Bush Stone-curlew		R
Cacatua leadbeateri	Major Mitchell's Cockatoo		R
Calidris melanotos	Pectoral Sandpiper		R
Calidris subminuta	Long-toed Stint		R
Charadrius mongolus	Lesser Sand Plover		R
Cladorhynchus leucocephalus	Banded Stilt		V
Climacteris affinis	White-browed Treecreeper		R
Conopophila whitei	Grey Honeyeater		R
Coturnix ypsilophora	Brown Quail		V
Egretta garzetta	Little Egret		R
Elanus scriptus	Letter-winged Kite		R
Emblema pictum	Painted Finch		R
Epthianura crocea	Yellow Chat		E
Falco hypoleucos	Grey Falcon		R
Falco peregrinus	Peregrine Falcon		R
Gallinago hardwickii	Latham's Snipe		R
Geophaps plumifera	Spinifex Pigeon		R
Grantiella picta	Painted Honeyeater		R
Grus rubicunda	Brolga		V
Hamirostra melanosternon	Black-breasted Buzzard		R
Limosa limosa	Black-tailed Godwit		R
Lophoictinia isura	Square-tailed Kite		E
Melanodryas cucullata	Hooded Robin		ssp[3]
Melithreptus gularis laetior	Golden-backed Honeyeater		R
Myiagra cyanoleuca	Satin Flycatcher		E
Myiagra inquieta	Restless Flycatcher		R
Neophema chrysostoma	Blue-winged Parrot		V
Neophema splendida	Scarlet-chested Parrot		R
Ninox connivens	Barking Owl		R
Oriolus sagittatus	Olive-backed Oriole		ssp[3]
Oxyura australis	Blue-billed Duck		R
Pedionomus torquatus	Plains-wanderer	CE	E
Pezoporus occidentalis	Night Parrot	E	E
Phaps histrionica	Flock Bronzewing		R
Plegadis falcinellus	Glossy Ibis		R
Pluvialis fulva	Pacific Golden Plover		R
Podiceps cristatus	Great Crested Grebe		R
Porzana tabuensis	Spotless Crake		R
Rostratula australis	Australian Painted Snipe	E	V
Stictonetta naevosa	Freckled Duck		V
Thinornis rubricollis	Hooded Plover (Hooded Dotterel)		V

Species	Common Name	Conservation Status[2]	
		AUS	SA
Tringa glareola	Wood Sandpiper		R
Tyto longimembris	Eastern Grass Owl		R
Tyto novaehollandiae	Australian Masked Owl		E
Mammals			
Caloprymnus campestris	Desert Rat-kangaroo	EX	E
Dasycercus cristicauda	Crest-tailed Mulgara (Ampurta)	V	
Dasyuroides byrnei	Kowari	V	V
Macrotis lagotis	Greater Bilby (Bilby)	V	V
Macrotis leucura	Lesser Bilby	EX	E
Notomys cervinus	Fawn Hopping-mouse		V
Notomys fuscus	Dusky Hopping-mouse	V	V
Nyctophilus corbeni	Corbens's Long-eared Bat	V	V
Petrogale xanthopus xanthopus	Yellow-footed Rock-wallaby	V	V
Pseudomys australis	Plains mouse, Palyoora	V	V
Pteropus scapulatus	Little Red Flying-fox		R
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat		R
Trichosurus vulpecula	Common Brushtail Possum		R
Reptiles			
Aspidites ramsayi	Woma		R
Ctenotus astarte	Ashy Downs Ctenotus		R
Ctenotus joanae	Blacksoil Ctenotus		R
Demansia rimicola	Channel Country Whipsnake		R
Emydura macquarii	Macquarie Tortoise		V
Morelia spilota	Carpet Python		R
Proablepharus kinghorni	Blacksoil Skink		R
Pseudonaja guttata	Spotted Brown Snake		R
Frogs			
Cyclorana cultripes	Knife-footed Frog		R
Uperoleia capitulata	Small-headed Toadlet		R

[1]Search area is 26°S-30°S, 138°E-140°E. Database records and species ratings were current at the time of searching (late 2014) (see DEWNR 2014, DoE 2014).

[2]Conservation status under the SA *National Parks and Wildlife Act 1972* & Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*: R – Rare, V – Vulnerable, E – Endangered, CE – Critically Endangered, EX – Extinct

[3]Subspecies is listed under the *National Parks and Wildlife Act 1972*, however subspecies information is not contained in BDBSA records.

* Indicates the species has been predicted to occur by the protected matters search tool (DoE 2014) but has not been recorded in the BDBSA (DEWNR 2014).

Appendix 3

Beach Energy Priority Plant List

PLANT PRIORITY LIST – COOPER BASIN

Introduction

Beach Energy is committed to minimising the impact of exploration and production activities on the environment. To assist with minimising impacts on plants in the Cooper Basin (both South Australia and Queensland) a conservation priority has been assigned to a variety of trees, shrubs, grasses and herbs that occur in the Cooper Basin.

The characteristics of each plant, including longevity, growth rate, abundance and State / Commonwealth legislation have been taken into account to assign a conservation priority to each plant species. The conservation priorities are as follows:

- Priority 1 – very high conservation value
- Priority 2 – high conservation value
- Priority 3 – moderate conservation value
- Priority 4 – low conservation value

These conservation priorities must be considered prior to undertaking vegetation clearing for seismic lines, roads, borrow pits, camp sites, well sites, pipelines and facilities.

Common Name	Scientific Name	Perennial	Years to maturity	Regenerates readily from seed	Regenerates readily from root-stock	Conservation Priority*	Habitat / Occurrence
Trees							
Beefwood	*Grevillea striata*	✓	30-50			1	Acacia Woodlands (Q) / Mulga Woodlands (Q) / Dunefields (SA, Q)
Belah / Black Oak / Scrub She-oak	*Casuarina cristata*	✓				1	Acacia Woodlands (Q)
Bendee	*Acacia catenulata*	✓				2	Mulga Woodlands (Q)
Bloodwood	*Corymbia tumescens*	✓	30-50	✓		1	Dunefields (SA, Q)
Boonaree / Bullock Bush	*Alectryon oleifolius*	✓				1	Acacia Woodlands (Q) / Mulga Woodlands (Q)
Bowyakka	*Acacia microsperma*	✓				1	Acacia Woodlands (Q)
Brigalow	*Acacia harpophylla*	✓				1	Mulga Woodlands (Q) - Cooper Basin is on W limit of known occurrence
Broughton Willow	*Acacia salicina*	✓	30-50	✓	✓	2	Floodplains (SA,Q) / Drainage lines (SA,Q)
Bull Oak	*Hakea chordophylla*	✓	30-50			1	Dunefields (SA, Q)
Coolibah	*Eucalyptus coolabah*	✓	30-50	✓		1	Floodplains (SA,Q) / Drainage lines (SA,Q

PLANT PRIORITY LIST – COOPER BASIN

Common Name	Scientific Name	Perennial	Years to maturity	Regenerates readily from seed	Regenerates readily from root-stock	Conservation Priority*	Habitat / Occurrence
Corkwood Oak / Bootlace Oak	*Hakea lorea*	✓				1	Acacia Woodlands (Q)- Cooper Basin is on W & S limit of known occurrence
Emu apple / Sour plum	*Owenia acidula*	✓	30-50	✓		2	Dunefields (SA,Q) Acacia Woodlands (Q) / Mulga Woodlands (Q)
Ghost Gum	*Corymbia blakei*	✓				1	Mulga Woodlands (Q)
Gidgee / Stinking Wattle	*Acacia cambagei*	✓	30-50			2	Floodplains (SA,Q) / Drainage lines (SA,Q) / Dunefields (SA, Q) / Tablelands (SA, Q)
Ironwood	*Acacia excelsa*					1	Acacia Woodlands (Q)- Cooper Basin is on W limit of known occurrence
Lime Bush / Desert Lime	*Citrus glauca*	✓				1	Acacia Woodlands (Q) / Mulga Woodlands (Q)
Long-fruited Bloodwood	*Corymbia terminalis*	✓				1	Mulga Woodlands (Q)
Mountain Yapunyah / Yapunyah, Thozet's Box	*Eucalyptus thozetiana*	✓				1	Acacia Woodlands (Q)
Mulga	*Acacia aneura*	✓	30-50			2	Dunefields, rocky hills and ranges (SA,Q) Acacia Woodlands (Q) / Mulga Woodlands (Q)
Narrow-leaf Bumble Tree	*Capparis loranthifolia*	✓				1	Acacia Woodlands (Q) / Mulga Woodlands (Q)
Native Apricot	*Pittosporum phylliraeoides*	✓	30-50			1	Dunefields (SA,Q) / Floodplain (SA,Q) / Gibber Plain (SA,Q)
Poplar Box	*Eucalyptus populnea*	✓				2	Acacia Woodlands (Q) / Mulga Woodlands (Q)
Queensland Bean Tree / Bauhinia	*Lysiphyllum gilvum*	✓	50-100			1	Watercourses (SA,Q) / Floodplains (SA,Q)
Queensland Peppermint	*Eucalyptus exserta*	✓				2	Acacia Woodlands (Q)- Cooper Basin is on W limit of known occurrence
Red Ash	*Alphitonia excelsa*	✓				2	Acacia Woodlands (Q)- Cooper Basin is on W & S limit of known occurrence
Red Mulga / Minni ritchi	*Acacia cyperophylla*	✓	30-50			2	Watercourses in Tablelands (SA,Q)
River Cooba	*Acacia stenophylla*	✓	30-50	✓		2	Watercourses, Floodplains (SA,Q)

Common Name	Scientific Name	Perennial	Years to maturity	Regenerates readily from seed	Regenerates readily from root-stock	Conservation Priority*	Habitat / Occurrence
River Paperbark	*Melaleuca trichostachya*	✓	30-50	✓	✓	1	Watercourses (SA,Q)
River Red Gum	*Eucalyptus camaldulensis (var.obtuse)*	✓	50-100	✓		1	Watercourses (SA,Q) / Floodplains (SA,Q)
Sandalwood / Plum Bush (root parasite)	*Santalum lanceolatum*	✓	30-50	✓		2	Dunefields (SA,Q) / Floodplain (SA,Q) / Gibber Plain (SA,Q) Acacia Woodlands (Q) / Mulga Woodlands (Q)
Silver-leaved Ironbark	*Eucalyptus melanophloia*	✓				1	Acacia Woodlands (Q) / Mulga Woodlands (Q) - Cooper Basin is on W limit of known occurrence
Straggly Corkbark	*Hakea eyreana*	✓	30-50			1	Dunefields (SA,Q) / Watercourses (SA,Q) / Gibber Plain (SA,Q)
Vine Tree / Supplejack/ Kumianna	*Ventilago viminalis*	✓				2	Acacia Woodlands (Q) / Mulga Woodlands (Q)
Whitewood	*Atalaya hemiglauca*	✓	30-50	✓		2	Dunefields (SA,Q) / Acacia Woodlands (Q) / Mulga Woodlands (Q
Wild Orange (SA) / Bumble Tree (Qld)	*Capparis mitchellii*	✓	30-50			1	Floodplains (SA,Q) / Acacia Woodlands (Q) / Mulga Woodlands (Q)
Wilga	*Geijera parviflora*	✓				2	Acacia Woodlands (Q) / Mulga Woodlands (Q)- Cooper Basin is on W limit of known occurrence
Yapunyah	*Eucalyptus ochrophloia*	✓	30-50			2	Floodplains (SA,Q) / Drainage lines (SA,Q)
Shrubs							
Bean Bush / Fire Bush / Native Senna	*Senna pleurocarpa*	✓				4	Acacia Woodlands (Q) / Mulga Woodlands (Q)
Bitter Bark	*Alstonia constricta*	✓				1	Acacia Woodlands (Q) / Mulga Woodlands (Q)- Cooper Basin is on W limit of known occurrence
Black-fruit Bluebush	*Maireana melanocarpa*					3	Mulga Woodlands (SA) – Cooper Basin is N & E limit of known occurrence
Bladder Saltbush	*Atriplex vesicaria*	✓	5-10	✓		3	Dunefields (SA,Q) / Floodplains (SA,Q) / Gibber Plains (SA,Q) / Salt lakes (SA)(
Bluebush Pea / Loose-flowered Rattlepod	*Crotalaria eremaea*	✓	3-5	✓		4	Dunefields (SA,Q)

Common Name	Scientific Name	Perennial	Years to maturity	Regenerates readily from seed	Regenerates readily from root-stock	Conservation Priority*	Habitat / Occurrence
Boobialla	*Myoporum montanum*	✓				2	Acacia Woodlands (Q) / Mulga Woodlands (Q)
Bristly Sea-heath	*Frankenia serpyllifolia*	✓	10-30			3	Dunefields (SA,Q) / Floodplains (SA,Q) / Gibber Plains (SA,Q)
Broom Bush / Warrior Bush / Currant Bush	*Apophyllum anomalum*	✓				1	Acacia Woodlands (Q) / Mulga Woodlands (Q)- Cooper Basin is on S & W limit of known occurrence
Buckbush / Roly poly	*Salsola australis*	✓	1-3			4	Dunefields (SA,Q) / Floodplains (SA,Q)
Butterfly Bush	*Petalostylis labicheoides*	✓				3	Acacia Woodlands (Q) / Mulga Woodlands (Q)- Cooper Basin is on W, S & N (SA) limit of known occurrence
Charleville Turkeybush	*Eremophila gilesii*					2-3	Mulga Woodlands (Q)
Crimson Turkeybush	*Eremophila latrobei*					3	Mulga Woodlands (Q)
Cunningham's Bird Flower / Parrot pea	*Crotolaria cunninghammii*					4	Dunefields (SA,Q)
Currant Bush / Native Currant	*Carissa ovata*	✓				3	Acacia Woodlands (Q)- Cooper Basin is on S limit of known occurrence
Dead Finish	*Acacia tetragonophylla*	✓	10-20	✓		2	Dunefields (SA,Q)
Deane's Wattle / Fern-leaf Wattle	*Acacia deanei*	✓				3	Acacia Woodlands (Q) / Mulga Woodlands (Q) - Cooper Basin is on W limit of known occurrence
Desert Fuchsia	*Eremophila dalyana*	✓	20-30			2	Gibber Plains (SA,Q)
Dwarf Needlewood	*Hakea collina*					2	Mulga Woodlands (Q)
Ellangowan Poison Bush / Turkey Bush	*Eremophila deserti*	✓				3	Acacia Woodlands (Q) / Mulga Woodlands (Q)- Cooper Basin is on W & N (SA) limit of known occurrence
Emu Bush	*Eremophila longifolia*	✓	20-30	✓	✓	3	Dunefields (SA,Q) Acacia Woodlands (Q) / Mulga Woodlands (Q)
Eurah / Bignonia emu bush	*Eremophila bignoniiflora*	✓	10-20			3	Floodplains (S)
False Sandalwood	*Eremophila mitchellii*					2-3	Acacia Woodlands (Q) / Mulga Woodlands (Q)
Fern-leaf Grevillea / Golden Parrot Tree	*Grevillea pteridifolia*	✓	20-30			1	Dunefields (SA,Q) / Floodplains (SA,Q)

Common Name	Scientific Name	Perennial	Years to maturity	Regenerates readily from seed	Regenerates readily from root-stock	Conservation Priority*	Habitat / Occurrence
Flowering Lignum	*Eremophila polyclada*	✓	20-30			1	Floodplains (SA,Q) / Gibber Plains (SA,Q)
Golden Goosefoot / Queensland Bluebush	*Chenopodium auricomum*	✓	5-10			3	Floodplains (SA) Yupunyah-Gidgee Woodlands (Q) / Floodplains (Q)
High Sida	*Sida trichopoda*					4	Yupunyah-Gidgee Woodlands (Q) / Floodplains (Q)
Honeysuckle Spider-flower	*Grevillea juncifolia*	✓	5-10			3	Dunefields (SA,Q)
Hop bush	*Dodonaea viscosa(ssp. angustissima)*	✓	10-15	✓		3	Dunefields (SA,Q)
Lignum	*Duma florulenta*	✓	20-30		✓	2	Floodplains (SA,Q)
Lifesaver Burr	*Sida platycalyx*					4	Mulga Woodlands (Q)
Marpoo / Sandhill Wattle	*Acacia ligulata*	✓	10-15	✓		3	Dunefields (SA,Q)
Miles Mulga	*Acacia aprepta*	✓				2	Mulga Woodlands (Q)
Mimosa Bush / Sweet Acacia	*Acacia farnesiana*	✓	10-20	✓		2	Dunefields (SA,Q) / Drainage lines (SA,Q) Acacia Woodlands (Q) / Mulga Woodlands (Q)
Murray's Wattle / Sandplain Wattle	*Acacia murrayana*	✓	20-30			2	Dunefields (SA,Q) / Floodplains (SA,Q)
Native Currant	*Canthium latifolium*	✓	10-30			2	Gibber Plains & Tablelands (SA,Q) / Sandfields (SA, Q)
Needlewood	*Hakea leucoptera*	✓	20-50	✓		2	Dunefields (SA,Q)
Nitre Bush / Nitre Goosefoot	*Chenopodium nitrariaceum*	✓	5-10			3	Floodplains (SA,Q)
Old Man Saltbush	*Atriplex nummularia*	✓	30-50		very poor	2	Dunefields (SA,Q) / Floodplains (SA,Q) / Salt lakes (SA)
Prickly Wattle / Elegant Wattle	*Acacia victoriae*	✓	10-15	✓		3	Dunefields (SA,Q) / Floodplains (SA,Q)
Ruby Saltbush	*Enchylaena tomentosa*	✓	5-10			3	Dunefields (SA,Q) / Floodplains (SA,Q)
Samphire	*Halosarcia indica*	✓	20-30			3	Salt lakes (SA, Q) / clay flats (SA,Q) / Gibber Plain (SA,Q)
Sandhill Spider-flower	*Grevillea stenobotrya*	✓	20-30			2	Dunefields (SA,Q)

Common Name	Scientific Name	Perennial	Years to maturity	Regenerates readily from seed	Regenerates readily from root-stock	Conservation Priority*	Habitat / Occurrence
Silver Cassia (SA) / Butter Bush (Qld)	*Senna artemisioides (ssp. artemisioides)*	✓	5-10			3	Dunefields (SA,Q) / Gibber Plain (SA,Q) Acacia Woodlands (Q) / Mulga Woodlands (Q)
Silver Turkeybush	*Eremophila bowmanii*	✓				3	Mulga Woodlands (Q)
Spiny Saltbush / Thorny Saltbush	*Rhagodia spinescens*	✓	5-10			3	Dunefields (SA,Q) / Floodplains (SA,Q)
Spotted emu bush	*Eremophila maculate (var. maculate)*	✓	20-30			2	Watercourses & Floodplain (SA, Q)
Sticky Hopbush	*Dodonaea viscosa*	✓				3	Acacia Woodlands (Q)
Sturt's Pigface	*Gunniopsis quadrifida*					2-3	Dunefields (SA,Q) / Floodplains (SA,Q) / Gibber Plain (SA,Q) / Salt lakes (SA)
Tangled Lechenaultia	*Lechenaultia divaricata*	✓	2-5			2	Dunefields (SA,Q)
Umbrella Wattle	*Acacia oswaldii*					2	Dunefields (SA,Q)
Wait-A-While / Split Jack / Bush Passionfruit	*Capparis lasiantha*	✓				3	Acacia Woodlands (Q) / Mulga Woodlands (Q)
White Fringe Myrtle	*Calytrix tetragona*	✓				3	Acacia Woodlands (Q) - Cooper Basin is on W limit of known occurrence
Bastard Mulga / Witchetty Bush	*Acacia stowardii*					1	Mulga Woodlands (Q) Yupunyah-Gidgee Woodlands (Q) / Floodplains (Q)
Herbs							
Barley Mitchell-grass	*Astrebla pectinata*	✓	2-3			4	Gibber Plain, Floodplain (SA,Q)
Cat-head	*Tribulus hystrix*		<1	✓		4	Dunefields (SA,Q)
Cattle bush	*Trichodesma zeylanicum*	✓	1-3			4	Dunefields (SA,Q) / Floodplains (SA,Q) / Gibber Plain (SA,Q)
Dark Wiregrass	*Aristida calycina*					4	Yupunyah-Gidgee Woodlands (Q) / Floodplains (Q)
Erect Kerosene grass	*Aristida holathera*					4	Dunefields (SA,Q)
Fleshy Groundsel / Yellow-tops	*Othonna gregorii*		<1	✓		4	Dunefields (SA,Q)
Leafy nine-awn	*Enneapogon polyphyllus*					4	Mulga Woodlands (Q)
Lobed Spinifex / Hard Spinifex	*Triodia basedowii*	✓	10-20	✓		2-3	Dunefields (SA,Q)
Long-tails / Pussy-tails	*Ptilotus polystachyus*	✓	1-2			4	Dunefields (SA,Q)

Common Name	Scientific Name	Perennial	Years to maturity	Regenerates readily from seed	Regenerates readily from root-stock	Conservation Priority*	Habitat / Occurrence
Mulga grass / Kerosene grass	*Aristida contorta*	✓	1-3			4	Dunefields (SA,Q)
Nardoo	*Marsilea drummondii*		<1		✓	4	Floodplain (SA,Q)
Pea flower	*Swainsona campylantha*	✓	1-3	✓		4	Dunefields, Floodplain, Gibber Plain (SA,Q)
Poached Egg Daisy	*Myriocephalus stuartii*		<1	✓		4	Dunefields (SA,Q)
Ray grass / Katoora	*Sporobolus actinocladus*					4	Yupunyah-Gidgee Woodlands (Q) / Floodplains (Q)
Sandhill Canegrass	*Zyglochloa paradoxa*	✓	5-10	✓		4	Dunefields (SA,Q)
Swamp Canegrass	*Eragrostis australasica*	✓	5-10	✓		4	Floodplain (SA,Q)
Variable Groundsel	*Senecio lautus*	✓	5-10			4	Dunefields (SA,Q)
Wanderrie grass	*Eriachne mucronata*					4	Yupunyah-Gidgee Woodlands (Q) / Floodplains (Q)

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Appendix 4

Government Agency Consultation Comments and Responses

Government Agency Comments on the EIR

Agency	Document Section	Comment	Response
AARD	2.2 (Table 1)	At p7: Where it says "Issue - Permission required if Aboriginal sites, objects or remains are to be damaged, disturbed or interfered with", I suggest you replace "Permission" with "Authorisation", to reflect the wording of the Act.	Text replaced.
	4.7.1	Table 12 at p53: I acknowledge that Table 12 is sourced from a Santos document but a better heading than "Land systems and sites of Aboriginal artefacts" would have been "Land systems and Aboriginal heritage". The word 'artefacts' is quite narrow in scope while 'Aboriginal heritage' covers sites, objects and remains and defined in the Act. Other Tables in the EIR (for instance Tables 18, 21 and 22) are good in that they recognise and acknowledge Aboriginal heritage and the likelihood of activities impacting on heritage in given circumstances. I emphasise "recognise and acknowledge Aboriginal heritage".	Heading altered accordingly.
		<u>Risk Management - Comments Applicable to both EIS and SEQ</u> In areas where the heritage is unknown or may be sub-surface, a proponent may choose to manage its risk of breach of the Act by implementing a program of identification, analysis and assessment followed by controls which mitigate any risk of damage, disturbance or interference with any Aboriginal sites, objects or remains discovered during project works. Risk management is about managing the risk of a possible breach the Act. It is a process of gathering all the information regarding heritage that will allow you to assess your risk of breaching the Act. Generally speaking, risk management is the identification, analysis and assessment of the effects of uncertainty followed by the application of controls which are designed to avoid, minimise or eliminate the probability of unacceptable consequences. In order to satisfactorily pursue a risk management strategy that complies with the provisions of the Act it is necessary to ensure there is no damage, disturbance or interference to any Aboriginal sites, objects or remains. DSD-AAR has a Risk Management Guideline that suggests steps a proponent should address when adopting a best practice risk management strategy. Included in that document are measures designed to mitigate the risk of a breach of section 23 of the Act. These steps include: ▪ requesting a search of the Central Archive's Register of Aboriginal Sites and Objects; ▪ seeking the views of the relevant Aboriginal parties as identified in the El R, and	Noted. The Work Area Clearance process that Beach undertakes prior to all new disturbance is consistent with the DSD-AAR Risk Management Guideline.

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		▪ engaging professional expertise where appropriate to conduct an archaeological and/or anthropological survey with the participation of appropriate Aboriginal custodians who have knowledge of and responsibility for the area of country and/or Aboriginal sites in question.	
		Delegations under the Act - Comments Applicable to both EIS and SEQ Aboriginal organisations or Traditional Owners of an Aboriginal site or object can apply under the relevant paragraphs of section 6 of the Act, for a delegation from the Minister of the Minister's powers under sections 21, 23, 29 and 35. It is advisable for a risk management strategy to include inquiry into whether an application for a delegation has been made under the provisions of section 6 of the Act in the area where any development activity is proposed. I note the areas of interest to Beach Energy as indicated at Figure 1 (p3) and Figure 2 (p17), EIR. I need to inform you that the Yandruwandha Yawarrawarrka Traditional Land Owners Aboriginal Corporation has been granted a Delegation pursuant to s6(1) of the AHA, and as such they have the delegated authority to make decisions under sections 21, 23, 29 and 35 of the AHA, in their claim area SAD 6024/98.	Noted
EPA	2.2 (Table 1)	The entry under EPA states "National Environment Protection Measures which operate as an EPP under the EP Act". This is not correct. The EPPs made under Part 5 under EP Act as current are listed at: https://www.legislation.sa.gov.au/listAZPolicies.aspx?key=E Any change in the listing will be reflected at the State's legislation database.	Text amended. Beach note that this wording was included because EPA had specifically requested its inclusion in documentation submitted in 2014.
	3.3	Produced formation water The section states that "If secondary use of PFW is proposed, water quality criteria for other analytes are also relevant, as discussed in Section 3.3.2". However, the section 3.3.2 does not provide any information about the water quality criteria.	Section 3.3.2 discusses water quality being consistent with relevant guidelines for the intended use. Specific details of water quality criteria would depend on the use and the guideline that is relevant.
	3.3.2	Secondary use of PFW Second last paragraph – could also refer to the Environment Protection (Water Quality) Policy 2015 which indicates that groundwater with a background TDS level of 3000 mg/L or more but less than 13000mg/L has an applicable environmental value of 'Primary industries – livestock drinking water'.	Noted.

Agency	Document Section	Comment	Response
	3.4	<u>Waterflood and reinjection</u> Reinjection – Reinjection of water for disposal is not best practice from an environmental perspective and should be very carefully considered. It is recommended DSD receive a detailed proposal from Beach prior to this occurring for DSD, EPA and DEWNR's consideration. Reinjection into a different formation represents a higher risk than reinjection into the source formation.	As noted in Section 5.5, any reinjection program would be subject to detailed assessment and would require approval from DSD before commencement. Consultation with EPA and DEWNR would form part of this process. Depending on injection parameters, EPA licensing (e.g. via a variation to Beach's licence) is likely to be required.
	5.5 (Table 20)	<u>Waterflood / reinjection risk assessment</u> Injection of contaminated water into the target or other aquifer zones – Management Strategy column – This is non-specific criteria. Should include detail on frequency, analytes etc. in SEO	Detail on frequency, analytes etc would be dependent on the specifics of the injection program. This information would be provided in the detailed information submitted for approval.
DEWNR (SMK)	General	Use of the term 'abandon' , to be replaced with decommission	No change. In the context of petroleum wells, 'abandon' and 'abandonment' are technical terms with specific meaning that are used in international standards (e.g. ISO/TS16530-2:2014) and in the Petroleum and Geothermal Energy Regulations and DSD guidelines.
		It appears that knowledge gained from activities and subsequent monitoring undertaken under the current and previous EIR and SEO is not reflected in this document. The EIR provides very little reflection, and no analysis or presentation of any data, of any systematic water, ecological or soil monitoring, nor assessment of the actual impact resulting from activities undertaken under the EIR/SEO. Provision of this information / data would assist in assessing the SEO.	Knowledge gained during Beach's Cooper Basin activities has been included where relevant to the requirements of the EIR (as specified by the Petroleum and Geothermal Energy Act) and has been integrated into the activity description, environment description and risk assessment. The EIR has been prepared in accordance with the requirements of the PGE Act and Regulations. It is not the intention (or a requirement under the Act or Regulations) of the EIR to provide a review of monitoring data.
		There does not appear to be any monitoring plan (or reference to) to accompany listed environmental objectives or assessment criteria, for which to assess compliance against or to determine its appropriateness for the given objectives.	Section 6.7 provides an overview of the monitoring and audit program. Detailed monitoring is addressed outside the EIR and SEO, under Part 4 of the PGE Regulations (in particular the Regulation 16(2) operator assessment factors). Regulation 16 requires operators to develop systems to monitor, evaluate, audit and review compliance against regulatory requirements and objectives. Information relevant to Part 4 of the Regulations is submitted to DSD. Beach have developed a specific monitoring plan for the Western Flank of the Cooper Basin.
		Comment is required on the licensing of co-produced water and what are the reporting requirements. Do any conditions exist on the production of co-produced water? Condition 5 of the water licence issued to the minister for the taking of co-produced water states: Submissions made to Petroleum & Geothermal Group, PIRSA, for the taking of co-produced water from a well located within a Petroleum Exploration Licence (PEL), in particular those PELs located in the Southwest Springs Groundwater Management Zone, are to consider potential impacts on GAB springs as part of their submission.	The licensing of co-produced water under the NRM Act and Beach's reporting to DSD are covered in Section 3.3 and 5.4. A reference to condition 5 of the water licence has been added to Section 5.4. Comments on the location of GAB springs and the Southwest Springs Groundwater Management Zone in relation to Beach licence areas have been added to Section 4.3.3 and 5.4. Beach do not currently have any PELs in the Southwest Springs Groundwater Management Zone (note added in Section 5.4).

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	4.2	Landforms and Land Systems The Interim Biogeographic Regionalisation for Australia (IBRA) classifies Australia into geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. The landforms and land systems information presented in the EIR, whilst is similar, has been superseded by the IBRA system and future updates to the EIR are to consider move to the IBRA system to describe the existing environment. Further information regarding this system can be found at: http://www.environment.gov.au/land/nrs/science/ibra including a download facility.	IBRA bioregions were considered for use in the EIR, however landsystems were retained as they provide a finer level of detail that is more appropriate to the landform level of assessment used in the EIR. A specific reference to the IBRA bioregions in the Cooper Basin has been added.
	4.6	Hydrogeology ▪ 2nd paragraph – to note that the Surat Basin extends across both NSW and Queensland. ▪ This section needs to mention that the GAB aquifers support the GAB springs which are EBPC listed communities. Recent work has shown that water from the Tertiary aquifers may also be contributing to the spring flows. GAB springs occur near the southern extent of the Cooper Basin whilst the 5 km buffer around the springs near Lake Blanche overlaps the extent of the Cooper Basin.	Added. Added mention of EPBC listed community, with a cross-reference to information in Section 4.3.3. Additional information on GAB spring locations added in Section 4.3.3, 5.4 and new map added.
	5.2 Table 17	pg 61 – 1st item – to consider adding a potential consequence relating to downhole failure and impact to relevant groundwater systems. Additions to the management strategy may be needed to address this potential consequence.	Consequence 'Contamination of aquifers' added under 'Well integrity' in Table 17. Description of the relevant activity/event ('Downhole production equipment failure') has also been expanded to include examples for clarity.
		pg 62 – Disposal of hydrocarbon and formation waters – given that formation water may be disposed of in a free form area the management strategy provided does not address the potential consequences.	'Disposal of hydrocarbon and formation waters' in this section of the table is referring only to fluids that may be produced during completions and workovers. Any hydrocarbon or formation water produced to surface during completions and workover activities would be captured in tanks as noted in the management strategy. These fluids would typically be taken to a facility and would be handled in accordance with the hydrocarbon and water handling processes and management strategies covered by Sections 5.3.2 and 5.4.
	5.4 Table 19	pg 75 – Co-produced water. ▪ Where the production of co-produced water may result in a drawdown at the boundary of the 5 km buffer – activity to be considered a medium impact activity. Further work will be required. ▪ Where the production of co-produced water may result in a drawdown at the state border – activity to be considered a medium impact activity. Further work will be required.	Noted. Reference to compliance with the WAP and water licence conditions added to Table 19 and the SEO.

Agency	Document Section	Comment	Response
	4	A more detailed map showing the major regional surface water features and the relative proximity of major Beach Energy infrastructure is required. The RAMSAR-listed Coongie Lakes and Lake Goyder on the Cooper River system are noted but proximity of Beach activities to these features not discussed.	New map added.
		Noted that GAB springs are 'beyond the margins of the Cooper Basin' but no discussion of connectivity and potential impacts.	Wording has been clarified to refer to the 'Cooper Basin region' (as opposed to the geological basin itself) and commentary on impacts added to Section 5.4. The broad discussion in the EIR regarding produced water extraction, controls and impacts on GAB springs is relevant to production of water from the Eromanga Basin (i.e. GAB) oil reservoirs (which represents the vast majority of co-produced water) as well as production from deeper Cooper Basin formations. Connectivity between the Cooper Basin formations and the GAB and potential impacts of water production from the Cooper Basin formations are highly site-specific. If proposed, it would be investigated in detail when addressing compliance with the WAP and water licence.
		<u>General / Overall comment</u> Section 4.2 provides description of the Landforms and Land Systems (Table 8) and Section 4.3 provides description of the Flora and Fauna (Table 10). It is also stated that "The sensitivity of each landform to disturbance depends upon its basic characteristics of geology, topography, soils, hydrology, flora and fauna, with the sensitivities outlined in Table 21". The descriptions provide a good generalised conceptual summary of the expected behaviour of the systems (landform, climate / hydrology and the flora / fauna) and the links between them. However, it is difficult to locate in any of the sections the actual impact of the on-ground activities on the systems (and the links), which would presumably be known only if data related to the systems were collected to provide evidence on disturbances and their impacts on the hydrology and in turn, the flora and fauna. NB: Relates to comment #4 provided below with respect to monitoring.	Section 4.2 aims to provide an overview of the existing environment and therefore does not provide information on impacts of activities; these are addressed in Section 5 in relation to each aspect of Beach's operations. Information collected during operations and monitoring of on-ground activities has been integrated into Section 5 and used to inform the risk assessment. The EIR has been structured to meet the requirements of the PGE Act and Regulations. The nature and scale of Beach's activities and of the Cooper Basin environment mean that most potential impacts are relatively localised and site-specific rather than system-wide or broad scale, particularly in relation to hydrology and flora and fauna. Consequently, activities are typically assessed, inspected and managed at this scale. The monitoring of system level or broad scale linkages and impacts would need to consider impacts from other stakeholders that operate in the region. This type of monitoring would need multi-industry and government involvement and is beyond what Beach could reasonably be expected to undertake, particularly given the scale and complexity involved in monitoring in such a large region with very high climatic and hydrological variability. Further comment is also provided with the comment below with respect to monitoring.
	3.6 Table 5	<u>Road construction methods</u> Wetlands noted as areas suitable for road construction 'utilise naturally cleared areas' and suitable to 'cap road surface with clay or similar borrow material'. No consideration given to effect of development on wetlands. Should be in same category as salt lakes ('avoid construction on land system').	There is coverage of construction activities in wetlands and their impacts in the EIR (e.g. section 5.6.1 and 5.7). Wetlands are generally avoided, particularly areas of higher value or sensitivity, as noted in the EIR. However, the information in Table 5 regarding construction in wetlands reflects the reality that a large proportion of the Cooper Basin could be classed as 'wetland' and that 'wetland' areas cannot be completely avoided. For example, the NRM Act defines a wetland as *an area that comprises land that is permanently or periodically inundated with water (whether through a natural or artificial process) where the water may be static or flowing and may range from fresh water to saline water and where the inundation with water influences the biota or*

Agency	Document Section	Comment	Response
			ecological processes (whether permanently or from time to time). The SAAL NRM Plan specifically acknowledges that *extensive areas of the region, where cyclical flooding occurs, may also fall within the definition of 'wetland'* (page 174)*.*
		Subsequent reference in Table 21 – Potential consequences, page 80. Note: 'wetlands are generally avoided' – change to 'wetlands are avoided'	No change – see previous comment.
	5.7 Table 24	<u>Road construction and maintenance</u> Road construction and use has a significantly greater potential to impact on the surface hydrology. References made to 'potentially disturb natural drainage patterns' but insufficient discussion of likely impact of this and how assessed and addressed	With the mitigation measures listed in Table 24 in place, significant impacts to surface hydrology are considered unlikely. Table 24 identifies the design features and steps in planning and construction that assess and address potential impacts. In addition, ongoing operational inspections and audits are used to identify any areas where there is evidence of disturbance to drainage patterns (e.g. evidence of water ponding or increased channelling, changes in vegetation either side of a road) and rectification measures are implemented.
		What does a 'hydrological assessment' entail and who undertakes these?	Where an elevated potential for impact identified in the planning phase indicates that a hydrological assessment is required (e.g. if constructing a raised, culverted road), the specifics of the assessment would depend on the particular project but usually involves engagement of a third party specialist and may involve field inspection and modelling. This is addressed at the activity notification stage (see Section 2.1.3).
	6.7	<u>Environmental monitoring and audits</u> pg.106 - Detail is required around the monitoring programs – a description of the monitoring undertaken and a summary of the current status/condition of the natural environment and the infrastructure designed to contain water discharges. Also a clear statement of how to determine whether infrastructure is having the same level of impact as when it was first installed.	As noted previously, detail regarding monitoring is addressed outside the EIR and SEO, under Part 4 of the PGE Regulations. It is not the intention (or a requirement under the Act or Regulations) of the EIR to provide a review of monitoring data. Beach have developed a specific monitoring plan for the Western Flank of the Cooper Basin. Ongoing inspections and audits are the principal tool in identifying whether infrastructure is having a greater level of impact than when first installed. Landholders (and DSD) also inform Beach if there are possible impacts, particularly if water flows and subsequent pasture production have been affected.
	3.1.4	The amount of gas that is vented is noted as being negligible. Provide an indication of how often this process occurs and the volume of gas.	Gas well deliquification, and in particular venting of gas during deliquification, is carried out very infrequently at Beach wells (e.g. Middleton-1) and quantities are very small (below NGER reporting thresholds).
	4.3.2	The document notes that the Coongie Lakes and the wetlands associated with the North-west branch of the Cooper Creek are of 'Exceptional ecological value'. This text should be updated to reflect that these areas are also areas listed as internationally important wetlands (RAMSAR convention) and Nationally important Wetland.	Added cross-reference to existing discussion of Ramsar listing in Section 4.7.4.
	4.3.3	It is listed previously that impacts on groundwater are all controlled and subject to appropriate processes, the GAB springs are one of the key ecological responders to the changes in groundwater level/pressure. A map of the locations of the records of rare and threatened species, along with the locations of GAB springs relative to the operations would be helpful to provide context.	A map showing GAB spring locations has been added. Mapping rare and threatened species records across the basin would not provide a particularly useful or meaningful map, so has not been included.

Agency	Document Section	Comment	Response
DEWNR (SAAL NRM)		There are a few additional points for consideration as the document identifies the risk to shallow aquifers in the event of a well failing but does not specifically indicate the risk to the Great Artesian Basin (GAB) if there is a down hole well failure. The GAB sits above the Cooper Basin and therefore some risk of contamination of the GAB exists should failure occur in a well.	Consequence 'Contamination of aquifers' added under 'Well integrity' in Table 17. Contamination of aquifers is also covered in the discussion preceding Table 17.
		The other comment is that Sunday Springs and Lake Blanche Springs are located on the edge of the Cooper Basin and there are minor concerns that activities in the area may pose a threat to the springs as there is suspected inter-aquifer linkages in the area, however a present Beach's operations are further north and unlikely to pose a threat.	Noted. As discussed above, additional information has been added into Sections 4.3.3 and 5.4 to cover distance to springs and the controls on activities that could impact GAB springs that are included in the WAP and water licence.

Government Agency Comments on the SEO

Agency	Document Section	Comment	Response
EPA	General	Reference to Environment Protection (Water Quality) Policy should refer to the latest version. In the SEO, 2003 version is referenced. It is to be noted that this 2003 version has been superseded with the new 2015 version. Copy of the same can be obtained from: https://www.legislation.sa.gov.au/listAZPolicies.aspx?key=E	Reference updated.
	Obj 6 To minimise land or water contamination	Goal 6.1: To prevent spills occurring and if they occur minimise their impact How Objectives can be achieved: 1. Containment of all hazardous substances including hydrocarbons and liquid waste in appropriate vessels and bunds. The bunds requirement is provided in EPA guideline 080/12 Bunding and Spill Management. 2. The EPA Guideline 509/14 Wastewater lagoon provides guidance for the construction Location, design and operation of production facilities (including ponds). 3. It is suggested to define the term "flooding" in the context of the statement "Location and design of production facilities to minimise risks posed by flooding." 4. It is suggested to define the term "flood inundation" in the context of the statement "Production operations will cease in event of flood inundation".	Noted. EPA guideline 080/12 is specifically referenced under goal 6.1 Noted. EPA Guideline 509/14 is specifically referenced under Objective 6.6 (produced formation water treatment and disposal) Flooding is used in the context of Cooper Creek flooding, as described in the EIR. Flood inundation refers to flooding (by the Cooper Creek) at facilities or fields as described in the EIR.
		Assessment Criteria 1. Note only – Viewing from Environment Protection Act 1993's (EP Act) requirement perspective and not from PGE Act compliance requirement: The statement "No escape or release of petroleum, processed substance, chemical or fuel to surface water and / or groundwater that poses an unacceptable risk to human health or the environment, as determined by an assessment in accordance with the NEPM, taking into account current and post-activity land uses. Any escape of petroleum, processed substance, chemical or fuel is either immediately contained and removed or assessed in accordance with NEPM guidelines and remediated in a timely manner." is not fully consistent with EP Act's meaning of site contamination as provided in section 5B of the EP Act. The EPA applies its site contamination internal policies, guidelines, etc. for assessing any site contamination cases. Hence, it is suggested that Beach Energy simply state that the assessment would be in accordance with the EP Act and the EPA's requirements without elaborating on use conditions. This will help Beach Energy's internal management system to be aligned with the	Noted. The wording has been edited in accordance with DSD comments (below) and the first sentence removed. The 'Guide to how' column refers to consistency with EPA guidelines for assessment and remediation.

Agency	Document Section	Comment	Response
		EPA's site contamination requirements.	
	Obj 6 Goal 6.4	Guide to How Objectives can be achieved 'Water discharged into existing ponds, or where quality is suitable, onto stable ground…Discharged water … assessed to ensure that water quality is consistent with relevant guidelines…' – should refer to the applicable water quality criteria (Environment Protection (Water Quality) Policy 2015 and other. Recommend to include specific compliance documents for DSD to consider.	ANZECC criteria and EPA guidelines are already referenced.
	Obj 6 Goal 6.6	Guide to How Objectives can be achieved Lacks specific detail. Suggest to include expansion on terms used. Example: Water quality criteria, shallow groundwater terms do not have any explanation or definition	Beach monitor a range of water quality parameters in bores at facilities / PFW ponds. Hydrocarbons are the key parameter of interest. The principal purpose of these bores is to monitor for trends that would indicate if significant seepage of potential contaminants to groundwater occurring, rather than comparing groundwater quality against specific criteria. Specific, fixed criteria are not generally suitable as unconfined groundwater quality is naturally variable (often both temporally and spatially), plus it is generally saline and unsuitable for most uses contemplated by ANZECC guidelines and it falls outside the environmental values under the Environment Protection (Water Quality) Policy. 'Shallow groundwater' refers to the unconfined water table. As noted in the EIR, this is typically saline and at depths of less than 10 m at most Beach sites.
	Obj 6 Goal 6.9	Lacks specific detail. Examples: What does "*State controls on radioactive substances followed*" mean? Reference to Radiation Protection and Control Act 1982 would be useful. What does "*no significant change in aquifer water quality…*" mean? It is suggested to include providing a proposal to DSD, DEWNR, EPA for approval. What does "no significant change in aquifer water quality…." Mean?	Reference to Act added. As noted in Section 5.5 of the EIR, any reinjection program would be subject to detailed assessment and would require approval from DSD before commencement. Depending on injection parameters, EPA licensing is likely to be required (e.g. via a variation to Beach's licence). Parameters concerning changes to water quality would need to take into account existing water quality and use, and would be defined at this detailed assessment stage.
DEWNR (SMK)	General	To assist in the review process, the document is to contain a table outlining the changes made to the previous version of the document with explanations for the changes. (As per the monitoring programs for Olympic Dam).	Noted. To be discussed with DSD for future SEO revisions.
		Use of the term 'abandon' , to be replaced with decommission	No change. In the context of petroleum wells, 'abandon' and 'abandonment' are technical terms with specific meaning that are used in international standards (e.g. ISO/TS16530-2:2014) and in the Petroleum and Geothermal Energy Regulations and DSD guidelines.
		Production of large volumes of co-produced water from PEL's 94 and 95 could have an impact on GAB springs located near Lake Blanche – contingency plans need to be in place should such activities occur.	Noted. If extraction of large volumes of water from PEL 94 and 95 is proposed, it will be undertaken in compliance with the Water Allocation Plan and the water licence, as discussed above for the EIR. A reference to these requirements has been

Agency	Document Section	Comment	Response
			added to Objective 5.2.
		The assessment criteria 'Vegetation cover is consistent with surrounding land' has been removed for the goal 2.2. Why has this been removed and what evidence exists to justify its removal? Relates to comment No.1.	This was removed from this goal as it was not a clear indicator of soil inversion (it could also be indicative of other factors and would only be relevant in areas where vegetation regrowth has been encouraged). However, the requirement for consistency of vegetation cover in rehabilitated areas is still captured in the SEO under the new objective 10 via the GAS criteria (Appendix C).
		All references to the Environment Protection Policy (Water Quality) 2003 need to be updated to Environment Protection Policy (Water Quality) 2015 and criteria need to be checked to ensure they remain compliant with the updated document.	References updated.
		The following criteria has been removed from the 'Assessment Criteria' for Objective 6, goal 6.1 - Compliance with the Environment Protection Act, Australian Standard 1940 and the Australian Dangerous Goods Code. Why has this been removed? Relates to comment No.1 [above].	This criteria has been moved to the 'Guide to how…' column and the list of legislation and standards broadened. The requirement to comply exists regardless of the PGE Act and the SEO, and Beach is aiming to minimise duplication of existing compliance obligations in the Assessment Criteria.
	Obj 5 Goal 5.2	Assessment criteria. To consider adding a criteria: ▪ Compliance with licence conditions for water licences held by Beach Energy. ▪ Water wells to be drilled, constructed and decommissioned in accordance with the 'Minimum Construction Requirements for Water Bores in Australia'.	This is covered in the 'Guide to how…' column by: *Water extraction for use in production operations (e.g. potable water supply) in accordance with water licence* Water wells are managed under the Natural Resources Management Act and are not covered by the EIR and SEO
	Obj 6 Goal 6.4	<u>Water disposal</u> What is deemed 'stable ground'? Reference made to 'suitable quality' and defined what the corresponding thresholds are, can indicative volumes also be provided? Consideration given to potential flow paths and topography when disposing to land?	'Stable ground' refers to ground that is not susceptible to erosion. Disposal of hydrotest water to land is not usually undertaken (typically water is captured and returned to the facility) and there are no recent examples that would provide indicative volumes. Volumes for hydrotesting can vary considerably depending on the test parameters (e.g. length and diameter of pipe). If disposal to land is undertaken, flow paths and topography are taken into account (as well as other factors such as sensitivity of vegetation and potential for shallow groundwater). As noted in the first comment in the 'Guide…', water disposal will prevent 'discharge or runoff to watercourses, surface water or environmentally sensitive areas'.
	Obj 6 Goal 6.6	pg 18, guide statements. More information needs to be provided for the annual monitoring of the evaporation ponds. What is being monitored and is annual monitoring effective to achieve the assessment criteria? Regarding the installation of monitoring bores – are there any existing facilities that do not have any monitoring wells that are to continue operation? If yes, then monitoring wells should also be installed at	A list of analytes that are monitored has been added to the EIR. These include total hydrocarbon, BTEX, PAHs, metals, anions and TDS. Produced water quality is relatively consistent over time and annual monitoring is effective to confirm that the assessment criteria are being met. Monitoring frequency is increased where warranted (e.g. if there are significant changes or modifications to the facility or PFW handling system). No, all oil facilities have monitoring bores installed.

Agency	Document Section	Comment	Response
		these facilities.	
	Obj 6 Goal 6.9	1st guide statement, pg 20 – to consider re-wording to 'Compatibility studies regarding water chemistry conducted prior to injection.'	Reworded as suggested.
DEWNR (NVMU)	Obj 3 Goal 3.2	The DWLBC (2005) Guidelines For a Native Vegetation Significant Environmental Benefit Policy For the clearance of native vegetation associated with the minerals and petroleum industry will be subject to review and updating during the end the 2016 calendar year. This is intended to account for proposed changes to Native Vegetation Council policy relating to the process for determining and achieving an SEB. Also, the Native Vegetation Regulations 2003 are also currently under review and will be changed during 2016. The SEO should acknowledge these proposed changes and ensure that it will remain compliant with any subsequent policy or regulatory changes when they occur.	Noted. Date of regulations removed and a note added regarding updates to the Guidelines (note added in the EIR also).
	Obj 4 Goal 4.1	The reportable incidents to include any event that resulted in the removal/damage of native vegetation not within the approved area is reported to DSD and subsequently the Compliance Unit for consideration.	Noted. The reportable incident definitions are industry-wide standard definitions prepared by DSD following consultation and any such change would need to be applied through DSD. Referral to the Compliance Unit would be a DSD/DEWNR procedure/policy issue rather than an SEO matter. If a significant unauthorised clearance occurred, there are existing processes under the PGE Act that DSD use to address activity outside approved areas.
DEWNR (SAAL NRM)	Obj 5	In the section on Guide to How Objectives can be Achieved for Objective 5 "To minimise the impact of production activities on water resources" include a measure to plan activities and seek appropriate approvals to undertake activities on/in areas defined as lakes and wetlands and to minimise disturbance to aquatic habitats. In addition where regular patrols are undertaken to look for evidence of erosion, abnormal vegetation growth or death, include monitoring and appropriate measures implemented to address issue/s.	Reference to planning added. Need to seek approvals is covered by the assessment criteria 'No new water affecting activities …unless relevant permits have been obtained'. Aquatic habitats are covered under Objective 3 and the measures listed there will achieve this outcome. Included reference to monitoring / remedial measures.
DSD	Table 1	The table name has been changed from definition to description as provided in previous versions. DSD requests that this table be named 'Incident Classifications'. DSD also deems that by including this table within the SEO, particularly those defined as Serious Incidents, Beach Energy adopts these definitions as classifications under Section 85(1)(e) of the *Petroleum and Geothermal Energy Act 2000.*	Noted. Change has not been incorporated as: (i) this list is not framed as "classifications" as suggested by DSD in any other SEO; and (ii) Beach does not adopt these as classifications under Section 85 (1)(e) as incidents may occur which fall within the categories listed but which are not serious and should not be treated as such under the legislation.
	Appendix A Objective 6 – Goal 6.1	For the assessment criteria relating to contamination of surface water and/or shallow groundwater, DSD suggest removing the criteria 'No escape or release of petroleum, processed substance, chemical or fuel to surface water and / or groundwater that poses an unacceptable risk to human health or the environment, as determined by an assessment in accordance with the NEPM, taking into account current and post-	Criteria removed and replaced with: No unauthorised discharge or escape of petroleum, processed substance, chemical, fuel or solid wastes to surface water and/or groundwater.

Agency	Document Section	Comment	Response
		activity land uses' and replace with the following criteria – No unauthorised discharge or escape of any liquid (including water, petroleum, processed substance, chemical or fuel) or solid wastes to surface and/or groundwater. DSD requests that the following assessment criteria 'Any escape of petroleum, processed substance, chemical or fuel is either immediately contained and removed or assessed in accordance with NEPM guidelines and remediated in a timely manner' be explicitly written for spills to soil only. DSD believes that the requested changes to the 2 assessment criteria outlined above more appropriately reflect measurement against the Objective. That is, soil contamination must be 'minimised' and water contamination must be 'avoided' DSD also suggest moving the following criteria into the guide to how section 'spills or leaks are contained, cleaned-up, reported and cause investigated and corrective and/or preventative actions implemented.' Part of this criteria overlaps other criteria resulting in confusion and cause investigation and preventative actions are not a measure of achievement against the objective.	Criteria reworded to cover spills to land only Criteria moved.
	Appendix A Objective 6 – Goal 6.6	The draft SEO document (revision 1) previously submitted to DSD had the following assessment criteria under Goal 6.6- 'No evidence of visual hydrocarbons outside interceptor pond walls' and 'No salinisation or seepage evident outside designated disposal area (eg. Adjacent dune corridor)' These criteria appear to have been removed from document revision No.2. DSD request these assessment criteria be reinstated. Beach Energy has not provided any justification for the removal of these criteria.	These criteria were moved to the 'Guide…' column during the review process as they were not clear and unambiguous measures of the goal/objective and therefore considered unsuitable as assessment criteria. In the case of 'No evidence of visual hydrocarbons outside interceptor pond walls', this could refer to visual hydrocarbon on the ground or in the next pond in the series. In either case it would not necessarily result in adverse environmental impact or non-compliance (e.g. the next pond in the series is typically imperviously lined) and therefore is more appropriate as guidance. Visual hydrocarbon on the ground outside pond walls would be covered by the overflow assessment criteria under this goal and the spill provisions in 6.1. In the case of 'No salinisation or seepage evident outside designated disposal area (e.g. Adjacent dune corridor)', this would not necessarily result in an adverse environmental impact (e.g. seepage of fresh water from a freeform area through a bounding small dune could have little impact or even positive impact). Additionally, it is captured better by the last two assessment criteria (particularly 'No observed adverse impact to vegetation outside of the designated disposal area').