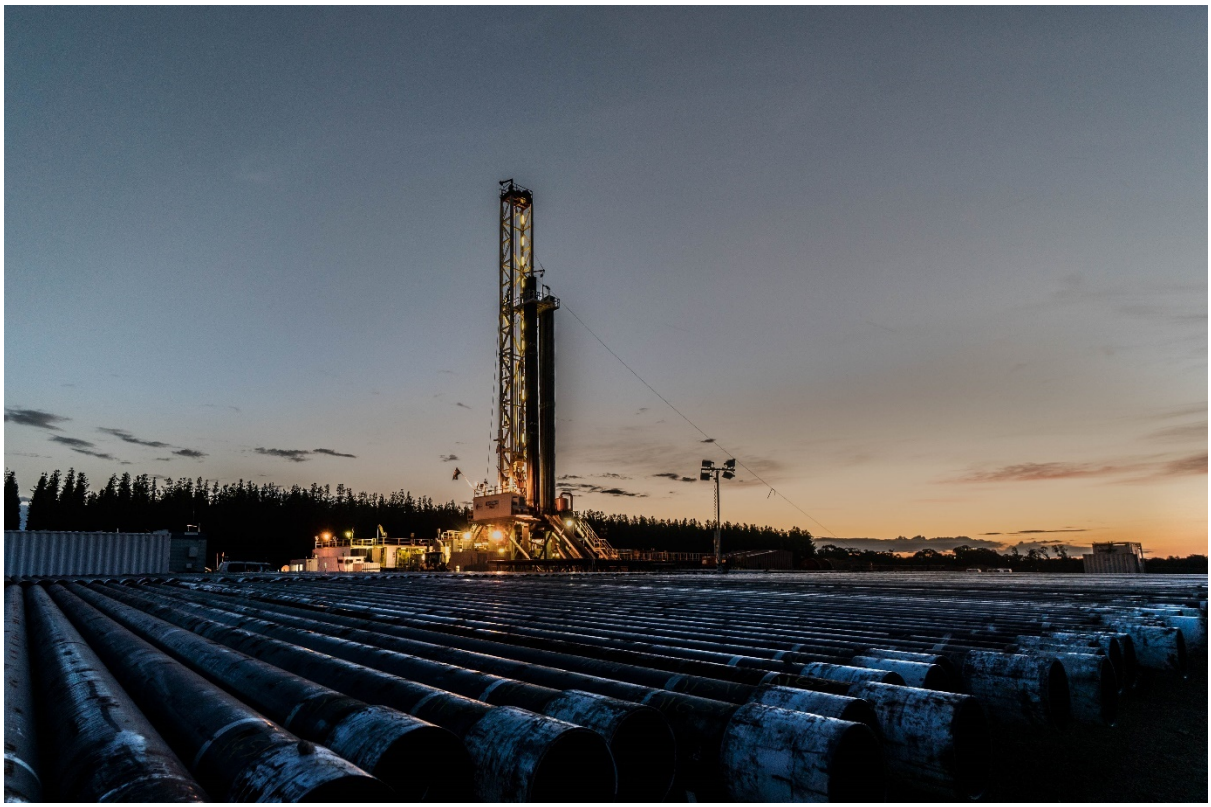
Environmental Impact Report

Drilling, Completion and Well Production Testing in the Otway Basin, South Australia

December 2018



Document Control					
Revision #	Purpose	Author	Reviewer	Approver	Date
0	Issued for submission	SM	SM	SM	4/10/2013
1	Finalised following agency consultation	SM	BW	SM	12/11/2013
2	Final DMITRE comments addressed	TF	SM	SM	13/11/2013
3	5-year review update - draft for internal review	ZB/MM	SM	TF	26/11/2018
4	5-year review update - draft for consultation	BW	SM	TF	30/11/2018

Contents

Figures

Tables

Plates

Summary

Beach Energy Limited and its group subsidiaries (Beach) hold a number of petroleum exploration, production and retention licences in the onshore Otway Basin in the South East of South Australia. This Environmental Impact Report (EIR) has been prepared under the *Petroleum and Geothermal Energy Act 2000* to cover Beach's ongoing drilling activities and related well operations in the region. It updates and supersedes the Environmental Impact Reports (and associated Statements of Environmental Objectives) that have previously been developed to cover drilling activities in the region.

Background

Exploration for hydrocarbons in the South East first commenced in the 1890s and the first deep exploration well, Robe-1, was drilled in 1915. The Katnook gas plant near Penola was established in 1991 following the first commercial gas discovery at Katnook in 1987 and the subsequent discovery of further commercial gas fields. Since this time, companies such as Beach, Origin Energy and Adelaide Energy have continued to explore for hydrocarbons, with a number of successful wells discovering new gas fields.

This EIR relates to ongoing drilling activities, well completions / workovers and well production testing in the onshore Otway Basin. It does not cover other petroleum exploration or production activities such as seismic operations or processing operations at the Katnook gas plant site. Fracture stimulation activities are not proposed and are not covered by this document. This EIR (and the resultant SEO) is 'generic' in nature, covering activities in current and future Beach licences across a relatively broad geographical area, rather than relating to a specific site or sites.

Land Use and Environment

The fertile land of the South East supports a diverse range of industries including wool, meat, dairy, forestry, wine grapes, cereal cropping, horticulture crops and seed production, which are heavily dependent upon water resources in the region. Groundwater is the primary source of water, with the irrigation industry being the most significant user.

The region has low topographical relief and a general absence of surface watercourses. A network of constructed drains is present, which has allowed formerly inundated land to be developed, minimising seasonal waterlogging and removing salt from the region. The alteration of wetland flooding and drying regimes has resulted in a decline in biodiversity in some areas. Native vegetation clearance across the South East is extensive, with an average of 10% of native vegetation remaining. A number of threatened ecological communities and threatened flora and fauna species occur in the region, and are generally confined to or reliant on areas of remnant vegetation.

The region hosts an extensive network of limestone sinkholes and caves, including the World Heritage-listed Naracoorte Caves which are located predominantly north of the Beach licence areas. Eleven National Parks and Wildlife Act reserves are present within the licence areas, however this EIR does not cover activities in National Parks and Wildlife Act reserves.

Penola is the largest town centre within the Beach licence areas. Other nearby population centres include Naracoorte and Lucindale (to the north of the licence areas), Millicent (to the south) and Robe and Beachport (to the west).

Environmental Impact Assessment

This EIR assesses the potential impacts posed by hazards that may result from drilling, completion and well production testing activities. Potential hazards addressed include:

- well site, access track and camp site construction and rehabilitation
- physical presence of drill rig and camp and personnel

- emissions from drilling and workover activities (air, noise, light)
- use of roads and movement of vehicles and heavy machinery
- drilling through shallow freshwater aquifers
- well control incidents (e.g. blowout or kick)
- other downhole issues (e.g. lost circulation, sloughing shales, stuck pipe or drill pipe failure, loss of radioactive source down hole)
- loss of well integrity (e.g. casing or cement failure)
- spills or leaks
- unauthorised access by third parties
- fire
- storage, handling and disposal of waste.

The risk assessment contained in this EIR indicates that the level of risk posed by drilling, completion and well production testing activities is generally low and can be adequately managed to prevent unacceptable environmental impacts. In particular:

- Potential impacts to land use and property management are mitigated through consultation with landowners regarding the location, management and timing of proposed activities, with the aim of minimising disturbance. Ongoing liaison with landowners will be carried out following drilling (and throughout a well's life if it is successful). Sites will be rehabilitated to the satisfaction of landowners following the conclusion of activities, with stockpiled topsoil respread, site contours reinstated and pasture or vegetation re-established, unless landowners request that paved areas (e.g. access tracks) are left in place.
- Significant impacts to flora and fauna are avoided through the environmental assessment and planning process undertaken for individual well sites. This will include locating wells in previously disturbed or cleared areas, fencing to prevent fauna (or stock) access, weed and fire prevention measures and transport procedures. Areas of high quality or significant native vegetation and significant wetland areas will be avoided.
- Spills or leaks of fuels, oils or chemicals are mitigated by restricting the storage and handling of fuel and chemicals to designated areas on the paved drill pad, use of appropriate secondary containment and immediate clean-up and remediation of any spills. The drilling sump will be lined with an impermeable liner to prevent percolation into the soil and sump contents will be removed on completion of the activities.
- Aquifers will be protected by casing and cementing of wells. Well integrity will be maintained via appropriate design, installation and monitoring of wells during drilling and throughout the well's life.
- Well control incidents are extremely rare, particularly in areas such as the Otway Basin. Considerable safety measures including guidelines, procedures, safety practices, design considerations, certification of trained individuals and an emergency response plan will be in place.
- Traffic management and noise limitation procedures will be implemented, and adequate buffers will be maintained between well sites and residences. Impacts to landholders and communities will be mitigated through ongoing consultation regarding the proposed activities, with the aim of identifying potential issues and minimising disturbance.

A range of management measures that will be implemented are listed in the EIR and will be incorporated into the accompanying Statement of Environmental Objectives.

Stakeholder Consultation

Beach is committed to maintaining open and effective communication and good relations with all stakeholders and has been undertaking a program of consultation with directly affected parties, the broader community and other stakeholders. In August 2018, Beach held 'drop-in' sessions at the Wattle Range Council offices in Millicent and Penola. The aim of the sessions was to provide the local community an opportunity to meet with Beach to discuss future development plans for the Penola region. A multi-discipline team of Beach employees attended the sessions to answer questions on exploration and production activities.

Beach informed stakeholders who attended the public meetings and used local ABC radio to inform the draft documents would be available for review on its website over a four-week period. Hard copies of the documents were provided to stakeholders upon request. Comments are addressed in this EIR and the accompanying SEO. [To be completed following public consultation on draft documents]

Ongoing liaison will be undertaken with landowners whose properties are likely to be sites for future wells and Beach will continue to consult with stakeholders as the drilling operations progress, to ensure that all potential concerns are identified and appropriately addressed.

Beach is confident that with the implementation of the management measures outlined in the EIR, the proposed activities do not present a significant level of environmental risk

1 Introduction

Beach Energy Limited and its group subsidiaries (Beach) hold a number of petroleum exploration, production and retention licences in the onshore Otway Basin in the South East of South Australia.

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 Otway Basin Drilling SEO was originally approved in 2013. The SEO is subsequently being revised. This Environmental Impact Report (EIR) has been prepared to use as a basis for preparation of the revised SEO.

1.1 Background

The Otway Basin is located along the south-east margin of the Australian mainland and is second only to the Cooper and Eromanga Basins as the most explored province in South Australia for oil and gas. About 70% of the basin is offshore, commencing in South Australian waters south-east of Kangaroo Island in the west where the basin passes into the Duntroon Basin and continues to the east of Port Phillip Bay in Victoria. The South Australian onshore sector of the Otway Basin is located in the South East region and covers approximately 9,650 km^2 (Boult and Hibburt 2002).

Exploration for hydrocarbons in the South East commenced in the 1890s, with the first deep exploration well, Robe-1, drilled in 1915. The first commercial gas discovery was made at Katnook in 1987, followed by discovery of the Ladbroke Grove Field in 1989. Since then the Katnook, Haselgrove, Haselgrove South and Redman commercial gas fields have been discovered and the Katnook gas plant was established in 1991. Since this time, Origin Energy, Adelaide Energy and Beach have continued to explore for hydrocarbons, with a number of successful wells discovering new gas fields including Wynn-2 in 2005 and Jacaranda Ridge-2 in 2007. Beach has a long history of exploration in the onshore Otway Basin, with Beach's first well in the basin (Geltwood Beach-1) drilled in 1963. Beach has drilled a total of 33 wells in the onshore Otway Basin across South Australia and Victoria. Most recently, Beach drilled the Haselgrove-3 well approximately 8 km south of Penola in September 2017.

Beach considers the Otway Basin to have substantial exploration potential because of its existing conventional gas, condensate and oil discoveries.

Beach plans to continue exploration for hydrocarbons in the Otway Basin and has prepared this EIR to cover ongoing drilling activities.

1.2 Beach Energy Company Profile

Beach Energy is an ASX listed, oil and gas exploration and production company headquartered in Adelaide, South Australia. It has operated and non-operated, onshore and offshore, oil and gas production from five producing basins across Australia and New Zealand, and is a key supplier to the Australian east coast gas market.

Beach's asset portfolio includes ownership interests in strategic oil and gas infrastructure, such as Moomba processing facility, as well as a suite of high potential exploration prospects.

Beach currently holds one exploration licence, three production licenses and four retention licenses in the South Australian section of the Otway Basin, both in its own right and with co-ventures. The locations of Beach's operations are shown in Figure 1.1.

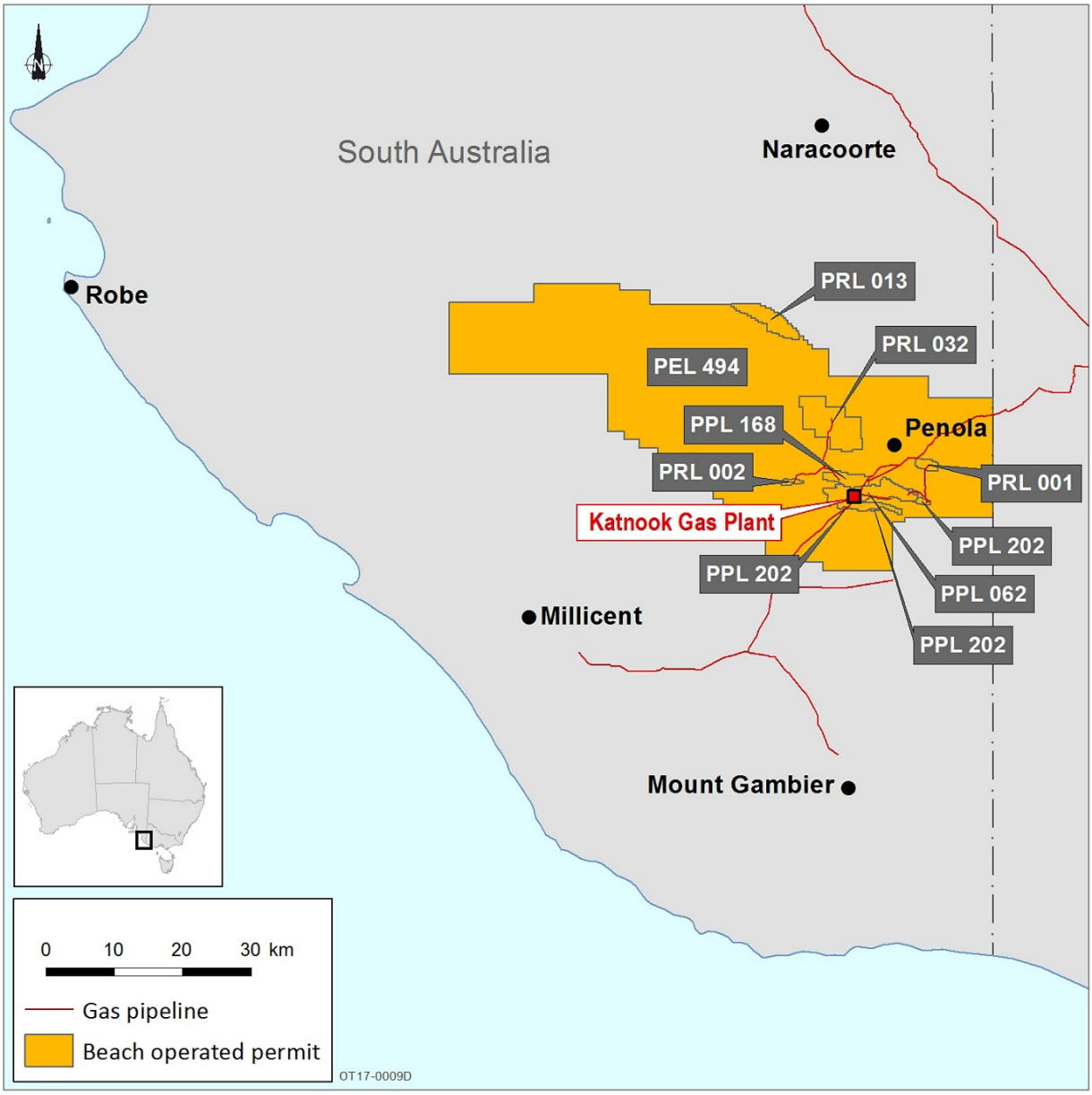


Figure 1.1: Location of Beach Energy's onshore South Australian Otway Basin Licence Areas

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 Section 97 of the Act and Regulation 10 of the *Petroleum and Geothermal Energy Regulations 2013*.

The regulator, Department for Energy and Mining (DEM), is to undertake an Environmental Significance Assessment of this document to classify the activities which are the subject of this EIR as 'low', 'medium' or 'high' impact (refer Section 2.1.3). Following this classification, a Statement of Environmental Objectives (SEO) will be developed reflecting the activities and impacts detailed in this document or other assessments that may be required depending on the classification. The SEO will outline the environmental objectives that must be achieved and the criteria on which achievement of the objectives is to be assessed.

1.3.1 Scope

This document (and the accompanying SEO) is 'generic' in nature, covering drilling, completion and well production testing activities in current and future Beach licences across a relatively broad geographical area, rather than relating to a specific site or sites, or to specific projects. This approach has been applied in many other EIRs and SEOs that have been developed under the Petroleum and Geothermal Energy Act including previous EIRs and SEOs developed by Origin Energy, Adelaide Energy and Beach Energy for exploration in the onshore Otway Basin.

As discussed in Section 2.1.4, prior to the commencement of drilling activities, additional site-specific and technical detail for operations at individual well sites must be provided to DEM under the activity notification / approval requirements of the Act, including a demonstration that the activities are covered by (and are compliant with) an applicable SEO.

This document relates to drilling activities, well completions / workovers, well production testing and decommissioning following drilling[1] in the onshore Otway Basin in South Australia. This EIR and the accompanying SEO do not apply to petroleum activities such as:

- seismic exploration activities
- fracture stimulation
- production and processing operations beyond well production testing
- production and processing operations at the Katnook gas plant site
- well operations (after drilling has finished) including production completions and workovers, well integrity management, artificial lift and wellhead production equipment, gas well deliquification and downhole decommissioning following production[2]

[1] Decommissioning of wells is equivalent to 'abandonment', which is the technical term used in the Petroleum and Geothermal Energy Regulations.

[2] Well decommissioning following production is proposed to be covered under the scope of Beach's Onshore Otway Basin Petroleum Production Operations EIR and SEO. It has been retained in this drilling EIR and the accompanying SEO to ensure coverage is maintained, as the production EIR and SEO had not been approved at the time of writing. Once approved, the production SEO would provide coverage of decommissioning following production.

- field production / processing equipment installation, operation, decommissioning and rehabilitation
- pipeline construction, operation and decommissioning.

2 Legislative Framework

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

2.1 Petroleum and Geothermal Energy Act

The legislation governing onshore petroleum exploration and production in South Australia is the *Petroleum and Geothermal Energy Act 2000* and *Petroleum and Geothermal Energy Regulations 2013*. This legislation is administered by Department for Energy and Mining (DEM).

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.

The Act and Regulations are objective-based rather than prescriptive. An objective-based regulatory approach principally seeks to ensure that industry effectively manages its activities by complying with performance standards that are cooperatively developed by the licensee, the regulatory authority and the community. This contrasts with prescriptive regulation where detailed management strategies for particular risks are stipulated in legislation.

Regulated resources, as defined in Part 1 of the Act, are:

- a naturally occurring underground accumulation of a regulated substance
- a source of geothermal energy, or
- a natural reservoir.

A reference in the Act to petroleum or another regulated substance extends to a mixture of substances of which petroleum or other relevant substance is a constituent part. Regulated substances as defined in Part 1 of the Act are:

- petroleum
- hydrogen sulphide
- nitrogen
- helium
- carbon dioxide
- any other substance that naturally occurs in association with petroleum; or
- any substance declared by regulation to be a substance to which the Act applies.

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.

2.1.1 Statement of Environmental Objectives

As a requirement of Part 12 of the Act, a regulated activity can only be conducted if an approved Statement of Environmental Objectives (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's Otway Basin Drilling SEO was originally approved in 2013. The SEO is subsequently being revised. This Environmental Impact Report (EIR) has been prepared to use as a basis for preparation of the revised SEO.

2.1.2 Environmental Impact Report

In accordance with Section 97 of the Act, an Environmental Impact Report 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 Regulations, for the purposes of an EIR, a licensee must provide:

- 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 information on:
    - events during the construction stage (if any), the operational stage and the abandonment stage
    - events due to atypical circumstances (including human error, equipment failure or emissions, or discharges above normal operating levels)
    - information on the estimated frequency of these events

  - an explanation of the basis on which these events and frequencies have been predicted
- an assessment of the potential consequences of these events on the environment, including information on
  - the extent to which these consequences can be managed or addressed
  - the action proposed to be taken to manage or address these consequences
  - the anticipated duration of these consequences
  - the size and scope of these consequences and
  - the cumulative effects (if any) of these consequences when considered in conjunction with the consequences of other events that may occur on the relevant land (insofar as this is reasonably practicable); and
- an explanation of the basis on which these consequences have been predicted
- a list of all owners of the relevant land
- information on any consultation that has occurred with the owner of the relevant land, any Aboriginal groups or representatives, any agency or instrumentality of the Crown, or any other interested person or parties, including specific details about relevant issues that have been raised and any response to those issues, but not including confidential information.

2.1.3 Environmental Significance Assessment and SEO Consultation Requirements

The EIR is submitted to DEM and an Environmental Significance Assessment is undertaken in accordance with criteria established under Section 98 of the Act[3], 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 DEM will be required to undertake prior to approval decisions being made on 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[4] .
- **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 DEM website.

[3] Criteria for classifying the level of environmental impact of regulated activities are published on the DEM website: http://energymining.sa.gov.au/petroleum/legislation_and_compliance/environmental_register#criteria

[4] The activities described in the 2013 EIR were assessed as low impact and the results of consultation with government agencies were incorporated into the 2013 EIR and SEO.

2.1.4 Activity Notification / Approval Process

Prior to commencing a regulated activity, Section 74(3) of the Petroleum and Geothermal Energy Act requires 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 DEM 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.

The site-specific detail provided would include an assessment of the environment of the proposed location, investigation of specific issues (such as the likelihood of occurrence of threatened species or areas of sensitivity) and proposed measures to minimise impacts to key issues (e.g. modified techniques for more sensitive areas, sensitive locations to avoid).

2.2 Other Legislation

A variety of legislation applies to petroleum activities. Legislation that is particularly relevant to petroleum exploration is listed below (note that this is not a comprehensive list of all applicable legislation) and additional detail on key legislation is provided in the following the list.

Commonwealth

Aboriginal and Torrens Strait Islander Heritage Protection Act 1984

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Native Title Act 1993

South Australia

Aboriginal Heritage Act 1988

Crown Lands Act 1929

Development Act 1993

Environment Protection Act 1993

Fire and Emergency Services Act 2005

Forestry Act 1950

Heritage Places Act 1993

Marine Parks Act 2007

National Parks and Wildlife Act 1972

Native Title (South Australia) Act 1994

Native Vegetation Act 1991

Natural Resources Management Act 2004

National Trust of SA Act 1955

South Australian Public Health Act 2011

Work Health and Safety Act 2012

Commonwealth Environment Protection and Biodiversity Conservation Act

Approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required for activities that impact matters of national environmental significance including World Heritage properties, National Heritage places, Ramsar wetlands of international importance, listed threatened species and ecological communities, migratory species, Commonwealth marine areas, the Great Barrier Reef Marine Park, nuclear actions and a water resource in relation to coal seam gas development and large coal mining development.

With regard to operations in the onshore Otway Basin, issues that may trigger approval requirements under the EPBC Act can generally be avoided by site selection. Based on current expectations, Beach believes that a requirement for approval under the Act is not likely to be triggered.

Native Vegetation Act

Exploration activities that are approved under the Petroleum and Geothermal Energy Act do not require approval under the *Native Vegetation Act 1991* for clearance of native vegetation, provided that the activities are undertaken in accordance with approved industry standards that are directed towards minimising impact and encouraging regrowth of any native vegetation that is cleared (see Regulation 15 of the *Native Vegetation Regulations 2017*).

As discussed in Section 5.4, Beach plans to avoid activities in areas of high quality or significant remnant vegetation.

Environment Protection Act

The *Environment Protection Act 1993* imposes a general duty of care 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. Environmental authorisations are required to undertake activities prescribed under 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 lease or licence under the Petroleum and Geothermal Energy Act when produced and disposed of to land and contained within the area of the lease or licence.

Natural Resources Management Act

Drilling of a new water sourcing bore requires a permit under the Natural Resources Management (NRM) Act. Extraction of groundwater within a prescribed wells area (including the Lower Limestone Coast Prescribed Wells Area) generally requires a licence / allocation under this Act, however there is an authorisation in place under Section 128 of the NRM Act to take groundwater for use in drilling, construction and testing of hydrocarbon exploration wells.

The NRM Act and the South East Regional NRM Plan also set out a number of water affecting activities that must not be undertaken without a permit. These are usually avoidable by careful planning and siting of infrastructure to avoid watercourses and surface water features and maintain water flows. The NRM Act also governs the control of declared pest plants and animals.

Development Act

The Development Act has special provisions relating to activities carried out under the Petroleum and Geothermal Energy Act and it only applies in some cases. Activities classified as 'high impact' are required to be assessed under the provisions of the Development Act. DEM must refer applications for production tenements or Statements of Environmental Objectives to the Department of Planning, Transport and Infrastructure (DPTI) in some cases (e.g. in Schedule 20 areas). The Building Rules apply to some classes of building work carried out under the Petroleum and Geothermal Energy Act.

3 Description of Activities

The following section provides an overview of drilling, completion and well production testing activities.

3.1 Well Site, Access and Camp

3.1.1 Well Site

Drilling operations require the construction of a stable drill pad for the placement of the drilling rig, with areas for associated equipment including generators, fuel and chemical storage, casing and pipe storage and site offices.

A drill pad area of approximately 150 m x 150 m will be levelled and paved for the drill rig and associated equipment. At most well sites, topsoil is removed from the pad area and stockpiled adjacent to the pad for use in site rehabilitation. Any subsoil removed (e.g. from excavations) is stockpiled separately. In some circumstances, alternate construction methods such as laying paving materials on geotextile or directly on topsoil may be used (e.g. where very heavy soils are present or where the landowner has requested that the pad remains after drilling).

The pad will be paved with gravel to a depth of approximately 30 cm. Thicker paving (50 cm) may be required for the rig base (approximately 40 m x 20 m). The pad will be constructed so that any runoff from upslope of the pad will be directed away from the pad.

If the grass is dry or operations are within the fire season, the pad will be surrounded by a 10 m wide ploughed or graded firebreak.

A shallow sump (typically in the order of 25 m x 30 m x 2 m deep) will be constructed to hold drill cuttings and waste drilling muds. This sump will be lined with a polyethylene liner which is removed when the sump is rehabilitated. A 'turkeys nest' (a circular dam, lined with plastic to prevent water loss) may also be constructed to hold clean, fresh water on site prior to use in drilling, if required. If a turkeys nest is used, the liner would be removed at the end of drilling to prevent degradation issues.

A flare tank will be located adjacent to the drill pad for emergency situations during drilling operations. A vertical flare stack will be used for well production testing. A firebreak will be ploughed or graded around the flare tank or stack if required.

A fence will be constructed to enclose the well site area (approximately 3 hectares) and the access track, if required. Lockable gates will be placed across the start, or an appropriate section, of the access track. All activities will be confined to within the fenced area. A firebreak may be ploughed or graded along the outside of the fence.

Figure 3.1 shows an indicative layout of a well lease for a petroleum drilling rig.

3.1.2 Access Track

A short access track will be constructed from the public road to the drill pad, along an alignment approved by the landowner. Access tracks are typically 4 m wide except on bends and at entry and exit points to the camp and pad where the width is 8 m. There will generally be a ring road built for safety and for keeping trucks to the gravelled areas rather than causing wheel ruts in the undisturbed lease areas. If adjacent grass is dry, a graded or ploughed firebreak along each side of the access track will be constructed.

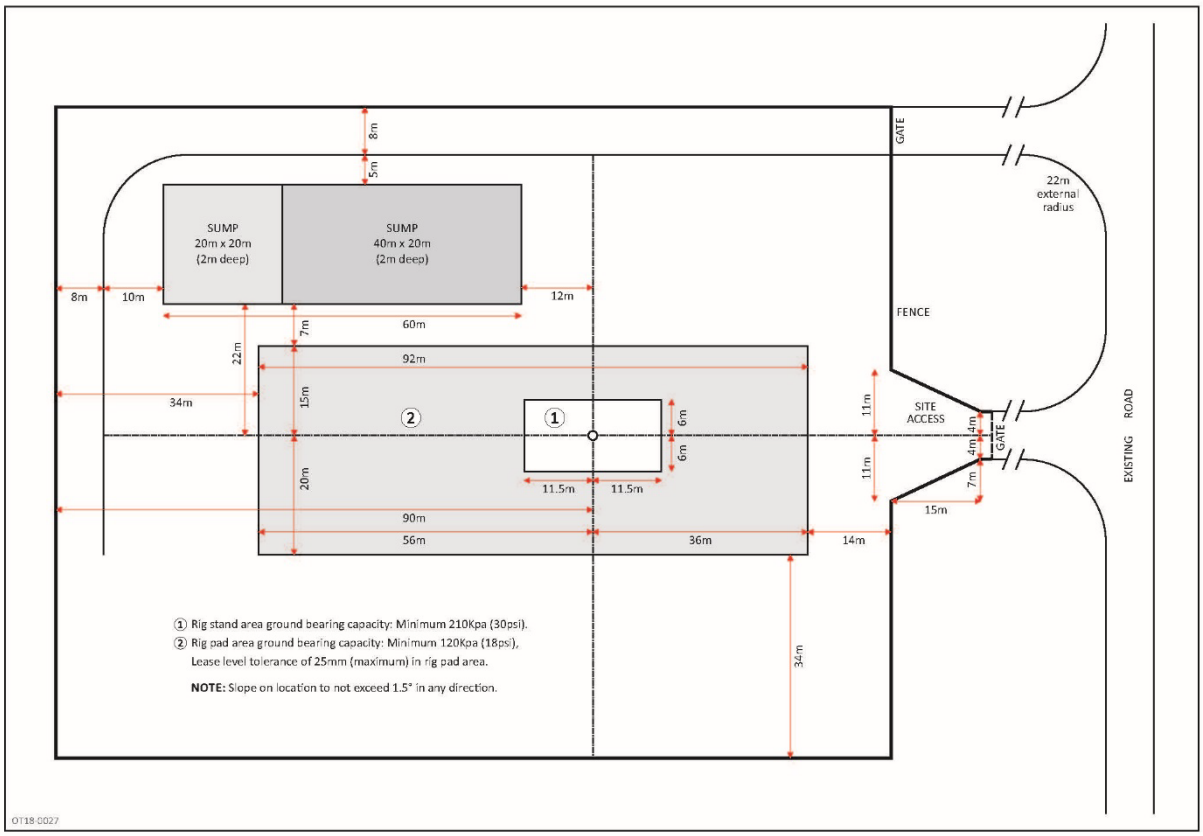


Figure 3.1: Indicative well lease layout diagram

3.1.3 Water Supply

A volume of less than 4 ML of water is typically required to drill a well. If a nearby water bore is acceptable, water will be pumped from it, subject to agreement of the landowner. A new bore may be required to be drilled on site if this is not an option. This will be drilled by a local licensed water well driller, with all necessary approvals (e.g. well construction permit) obtained from the relevant authority.

3.1.4 Camp

A camp will be required to house the drilling crew during construction. An area of approximately 80 m x 50 m adjacent to the drill pad will be used for a self-contained 40 person re-locatable camp equipped with wastewater processing units and septic tanks. Disturbance to the soil surface will be kept to a minimum. It will be necessary to lightly pave the camp area with gravel.

Toilet facilities with wastewater processing units and septic tanks will be provided at the camp and the well site. Septic tanks will be used to contain all wastewater (black water and grey water) and will be pumped out by licensed contractors as required for disposal at a licensed facility. Small pits will be constructed to house the tanks which will be removed after drilling operations are completed. Any necessary approvals (e.g. local council) for the installation of the septic tanks will be obtained.

3.2 Drilling Operations

Drilling activities will be typical of standard onshore petroleum exploration drilling. Drilling of a well in the onshore Otway Basin typically takes 21 to 50 days and is carried out on a 24-hour, seven day per week basis. Plate 1 shows a typical drilling rig in operation in the onshore Otway Basin.

Drilling operations involve drilling to a projected depth (typically 3000 m to 4500 m) with a rotary drilling rig using recirculated water-based muds (and possibly synthetic based muds (SBM) in deep sections of the well) and running and cementing various casing strings.

A diagram of a well showing the various casing strings for an indicative well design for the onshore Otway Basin is presented in Figure 3.2. The drilling process for this indicative well design would involve:

- installing the conductor pipe at the surface, which provides the initial stable structural foundation for the well
- drilling through the surface sediments to the top of the Eumeralla Formation, and installing and cementing the surface casing so that the surface aquifers are not in communication with the well bore
- drilling of a slightly smaller hole to approximately 1800 m to 2600 m, running the intermediate casing and cementing it in place
- drilling to the total depth of the well, running the final casing string in the hole and cementing it in place.

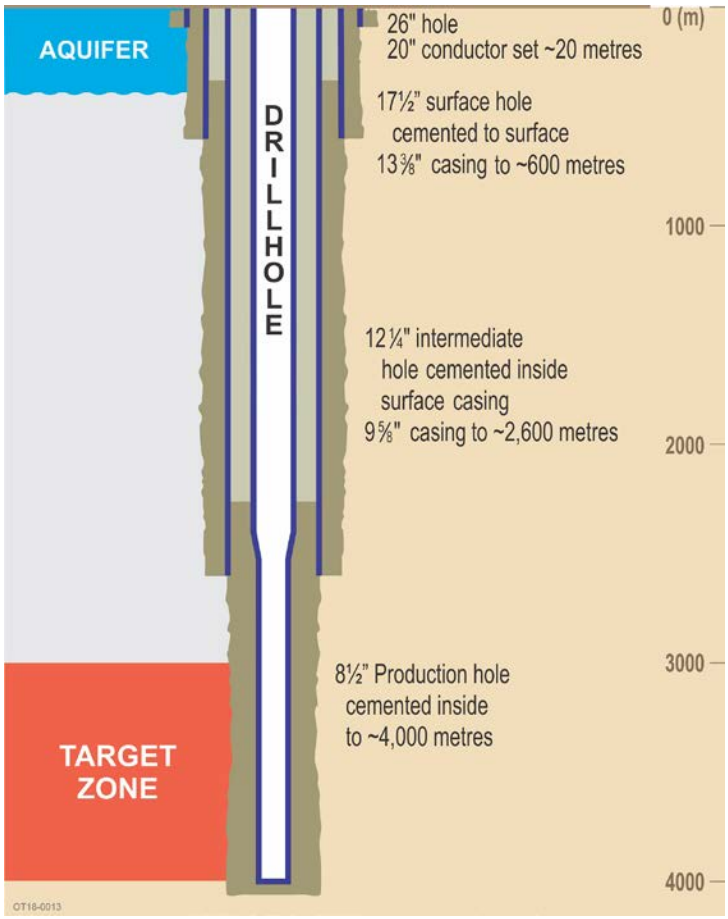


Figure 3.2: Indicative well design showing various casing strings

Variations to this indicative well design are possible, however the general principles of drilling, casing and cementing would remain the same. It is possible that wells could also be drilled with a directional section in the target zone, at the deepest part of the well. The well construction is likely to be similar

to that shown in Figure 3.2, except that while drilling the deepest part of the hole (the 8 ½" hole in Figure 3.2), the well trajectory would be gradually steered from the vertical to the required angle in the target layer. Once in the target zone, the well would continue to be drilled for several hundred metres up to 1,000 m or more, before being cased and cemented.

Logging is carried out during or after drilling, to measure the physical properties of the target formation to provide information on the lithology, formation fluid, formation porosity and formation permeability. Sidewall cores may be taken to obtain samples of the rock at specific depths. Reservoir pressure data and fluid samples may also be acquired. Logging can be performed whilst drilling or using wireline logging tools.

Plate 1: Drilling rig operating in the onshore Otway Basin, near Penola (Haselgrove-3, 2017).

Drill stem testing may be used to evaluate pressures and production from any potential hydrocarbon producing formation(s). Drill stem tools would be set to cover the zone of interest, and if the well has potential to flow, it will produce to the surface where it is measured. The production would flow through a separator tank or to a flare stack. Any small quantities of water produced would be directed to the sealed tank and removed off site for appropriate disposal at a licensed facility.

A range of chemicals may be used during drilling, completion and testing operations, including:

- polymers e.g. PHPA (partially-hydrolysed polyacrylamide)
- barites
- biocide
- bentonite
- caustic soda
- LCM (lost circulation material)

- potassium chloride
- sodium carbonate
- sodium sulphite
- synthetic base fluid for synthetic based mud (SBM) drilling fluids.

Drilling fluids are used to transport drilling cuttings to the surface, prevent well-control issues, preserve wellbore stability, and cool and lubricate the drill bit and drill string during drilling. Water-based fluids will predominantly be used for drilling operations. Water-based fluids consist of water mixed with potassium chloride, bentonite clay and barite to control mud density. Other substances are added to gain the desired drilling properties to assist with drilling parameters and removing drilled cuttings from the hole.

Synthetic based muds (SBM) may be used in intermediate or production hole sections in deeper wells to assist with drilling parameters and hole stability. SBM are emulsions where the base fluid is a synthetic fluid. As with water-based fluids, weighting materials such as barite are used to provide sufficient fluid density. SBM were developed for offshore drilling to improve both the technological and environmental profile of drilling fluids over traditional oil-based fluids. This fluid has superior inhibition characteristics when compared to WBM as it limits clay swelling and dispersion as well as improving clay stability. The use of SBM also reduces drag, torque and friction as a result of improved lubrication.

Drilling fluids selection and management will be undertaken in line with the Beach Well Engineering Construction System (WECS) to ensure that handling, management and disposal of drilling fluids does not pose an unacceptable risk to the environment.

Cuttings and drilling fluids will be contained in the lined sump or tanks during drilling operations and subsequently tested and disposed of at appropriately licensed waste disposal facilities. Tanks will be used to contain SBM muds and cuttings.

If commercial quantities of hydrocarbons are discovered, well production testing may be carried out, as discussed in Section 3.4. If a well fails to discover commercial quantities of hydrocarbons it will be plugged and abandoned as discussed in Section 3.5.

3.2.1 Traffic Movements

The drilling rig will be mobilised to site using public roads and the well access track. Traffic movements for a drilling operation would typically include 65-75 trucks for the drilling rig move, 10 trucks for the camp move, 15 trucks for casing, 4 trucks for cement, fuel deliveries every 5 days and food supply delivery weekly.

The rig, camp and ancillary services generally arrive on site over a period of 3-4 days at the start of the well and depart in a similar fashion upon conclusion of the well. Stakeholders (e.g. landholders, local councils, potentially affected residents) and emergency services are informed of significant activities such as rig mobilisation and demobilisation.

Daily traffic movements to and from the well site are relatively limited once drilling starts and are generally restricted to low numbers of light vehicles and the supply truck movements noted above. Cementing, logging and testing contractor personnel will be mobilised as required and visitors may access the site under control of the drilling supervisor. Access by the general public will be restricted.

3.2.2 Fuel and Chemical Storage

A variety of fuels and chemicals are required for drilling and well operations. These include fuel, lubes, oils, solvents and drilling mud additives. The volumes and types of chemicals used are dependent upon the type of operation. Fuels, oils and chemicals are stored in accordance with applicable standards

and guidelines (e.g. AS 1940, EPA guidelines), typically in approved containers in polythene lined bunded areas or on bunded pallets.

3.2.3 Waste

A range of wastes are generated during drilling and well operations. They include:

- domestic waste (e.g. food waste and packaging, plastic, glass, cans and paper)
- industrial waste (e.g. workshop waste (rags, filters), chemical bags and cardboard packaging materials, scrap metals, used chemical and fuel drums, chemical wastes and timber pallets).

Waste streams are segregated on site and collected and stored in covered bins before being collected for transport off-site by a licensed regulated waste contractor to an appropriately licensed facility for reuse / recycling (where possible) or disposal. Waste management practices will be guided by the principles of the waste hierarchy (i.e. avoid, reduce, reuse, recycle, recover, treat, dispose).

3.3 Completions and Workovers

Well completion activities are carried out to prepare the well for production. They are carried out after running and cementing the production casing and installation of the well head, and may include cleaning out the casing, perforating the zones of interest, running tubulars, setting packers, running production logging tools and static gradients.

Workover operations may also be carried out on a well. Typically these occur later in a well's life span but may be required soon after drilling. They may include cleaning sand out of the well, replacing liners, plugging the well, repairing casing, drilling deeper, drilling around any obstructions in the well, and re-perforating existing zones in production. Some workovers require only wireline equipment to lower tools into the hole to conduct operations, but others require a workover rig to be moved to the location. Pumps and storage tanks are required for operations that need to circulate workover fluids in the well.

3.4 Well Production Testing

In the event of a significant gas or oil discovery, the well will be completed and a well production test undertaken. Initial well production tests typically take place over a period of several days, however, extended well production testing may be necessary over a number of weeks on exploration and appraisal wells to allow for more detailed information on the reservoir.

3.4.1 Well Production Testing – Gas

In the case of a potentially producing gas discovery, a single / multirate flow and buildup operation would be undertaken, with produced gas flared off. Details will be dependent on the outcome of drilling, but a well production test for gas, while 'producing' under the meaning of the Petroleum Act, will not require significant additional surface infrastructure. A separator may be required to remove liquids to a tank for measurement and subsequent transportation by a licensed contractor to a processing or licensed waste disposal facility. If well production testing were successful, approval would be sought for upgrading to production rather than exploration facilities.

3.4.2 Well Production Testing – Oil

If warranted by oil shows, a drill stem test(s) would run with open / shut-in times based on hole and drilling conditions. Any zones would be progressively tested, based upon quality of oil shows. Total oil volume produced from such drill stem tests is low, likely from nil to 50 barrels maximum. Further oil well production testing may be performed to provide increased confidence in the commercial possibilities of the discovery. This testing would be conducted over a 24 hour to 7 day period following completion of the well. Produced oil would be stored in a special purpose tank for subsequent transport to a processing facility.

3.5 Well Decommissioning[5]

3.5.1 Decommissioning Following Drilling

Following the drilling of a well and testing and evaluation of its potential, a decision is made on whether to proceed with production of the well or to decommission it. If a decision is made to decommission the well the following steps are undertaken:

- plugs are set to isolate all formations that have hydrocarbons
- plugs are set across separate aquifers
- plugs are set across the surface casing shoe and intermediate casing shoe (if present)
- a plug (typically 30 m) is set at the surface prior to cutting off the surface casing bowl
- an abandonment plaque is posted (generally on the nearest fenceline).

The well site is then cleaned up and reinstated as described in Section 3.6 below.

Decommissioning programs are submitted to DEM for prior approval.

3.5.2 Decommissioning Following Production

Once a well has reached the end of its productive life a decision is made on whether to decommission the cased well bore or leave it in a suspended state until it can be decommissioned.

Each well is evaluated individually to design the decommissioning program based on best industry practice to ensure two independent and verifiable barriers are in place. Decommissioning programs are submitted to DEM prior to implementation. The decommissioning 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 deemed insufficient, a decision may be made to access outer annuli to place appropriate plugs to achieve isolation of aquifers with other aquifers or hydrocarbon producing zones
- 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 decommissioning at the surface will involve a surface cement plug and cutting or removing the wellhead to below natural ground level
- an abandonment plaque may be posted (generally on the nearest fenceline).

The well site is then cleaned up and reinstated as described in Section 3.6 below.

Note: As noted in Section 1.3, decommissioning following production is proposed to be covered under the scope of Beach's Onshore Otway Basin Petroleum Production Operations EIR and SEO. It has been retained in this drilling EIR and the accompanying SEO to ensure coverage is maintained, as the production EIR and SEO had not been approved at the time of writing. Once approved, the production SEO would provide coverage of decommissioning following production.

[5] Decommissioning of wells is equivalent to 'abandonment', which is the technical term used in the Petroleum and Geothermal Energy Regulations.

3.6 Site Clean-up and Reinstatement

Rehabilitation and restoration of the access road, camp and drill pad will be completed to meet the landowner's approved requirements.

If the well is decommissioned following drilling (i.e. 'plugged and abandoned' as a dry well) and the landowner does not seek to use the paved area, all paving material brought to the site will be removed. If the well is completed for production, the site will be partially restored, leaving sufficient pad and access required for a production well.

A fence will be installed around the sump following drilling. Contents of the sump will be tested to analyse their suitability for reuse, industrial recycling, fill or disposal as waste. Water from the sump may be removed for reuse if water quality meets applicable criteria for the reuse (e.g. EPA guidelines, ANZECC criteria). Sump contents to be disposed as waste will be removed by a licensed contractor to an EPA licensed waste disposal facility, as soon as possible after drilling is completed. The liner will be removed and the previously excavated sump materials will be returned in the correct order.

All pits including excavations for the septic tanks will be backfilled with previously excavated materials in correct order, so that normal cropping or grazing practices can resume after decommissioning of the site.

The original topography and slope of the well site will be restored and any topsoil evenly redistributed across the disturbed area to ensure that the original drainage and cropping potential are restored.

The whole area previously gravelled will be tine ripped before replacing of stockpiled topsoil. This alleviates soil compaction and enables good rehabilitation back to pasture or crops. Small stones not picked up by front end loaders or excavators will be rolled into the soil as is common farming practice. A final shallow ploughing / harrowing will be carried out to ensure soil aeration and permeability. A crop / pasture will then be sowed for additional soil stabilisation. Perimeter fencing is generally left in place until vegetation is well established.

If well sites are established in areas where native vegetation is present, site-specific rehabilitation methods will be developed. These may include respreading of cleared vegetation, reseeding or revegetation with local native species, or encouragement of natural regeneration by appropriate site preparation in areas where this is likely to be successful. Restoration is usually carried out in autumn to avoid the summer heat and dry soil conditions and to make the best use of autumn and winter rains to achieve the maximum vegetation regrowth. All restoration and rehabilitation activities will be undertaken in consultation with, and to the satisfaction of the landowner.

Plate 2 shows a rehabilitated well site (Cowrie-1) in the onshore Otway Basin north-west of Penola in July 2013, approximately seven years after drilling and rehabilitation.

Plate 2: Rehabilitated Cowrie-1 well site (July 2013). (Source: Beach).

4 Description of the Environment

This section provides an overview of the environment of the lower South East of South Australia, with a focus on the region encompassed by Beach's licence areas.

Figure 4.1shows the petroleum licences owned by Beach Energy in the region and shows surrounding towns, current infrastructure in place and conservation reserves.

4.1 Climate

The climate of the lower South East of South Australia is described as Mediterranean, with warm dry summers and cold wet winters (South East NRM Board 2010). The southern coastal zones of the region typically experience high average rainfall which gradually decreases inland and towards the north. Annual rainfall ranges from approximately 850 mm in the south of the region, to approximately 450 mm further north.

A summary of climate records for Coonawarra (Station no. 026091; BOM 2018) is provided in Table 4-1.

Table 4-1: Temperature and rainfall records for Station #026091 (Coonawarra)

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean Daily Max (°C)	27.4	27.5	25.0	21.0	17.2	14.5	13.9	14.8	16.9	19.6	22.7	25.0	20.5
Mean Daily Min (°C)	11.7	11.8	10.2	7.8	6.9	5.4	5.1	5.3	6.5	7.3	8.9	10.1	8.1
Mean Rainfall (mm)	28.9	17.9	27.4	37.5	54.4	74.3	80.5	82.3	62.4	45.4	35.3	36.8	568.7
Median Rainfall (mm)	20.0	17.6	21.6	31.3	51.0	68.8	76.6	82.8	63.2	42.8	34.5	26.8	545.6
Highest Rainfall (mm)	101.7	55.6	80.0	83.6	120.2	168.9	143.0	160.8	134.4	90.8	80.3	105.4	746.4

The Coonawarra climate data indicate that mean daily maximum temperatures across the Beach licence areas range from approximately 13.9°C in the coolest months (June to August) and 27.5°C in in the hottest months (December to March). Mean daily minimum temperatures range from between 5.1°C in the cooler months to 11.8°C in the hottest months.

Average annual rainfall at Coonawarra is 569 mm. Maximum rainfall occurs during July and August. The highest monthly rainfall recorded is 168.9 mm, in June 2003. The highest daily rainfall event on record (79.6 mm) occurred in January 2007. Winds tend to come from the south during the morning, and from the east and north east during the afternoon.

4.2 Landform and Soils

The South East region is characterised by a series of stranded dune ranges that rise between 20 m and 50 m above interdunal plains. The region hosts an extensive network of limestone sinkholes and caves, including the World Heritage-listed Naracoorte Caves (located approximately 30 km to the north of the licence areas).

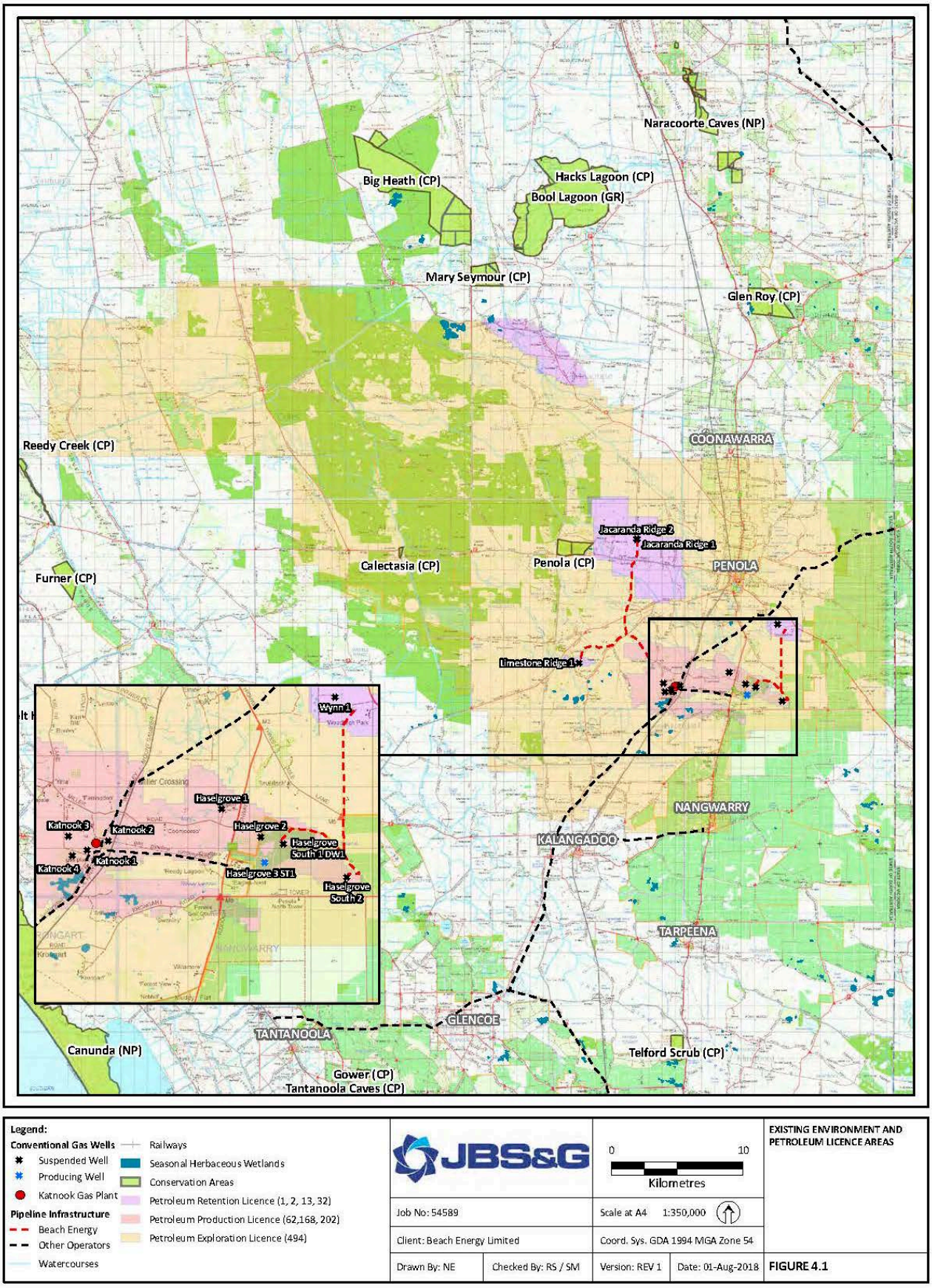


Figure 4.1: Existing Environment and Petroleum Licence Areas

Soils vary from sandy pedal mottled-yellow duplex soils, red weakly structured sandy soils, bleached sands and black organic soils. Wetland areas, such as Bool Lagoon, located approximately 5 km north of PEL 494, are black self-mulching cracking clays. The dunal ranges are comprised of a mix of deep sands and the interdunal flats are characterised by either heavier clays that overlie limestone or sands that overlie clay. The swamps are comprised of medium and fine textured saline soils. Along the coast soils are mostly calcareous sand with some small areas of acidic and alkaline peats (SENRCC 2003).

4.3 Petroleum Geology

The Otway Basin began to form in the Late Jurassic / Early Cretaceous as Australia began to separate from Antarctica about 145 million years ago.

Basement in the Otway Basin generally consists of Paleozoic igneous rocks and metasediments of the Kanmantoo Fold Belt. Dome minor hydrocarbon recovery has occurred from fractured basement sections, when the fault geometry is favourable.

The earliest sediments to be deposited in the subsiding basin were shales of the Casterton Formation. This unit was deposited in a low energy environment (Kopsen and Schofield, 1990) such as a lake and the organic material within is interpreted to be the source of the gas, condensate and oil discoveries in the south-east of South Australia.

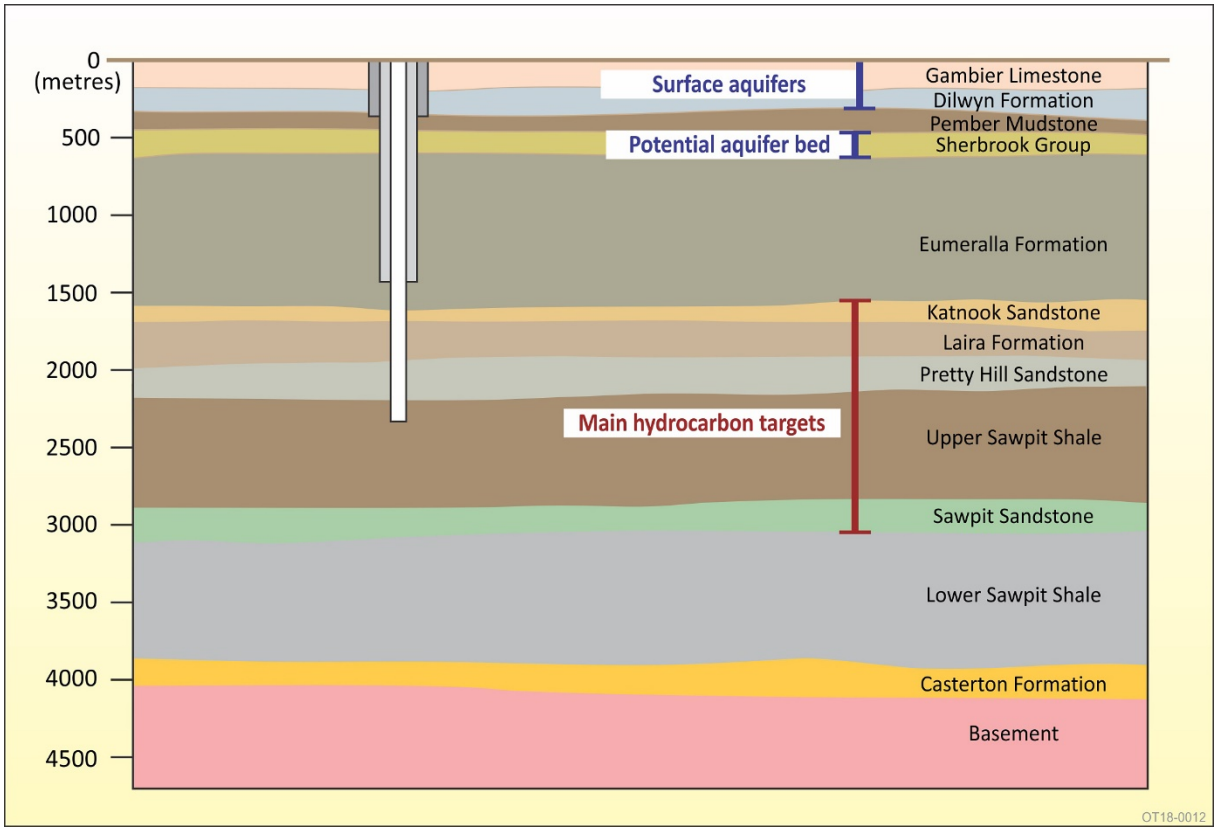


Figure 4.2: Indicative cross-section in the onshore Otway Basin, showing expected stratigraphy and targets

The overlying the Casterton Formation are the Lower Sawpit Shale, Sawpit Sandstone, Upper Sawpit Shale, Pretty Hill Sandstone, Laira Formation and Katnook Sandstone. These were deposited during episodic rifting, driving crustal extension during the Lower Cretaceous. Like the Casterton Formation, the Lower Sawpit Shale was also deposited in a low energy environment and it may also be the original source of oil, gas and condensate discoveries.

The overlying Sawpit Sandstone and the younger sand units, the Pretty Hill Sandstone and Katnook Sandstone are interpreted to be deposited in a braided stream environment and these units have traditionally been the main target of oil and gas exploration in the south-east of South Australia as they are reservoir rocks. All three units have flowed gas or gas, oil and condensate upon testing. For example, the Katnook Field produces gas that flows out of the Pretty Hill Sandstone reservoir.

The Upper Sawpit Shale and Laira Formations are comprised of siltstone and shale and were deposited in a low energy environment such as a floodplain or lake. Both of these units are important as they act as seals to the Sawpit Sandstone and Pretty Hill Sandstone respectively thereby trapping hydrocarbons at depth, and isolating the reservoirs from the more shallower aquifers.

A period of structural activity occurred after the Katnook Sandstone was deposited about 125 million years ago. The surface was uplifted and eroded before activity waned and a thick sequence of interbedded shales, siltstones and fine-grained sandstones of the Eumeralla formation was deposited on a fairly low relief, slowly subsiding surface possibly in an expansive system of shallow lakes.

The overlying Sherbrook Group of Late Cretaceous age is a thin sandstone sequence in the northerly part of the South Australian Otway Basin but in the south and particularly offshore it thickens and can be subdivided into lithological units representing the facies of a delta system (Moreton, 1990).

The overlying Tertiary aged sediments are also relatively thin onshore, consisting mainly of sandstones of the Dilwyn Formation and shales of the Pember Mudstone and fossiliferous limestones of the Gambier Limestone. The Dilwyn, Pebble Point and Pember formations were probably deposited in a fluvial-deltaic setting (Gravestock *et al*. 1986) and the overlying Gambier Limestone in a prograding marine sequence. All the Tertiary units thicken offshore. The Gambier Limestone and the Dilwyn Formation are important aquifers for the south-east of South Australia.

The Haselgrove-3 ST1 well was drilled in January 2018 as a deviated well to a total measured depth of 4,331 m and targeted the Sawpit Sandstone and shallower Pretty Hill Sandstone.

Figure 4.2 shows an indicative cross-section in the onshore Otway Basin. The deep formations that are being targeted for hydrocarbon exploration are shown, along with the near-surface aquifers of the Gambier Limestone and Dilwyn Formation.

4.4 Bioregions

The licence areas fall within the Bridgewater, Lucindale and Glenelg Plain IBRA (Interim Biogeographical Regionalisation for Australia) sub-regions of the Naracoorte Coastal Plain IBRA region. The Naracoorte Coastal Plain IBRA region is a broad coastal plain of Tertiary and Quaternary sediments with a regular series of calcareous sand ridges separated by inter-dune swales, and closed limestone depressions.

The area is primarily a coastal plain with clayey lagoon deposits and isolated sand and calcarenite dunes. Adjacent to the coast are indurated dunes of calcareous sand and dunes of orange sand. In some areas, particularly within the Dismal Swamp IBRA association of the Glenelg Plain sub-region, are plains that are locally veneered with sand, frequent swamps and lakes backed by low lunettes (crescent shaped clay dunes).

4.5 Flora and Fauna

4.5.1 Vegetation Communities

There has been widespread vegetation clearance across the South-East region. The proportion of native vegetation remaining ranges from approximately 2.5% remnant vegetation within the Hundred of Mount Muirhead (north of Millicent) to 19% in the Hundred of Waterhouse. The majority of areas average approximately 10% remnant vegetation. Remnant vegetation mapping in the licence areas indicates native vegetation cover ranging approximately from 8% to 14 % (NatureMaps 2018).

Broad vegetation communities present include eucalypt woodland and forest, mallee, coastal shrublands, heath, shrublands, coastal tussock grasslands, sedgeland, and fernland (Croft *et al*. 1999). A list of floristic communities mapped in areas of remnant native vegetation within Beach's licence areas is provided in Appendix 1.

4.5.2 Biodiversity Values

The South East of South Australia, together within adjacent areas in Victoria, is considered one of Australia's 15 national biodiversity hotspots (DSEWPC 2009). The South-East region includes two Ramsar-listed wetlands, with one (Bool Lagoon) approximately 5 km north of PEL 494 and the Piccaninnie Ponds Karst Wetlands located on the coast approximately 55 km south of the boundary of the exploration licence.

The region is a transition zone, grading from the temperate climate to a more arid landscape in the west. As a result, species adapted to temperate environments as well as species adapted to more arid environments are both present.

More than 1,300 native flora species and 750 native fauna species have been recorded in the South East (Croft *et al*. 1999). Many of these species are restricted to the South-East region, including 4% of the plants, 16% of the mammals, 9% of the birds (excluding vagrants and seabirds), 8% of the reptiles (excluding sea turtles), 4% of the frogs and 5% of the fish.

4.5.3 Threatened Ecological Communities

Many ecological communities in the South East are now considered threatened, principally as a result of widespread vegetation clearance. Of the 34 ecological communities that have been mapped in the South East, 27 communities that are considered threatened (i.e. that have less than 10% of the original pre-European settlement area remaining) have been identified (Croft *et al*. 1999). The threatened ecological communities are typically grasslands, grassy woodlands, or associated with wetlands and interdunal flats. These communities are now mainly confined to roadsides, railways, drainage reserves and small areas of Crown Land such as water reserves. These are key significant areas of remnant vegetation (Croft *et al*. 1999).

A search of the EPBC Act Protected Matters Database (DEE, 2018) identified three nationally listed threatened ecological communities potentially present within the area (Table 4-2).

Table 4-2: EPBC Act-listed threatened ecological communities potentially occurring within the area

Community Name	EPBC Act Status
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered
Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered

A review of vegetation mapping indicated that there are several mapped occurrences of seasonal herbaceous wetlands within the Beach's licence areas. There are no mapped occurrences of the other two threatened ecological communities within the licence areas (NatureMaps 2018).

The Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains ecological community (referred to as Seasonal Herbaceous Wetlands) was formally listed as critically endangered under the EPBC Act in March 2012. Seasonal Herbaceous Wetlands occur on lowland plains, where they are generally associated with fertile, poorly draining clays; in some cases, including Gilgai (shrinking/swelling mounded clay soil formations).

Seasonal Herbaceous Wetlands typically fill and dry annually, however, in a drought or unseasonal wet phase they may appear respectively ephemeral or permanent for occasional periods. They are generally very fresh, with salinities of less than 1,000 mg/L, however, during drying it is possible that they may evapo-concentrate, with salinities increasing up to 3,000 mg/L (Dickson *et al.* 2014).

A seasonal herbaceous wetland is present approximately 150 m south of the Katnook gas plant site boundary. This has been fenced to control stock access, particularly when the wetland is filled.

4.5.4 Threatened Flora

The South East supports a large number of rare or threatened plant species, which predominantly occur within patches of remnant native vegetation. For the purposes of this discussion, two extents and searches of the Biological Databases of South Australia (DEW 2018[6]) have been carried out. The initial extent covered all areas within PEL 494 with a 5km buffer beyond the boundary of the licence area. The second extent covers all areas within Beach's production and retention licences.

The wider search of PEL 494 identified a total of 135 flora species recorded and listed as rare or threatened at State level; including, 22 endangered species, 33 vulnerable species and 80 rare species. Further detail on these species is provided in Appendix 1.

A refined search of Beach's production and retention licence areas identified a total of 17 flora species listed as rare or threatened at State level; including, one endangered species, 12 rare species and one vulnerable species. There were no records of species listed under the EPBC Act recorded within areas covered by Beach's production or retention licences.

Eight plant species that are listed under the EPBC Act have been recorded within PEL 494 and these species are listed in Table 4-3.

Table 4-3: EPBC Act listed plant species recorded or potentially occurring in exploration licence area (PEL 494)

Species	Common Name	Conservation Status	
		EPBC	SA
Caladenia formosa	Elegant spider-orchid	V	V
Caladenia fulva	Tawny spider orchid	E	E
Dipodium campanulatum	Bell-Flower Hyacinth Orchid	E	V
Caladenia versicolor	Grampians spider-orchid	V	E
Dodonaea procumbens	Trailing hop-bush	V	V
Glycine latrobeana	Clover glycine	V	V
Thelymitra epipactoides	Metallic sun-orchid	E	E
Thelymitra matthewsii	Spiral Sun-orchid	V	E

EPBC: *Environment Protection and Biodiversity Conservation Act 1999*; SA: *National Parks and Wildlife Act 1972*
Status: V: Vulnerable; R: Rare; E: Endangered

4.5.5 Threatened Fauna

A search of the BDBSA[6] for the wider search of PEL 494 identified a total of 57 fauna species recorded and listed as rare or threatened under the National Parks and Wildlife Act including 10 endangered species, 16 vulnerable species and 31 rare species. Further detail on these species is provided in Appendix 1.

[6] This data has been sourced from the South Australian Department of Environment, Water and Natural Resources Biological Database of SA. Recordset number DEWNRBDBSA180307-1

A search of Beach's production and retention licence areas identified a total of 11 fauna species listed as rare or threatened at State level including one endangered species, 8 rare species and two vulnerable species. Nine fauna species listed as threatened under the EPBC Act have been recorded in the wider PEL 494 licence area and these species are listed in Table 4-4. Further detail on these species is provided in Appendix 1.

Table 4-4: EPBC Act listed fauna species recorded or potentially occurring in the exploration licence area (PEL 494)

Species	Common Name	Conservation Status	
		EPBC	SA
Birds			
Botaurus poiciloptilus	Australasian Bittern	E	V
Calyptorhynchus banksii graptogyne	Red-tailed Black-cockatoo, south-eastern	E	E
Rostratula australis	Australian Painted Snipe	E	V
Frogs			
Litoria raniformis	Southern Bell Frog	V	V
Mammals			
Isoodon obesulus obesulus	Southern Brown Bandicoot, eastern	E	V
Miniopterus orianae bassanii	Large Bent-wing Bat/ Southern Bent-wing Bat	CE	E

4.5.6 Significant Migratory Species

The EPBC Act Protected Matters Report (DEE 2018) identified 13 migratory species listed under the EPBC Act as potentially occurring within the PEL 494 search area. The BDBSA search indicated that four of these species have been recorded in the area, as listed in Table 4-5.

Table 4-5: Listed migratory species recorded in the exploration licence area

Species	Common Name	Protected matters – type of presence
Apus pacificus	Fork-tailed swift	Species or species habitat may occur within area
Hirundapus caudacutus	White throated Needletail	Species or species habitat may occur within area
Myiagra cyanoleuca	Satin Flycatcher	Breeding likely to occur within area
Gallinago hardwickii	Latham's Snipe	Roosting known to occur within area

4.5.7 Introduced Species

Weed Species

Twenty two weed species declared under the Natural Resources Management Act have been identified for priority management by the South East Natural Resources Management (NRM) Board, (South East NRM Board 2018) with the aim to eradicate the species from the NRM region (two species), or significantly reduce the extent of the species in the region (five species), or prevent the ongoing spread of the species in the board region (15 species). An additional 34 declared species have been identified as alert species, which although not present in the South East NRM region, or present

in very limited numbers, are species with the potential for significant negative impacts if they become established (South East NRM Board, 2018). A list of priority and alert weed species in the South East NRM Region is provided in Appendix 1.

Pest Fauna Species

Twelve key pest fauna species have been identified by the South East NRM Board for priority management in the region and all are declared under the Natural Resources Management Act. The goal of the Board is to eradicate two of the species from the region, significantly reduce the extent of occurrence of six species, and prevent ongoing spread of four species in the region (South East NRM Board, 2018). A list of the priority pest fauna species of the South East NRM Region is provided in Appendix 1.

Pathogens

Pathogens of potential concern in the region include the soil-borne fungus *Phytophthora cinnamomi,* which affects a wide range of native plant species but is yet to be recorded in the region (South East NRM Board 2010), the grape vine insect pest Phylloxera (which has to date been excluded from South Australia), and diseases such as Ovine / Bovine Johne's Disease (OJD / BJD).

4.6 Water Resources

4.6.1 Surface water

The South-East region has a low relief, with a general gradient toward the coast of 1:1600 and to the north less than 1:5000 (Croft *et al*. 1999). Across most of the region, surface water historically moved slowly towards the coast until meeting one of the ranges (the north-north-west trending low ridges), where it was directed northwards along the eastern side of the range. This resulted in extensive swamps and lakes, which were prevalent at the time of European settlement. There is generally a lack of surface streams and rivers, but where they exist, such as Morambro, Mosquito and Naracoorte Creeks, their catchments originate in western Victoria. Mosquito Creek discharges into the Ramsar listed wetlands of Bool and Hacks Lagoons.

Over the years an extensive drainage system has been constructed throughout the lower South-East region to drain water from inundated land. This network has altered the movement of surface water, directing it in an east–west direction and discharging it to wetlands, lakes or the coast. The implementation of the drainage system has allowed formerly inundated land to be developed, minimising the effects of water logging and removing salt from the region. In some areas the drainage network has prevented wetlands from receiving water thus altering the usual wetting and drying process typical of these ecosystems. This has caused a decline or change in the biodiversity in some areas (Paydar *et al.* 2009).

4.6.2 Groundwater

Groundwater is the primary source of water for the South East and the region's economy, environment and community are all reliant upon this resource. Water resources in the area are also important from a social perspective as they provide drinking water, support recreation activities and enhance the appearance of the landscape. Many ecosystems are dependent on the groundwater of the region including wetlands, riparian vegetation and near coastal marine environments which are important tourist attractions that contribute to the regional economy (Brown *et al.* 2006).

The groundwater resource that underlies the South East encompasses some of the largest groundwater systems in Australia (Brown *et al.* 2006). The resource is made up of two distinct systems, an upper unconfined aquifer referred to as the Tertiary Limestone Aquifer (TLA) and a deeper confined aquifer referred to as the Tertiary Confined Sand Aquifer (TCSA). The flow of groundwater is generally in an east to west direction and originates from the topographic high of the Dundas plateau located

in south-western Victoria (Paydar *et al.* 2009). Low permeability aquitards separate the two aquifers. Leakage through the aquitard has been assumed to be generally very low, except in areas where the aquitard is very thin, absent or fractured, such as around Tarpeena-Nangwarry (South East NRM Board 2010). However, recent work has revealed moderate to good hydraulic connection between the two aquifers and indicated that they are more highly connected than previously assumed (South East NRM Board 2013).

The unconfined TLA is utilised more extensively than the TCSA, however there has been increased interest in the resource of the lower TCSA due to the recent allocation of most of the available groundwater from the TLA.

Tertiary Limestone Aquifer (unconfined)

The unconfined TLA is comprised mostly of Gambier Limestone with a water table depth varying from 2 m to greater than 20 m. The aquifer thickness varies over the region with a maximum of 300 m occurring south of Mount Gambier. As well as primary porosity, the aquifer has significant secondary porosity resulting from karstic features within the limestone. The secondary porosity creates paths for preferential flow and gives rise to high transmissivity (200 m^2 / day to 10,000 m^2 / day). Groundwater flow at the local scale can vary which is largely the result of spatial variability of recharge and discharge (Paydar *et al*. 2009).

Recharge of the aquifer occurs primarily through the diffusion of rainfall on the flats and dunal ranges. Local contributions include seepage from wetlands and swamps, surface water discharge into sinkholes and returns from irrigation drainage. Upward seepage of water from the TCSA may also recharge the TLA in locations where differences in hydraulic head between the aquifers permit flow. Mean annual rates of recharge vary from a few mm / year to more than 150 mm / year with higher rates occurring in locations of higher rainfall or highly permeable soils. Groundwater discharge from the TLA occurs mostly to the sea in the area south of Mount Gambier. Some minor drainage also occurs via drains, wetlands, streams, springs and seeps.

Groundwater salinity varies extensively over the aquifer with less than 500 mg/L found in the south and 3,000 mg/L to 7,000 mg/L in the north and is increasing at a significant rate in some locations. Wells located between the townships of Naracoorte and Penola commonly exceed the salinity trigger value of 2% increase per year defined in the Water Allocation Plan (South East NRM Board 2013). The increase in salinity levels is likely to be due to either the recycling of irrigation drainage water, vegetation clearance or forestry harvesting with the resulting mobilisation of salt caused by an increase in vertical recharge (South East NRM Board 2013).

The water table has declined in some areas over the last 30 to 40 years and in other areas it has risen. In the area surrounding the Hundred of Stirling (located approximately 105 km north of PEL 494), the water table has fallen due to a drier climate and extraction of groundwater for irrigation, whereas in the upper South East, until recently, the water table was rising due to land clearing (Paydar *et al.* 2009). Throughout the Lower Limestone Coast, a review of the change in depth to the water table in the 10 years to March 2012 has revealed a general decline in depth to water, ranging from 0.5 metres to greater than two metres (South East NRM Board 2013).

Tertiary Confined Sand Aquifer

The TCSA occurs in the Dilwyn Formation within an interbedded sequence of sands, gravel and clays. The aquifer has varying depth and increases in thickness towards the south reaching more than 500 m near the coast. The flow of groundwater is generally in a westerly or southerly direction towards the sea. The aquitard separating the TCSA from the upper TLA is comprised of clay and marl units at the base of the Gambier Limestone and a clay unit at the top of the Dilwyn Formation (SENRCC 2003).

Recharge of the TCSA occurs at a slow rate (Brown *et al.* 2001), primarily on the eastern edge of the aquifer in Victoria and over some areas in SA. As there are very few areas in which the TCSA is exposed

at the surface, vertical recharge is primarily through downward leakage of groundwater from the above TLA. This occurs mostly in the east where the head differences between the aquifers and the confining layer permit flow. The opposite is found in the west and south where the hydraulic head gradient provides the potential for upward flow of groundwater from the TCSA to the TLA (Brown *et al.* 2001).

Salinity of the groundwater within the TCSA is generally low, associated with low total dissolved solids (TDS) (less than 700 mg/L); however, there are areas where high salinity levels are found (associated with TDS of more than 1,500 mg/L) (Brown *et al.* 2001). It is believed that most of this low salinity groundwater was recharged during the last glacial period when lower sea levels caused the zero head difference to move approximately 50 km east of its present position (Love *et al.* 1993, Love *et al.* 1994). This prevented vertical recharge in the area until the end of the glacial period when the zero head difference moved to its current location (Paydar *et al.* 2009).

Deeper Units

Beneath the Dilwyn Formation is a number of deeper aquifers from the Late Jurassic, Early and Later Cretaceous and Tertiary ages of variable water quality and lateral extent down to over 4000 metres, which demonstrate increasing salinity with depth (South East NRM Board 2015). These aquifers are not used for irrigation, industrial or town water supplies due to their depth and generally high salinity (South East NRM Board 2015). The aquifers within these deeper formations are noted in the Water Allocation Plan (South East NRM Board 2015) as being of potential value as targets for petroleum and geothermal exploration and production.

4.6.3 Water Use

The most significant user of groundwater in the South East NRM region is the irrigation industry, accounting for 95% of total volume used (ABS 2016). The main irrigated crops are pasture grasses and lucerne. Groundwater is also used for grapevines, fruit and vegetables for human consumption, cereals, nurseries, stock water and domestic supplies. Most groundwater for consumption is extracted from the Gambier Limestone aquifer. Groundwater from the Dilwyn Formation aquifer is used as the primary water supply for Penola and Kalangadoo. Utilisation of Dilwyn Formation groundwater is likely to increase in the future as shallower groundwater becomes fully allocated. Plantation forests are also a considerable user of groundwater with over 150,000 ha of plantations located in the South East.

The total volume of water extracted from the unconfined aquifer in the Lower Limestone Coast Prescribed Wells Area was approximately 567,000 ML in 2010/11 (South East NRM Board 2015).

The TCSA is used as the primary water supply for eight towns in the region (Beachport, Kalangadoo, Kingston, Lucindale, Naracoorte, Port MacDonnell, Robe and Tarpeena) and is an important source of water for irrigation and aquaculture, particularly around Kingston and Robe (South East NRM Board 2015).

The aquifers that supply the surrounding populations and industry are separated from gas bearing reservoirs by a number of major regional aquitards (low permeability rocks). The major regional aquitards can be more than 1,000 m in thickness.

4.7 Land Use

4.7.1 General Land Use

The South-East region of South Australia is comprised of exceptionally fertile land accounting for three-quarters of the State's forests and one-third of its pastures. The area supports a diverse range of industries including wool, meat, dairy, cereal cropping, wine grapes, horticulture crops and crop and pasture seed production, all of which are heavily dependent upon water resources in the region. In general, the northern areas of the South East are used for cropping and the cooler, wetter southern

areas are used for livestock grazing and forestry (Binks 2000). Beef cattle are found throughout the region and are the most prominent livestock in the South East.

There are approximately 2,300 farms in the South-East region with over 80,000 ha of this land being irrigated. Crops include cereals, pasture for seed, vegetables, vegetable seeds, oil seed, fruit and nuts and fodder crops. The largest areas of grapevines are seen in the long-established Coonawarra district and more recently in the Padthaway area (to the north of the licence areas). The vineyards are located on slightly elevated areas within the plains in friable, highly permeable clays of moderate to high fertility. The lucerne seed industry is concentrated around the town of Keith (north of the licence areas) and there is limited horticultural activity on the loams derived from volcanic ash and drained clay soils of Mount Gambier and Millicent respectively.

Since the establishment of forestry plantations in the late nineteenth century, the commercial forestry industry, has thrived in the area with over 150,000 ha currently planted, representing 84% of the State's total, encapsulating 35% of employment in the region and contributing an estimated $759 million and directly and indirectly to gross regional product (PIRSA, 2017). Radiata Pine (*Pinus radiata*) and Tasmanian Blue Gum (*Eucalyptus globulus*) are the species most commonly planted and are located in the areas of highest rainfall on sandy soils.

Tourism is a large contributor to the local economy, with over 550,000 visitors to the South-East region per year, directly employing 1,800 people (South Australian Tourism Commission, 2017). Key attractions include coastal resorts at Robe and Beachport, Naracoorte Caves and Tantanoola Caves, Coonawarra, Wrattonbully, Padthaway and Mount Benson wine regions, Bool Lagoon and the Blue Lake (South Australian Tourism Commission, 2017).

Gas production occurs at Beach's Katnook gas plant (located approximately 10 km south of Penola), which is fed by a network of pipelines from approximately 12 wells in surrounding gas fields. Since the 1960's approximately 80 oil and gas wells have been drilled in the region. The Katnook gas plant feeds into the South-East Pipeline system, which supplies gas to regional industries and the town of Mount Gambier. Gas production from the Katnook gas plant has declined in recent years, and the majority of the gas fed into the South-East pipeline system is currently obtained from the SEA Gas pipeline via the SESA pipeline, which runs from Poolaijelo in Victoria to Katnook. Origin Energy's 86 MW Ladbroke Grove power station is located adjacent to the Katnook plant, and it provides peaking power from its gas-fired turbines during periods of high demand for electricity.

4.7.2 Conservation Areas

The South East NRM Region contains three National Parks, 53 Conservation Parks and four Game Reserves established under the National Parks and Wildlife Act (South East NRM Board 2010). Nine reserves established under the National Parks and Wildlife Act are located in the vicinity of, within or overlap the licence areas:

- Big Heath Conservation Park (6km north of PEL 494)
- Bool Lagoon Game Reserve (5km north of PRL 13)
- Hacks Lagoon Conservation Park (12km north of PRL 13)
- Mary Seymour Conservation Park (2.5 km north of PRL 13)
- Glen Roy Conservation Park (14 km east of PRL 13)
- Penola Conservation Park (within PEL 494 and immediately to the west of PRL 32)
- Calectasia Conservation Park (within PEL 494)
- Reedy Creek Conservation Park (2km west of PEL 494)
- Furner Conservation Park (8km south west of PEL 494).

This EIR and the SEO do not cover activities in reserves established under the National Parks and Wildlife Act or exploration activities immediately adjacent to a Marine Park established under the *Marine Parks Act 2007*.

The region also includes a number of other protected areas, including Native Forest Reserves established under the *Forestry Act 1950* and Heritage Agreement Areas established under the *Native Vegetation Act 1991.*

Bool and Hacks Lagoons are listed as wetlands of international importance under the 1971 Ramsar Convention and are consequently covered by the Commonwealth Environment Protection and Biodiversity Conservation Act.

The World Heritage-listed Naracoorte Caves are located in the Naracoorte Caves National Park and lie to the north of the licence areas. This site is also covered by the EPBC Act.

4.8 Social Environment

The South East NRM region covers seven local government areas (LGAs), and the Beach licence areas are situated within two LGAs:

- Wattle Range Council
- Naracoorte Lucindale Council.

Penola is the largest centre within the licence areas, with a population of 3,117 (ABS, 2016). Other population centres in proximity to the licence areas include Naracoorte (located to the north of PEL 494), Millicent (located to the south of PEL494), Lucindale (located to the north of PEL 494), as well as popular holiday destinations including Robe and Beachport along the coast.

Population statistics for the LGAs are shown in Table 4-6. Census data from 2016 for the two LGAs indicates that the population of 19,968 is distributed relatively evenly across the ages 0 to 64, with steady proportional population decline in older age cohorts. The median weekly household income across the two LGAs ranged from $1,023 to $1,203; this compares to a median weekly household income of $1,206 across South Australia.

Table 4-6: Population by Local Government Area

Local Government Area	Male	Female	Total
Wattle Range Council	5,893	5,784	11,677
Naracoorte Lucindale District Council	4,308	3,984	8,291

Source: Australian Bureau of Statistics Census Data 2016

The main industries of employment in the region are agriculture, forestry and fishing, with manufacturing employing the second highest number of workers. The high levels of employment within the agriculture, forestry and fishing industry reflects the economic importance of agricultural production within the region.

4.9 Indigenous Cultural Heritage

All of Beach's petroleum licences are located within the First Nations of the South East#1 (SC2017/002) Native Title claim area (Registered November 2017). Currently South Australian Native Title Services (SANTS) are the contact group for the claim, and the claimants have instructed Beach that the South East Aboriginal Focus Group will continue to manage heritage matters for Beach's operational area.

The Aboriginal Affairs and Reconciliation Division (AARD) within the Department of State Development (DSD), advised Beach in March 2017 that the Register of Aboriginal Sites and Objects, does not contain

any sites recorded with PPL 62, and one site (#7023 5304) directly south of PPL 62 beside the Riddoch Highway. Importantly this register is not comprehensive, nor does it capture undiscovered sites.

The South Australian *Aboriginal Heritage Act 1988* protects Aboriginal sites, objects and remains (Aboriginal Heritage) in all areas of South Australia. Beach complies with this legislation, by ensuring that all first or additional surface disturbance activities are assessed by the local Aboriginal group or other appropriate specialists as required before earthworks commence. Further, Beach land access and cultural heritage procedures ensure that any sites identified are not disturbed during construction through compliance with Beach inductions, pre-earthworks checklists, and field site identification pickets.

4.10 Non-Indigenous Cultural Heritage

A desktop study of South Australian heritage places was conducted using the South Australian Heritage Places Database (SAHPD). The database provides a comprehensive listing of:

- State Heritage Places from the South Australian Heritage Register
- Local heritage places from South Australian Development Plans
- Contributory items from South Australian Development Plans.

A search of heritage places in the Wattle Range Council and Naracoorte Lucindale Council using the SAHPD identified 46 State Heritage Places and 177 local heritage places (NatureMaps, 2018). No heritage places are present within Beach's current production licence areas. The majority of the heritage places are buildings (including churches, farmhouses, barns, hotels and shops), as well as cemetery features, and plantations (a sugar gum plantation north of the licence areas). There are three isolated heritage places located within 10 km of the boundary of Beach's current production licence areas. The Yallum Park homestead and Austin Cottage dwelling are located approximately 3 km to the north East of PPL 168 and Kalangadoo House approximately 9 km to the south west of PPL 202.

State Heritage Places located in the region vary with sites including former dwellings, farming homesteads, railway stations, schools, churches, hotels and cemeteries. Local heritage places located in the region are also diverse, ranging from houses, sheds, homesteads and churches to bridges, shopping centres, and recreational parks.

A search of the Australian Heritage Database did not identify any World, Commonwealth or National heritage listed places in the licence areas. The Australian Fossil Mammal Sites (Naracoorte), which is registered as a World Heritage and National Heritage site is in close proximity to the licence areas, with the majority of the site located approximately 19 km north of PEL 494.

5 Environmental Impact Assessment

This section discusses potential environmental impacts related to drilling, completion and well production testing activities in the onshore Otway Basin.

The discussion is supported by an environmental risk assessment. The risk assessment is presented in Table 5-1 (in Section 5.9), which outlines the key hazards, management measures and resulting level of risk.

The following discussion summarises the management measures that will be implemented, with the detail provided in Table 5-1.

Reference is made to the results of the risk assessment where relevant throughout the discussion.

5.1 Soil and Shallow Groundwater

Potential impacts to soil and shallow groundwater arise mainly from:

- Earthworks for well site, access track and camp site construction and rehabilitation (e.g. erosion, inversion, compaction)
- Spills or leaks associated with storage and handling of fuel, oil and chemicals, drilling procedures and well production testing / flaring
- Well control incidents or loss of well integrity
- Storage, handling and disposal of waste.

<u>Earthworks for construction and rehabilitation</u>

Earthworks and site construction activities have the potential for localised impacts to soil through inversion, compaction or increased erosion.

In order to minimise surface impacts and facilitate rehabilitation, landowners will be consulted regarding the earthworks required, the location of the well site, access track and camp site and other relevant issues.

The preferred location of the well site is determined by the sub-surface targets, however it can generally be moved within allowable tolerances to minimise surface disturbance.

Topsoil is removed from the well site and stockpiled for use in rehabilitation, and the well site and access track paved with gravel imported from a licensed quarry. Paving materials are usually removed during rehabilitation (unless the landowner requests that they are retained) and stockpiled topsoil respread over the site.

Disturbance to soil from site construction activities is relatively localised and restricted to a defined and agreed area. Rehabilitation will be undertaken in consultation with the landowner, with measures such as ripping of compacted soils, replacement of topsoil that has been removed, restoration of soil profiles and contours and reseeding implemented to ensure rehabilitation success.

<u>Spills or leaks</u>

Improper storage and handling of fuel, oil and chemicals has the potential to result in localised contamination of soil and shallow groundwater. In order to minimise this risk, fuel, oil and chemicals on site are stored and handled in accordance with relevant standards and guidelines. Fuel, oil and chemicals will be stored in their product containers with appropriate secondary containment (e.g. lined, bunded areas or on self-bunded pallets). Storage and handling of fuel and chemicals is restricted to designated areas on the paved well pad.

Runoff from higher risk areas (e.g. drill rig, generators) is directed into the sump to minimise the risk of movement of contaminants off-site. Any spills will be immediately cleaned up and any

contaminated material removed off-site for appropriate treatment or disposal to a licensed facility. If larger scale spills occur that cannot be immediately contained and cleaned up they would be assessed consistent with the requirements of the National Environmental Protection Measure (NEPM) and, where required, remediated in accordance with relevant guidelines (e.g. EPA guidelines).

Drilling sumps are used to contain drilling fluids and cuttings and may collect surface runoff from the well lease. They have the potential to result in localised contamination of soil and shallow groundwater. Consequently, sumps will be lined with an impermeable liner to prevent percolation into the soil.

Drilling muds will generally be water-based, and non-toxic to low toxicity additives will be used. Synthetic based muds (SBM) may be used in some deeper sections of wells. SBM cuttings circulated to surface will exit via an enclosed mud system to holding tanks, which will be in a lined area to ensure containment. SBM muds and cuttings will be removed from site by a licensed contractor to a licensed treatment or disposal facility.

After drilling, water from the sump may be removed for reuse if water quality meets applicable criteria. Sump contents to be disposed as waste will be removed by a licensed contractor to an EPA licensed waste disposal facility, as soon as possible after drilling is completed.

Spills or leaks during well production testing activities could also result in localised contamination of soil or shallow groundwater. Well production testing will be carried out on the paved well lease in accordance with industry standards. Production tanks would be located in lined, bunded areas. All tanks and production lines would be inspected and tested for leaks prior to use. A separator tank would be used to separate any produced liquids from gas before gas is sent to the flare, so that produced fluids are not sent to the flare. If water is produced during well production testing, it would be in small quantities which would be directed to the sealed tank and removed off site for appropriate disposal at a licensed facility. Personnel would remain on site during any well production testing activities and fluid levels in production tanks would be continually monitored to avoid overfilling.

Well control and well integrity

Well control and well integrity risks are managed by a range of measures that are discussed in Section 5.3. The likelihood of impact to soil from well control or well integrity issues is very low.

Waste management

Inappropriately managed waste has the potential to result in localised disturbance or contamination of soil and shallow groundwater. Storage of waste and transport to licensed disposal or recycling facilities will be undertaken in accordance with relevant legislation and guidelines. Waste generation will be minimised where practicable, waste will be stored securely and licensed waste contractors will be used for waste transport. Septic tanks will be used to contain all wastewater (black water and grey water) which will be pumped out by licensed contractors as required for disposal at a licensed facility.

Risk Assessment

The level of risk has been assessed as low for most of these potential hazards (see Table 5-1). A medium risk is assigned for spills or leaks and for well control incidents / loss of well integrity; although it is unlikely to occur, the consequence to shallow groundwater is moderate (see Table 5-1). Note: Risks have been assessed taking into consideration the high importance of shallow groundwater (the unconfined Tertiary Limestone Aquifer) in the region.

5.2 Surface Water

Potential impacts to surface water arise mainly from:

- Earthworks for well site, access track and camp site construction and rehabilitation (e.g. disturbance to natural drainage patterns, increased erosion / sedimentation)

- Spills or leaks associated with storage and handling of fuel, oil and chemicals, drilling and workover operations and well production testing / flaring
- Well control incidents or loss of well integrity
- Storage, handling and disposal of waste.

Earthworks

Earthworks for well site, access track and campsites have the potential to alter natural drainage patterns or result in increased sedimentation of surface water features. This can potentially affect native vegetation and fauna (particularly wetland communities) as discussed in Section 5.4.

Well sites, access tracks and campsites will be located and constructed to avoid significantly impacting surface drainage patterns or surface water features. Where necessary, temporary culverts will be installed to ensure surface drainage is maintained. Landowners are consulted regarding crossings of features such as drainage channels and appropriate measures (e.g. culverts) are installed where required. Sites will be rehabilitated to restore natural surface profiles and original drainage patterns.

The soil types, general lack of defined drainage and relatively flat nature of the area result in a relatively low risk of erosion or sedimentation. Sediment and erosion control structures such as sediment fences are often not necessary, but would be installed where required (e.g. if in close proximity to drains or surface water features).

Spills or leaks

The principal risk to surface water results from the potential transport off-site of material from spills or leaks. The measures discussed above in Section 5.1 will be implemented to ensure safe storage and handling of fuel and chemicals and appropriate management of well production testing. Spill containment and cleanup equipment would be present on site and any spills immediately cleaned up. Runoff from higher risk areas would be directed into the lined sump.

Runoff from bunded fuel or chemical storage areas would be similarly contained and would not be allowed to drain off-site. If required (e.g. after heavy rainfall) the sump can be pumped out and the contents disposed at a licensed facility to ensure sufficient capacity is maintained. The risk of flooding is considered in the location and construction of well leases, and if required, additional measures such as a small berm around the sump to prevent floodwater entering the sump may be implemented.

Well control and well integrity

Well control and well integrity risks are managed by a range of measures that are discussed in Section 5.3. The likelihood of impact to surface water from well control or well integrity issues is very low.

Waste management

Measures to ensure secure storage and handling of waste will be implemented as outlined in Section 5.1.

Risk Assessment

The level of risk has been assessed as low for earthworks and waste management (see Table 5-1). A medium risk is assigned for spills or leaks and for well control incidents / loss of well integrity; although it is unlikely to occur, the consequence is moderate (see Table 5-1).

5.3 Groundwater

Potential impacts to groundwater arise mainly from:

- Drilling through aquifers
- Well control incidents

- Loss of well integrity (e.g. casing or cement failure)
- Other downhole issues.

Potential impacts to shallow groundwater also arise from surface activities including fuel and chemical storage and handling and waste management and are discussed in Section 5.1.

Drilling through aquifers

Drilling fluids in the down-hole environment have the potential to invade freshwater aquifers near the well bore and cause localised salinisation or contamination. Freshwater muds and native gel (bentonite) mud systems are used when drilling the top section of hole through the Gambier Limestone and Dilwyn formations in the Otway Basin to avoid contamination or salinisation of the freshwater aquifers near the well bore.

Following drilling of the top hole, surface casing is installed and cemented into place, which isolates these freshwater aquifers from drilling fluids used to drill the deeper sections of the hole. Water based muds or synthetic based muds may be used in the intermediate to production hole section but any impact of near-well bore invasion by mud filtrate will be minimal, as mud properties allow for the build-up of filter cake on the borehole wall, which creates a barrier and minimises the potential for the loss of fluids to permeable formations. The deeper aquifers are not used for irrigation, industrial or town water supplies due to their depth and generally high salinity (South East NRM Board 2015).

Well control incidents

A well control incident or blowout during drilling could result in a loss of containment of hydrocarbons and drilling fluids, possible crossflow between aquifers or loss of aquifer pressure and possibly an explosion or fire. There are considerable safety measures to avoid a blowout and they are extremely rare, particularly in areas such as the Otway Basin where reservoir pressures are understood. All drilling and completion operations will be carried out in accordance with regulatory requirements and approved well construction standards. The drilling rig will be equipped with fully functional and regularly tested blowout preventers. Guidelines, procedures, safety practices, design considerations, certification of trained individuals and an emergency response plan will be in place.

Well integrity

A loss of well integrity (through failure of the cement or casing in the well) could result in crossflow between aquifers, contamination of aquifers, reduction of pressure in aquifers and possibly the release of water, hydrocarbon and other reservoir gases if present (e.g. carbon dioxide, hydrogen sulphide) to the surface. The risk is restricted to as low as possible in the well design and construction process and managed through monitoring, during both drilling and the throughout the well's life.

Measures undertaken to ensure well integrity include:

- Wells are designed to meet pressure, temperature, operational stresses and loads
- Groundwater aquifers are isolated behind casing strings, cemented in place
- Surface casing is cemented to the surface with visible return
- Running of cement bond logs on production casing to confirm the quality of cement
- Undertaking of remedial action where there is evidence of insufficient isolation
- Ongoing well integrity monitoring in accordance with the Beach Management Systems.

Following a decision to decommission a well (either after drilling or at the end of the well's productive life) a specific well decommissioning program is developed and implemented, as discussed in Section 3.6. Cement plugs are installed in the well to isolate all aquifers and prevent cross flow, contamination or pressure reduction.

Other downhole issues

Other hazards associated with down hole operations predominantly include issues that can affect drilling progress but generally have very limited environmental consequences, such as lost circulation, sloughing shales, stuck pipe or drill pipe failure. A loss of a radioactive source down hole can also potentially occur. When the well is open hole logged after drilling, the neutron and gamma ray logging tools emit radiation into the formation and a receiver picks up the signal which is interpreted to relate the characteristics of the formation. If the tool is lost down hole, it is retrieved immediately in most cases. However, if it is not possible to retrieve the tool it is cemented in the hole to isolate it from adjacent formations.

Risk Assessment

The level of risk has been assessed as low for drilling through aquifers and other downhole issues (see Table 5-1). A medium risk is assigned for spills or leaks and for well control incidents / loss of well integrity; although it is unlikely to occur, the consequence is moderate (see Table 5-1).

5.4 Native Vegetation and Fauna

Potential impacts to native vegetation and fauna arise from:

- Well site, access track and camp site construction and rehabilitation
- Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)
- Use of roads and movement of heavy vehicles and machinery
- Access to contaminants (e.g. from well control incidents, the drilling sump or spills and leaks) and waste
- Fire.

Well site, access track and camp site construction

Earthworks and clearing activities have the potential to damage native vegetation and wildlife habitats (including wetland communities) and disturb or injure fauna. In the onshore Otway Basin, a large proportion of the native vegetation has been cleared or heavily modified for agriculture and forestry. Consequently, the clearance of native vegetation for well sites, access tracks and camp sites can generally be avoided by locating well sites and access tracks in previously cleared or disturbed areas.

Well sites are subject to environmental assessment in the planning process to ensure that any issues such as native vegetation, presence of rare or threatened species or risk of introduction of weeds are identified and appropriate avoidance or mitigation strategies are developed. Large trees, high quality native vegetation and significant wetland areas will be avoided[7]. Low quality native vegetation will also be avoided unless there are no viable alternatives (e.g. use of adjacent cleared areas). As discussed in Section 5.2, activities will also be carried out to ensure surface drainage patterns and water quality are maintained, which will avoid potential indirect impacts on native vegetation, fauna and particularly wetland communities.

Disturbance from site activities

Potential disturbance to native fauna from site activities (e.g. light, noise, presence of the drill rig, camp and personnel) is short term, localised and generally of limited significance in the region given the existing land uses and extent of vegetation clearance and habitat modification. The environmental assessment undertaken during the planning process will identify whether there are specific issues at

[7] Site-specific assessment by an appropriately qualified specialist would be used to determine whether vegetation meets these parameters.

an individual well site (e.g. breeding of the Endangered Red-tailed Black-Cockatoo, or likely indirect impacts to adjacent conservation reserves) and develop measures to avoid or mitigate potential impacts. Relevant agencies (e.g. DEW, DEE) would be consulted where required.

The presence of excavations on site (e.g. the drilling sump) also has the potential for localised impacts to native fauna. The presence of site personnel and the fencing of the drilling sump following drilling will generally preclude impacts to larger species. Well sites are likely to be located in areas where there is limited habitat value for smaller species and their presence on the well lease is unlikely, however excavations will be regularly checked for trapped fauna to minimise potential impacts.

Use of roads and movement of heavy vehicles and machinery

The movement of vehicles and machinery along existing roads and the access track has the potential to impact native fauna, principally through collisions. This is likely to be relatively insignificant due to the level of existing traffic, the short-term nature of the activities and the limited extent of significant fauna habitats. Transport procedures (e.g. speed restrictions, limitation of movements at night) will also reduce the potential level of impact.

Access to contaminants (e.g. from well control incidents, drilling sump, spills or leaks) and waste

The potential for native fauna to access contaminants and waste is limited. The well site and sump will be fenced, as discussed above, and any contaminants from spills or leaks are likely to be confined to the area of the well lease, and will be immediately cleaned up. Waste will be stored in covered bins before being transported off-site for disposal.

Fire

Fire initiated by site activities (e.g. flaring, sparks from vehicles or equipment, cigarette butts) has the potential to impact large areas of vegetation. Measures will be in place to prevent fires including firebreaks, restriction of vehicles to tracks and cleared areas, maintenance of suitable fire-fighting equipment on site and liaison with the CFS. The flare tank or flare stack will be designed and located to avoid radiant heat impacting or burning trees.

Risk Assessment

The level of risk has been assessed as low for these potential hazards (see Table 5-1).

5.5 Land Use

Potential impacts to land use arise from:

- Well site, access track and camp site construction and rehabilitation
- Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)
- Access to contaminants by stock (e.g. from well control incidents, the drilling sump, spills or leaks, waste)
- Fire.

Other potential impacts to landholders are discussed under ‘Landholders and local community’ in Section 5.6 below.

Well site, access track and camp site construction and rehabilitation

Construction, use and rehabilitation of the well site, access track and camp site have the potential to affect land use through disturbance to soil, groundwater and surface water within the footprint of the activity (as discussed in Sections 5.1 to 5.3). The measures discussed in these previous sections will be implemented to ensure that these impacts are minimised and appropriate rehabilitation is undertaken.

Poor planning and execution of construction and rehabilitation activities also has the potential to impact land use beyond the activities' direct footprint, for example if well sites and access tracks are not sited to minimise the disruption to overall property access and management. Landholders will be consulted regarding the location, management and timing of proposed activities, with the aim of minimising disturbance. Ongoing liaison with landholders is carried out following drilling (and throughout the well's life if it is successful).

Appropriate access tracks to drill sites are chosen in consultation with landowners and any deterioration of property tracks or infrastructure as a result of drilling-related traffic is rectified. Previous experience in the Otway Basin has indicated that access tracks can generally be located so that they can be retained as all-weather access across the property and provide a long-term benefit to property operations.

The introduction of weeds or pathogens by vehicles and equipment (particularly earthmoving equipment) is a potentially significant impact to land use. A range of measures will be undertaken to manage the potential for the introduction or spread of weeds or pathogens, including:

- consultation with landholders and NRM Board officers to identify any potential issues or specific management requirements
- ensuring that vehicles and equipment arriving at the site are clean and free of soil and plant material
- assessment of vehicles and equipment entering the region or moving between sites (especially from weed or pathogen infested areas into non-infested areas) for the risk of transporting weeds and pathogens and cleaning them down where appropriate
- using local earthworks contractors where possible rather than bringing in equipment from outside the region
- sourcing of paving materials from licensed quarries that are free of weeds
- monitoring sites and access tracks for new weed infestations, with treatment undertaken as necessary in accordance with requirements of the landholder, and if appropriate the NRM Board.

Under the Petroleum and Geothermal Energy Act, landowners have rights to compensation. Compensation is payable where there is:

- deprivation or impairment of the use and enjoyment of the land
- damage to the land (not including damage that has or will be made good by the licensee)
- damage to, or disturbance of, any business or other activity lawfully conducted on the land
- consequential loss.

Compensation agreements are agreed and put into place before any activities are undertaken.

<u>Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)</u>

Drilling activities and transport moves have the potential to disturb and possibly injure stock. Consultation with landholders is undertaken to ensure that the location and timing of activities minimise the potential for impact. Measures in place to minimise impacts include speed limits, fencing of access tracks if required, positioning lighting to minimise light emanating from the site during drilling operations, avoidance of night transport moves as far as possible, and prompt removal of drill rigs and camps from site following the completion of operations.

Access to contaminants by stock (e.g. from well control incidents, drilling sump, spills or leaks, waste)

The potential for stock to access contaminants and waste is limited. The well site and sump will be fenced, as discussed previously, and any contaminants from spills or leaks are likely to be confined to the area of the well lease and will be immediately cleaned up. Waste will be stored in covered bins before being transported off-site for disposal.

Fire

Fire initiated by site activities (e.g. flaring, sparks from vehicles or equipment, cigarette butts) has the potential to significantly impact land use (e.g. via damage to pasture, forestry, crops and infrastructure). Measures discussed in Section 5.4 above will be in place to prevent fires including firebreaks, restriction of vehicles to tracks and cleared areas, maintenance of suitable fire-fighting equipment on site and liaison with the CFS.

Risk Assessment

The level of risk has been assessed as low for these potential hazards (see Table 5-1).

5.6 Landholders and Local Community

Potential impacts to landholders and the broader local community arise principally from:

- Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel)
- Generation of dust and air emissions
- Use of roads and movement of vehicles and heavy machinery
- Unauthorised site access
- Fire.

Disturbance from site activities

Disturbance from site activities (e.g. light, noise, presence of the drill rig, camp and personnel) can result in short term impact to the landholder and nearby residents. A range of measures will be implemented to manage these potential impacts.

Landholders and other stakeholders (e.g. the local council) will be consulted regarding the proposed activities, with the aim of identifying potential issues and minimising disturbance. Well site and access track construction will be restricted to daylight hours. Noise limitation during drilling (particularly at night) will be included as part of induction procedures (e.g. noisy tubular / pipe handling, unnecessary use of horns, reversing of forklifts). Adequate buffer distances will be maintained between the well site and residences and systems will be in place for logging stakeholder complaints to ensure that issues are addressed as appropriate.

Lighting will be positioned to minimise light emanating from the site during drilling operations. Flaring during well production testing will be kept to the minimum length of time necessary. Drill rigs and camps will be promptly removed from site following the completion of operations, particularly in visible locations.

Generation of dust and air emissions

Generation of dust during site construction and use of unsealed roads and tracks can result in temporary and localised impacts to air quality. Dust generation will be minimised by restriction of speeds on unsealed roads and spraying of unsealed roads with water where required.

Emissions from fuel burning equipment, flaring and fugitive emissions from well operations have the potential to cause localised impacts to air quality and contribute to greenhouse gas emissions.

Equipment will be operated and maintained appropriately in order to minimise emissions, and flaring during well production testing will be kept to the minimum length of time necessary to establish resource parameters. Fugitive emissions will be minimised by maintenance of well integrity (as discussed in Section 5.3) and appropriate maintenance and operation of well heads and other surface infrastructure. Greenhouse gas emissions will be recorded and reported on in accordance with National Greenhouse and Energy Reporting Act requirements.

Use of roads and movement of vehicles and heavy machinery

The use of roads for drilling operations has the potential to increase noise disturbance to the community and can result in an increased road hazard to local road users. Use of roads and tracks for drilling operations, particularly unsealed roads or farm tracks can also cause damage or degradation.

Impacts of road use are generally short term, with peak traffic movements occurring during rig moves. Landholders, local councils, potentially affected residents and police will be informed of significant activities such as rig mobilisation and demobilisation. Rig movements will detour around town centres where possible. Warning signs and traffic management measures will be installed where appropriate near well sites. All necessary permits will be obtained for trucks transporting drilling and other equipment. Transport moves will be restricted to daylight hours as far as possible.

Any deterioration of property tracks or infrastructure as a result of drilling-related traffic will be rectified.

Unauthorised site access

Unauthorised or uncontrolled access to the well site, particularly during drilling, could expose members of the public to potential harm. Access to the site will be restricted during operations, the site will be fenced and 'No entry' signage warning of dangers associated with drilling operations will be placed at the entry to the site access track. The access gate to the well site will be closed during testing. Following drilling, the well site will be fenced until rehabilitation is completed. Fencing and signage will be installed to prevent unauthorised access to the well head at any well that is successful.

Fire

Fire initiated by site activities (e.g. flaring, sparks from vehicles or equipment, cigarette butts) has the potential to significantly impact landholders and the community through damage to property or possibly loss of life. Measures discussed in Section 5.4 and 5.5 above will be implemented to manage fire risk.

Risk Assessment

The level of risk has been assessed as low for most of these potential hazards (see Table 5-1). A medium risk is assigned for the use of roads and movement of heavy machinery; although it is unlikely to occur, the consequence is major. Similarly, a medium risk is assigned for fire resulting from activities; although the likelihood is remote, the consequence is major (see Table 5-1).

5.7 Cultural Heritage

Potential impacts to cultural heritage arise predominantly from earthworks during construction and rehabilitation activities. Cultural heritage inspections will be carried out with the relevant Aboriginal heritage group and any identified sites will be avoided and flagged off where necessary. Damage, disturbance or interference to any Aboriginal sites, objects and remains is avoided unless authorisation has been obtained under the *Aboriginal Heritage Act 1988*. Heritage registers and the Heritage Branch, DEW will be consulted regarding the location of non-indigenous heritage sites where appropriate. Cultural heritage issues will be covered in inductions and a procedure will be in place to respond in the event that any sites are discovered during activities.

The level of risk to cultural heritage has been assessed as low (see Table 5-1).

5.8 Economic Impact

Many of the identified environmental risks have potential for negative economic impact on landholders and other stakeholders. Application of the measures discussed above to minimise the environmental risk also minimises the economic risk.

There are a number of potential economic benefits for landholders, the community and the State, including:

- Well access tracks are often of use to landholders as all-weather access tracks and may save construction costs to the landholder and enhance property management.
- Potential for utilisation of local food, fuel and accommodation which has direct benefit to business owners and benefits the regional economy.
- Potential for engagement of local contractors for activities such as earthworks and fencing.
- Potential for royalties to be paid if exploration and appraisal are successful and project economics are favourable, which benefits the State.
- Potential for enhanced gas supply to the region, which currently relies on gas imported from Victoria via the SEA Gas pipeline.
- Potential enhancements or increased maintenance to infrastructure such as roads, dependent on success and ongoing activity.
- Increased understanding of the geological zones under the ground resulting from drilling and testing, which provides information for other licensees in the area once data becomes open file.

5.9 Environmental Risk Assessment Summary

As discussed above, Beach has undertaken an environmental risk assessment of drilling and well operations in the onshore Otway Basin. This section summarises the process and results of the assessment.

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[8].

The level of risk has been assessed based on the assumption that the management measures that are discussed in this EIR will be in place. The risk assessment was carried out by Beach, based on knowledge of the existing environment, understanding of proposed operations and extensive knowledge and experience derived from previous drilling, completion and well production testing

[8] The risk assessment process is iterative for many 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.

activities in the onshore Otway Basin as well as other areas such as the Cooper Basin in northern South Australia.

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 contained in Appendix 2. These tables 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.
- 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.

A summary of the level of environmental risk for drilling, completion and well production testing activities is provided in Table 5-1 below. The level of risk has been assessed based on the assumption that the management measures outlined in this EIR will be in place.

Table 5-1: Environmental risk assessment for drilling, completion and well production testing in the Otway Basin, South Australia

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comment	Consequence	Likelihood	Residual Risk
Well site, access track and camp site construction and rehabilitation	Impacts to soil (e.g. erosion, inversion, compaction) Visual impact	Landowner to be consulted about earthworks required, location of access tracks and general information to minimise surface damage and to facilitate rehabilitation. Locate and orientate well lease and access to minimise soil removal and area of cut and fill. Soil removed in construction to be stored on site and returned to its original stratigraphic level upon restoration of the drill site. Separate storage of topsoil, subsoil and clays will be undertaken to assist in regeneration of pasture or crops. Well sites are rehabilitated following drilling or the lease area reduced to the minimum size necessary if the well is successful. Restoration of the well site to be approved by the landowner or in accordance with landowner's wishes should retention of specific parts of the site be requested (e.g. pad or access track). During rehabilitation the soil beneath the tracks, camp and pad will be ripped after removal of imported fill and before the returning of stockpiled topsoil. Soil profile and contours will be reinstated following completion of operations.	Minor	Unlikely	Low
	Disturbance to natural drainage patterns Sedimentation of surface waters	Well sites and access tracks are located to avoid surface water features such as swamps and significant wetland areas and to maintain pre-existing water flows. Temporary drainage depressions / culverts installed where required to maintain surface runoff. Landowners or infrastructure owners consulted regarding requirements for crossings of artificial drainage channels. Appropriate measures implemented where required (e.g. culverts). Sediment and erosion control measures (e.g. sediment fences) installed where necessary (e.g. if in close proximity to drains or surface water features). Any soil removed during the construction of the drill pad will be respread over the disturbed area during restoration. Topsoil and subsoil will be stored separately and returned to their original stratigraphic level. Any area artificially elevated via pad or access track construction will be lowered to original ground level by removal of paving material unless otherwise instructed by the landowner. Original drainage patterns will be restored.	Minor	Unlikely	Low
	Introduction and spread of weeds or pathogens	All reasonable and practical endeavours taken to minimise the risks of introducing weeds, exotic pest fauna and pathogens into the tenement areas. Appropriate consultation regarding weeds or pathogens carried out with landholders and NRM Board officers. Vehicles and equipment arriving at the site must be clean and free of soil and plant material. Vehicles and equipment entering the region or moving between sites (especially from weed or pathogen infested areas into non-infested areas) will be assessed for the risk of transporting weeds and pathogens and cleaned down where appropriate. Biosecurity procedures implemented as agreed with landholders. All records of vehicle or equipment inspections and cleaning will be kept for auditing. Paving materials will be sourced from licensed quarries that are free of weeds. Sites and access tracks will be monitored on a regular basis for new weed species / infestations, and treated as necessary in accordance with requirements of the landholder, and if appropriate the NRM Board. Records of detection, monitoring or eradication of weeds or pathogens introduced by activities are kept and available for review.	Minor	Unlikely	Low

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comment	Consequence	Likelihood	Residual Risk
	Damage to native vegetation and wildlife habitats Disturbance to native fauna	Appropriately trained and experienced personnel have assessed or scouted proposed well site, access track and camp locations to identify and flag significant (or rare, vulnerable or endangered) species and communities (including wetland communities). Native vegetation clearance avoided or minimised by locating well sites and access tracks appropriately. Removal of large trees (including dead trees with hollows) is avoided. Areas of low quality native vegetation are avoided unless there are no viable alternatives (e.g. use of adjacent cleared areas). Areas of high quality or significant[9] remnant vegetation or Heritage Agreement Areas are avoided. Activities are not carried out in parks or reserves established under the National Parks and Wildlife Act. If well sites are in close proximity to a park or reserve established under the National Parks and Wildlife Act and indirect impacts are likely, consultation is undertaken with DEW to determine appropriate mitigation measures. Excavations (e.g. sump) checked regularly for trapped fauna. Sumps and well site are appropriately fenced to minimise fauna access. If threatened species (e.g. Red-tailed Black-Cockatoos) are detected or likely to occur near the well site, specialist advice is sought regarding measures to mitigate potential impacts, particularly during breeding season. Undertake detailed assessments and EPBC Act referral (if required) if avoidance of species or habitats is not possible. Well sites with native vegetation are rehabilitated in consultation with DEM, DEW and other relevant stakeholders.	Minor	Unlikely	Low
	Damage to infrastructure Disturbance to stock Disturbance to land use Dust generation Noise generation	Landholder is consulted regarding the location management and timing of proposed activities. Ongoing landholder liaison during and following operations. Activities are restricted to agreed / defined areas. All gates left in the condition in which they were found (open / closed). Well site and access track construction restricted to daylight hours. Systems in place for logging stakeholder complaints to ensure that issues are addressed as appropriate. Compliance with Part 10 of the Petroleum and Geothermal Energy Act (Notice of Entry requirements). In the case of a decommissioned restored site, the entire area will be restored to original land surface topography with no irregularities likely to cause injury to stock, unless otherwise agreed with the landowner. During well site and access track rehabilitation, imported materials are removed from site and soil profiles and contours restored unless otherwise agreed with the landowner. If necessary, unsealed roads will be sprayed with water as required to minimise dust generation.	Minor	Unlikely	Low
	Damage to cultural heritage sites	Cultural heritage inspection of proposed well sites and access tracks undertaken with the relevant Aboriginal heritage group. Known sites identified and protected from operations (e.g. using temporary flagging). Damage, disturbance or interference to any Aboriginal sites, objects and remains is avoided unless authorisation has been obtained under the *Aboriginal Heritage Act 1988*. Cultural heritage issues covered in inductions. Key personnel (e.g. supervisors, machinery operators) receive appropriate cultural heritage training. Procedure in place for the appropriate response to any sites discovered during activities. Records of sites forwarded to the Aboriginal Heritage Branch in compliance with the Aboriginal Heritage Act. Records relating to sites of cultural heritage significance kept and available for audit. Heritage site registers and Heritage Branch, DEW, consulted regarding the location of non-indigenous heritage sites where appropriate.	Moderate	Remote	Low
Physical presence of drill rig and camp and personnel. Light emissions (rig lighting, flaring)	Visual impact Disturbance to native fauna Disturbance to stock Disturbance to land use Disturbance to local community	Landholders and relevant stakeholders (e.g. local council, industry associations) consulted regarding location of proposed activities. Activities are restricted to agreed / defined areas Drill rigs and camps removed from site promptly following completion of activities, particularly in visible locations. Any lighting required is positioned to minimise light emanating from the well site. Flaring during well production testing kept to minimum length of time necessary. See Well site, access track and camp site construction and rehabilitation above for detail on: • fauna • well site restoration.	Minor	Unlikely	Low

[9] Significant in this context includes listed plant species, listed communities or important fauna habitat

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comment	Consequence	Likelihood	Residual Risk
Air emissions	Reduction in local air quality Generation of greenhouse gas emissions	Equipment operated and maintained in accordance with manufacturer specifications. Flaring during well production testing kept to minimum length of time necessary. If necessary, unsealed roads will be sprayed with water as required to minimise dust generation. Note: Greenhouse gas emissions recorded and reported in accordance with NGER requirements.	Minor	Unlikely	Low
Noise emissions	Disturbance to native fauna Disturbance to stock Disturbance to local community	Equipment operated and maintained in accordance with manufacturer specifications. Transport trucks to be restricted to daylight hours as far as possible. Heavy truck drivers to be instructed not to use engine brake near dwellings. Noise limitation (particularly at night) to be included as part of induction procedures (e.g. noisy tubular / pipe handing, unnecessary use of horns, reversing of forklifts). Systems in place for logging stakeholder complaints to ensure that issues are addressed as appropriate. Adequate buffer maintained between well site and residences.	Minor	Unlikely	Low
Use of roads; movement of vehicles and heavy machinery	Injury or death of stock or fauna Dust generation Noise generation Damage to third party infrastructure Disturbance lo local community	Control production and dispersion of dust on unsealed roads and drilling lease areas. Compliance with relevant speed restrictions on access roads and tracks. Warning signage and traffic management measures installed where appropriate in the vicinity of well sites. If necessary, unsealed roads will be sprayed with water as required to minimise dust generation. Driver behaviour and vehicle speed limits to be included in compulsory induction. Vehicle speed limits to be observed. Landholders, local councils, potentially affected residents and emergency services will be informed of significant activities such as rig mobilisation and demobilisation. All required authorisations (e.g. local council, DPTI, police) obtained where required for movement of rig along public roads, including joint inspections of roads before and after transport moves if necessary. Rig mobilisation and demobilisation to detour around town centres where possible. Any deterioration of property tracks or infrastructure as a result of drilling-related traffic is rectified.	Minor	Unlikely	Low
	Road hazard / disturbance to local road users		Major	Unlikely	Medium
Drilling through Gambier Limestone and Dilwyn shallow freshwater aquifers	Contamination or salinisation of aquifers	Wells designed in accordance with Beach Well Engineering Construction System (WECS), including the casing and cementing design to ensure aquifer systems are isolated. Water based drilling muds are used in the top hole. Fresh water mud is used in the top hole to prevent saline mud filtrate impacting shallow freshwater aquifers. Surface casing installed and cemented back to surface before drilling of intermediate to production hole section. Shallow aquifers isolated from saline water based WBM or synthetic based mud used in intermediate to production hole section by surface casing. Drilling fluids selection and management is consistent with Beach WECS . Mud properties allow for build-up of filter cake on the borehole wall, creating a barrier and minimising potential loss of fluids to permeable formations. Volume of mud filtrate is insignificant relative to the volume of the aquifer. Note: Deeper aquifers are not used for irrigation, industrial or town water supplies due to depth and generally high salinity.	Minor	Unlikely	Low
Well control incidents (e.g. blowout or kick)	Contamination of soil, groundwater and surface water Crossflow, aquifer contamination or reduction in pressure in aquifers Uncontrolled release of water and hydrocarbon to surface Loss of reserves and reservoir pressure Injury / danger to health and safety of employees, contractors and possibly the public	Drill rig, ancillary and any testing equipment to comply with Regulations, meet relevant industry standards and be 'Fit for Purpose'. Blow out prevention precautions in place in accordance with defined procedures and appropriate to the expected downhole conditions. Well control equipment used during coiled tubing, wireline and workover activities. Satisfactory kick tolerance in casing program design. Work is performed as set out in the Drilling Program. Emergency response procedures in place. Emergency response procedures included in staff training. Confinement of flammable sources, restrictions on certain procedures and ready access to suitable fire-fighting equipment.	Moderate	Unlikely	Medium

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comment	Consequence	Likelihood	Residual Risk
	Access to contaminants by stock and wildlife Atmospheric pollution		Minor	Unlikely	Low
Other downhole drilling issues (e.g. lost circulation, sloughing shales, stuck pipe or drill pipe failure)	Contamination of soil, groundwater and surface water Crossflow, aquifer contamination or reduction in pressure in aquifers Uncontrolled release of water and hydrocarbon to surface Loss of reserves and reservoir pressure	See measures above for Well control incidents	Negligible	Possible	Low
Loss of radioactive source down hole	Contamination of aquifers	Immediate retrieval of tool. If retrieval is not possible, tool is cemented in hole to isolate it from adjacent formations. Relevant government approval obtained for abandonment of any radioactive tool left downhole.	Moderate	Unlikely	Medium
Loss of well integrity (e.g. casing or cement failure)	Contamination or over-pressurisation of aquifers (resulting from cross-flow) Contamination of soil, groundwater and surface water Emissions to the atmosphere Injury / danger to health and safety of employees, contractors and possibly the public	Activities performed in accordance with applicable industry and regulatory standards. Wells designed to meet pressure, temperature, operational stresses and loads. Effective barriers exist to maintain well control and prevent crossflow between aquifers systems or hydrocarbon reservoirs. Operational reports verify that barriers have been set and/or remedial cement work carried out in accordance with the work program submitted to and agreed with DEM. Groundwater aquifers isolated behind casing strings, cemented in place. Surface casing to be cemented to surface with visible return. Cement bond logs run on production casing to confirm quality of cement. Immediate retrieval of any radioactive source lost downhole. If retrieval is not possible, tool is cemented in hole to isolate it from adjacent formations. Relevant government approval obtained for decommissioning of any radioactive tool left downhole. Periodic well integrity processes in place for whole of life well monitoring and management. 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 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.[10] Emergency response plan in place and drills conducted. Emergency response procedures included in staff training Water bore to be drilled by licensed driller with knowledge of local aquifers (e.g. the seal above the Dilwyn formation which must not be penetrated). <u>Well Decommissioning</u> Well decommissioning program submitted to DEM prior to implementation. Downhole decommissioning 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.	Moderate	Unlikely	Medium

[10] These ongoing well integrity management measures have been retained to ensure coverage is maintained, as the production EIR and SEO had not been approved at the time of writing. Once approved, the production SEO will provide coverage.

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comment	Consequence	Likelihood	Residual Risk
Spills or leaks associated with: ▪ drilling procedures and storage of drilling muds and cuttings in sump ▪ storage of fuel, oil and chemicals ▪ refuelling operations and high pressure hydraulic systems ▪ well production testing / flaring	Localised contamination of soil, surface water and groundwater	Drilling sump to have sufficient capacity. All drill pad runoff from high risk areas (e.g. drill rig, generators) directed into sump. Flooding risk is considered in well lease location and construction and additional measures implemented if required (e.g. a small berm around the sump to prevent floodwater entering the sump). Camp and drill rig generators to be appropriately located to contain any spills (e.g. in polyethylene lined bunded areas or with suitable alternative spill containment). Fluid losses will be controlled during drilling. Information on muds and chemicals to be readily available on the rig. The sump will be lined with a suitable impermeable liner to prevent percolation into the soil. If required the sump may be pumped and excess fluid disposed of as appropriate. Synthetic based mud and cuttings circulated to surface will exit via an enclosed mud system to holding tanks, which will be in a lined area to ensure containment. Synthetic based mud and cuttings removed from site by a licensed contractor to a licensed treatment or disposal facility.	Moderate	Unlikely	Medium
	Damage to native vegetation and wildlife habitats Access to contaminants by stock and wildlife	Synthetic based mud / cuttings will be returned to enclosed tanks for collection, treatment and disposal at a licensed facility. Any oil contamination of sump from contaminated drill cuttings will be controlled and pumped out to a disposal tank. On completion of drilling the drill cuttings and sump water will be tested to analyse their suitability for reuse, industrial recycle, fill or waste and will be disposed of accordingly, along with the sump liner. Sump contents to be disposed as waste will be removed by a licensed contractor to an EPA licensed waste disposal facility. Waste water (e.g. excess water from the sump) will not be disposed to land (e.g. by irrigation) unless it has landowner agreement and water quality meets applicable criteria (e.g. EPA guidelines, ANZECC criteria) and any relevant approvals (e.g. DEM / EPA) have been obtained. Wastewater is not allowed to drain to surface water drainage features such as swamps. Fuel and chemical storage and handling Safety Data Sheet information readily available at the well site. Bunded areas must have sufficient freeboard. All fuel and chemical storage areas will be in accordance with EPA guidelines 080/16 Bunding and Spill Management. Hazardous materials stored, used and disposed of in accordance with relevant legislation on dangerous substances. All hazardous materials including fuels, oils and chemicals are to be stored in approved containers in polythene lined bunded areas or on bunded pallets. No refuelling outside designated refuelling or servicing areas. Appropriate drip capture / spill capture methods implemented in refuelling areas (e.g. use of drip trays or liners). Appropriate spill response equipment is available on site. Personnel have received training in the use of spill response equipment. Spills or leaks are immediately reported and clean up actions initiated. All contaminated soil will either be treated in-situ or removed for treatment / disposal at an EPA approved facility. Assessment and remediation of uncontained spills with larger scale impact is consistent with the National Environment Protection (Assessment of Site Contamination) Measure and relevant SA EPA guidelines. Records of spill events and corrective actions are maintained. <u>Well production testing / flaring</u> Production tanks to be located in lined bunded areas. Production lines and tanks to be inspected prior to use. Personnel remain on site during well production testing. Separator tank used during well production testing to separate any produced liquids from gas before gas is sent to flare. Flare tank is used for emergency well control situations while drilling.	Minor	Unlikely	Low

Risk Event / Hazard	Potential Environmental Impacts	Key Management Measures / Comment	Consequence	Likelihood	Residual Risk
Unauthorised access by third parties	Injury / danger to health and safety of employees, contractors and third parties	"No Entry" signs warning of dangers associated with drilling operations placed at the entry to the site access track. Site area to be fenced with a gate on the access track. Access gate to well site will be closed during testing and appropriate signage will be in place to restrict entry. Drilling Supervisor and Drilling Contractor Manager given authority to refuse entry of unauthorised third parties. All minor excavations (e.g. for septic tank) to be backfilled soon after rig release. Well head and sump to be individually fenced if delay in clean-up / workover rig operations to occur. Necessary measures (e.g. fencing, signage) taken to prevent the public accessing the well head equipment or waste relating to the well. Effective rehabilitation of the well site so that potentially dangerous variations in ground level do not remain.	Moderate	Remote	Low
Fire (resulting from activities)	Danger to health and safety of employees, contractors and possibly the public	Confinement of flammable sources, restrictions on certain procedures and ready access to suitable firefighting equipment (e.g. fire unit consisting of trailer with water tank, pump and hoses in high fire danger season). Liaise with CFS regarding operations to ensure fire concerns are addressed and any Fire and Emergency Services Act requirements are met (e.g. permits for 'hot work' on fire ban days if required). Where necessary (e.g. in fire danger season), fire break constructed around well lease. Flare tank / stack designed and located to ensure that radiant heat does not impact trees. Response to fire included in Emergency Response Plan. Emergency response procedures included in staff training. Ensure fire risk is included in the induction and all personnel are fully informed on the fire danger season and associated restrictions.	Major	Remote	Medium
	Loss of vegetation and habitat Disturbance, injury or death of fauna Atmospheric pollution Damage to infrastructure Disruption to land use		Moderate	Remote	Low
Storage, handling and disposal of waste	Localised contamination of soil, surface water and groundwater Damage to vegetation and habitat Attraction of scavenging animals (native / pest species) and access to contaminants by stock and wildlife Litter / loss of visual amenity	EPA's Waste Hierarchy model (avoid, reduce, reuse, recycle, recover, treat, dispose) should be complied with and waste management undertaken with regard to the *Environment Protection (Waste to Resources) Policy 2010*. Covered bins are provided for the collection and storage of wastes. All loads of rubbish are covered during transport to an approved waste facility. Waste streams are segregated on site and transported to appropriate facilities to maximise waste recovery, reuse and recycling. Production of waste is minimised by purchasing reusable, biodegradable or recyclable materials where practical. All waste disposal is at an EPA licensed facility. Hazardous wastes handled in accordance with relevant legislation and standards. Licensed contractors used for waste transport. All wastewater is disposed in accordance with the *South Australian Public Health (Wastewater) Regulations 2013*. Sewage treatment units and septic tanks used at camp and drill rig ablutions. Septic tanks pumped out on an 'as required' basis by a licensed septic waste removal contractor and disposed of at a licensed facility. Any necessary approvals are obtained for use of wastewater disposal system. Well site is kept free of litter and rubbish.	Minor	Unlikely	Low

6 Environmental Management Framework

Drilling, completion and well production testing activities will be undertaken in accordance with Beach's Health, Safety and Environment Management System (HSEMS). 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 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.

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. The indicative organisation and responsibilities for personnel overseeing environmental management are detailed in Table 6-1. 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 drilling contractor 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 6-1: Indicative roles and responsibilities

Role	Responsibility
Beach Executive Management	Licence holders Hold overall responsibility for Beach activities and environmental management
Beach Drilling Manager	Responsible for coordinating the management of the activities, including all environmental aspects Responsible for overall implementation of EHS Responsible for the overseeing and fulfilling of commitments contained in EIR and SEO Overall responsibility for reporting on environmental performance and due diligence Coordinates environmental incident internal reporting and investigation Incident notification to Authorities
Beach Health, Safety and Environment Personnel	Oversee implementation of EIR and SEO Monitor the activities of construction contractors and assesses compliance with the SEO Coordinates the monitoring and audit program Environmental internal reporting and incident investigation
Beach Rig Company Man	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 Drilling Manager on environmental performance and due diligence Environmental internal reporting and incident investigation
Beach Landholder Liaison	Landholder liaison Supervision of lease build and rehabilitation
Drilling Manager (contractor)	Responsible for ensuring that works meet regulatory requirements and all environmental objectives contained in the SEO Directly responsible for the overseeing and fulfilling of commitments contained in relevant approvals, 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 Environmental internal reporting and incident investigation Reports to the Beach Rig Company Man

6.3 Environmental Management Procedure

All Beach employees and contractors are responsible for ensuring compliance with the Beach environmental procedures which are embedded within the integrated HSEMS. The procedures have been developed to set minimum operating standards to ensure Beach and its contractors comply with the relevant environmental legislation. The environment related HSE procedures cover 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 HSE procedures to monitor performance to verify Beach is meeting its policies, legislative requirements and environmental objective commitments and whether the procedures have 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.

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 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.

6.7 Environmental Monitoring and Audits

Monitoring and auditing of drilling operations will be undertaken to determine whether significant environmental risks are being managed, minimised and where reasonably possible, eliminated.

Monitoring and auditing undertaken will assess aspects such as:

- compliance with regulatory requirements (particularly the Statement of Environmental Objectives)
- visual impact of the operations
- impact upon land use
- impact on flora and fauna
- integrity of bunding and containment systems
- site contamination
- site revegetation following program completion and any restoration
- contractor performance.

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 DEM website.

7 Stakeholder Consultation

The South-East region of South Australia is comprised of exceptionally fertile land accounting for three-quarters of the State's forests and one-third of its pastures. The high levels of employment within the agriculture, forestry and fishing industry reflects the economic importance of agricultural production within the region.

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 Otway Basin region include landholders and the local community, native title groups, regulatory agencies, local councils, industry groups and environmental organisations.

Beach's long-term sustainability is contingent upon maintaining strong and meaningful relationships with the communities in which Beach operates. As such, Beach maintains a permanent presence in Penola to ensure these relationships are fostered and maintained. This ensures Beach creates a lasting legacy as an environmentally and socially responsible organisation across the regions in which it operates. Beach maintains a wide range of engagement with stakeholders in the region. A list of stakeholders and the frequency of engagement is provided in Table 7-1.

Beach's approach to supporting communities is guided by various policies, including the Aboriginal Engagement Policy, the Community and Stakeholder Engagement Policy as well as the Sponsorships and Donation Policy, all of which can be viewed on Beach's website. Beach also actively engages with community members via regular and informal meetings, information sessions and community events.

Importantly, 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.

7.1 Community Consultation

In August 2018 Beach held 'drop-in' community consultation sessions at the Wattle Range Council offices in Penola and Millicent. The aim of these sessions was to provide the local community an opportunity to meet with Beach to discuss future development plans for the Penola region including the revision of the Drilling EIR and SEO. A multi-discipline team of Beach employees attended the sessions to answer questions on exploration and production activities.

There was an extensive media campaign undertaken to communicate the consultation activities Beach was undertaking as part of the update to the Production and Drilling EIR and SEO. This media coverage extended across print media, in particular The Border Watch, The Pennant (Penola), The South-Eastern (Millicent) and The Naracoorte Herald, as well as local ABC South East Radio, which combined have an audience catchment of approximately 56,000 people extending from Padthaway in the mid South-East to Port MacDonnell on the South-East coastline.

To ensure any direct or in-direct parties living outside the catchment area of the South-East were also informed, Beach Energy advertised the consultation events across regional South Australia via the ABC Statewide Regional radio broadcast and in The Stock Journal weekly print publication. The advertisements in the print publications (Figure 7.1) were run in the two weeks leading into the consultation events with a number of publications running follow up stories on the success of the respective events in Penola and Millicent.

Due to the high level of interest in Beach's activities in the region, Beach decided to make the draft EIR and accompanying SEO publicly available on its website for all stakeholders to review who are directly and indirectly impacted by Beach's drilling operations. Beach informed stakeholders who attended the public meetings and used local ABC radio to inform the draft documents would be available for review on its website over a four-week period. Hard copies of the documents were

provided to stakeholders upon request. Comments are addressed in this EIR and the SEO and a summary of all comments received and responses is provided in

Table 7-2.

[To be completed following public consultation on draft documents]

Figure 7.1: Print advertisement for community consultation sessions

Table 7-1: Stakeholders and frequency of engagement

Stakeholder	Frequency of Engagement				
	Weekly	Fortnightly	Monthly	3-Monthly	6-Monthly
Wattle Range Council		X			
City of Mount Gambier					X
District Council of Grant					X
Limestone Coast Grape and Wine Council					X
Local landholders	X				
Regional Development Australia – Limestone Coast			X		
Local Government Association – Limestone Coast					X
ABC South East			X		
The Border Watch / Penola Pennant / South Eastern Times		X			
Naracoorte Herald			X		
The Stock Journal				X	
Cooper Energy					X
Rawson Energy					X
Origin Energy					X
ElectraNet					X
APA Group					X
Epic Energy					X
Penola Men's Shed			X		
Penola Golf Club				X	
Penola Show Society					X
Penola Bowls Club					X
Penola Croquet Club					X
Penola Football Netball Club				X	
CFS – South East Region and Penola Brigade				X	
SAPOL – Millicent and Penola				X	
Kimberly-Clark Australia - Millicent			X		
Union Dairy Company - Penola				X	
OneFortyOne Plantations			X		
Kalangadoo Football Netball Club				X	
SE NRM Board				X	
PIRSA – Regions SA				X	
Local Business enterprises in Penola	X				
Local Business enterprises in Mount Gambier	X				

Stakeholder	Frequency of Engagement				
	Weekly	Fortnightly	Monthly	3-Monthly	6-Monthly
Limestone Coast Protection Alliance					
SE Fracking Watchdogs				X	

Table 7-2: Summary of issues raised during stakeholder consultation undertaken by Beach Energy

Stakeholder	Issue / Comment	Response
	To be completed following public consultation on draft documents	

8 References

ABS 2016. 2016 Census data and analysis. Accessed on April 2018 at http://www.abs.gov.au/websitedbs/censushome.nsf/home/2016 Australian Bureau of Statistics. Canberra, ACT.

Adelaide Energy (2007). *Environmental Impact Report: Drilling, Completion and Initial Production Testing, PEL 255 Otway Basin, South East, South Australia*, *May 2007.* Adelaide Energy Ltd, Adelaide.

ANZECC (2000*). Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. National Water Quality Management Strategy. Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Backhouse, G.N. & J.A. Jeanes 1995. The Orchids of Victoria. Carlton: Miegunyah Press, Melbourne University Press.

Bates R.J. 2011. South Australia's Native Orchids. E-book. Native Society of South Australia Inc., Adelaide.

Binks, B. 2000. (1999). Profile of the South East Irrigation Industry, South East Catchment Water Management Board, South Australia, September 2000.

BirdLife International 2009. Apus pacificus In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. Apus pacificus. IUCN Red List

Bishop, A. 1996. Field Guide to Orchids of New South Wales and Victoria. Sydney, NSW: University of New South Wales Press.

Blakers, M., S.J.J.F. Davies & P.N. Reilly 1984. The Atlas of Australian Birds. Melbourne, Victoria: Melbourne University Press.

BoM (2018). Climate Data Online. Accessed in March 2018 at http://www.bom.gov.au/climate/data/. Bureau of Meteorology, Australia.

Boult and Hibburt (2002). The Petroleum Geology of SA Volume1: Otway Basin, 2nd edition, August 2002. South Australian Government.

Brown, K., Harrington, G., and Lawson, J. (2006). Review of groundwater resource condition and management principles for the Tertiary Limestone Aquifer in the South East of South Australia. South Australia. Department of Water, Land and Biodiversity Conservation. DWLBC Report 2006/2.

Brown, K., Love, A., and Harrington G. (2001). Vertical groundwater recharge to the Tertiary confined sand aquifer, South East, South Australia, Department of Water Resources South Australia, Report Book DWR 2001/002 (unpublished).

Carter, O. (2010). National Recovery Plan for Trailing Hop-bush *Dodonaea procumbens*. Department of Sustainability and Environment, Melbourne, Victoria.

Croft. T.S., Carruthers, S., Possingham, H., Inns, B. (1999). Biodiversity Plan for the South East of South Australia. Department for Environment, Heritage and Aboriginal Affairs, Adelaide, SA.

Crowley, G.M. & S.T. Garnett 1998. Vegetation change in the grasslands and grassy woodlands of central Cape York Peninsula. Pacific Conservation Biology. 4:132-148.

Department of Planning and Local Government (2012). SA Heritage Register database. Searched May 2012. http://www.environment.sa.gov.au/our-places/Heritage/SA_Heritage_Register/Database>

Davies, R.J.P. 1986. Threatened Plant Species of the Mt Lofty Ranges and Kangaroo Island Regions of South Australia. Conservation Council of South Australia.

Davies, R.J.P. 1992. Threatened Plants of the Murray Mallee, Mt Lofty Range and Kangaroo Island Region of South Australia. Conservation Council of South Australia.

DEE 2018. EPBC Act Protected Matters Search Tool – online database http://www.environment.gov.au/epbc/pmst/index.html. Department of the Environment and Energy, Canberra. Searched March 2018.

DEE 2018a. Species Profile and Threats Database: *Glycine latrobeana* – Clover Glycine, Purple Glycine. Accessed on May 2018 at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=13910. Department of the Environment and Energy, Canberra.

DEE 2018b. Species Profile and Threats Database: *Calyptorhynchus banksii graptogyne* — Red-tailed Black-Cockatoo (south-eastern). Accessed on May 2018 at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=25982. Department of the Environment and Energy, Canberra.

DEE 2018c. Species Profile and Threats Database: *Litoria raniformis* — Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog. Accessed on May 2018 at http://www.environment.gov.au/cgibin/ sprat/public/publicspecies.pl?taxon_id=1828. Department of the Environment and Energy, Canberra.

DEE 2018d. Species Profile and Threats Database: *Isoodon obesulus obesulus* – Southern Brown Bandicoot (Eastern). Accessed on May 2018 at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68050. Department of the Environment and Energy, Canberra.

DEE 2018e. Species Profile and Threats Database: *Miniopterus schreibersii bassanii* — Southern Bent-wing Bat. Accessed on May 2018 at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=76606. Department of the Environment and Energy, Canberra.

DEW 2018. Biological Databases of SA. Department of Environment and Water. Record set number DEWNRBDBSA180307-1

DSEWPC (2009). Australia's 15 National Biodiversity Hotspots. A WWW publication accessed on 25 June 2012 at http://www.environment.gov.au/biodiversity/hotspots/nationalhotspots. Html#hotspot6

DSEWPC 2011. *Environment Protection and Biodiversity Conservation Act 1999* referral guidelines for the endangered southern brown bandicoot (eastern) *Isoodon obesulus obesulus*. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.

Dickson, C.R., Farrington, L & Bachmann M. 2014. Survey and description of the Seasonal Herbaceous Wetlands (freshwater) of the Temperate Lowland Plains in the South East of South Australia. Nature Glenelg Trust.

EBS. (2011). Case Study: Southern Bell Frog Surveys. http://www.ebsecology.com.au/documents/StateGovernment- SouthernBellFrogSurveys_000.pdf

EPA (2016). *Bunding and spill management, EPA Guideline 080/16*. Environment Protection Agency, South Australia.

Frith, H.J., F.H.J. Crome & B.K. Brown 1977. Aspects of the Biology of the Japanese Snipe Gallinago hardwickii. Australian Journal of Ecology. 2:341-368

Garnett. S.T., Crowley, G.M. (2000). The Action Plan for Australian Birds. Environment Australia and Birds Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/birds2000/index.html

Garnett, S.T., & S. Shephard 1997. Cape York Peninsula, Australia, as a stopover site for Latham's Snipe Gallinago hardwickii. Stilt. 30:54-55.

Gravestock, D.I., Hill, A.J. and Morton, J.G.G. (1986). A review of the structure, geology and hydrocarbon potential of the Otway. Basin in South Australia. South Australia. Department of Mines and Energy. Report Book, 86/77.

Hill, R., Burnard, T. (2001). Habitat Management Plan for the South-eastern Red-tailed Black-Cockatoo. Red-tailed Black-Cockatoo Recovery Team. Birds Australia, Melbourne, Victoria.

Kopsen, E. and Scholefield, T. (1990). Prospectivity of the Otway Supergroup in the central and western Otway Basin. APEA Journal, 30:263-279.

Laut, P., Heyligers, P.C., Kreig, G., Loffler, E., Margules, C., Scott, R.M., Sullivan, M.E. (1977). Environments of South Australia Province 1 South East. CSIRO Division of Land Use Research, Canberra, ACT.

Littler, F.M. 1910. A Handbook of the Birds of Tasmania and its Dependencies. Launceston: Published privately.

Love, A., Herczeg, A., Armstrong, D., Stadter, F., and Mazor, E. (1993). Groundwater flow regime within the Gambier Embayment of the Otway Basin, Australia: evidence from hydraulics and hydrochemistry, Journal of Hydrology, 143:297–338.

Love, A., Herczeg, A., Leaney, F., Stadter, M., Dighton, J., and Armstrong, D. (1994). Groundwater residence time and palaeohydrology in the Otway Basin, South Australia: 2H, 18O and 14C data, Journal of Hydrology, 153:157–187.

Marchant, S., Higgens. P.J. (1990). Handbook of Australian, New Zealand and Antarctic Birds. Volume One – Ratites to Ducks. Oxford University Press, Melbourne, Victoria.

Naarding, J.A. 1981. Latham's Snipe (*Gallinago hardwickii*) in Tasmania. Wildlife Division Technical Report. 81/2. Tasmania: National Parks and Wildlife Service.

Naarding, J.A. 1985. Latham's Snipe (*Gallinago hardwickii*) in Australia and Japan. Wildlife Division Technical Report. 85/2. Tasmania: National Parks and Wildlife Service.

NatureMaps 2018. Online search tool –Accessed at http://www.naturemaps.sa.gov.au/. Department of Environment, Water and Natural Resources, South Australia.

Paydar, Z., Chen, Y., Xevi, E., and Buettikofer, H. (2009). Current understanding of the water cycle in the Limestone Coast region. Cooperative Research Centre for Irrigation Futures. Technical Report No. 03/09.

PIRSA 2017. Forestry in South Australia brochure. Government of South Australia. Primary Industries and Regions SA.

South Australian Tourism Commission. 2017. Website access April 2018. http://tourism.sa.gov.au/

South East NRM Board 2010. Natural Resource Management Plan, Part One: Regional Description. South East Natural Resource Management Board, Government of South Australia.

South East NRM Board 2013. Draft Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area. Prepared by the South East Natural Resources Management Board, March 2013.

South East NRM Board 2015. Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area. Prepared by the South East Natural Resources Management Board.

South East NRM Board 2018. South East Natural Resources Management Board. Pest Management Strategy Summary. Government of South Australia.

South East Natural Resource Consultative Committee (SENRCC). (2003). South East Natural Resource Management Plan, A plan for the integrated management of natural resources in the South East, Consultation Report.

Threatened Species Scientific Committee (TSSC) 2012. Approved Conservation Advice for the Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains Todd (2000). Recovery Plan for Twelve Threatened Spider-orchid *Caladenia* taxa (*Orchidaceae: Caladeniinae*) of Victoria and South Australia 2000 – 2004. Department of Natural Resources and Environment, Melbourne, Victoria.

Weston, M.A. 1995. Snipers band together in the suburbs. Geo. 17:18-19.

9 Abbreviations and Glossary

AARD	Aboriginal Affairs and Reconciliation Division, Department of Premier and Cabinet (SA)
ANZECC	Australian and New Zealand Environment and Conservation Council
aquitard	A bed of low permeability adjacent to an aquifer
AS 1940	Australian Standard AS 1940 Storage and Handling of Flammable and Combustible Liquids
BDBSA	Biological Databases of South Australia
blowout	An uncontrolled flow of reservoir fluids into the wellbore, and sometimes catastrophically to the surface. A blowout may consist of water, oil, gas or a mixture of these.
BoM	Bureau of Meteorology
bund	An earth, rock or concrete wall constructed to prevent the inflow or outflow of liquids.
casing	Large diameter steel rods that are screwed together to form a casing string, which is run into a core hole or well and cemented in place
casing annulus	Space between the casing and any piping, tubing or casing surrounding it
casing string	A series of casing rods screwed together
cement bond log	The output from an acoustic tool that is lowered down an oil or gas well to evaluate the integrity of the bond of the cement to the casing and formation
conventional gas	Natural gas trapped in underground structures in highly permeable sandstones
ºC	degrees Centigrade
DEE	Department of the Environment and Energy
DEH	Department for Environment and Heritage (South Australia) (now DEW)
DENR	Department for Environment and Natural Resources (South Australia) (now DEW)
DEWNR	Department of Environment, Water and Natural Resources (South Australia) (now DEW)
DFW	Department for Water (South Australia) (part of DEWNR as of 1 July 2012)
DEM	Department for Energy and Mining
DMITRE	Department for Manufacturing, Innovation, Trade, Resources and Energy (formerly PIRSA) (now DEM)
DEWNR	Department of Environment, Water and Natural Resources (now DEW)
DPTI	Department of Planning, Transport and Infrastructure
drill cuttings	Rock pieces dislodged by the drill bit as it cuts rock in the hole
drilling mud / drilling fluid	Fluids continuously circulated down the wellbore, to cool and lubricate the drill bit, lubricate the drill pipe, carry rock cuttings to the surface and control down hole pressure.
drill stem testing	A valved test tool is lowered down a well on the end of the drill string to a specific reservoir formation and the valve opened to admit formation fluids.
EIR	Environmental Impact Report prepared in accordance with Section 97 of the South Australian Petroleum and Geothermal Energy Act 2000 and Regulation 10
EPA	Environment Protection Authority (South Australia)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
ephemeral	Existing for only a short time, often dependent upon climatic influences.
flaring	The burning of gas through a pipe (called a flare).
formation	The term for the primary unit in stratigraphy consisting of a succession of strata useful for mapping or description, which possesses certain distinctive lithologic and other features.
h	hour

ha	Hectares
HSEMS	Health, Safety and Environment Management System
IBRA	Interim Biogeographical Regionalisation for Australia
ISO	International Standards Organisation
JSA	Job Safety Analysis
km	kilometre
km/h	kilometres per hour
lithology	Description of the physical characteristics of a rock such as colour, texture, grain size or composition
m	Metre
m^3	cubic metre (=10^3 litres or one kilolitre)
mg/L	milligrams per litre
ML	megalitre (10^6 litres)
mud	See 'drilling mud'
MW	Megawatt
Native Vegetation Council	A council established under the South Australian Native Vegetation Act 1991 to assess vegetation clearance applications.
NGER Act	National Greenhouse and Energy Reporting Act 2007 (Cth)
NGERS	National Greenhouse and Energy Reporting System
NPW Act	National Parks and Wildlife Act 1972 (South Australia)
NRM Act	Natural Resources Management Act 2004 (South Australia)
NRM Plan	Natural Resource Management Plan prepared under the Natural Resources Management Act
packer	A device that can be run into a wellbore with a smaller initial outside diameter that then expands externally to seal the wellbore.
PEL	Petroleum Exploration Licence
PPL	Petroleum Production Licence
PRL	Petroleum Retention Licence
perforating	The process of punching holes in the casing or liner of an oil or gas well to connect it to the reservoir
PIRSA	Department of Primary Industries and Regions, South Australia
plug and abandon	To place a cement plug into a dry hole or non-economic well and abandon the well.
prescribed well	Water well prescribed under s.125 of the Natural Resources Management Act 2004
production test	Tests in an oil or gas well to determine its flow capacity at specific conditions of reservoir and flowing pressures.
Ramsar wetland	A Wetland of International Importance listed under the Ramsar Convention (held in Ramsar, Iran 1971).
Ripping	The use of machinery to rake or shallow plough soil to relieve compaction and aerate soil.
tubulars	A generic term pertaining to any type of oilfield pipe, such as drill pipe, drill collars, pup joints, casing, production tubing and pipeline.
separation tank	A cylindrical or spherical vessel used to separate oil, gas and water in the total fluid stream produced by a well.
SEO	Statement of Environmental Objectives

static gradients	Process of running a pressure gauge into the well while it is shut in (not flowing) and stopping at several depths to measure the pressure.
stratigraphy	The study of rock layers and layering (stratification)
suspended well	A suspended well is not currently used for assessment or production and has been shut in. It will either be returned to assessment or production or plugged and abandoned.
TCSA	Tertiary Confined Sand Aquifer
TLA	Tertiary Limestone Aquifer
unconventional gas	Natural gas that is trapped in lower permeability reservoirs, rather than on underground structures such as anticlines and highly permeable sandstones.
WECS	Beach Energy Well Engineering Construction System
well completion	A generic term used to describe the assembly of downhole tubulars and equipment required to enable safe and efficient production from an oil or gas well.
well head	The part of an oil or gas well which terminates at the surface, where oil or gas can be withdrawn.
wireline logging	A measuring instrument is raised up the well on a wireline to log or record rock properties and fluids.
workover	Repair or stimulation of an existing production well for the purpose of restoring, prolonging or enhancing the production of hydrocarbons.
zone	An interval or unit of rock differentiated from surrounding rocks on the basis of its fossil content or other features, such as faults or fractures. Often used to describe a layer of reservoir rock that contains oil or gas

Appendix 1

Flora and Fauna Information

Flora and Fauna Information

This appendix provides additional detail on the vegetation communities, threatened and migratory species and weeds that are summarised in Section 4.5 of the EIR. The information in this appendix is derived largely from a draft report prepared for Beach by Coffey Environments in 2012.

1. Vegetation communities

Floristic communities mapped in areas of remnant native vegetation within Beach's licence areas include:

- *Eucalyptus camaldulensis var. camaldulensis* mid woodland over *Leptospermum continentale* shrubs over *Hypochaeris radicata, Hydrocotyle laxiflora, Ranunculus robertsonii, Schoenus apogon* forbs (most widespread association of the area).
- *Eucalyptus fasciculosa* low woodland over *Acacia longifolia* ssp. *sophorae*, *Banksia marginata* shrubs over *Xanthorrhoea caespitosa*.
- *Eucalyptus obliqua* mid woodland over *Acacia melanoxylon* shrubs over *Pteridium esculentum Leucopogon parviflorus, Hypochaeris radicata, Hydrocotyle laxiflora* ferns.
- Emergent *Eucalyptus obliqua* trees over *Xanthorrhoea caespitosa*, *Leptospermum continentale* mid open shrubland over *Leucopogon virgatus var. virgatus*, *Astroloma conostephioides, Isopogon ceratophyllus, Hypolaena fastigiata, Epacris impressa, Tetratheca ciliata.*
- *Eucalyptus leucoxylon* ssp. mid open woodland over *Acacia pycnantha* shrubs over *Astroloma humifusum, Hibbertia australis, Kunzea pomifera, Danthonia* sp. shrubs.
- *Baumea juncea, Gahnia trifida* mid sedgeland.
- *Melaleuca brevifolia, Leptospermum continentale* mid shrubland over *Apodasmia brownii, Baumea juncea* sedges.
- *Melaleuca halmaturorum* tall shrubland over *Gahnia filum* sedges over *Comesperma volubile, Samolus repens*.
- *Cyperaceae* sp., *Gramineae* sp. mid sedgeland.
- Emergent *Eucalyptus* sp. trees over *Pteridium esculentum* mid closed fernland.

2. Details for Selected EPBC Act Listed Plant Species

A selection of the EPBC Act-listed flora species that have been recorded within the licence areas (based on BDBSA records) are discussed in further detail below. For the selected species, habitat requirements, key threats thought to have led to the species' decline, and key recovery actions are discussed. Not all listed species are discussed however the selected species provide examples of threats and recovery actions consistent with the other species.

<u>Elegant Spider-orchid</u>

The Elegant Spider-orchid (*Caladenia formosa*) occurs in western Victoria and south-eastern South Australia, and is now restricted to isolated public land forest blocks south of Edenhope and north of Cavendish, and adjoining properties in Victoria, in Mt Scott and Mt Monster Conservation Parks, and private properties in the Naracoorte, Coonawarra and Kingston regions. The habitats *Caladenia formosa* typically occupy include damp-sands with herb-rich woodlands, with sedges, which may be seasonally inundated. Key threats to the species include disturbance (through timber harvesting, rabbit burrow ripping, horse riding and trail bikes), inappropriate fuel reduction burning in autumn, as well as weed invasion, and grazing from both native and exotic herbivores (Todd, 2000).

<u>Bell-flower Hyacinth Orchid</u>

In South Australia, the species *Dipodium campanulatum* is restricted to the south east of the state on an ancient shoreline extending parallel to 10–20 km from the Victorian border; from near Padthaway

south to the Glenelg River and was once common around Naracoorte. The bell-flower hyacinth orchid is typically found on deep grey sands or limestone in stringybark (*Eucalyptus baxteri /arenacea*) woodland with an understorey of bracken fern (*Pteridium esculentum*), *Acacia* species (Bates 2011). Key threats to the species include clearing and fragmentation of existing habitat, trampling and grazing pressures, road side maintenance, competition from weed species and illegal picking by the public.

Trailing Hop-bush

There are 55 known populations of the Trailing Hop-bush (*Dodonaea procumbens*) across Victoria, New South Wales, and South Australia. Little is known about the species, and population occurrences and population estimates are not fully understood. In South Australia, there are populations near Port Lincoln, Clare and Burra in the Mid North, Kangaroo Island, and a small population on a roadside near Penola in the South East. Habitats within which the species has been recorded are often low-lying areas, typically wet in winter, of woodland, low open forests, heathlands and grasslands, on sands and clays. The South Australian populations have been recorded in *Eucalyptus camaldulensis*, *Eucalyptus fasciculosa* and *Eucalyptus leucoxylon* woodland, and in native grasslands of *Lepidosperma viscida*, *Themeda triandra*, *Austrodanthonia* sp., *Austrostipa* sp., and shrubs of *Acacia acinacea*, *Dodonaea viscosa*, and *Bursaria spinosa* (Carter, 2010).

Clover Glycine

The Clover Glycine (*Glycine latrobeana*) is distributed across south-eastern Australia, including south-eastern South Australia. The overall extent of occurrence is calculated at 351,350 km^2, whilst the actual area of occupancy is estimated to be 131 km^2. In South Australia, the species has been found on undulating plains, gentle west facing slopes and lower south facing river valley slopes. In the south-east, it has been recorded in *Eucalyptus baxteri* woodlands with Banksia species (Davies, 1986). Threats to *Glycine latrobeana* include small population size, inappropriate fire regimes, grazing by both native and introduced stock, habitat fragmentation, Phytophthora and weeds. Ensuring key populations and their habitat are identified and protected has been identified as a key objective of the species recovery plan (DEE, 2018a).

Spiral Sun Orchid

The Spiral sun orchid (*Thelymitra matthewsii*) is currently known to occur in Victoria, South Australia and New Zealand. Throughout its range the species is rare and of sporadic distribution. The species favors open forests and woodlands in well-drained sand and clay loams. It is a post-disturbance coloniser that is usually found in open areas around old quarries and gravel pits, on road verges, disused tracks and animal trails (Backhouse & Jeanes 1995). It has been recorded as growing on gravely soils in disturbed areas of low coastal forest (Bishop 1996), in swampy soils, on lateritic podsol on gently sloping plateaus or from sand overlying limestone on undulating plains (Davies 1986, 1992). Current threats include disturbance to or destruction of plants and habitat, altered fire regimes, grazing/predation and weed invasion.

3. Details for Selected EPBC Act Listed Fauna Species

A selection of the EPBC Act-listed fauna species that have been recorded within the licence areas (based on BDBSA records) are discussed in further detail below. For the selected species, habitat requirements, key threats thought to have led the species' decline, and key recovery actions are discussed. Not all listed species are discussed however the selected species provide examples of threats and recovery actions consistent with the other species.

Australasian Bittern

The Australasian Bittern (*Botaurus poiciloptilus*) occurs in Australia, New Zealand and New Caledonia. Within South Australia, the species is confined to the south-east, ranging from north of the River

Murray and west to southern Eyre Peninsula, with the greatest population densities within the licence areas at Bool Lagoon (Marchant and Higgens, 1990). The species occupies densely vegetated freshwater wetlands, and occasionally estuarine habitats. Key habitat preferences are wetlands with tall dense vegetation, allowing for foraging in still, shallow water. Vegetation communities often occupied by the species are dominated by sedges, rushes, and reeds (of the genera *Phragmites, Cyperus, Eleocharis, Juncus, Typha*). The key threat to *Botaurus poiciloptilus* is loss or alteration of suitable habitat through diversion of water from wetlands for irrigation, and the salinisation of swamps (Garnett and Crowley, 2000).

Red-tailed Black-cockatoo (South-eastern)

The Red-tailed Black-cockatoo (south-eastern) (*Calyptorhynchus banksii graptogyne*) has a restricted distribution, confined to the south-east South Australia and neighbouring areas in western Victoria. It is considered widespread, but rare within its range. Preferred habitats include *Eucalyptus arenacea* and *Eucalyptus baxteri* woodlands on plains, as well as *Eucalyptus camaldulensis*, *Eucalyptus leucoxylon* and *Allocasuarina luehmannii* woodlands (DEE, 2018b). A key habitat requirement is large hollows in eucalypt trees, preferably hollows of dead trees over live trees, with entrances facing upwards, preferably vertical or near vertical, higher than 6 m from the ground, with an entrance 15 – 50 cm in diameter (Hill and Burnard, 2001). Key threats to the species are food shortages (due to impact of fire on food, loss of feeding habitat, grazing impacts on foraging sites, fragmentation of foraging habitat), nest site availability, firewood harvesting, nest predators, and human interference with nests.

Southern Bell Frog

The distribution of the Southern Bell Frog (*Litoria raniformis*) covered sections of New South Wales, Victoria, Tasmania and South Australia. The species has undergone substantial declines in abundance, and has become locally extinct in many areas of its former range. In the south-east of South Australia, the species occurs at Bool and Hacks Lagoons, which are within the licence areas. In 2011 there was a notable population increase of *Litoria raniformis* at Bool Lagoon, Hacks Lagoon and Lake Ormerod (EBS, 2011). Preferred habitat typically includes emergent vegetation of *Typha* sp., *Phragmites* and *Eleocharis* sp., in or surrounding the edges of still or slow moving lagoons, swamps, lakes, ponds and dams. Threats to the species include habitat loss and degradation, altered flooding regimes, disease, predation from introduced fish, and salinisation (DEE, 2018c).

Southern Brown Bandicoot (Eastern)

The Southern Brown Bandicoot (eastern) (*Isoodon obesulus obesulus*) is found in New South Wales, Victoria, and South Australia. The subspecies was once widely distributed along a broad coastal band from Eyre Peninsula in South Australia, through southern Victoria and south-eastern New South Wales to just north of Sydney. The current range has contracted, and the species is now patchily distributed in isolated populations throughout the former range (DSEWPC, 2011). In South Australia, the subspecies is found in the Mount Lofty Ranges, Kangaroo Island, and the south-east. There is little information on the habitats the subspecies utilises in the south-east, but in the Mount Lofty Ranges it inhabits eucalypt forests and woodlands with heath understoreys. Vegetation communities inhabited include *Eucalyptus obliqua*, *Eucalyptus fasciculosa*, *Leptospermum continentale*, *Leptospermum myrsinoides*, and *Banksia marginata*. Dense shrub understories, with at least 50% groundcover are preferred. Key threats are loss or habitat or modification, fragmentation, inappropriate fire regimes and extensive wildfires, and predation from introduced animals, as well as the isolation of the populations (DEE, 2018d).

Southern Bent-wing Bat

The Southern Bent-wing Bat (*Miniopterus schreibersii bassanii*) is found in wetland and river basins of in south-eastern South Australia and Victoria. The Naracoorte area is thought to be the species' most southern distribution in South Australia, with the key maternity cave located within Naracoorte Caves

National Park. The species' preferred habitat is associated with the availability of foraging areas, and proximity to suitable roosting caves. Habitat loss, disturbance and modification are the key threats to the species (DEE, 2018e).

4. Details for Significant Migratory Species

The following section discusses a selection of the migratory species that have been recorded within the licence areas (based on BDBSA records). For the selected species, habitat requirements and key threats are discussed. Not all listed migratory species are discussed however the selected species provide examples consistent with the other species.

Fork Tailed Swift

In South Australia the Fork-tailed Swift (*Apus pacificus*) is widespread from the Victorian border west to the Spencer Gulf. It is also common in coastal parts of Eyre Peninsula as far west as Franklin Island, off Streaky Bay and to the north. There have been a few recently published records beyond these bounds, such as in Flinders Ranges and the Lake Eyre Drainage Basin from Billa Kallina Station, Lake Eyre South and Marree. Sightings have also been recorded north to Moorayepe and east to Innamincka and Moomba (Higgins 1999). In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. There are no significant threats to the Fork-tailed Swift in Australia. Potential threats include habitat destruction and predation by feral animals. Due to the wide range of the species the potential impacts are thought to be negligible (Birdlife International 2009).

Satin Flycatcher

The Satin Flycatcher (*Myiagra cyanoleuca*) are occasionally recorded, mostly in the lower south-east, occasionally as far north as Naracoorte (Blakers *et al*. 1984). They generally inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Populations of the Satin Flycatcher are said to have been reduced by clearing and logging of forests in south-eastern Australia, mainly the loss of mature forests (Blakers *et al*. 1984).

Latham's Snipe

Latham's Snipe is a non-breeding visitor to south-eastern Australia and is a passage migrant through northern Australia (Higgins & Davies 1996). The species has been recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia (including the Adelaide plains and Mount Lofty Ranges, and the Eyre Peninsula).

Historically, the greatest threats to Latham's Snipe in Australia have been a loss of habitat caused by the drainage and modification of wetlands, and excessive mortality due to hunting (Frith *et al*. 1977; Littler 1910; Naarding 1985). The current major threat to the species appears to be the ongoing loss of habitat. The wetland habitats occupied by Latham's Snipe are threatened by a variety of processes including pollution, drainage, diversion of water for storage or agriculture, development of land for urban or other purposes, and land management practices such as mowing of habitat during summer (Frith *et al*. 1977; Garnett & Crowley 2000; Naarding 1981 1985; Weston 1995). The habitat is also potentially threatened by vegetational replacement (Crowley & Garnett 1998; Garnett & Shephard 1997; Garnett & Crowley 2000). Collisions with vehicles could be a potential minor threat to some snipe, as birds are known to roost at times beside roadside puddles.

5. Introduced Species

Table A1: Priority pest weeds and alert weeds identified by the South East NRM Board

Common name	Scientific name	NRM Act status: SE NRM Board management aim
Bridal veil	*Asparagus declinatus*	Declared: eradicate from region
Golden dodder	*Cuscuta campestris*	Declared: eradicate from region
Blackberry	*Rubus fruticosus*	Declared: destroy infestations
Western Cape bridal creeper	*Asparagus asparagoides*	Declared: destroy infestations
Innocent weed	*Cenchrus incertus / C. longispinus*	Declared: destroy infestations
Pampas grass	*Cortaderia spp*	Declared: destroy infestations
Silverleaf nightshade	*Solanum elaeagnifolium*	Declared: destroy infestations
Asparagus fern	*Asparagus scandens*	Not Declared: destroy infestations
Tree of heaven	*Ailanthus altissima*	Not Declared: destroy infestations
White weeping broom	*Retama raetam*	Not Declared: destroy infestations
African feathergrass	*Pennisetum macrourum*	Declared: contain the spread
Aleppo pine	*Pinus halepensis*	Declared: contain the spread
Bathurst burr	*Xanthium spinosum*	Declared: contain the spread
Boneseed ssp. *monilifera*	*Chrysanthemoides monilifera*	Declared: contain the spread
Caltrop	*Tribulus sp.*	Declared: contain the spread
Cape tulip	*Homeria sp.*	Declared: contain the spread
Creeping knapweed	*Rhaponticum repens*	Declared: contain the spread
Gorse	*Ulex europaeus*	Declared: contain the spread
Hoary cress	*Lepidium appelianum*	Declared: contain the spread
Salvation jane	*Echium plantagineum*	Declared: contain the spread
Three corner jack	*Emex australis*	Declared: contain the spread
Three horned bedstraw	*Galium tricornutum*	Declared: contain the spread
Variegated thistle	*Silybum marianum*	Declared: contain the spread
Yellow burweed	*Amsinckia calycina*	Declared: contain the spread
Noogoora burr	*Xanthium strumarium*	Declared: contain the spread
Bluebell creeper	*Sollya heterophylla*	Non-declared: contain the spread
Dolichos pea	*Dipogon lignosus*	Non-declared: contain the spread
Erica	*Erica baccans*	Non-declared: contain the spread
Radiata pine	*Pinus radiata*	Non-declared: contain the spread
Sallow wattle	*Acacia longifolia ssp.*	Non-declared: contain the spread
Alisma	*Alisma lanceolatum*	Declared: alert weed
Alligator weed	*Alternanthera philoxeroides*	Declared: alert weed
Arrowhead	*Sagittaria montevidensis*	Declared: alert weed
Azzarola	*Crataegus sinaica*	Declared: alert weed
Broadkernel espartillo	*Amelichloa brachychaeta*	Declared: alert weed

Common name	Scientific name	NRM Act status: SE NRM Board management aim
Broomrape	*Orobanche ramosa*	Declared: alert weed
Cabomba	*Cabomba caroliniana*	Declared: alert weed
Calomba daisy	*Oncosiphon suffruticosum*	Declared: alert weed
Cane needlegrass	*Nassella hyalina*	Declared: alert weed
Chilean needlegrass	*Nassella neesiana*	Declared: alert weed
Coolatai grass	*Hyparrhenia hirta*	Declared: alert weed
Elodea	*Elodea canadensis*	Declared: alert weed
Eurasian watermilfoil	*Myriophyllum spicatum*	Declared: alert weed
Horsetail	*Equisetum hyemale*	Declared: alert weed
Hydrocotyle	*Hydrocotyle ranunculoides*	Declared: alert weed
Lagarosiphon	*Lagarosiphon major*	Declared: alert weed
Leafy elodea	*Egeria densa*	Declared: alert weed
Mexican feathergrass	*Nassella tenuissima*	Declared: alert weed
Nightstock	*Matthiola longipetala*	Declared: alert weed
Pheasant's eye	*Adonis microcarpa*	Declared: alert weed
Plumerillo	*Jarava plumosa*	Declared: alert weed
Poison buttercup	*Ranunculus sceleratus*	Declared: alert weed
Primrose willow	*Ludwigia peruviana*	Declared: alert weed
Ragwort	*Senecio jacobaea*	Declared: alert weed
Rhus tree	*Toxicodendron succedaneum*	Declared: alert weed
Sagittaria	*Sagittaria graminea*	Declared: alert weed
Salvinia	*Salvinia molesta*	Declared: alert weed
Senegal tea plant	*Gymnocoronis spilanthoides*	Declared: alert weed
Serrated tussock	*Nassella trichotoma*	Declared: alert weed
Texas needlegrass	*Nassella leucotricha*	Declared: alert weed
Water caltrop	*Trapa natans*	Declared: alert weed
Water dropwart	*Oenanthe pimpinelloides*	Declared: alert weed
Water hyacinth	*Eichhornia crassipes*	Declared: alert weed
Water soldier	*Stratiotes aloides*	Declared: alert weed
Blue mustard	*Chorispora tenlla*	Declared: alert weed
Parrot's feather	*Myriophyllum aquaticum*	Declared: alert weed
Water primrose	*Ludwigia peruviana*	Declared: alert weed

Table A2: Priority pest fauna identified by the South East NRM Board

Common name	Scientific name	NRM Act status: SE NRM Board management aim
Wild dog / dingo	*Canis lupus/* ssp. *dingo*	Declared: eradicate
Goat	*Capra hircus*	Declared: eradicate
Chital	*Axis axis*	Declared: significantly reduce the extent
Rusa deer	*Cervus timorensis*	Declared: significantly reduce the extent
Sambar deer	*Cervus unicolour*	Declared: significantly reduce the extent
Red deer	*Cervus elaphus*	Declared: significantly reduce the extent
Wapiti deer	*Cervus canadensis*	Declared: significantly reduce the extent
Mallard	*Anas platyrhynchos*	Declared: significantly reduce the extent
Hog deer	*Axis porcinus*	Declared: prevent ongoing spread
Brown rat	*Rattus norvegicus*	Declared :prevent ongoing spread
Fallow deer	*Dama dam*	Declared :prevent ongoing spread
Rabbit	*Oryctolagus cuniculus*	Declared :prevent ongoing spread

Appendix 2

Environmental Risk Assessment Tables

Environmental Risk Assessment Tables

The risk assessment that is summarised in the EIR (Section 5.9) uses the risk matrix and definitions for consequences and likelihood outlined below.

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. The columns in the table that are directly related to impact to the environment have been used to assess consequence levels in the risk assessment; those that are not directly related to impact to the environment (e.g. reputation) are used as guidance only for the purposes of this EIR.

Table 1: 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 2: 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 3: 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 Table

A summary of the level of environmental risk for drilling, completion and well production testing activities is provided in Table 5-1 in the EIR. The level of risk has been assessed based on the assumption that the management measures outlined in the EIR will be in place.