PEL 120

Exploratory Coal Seam Drilling

Environmental Impact Report

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1 Introduction

SAPEX Limited (SAPEX) holds Petroleum Exploration Licence (PEL) 120, which is located to the north of Adelaide in South Australia. SAPEX plans to undertake drilling activities within this PEL to identify and delineate potential hydrocarbon (coal seam gas) prospects. This Environmental Impact Report (EIR) has been prepared as a requirement of the *Petroleum Act 2000* to provide information on the proposed activities, the potential environmental impacts and their management.

1.1 Location and Activities

Petroleum Exploration Licence 120 covers an area of approximately 9,600km² and extends from Carrieton and Peterborough in the north, past Bute and Owen (in the Mid North) and to Elizabeth (on the northern Adelaide Plains) and across to Price (on the Yorke Peninsula) in the south (Figure 1). SAPEX has also applied for two mineral exploration licences under the *Mining Act 1971*, which lie within PEL 120 and are also shown in Figure 1.

SAPEX intends to focus the initial exploration for coal seam gas (CSG) and underground coal gasification (UCG) prospects in two main areas within PEL 120 (see Figure 1):

- the northern St Vincent Basin coalfields (including the Lochiel, Clinton and Bowmans deposits and SAPEX's adjoining mineral Exploration Licence Application (ELA)) which are located in the central-southern portion of PEL 120 between Mallala, Price and Snowtown
- the Walloway Basin (including SAPEX's ELA), which is located in the northern portion of PEL 120, north of Orroroo.

These two areas are the focus of this EIR.

The field exploration program is being formulated but will include the drilling of a several boreholes and coreholes to assess the presence and quality of coals for CSG and for suitability for UCG. The initial drilling is likely to be carried out in the southern part of the Walloway Basin near Orroroo and to the south of the Bowman's coal deposit, in the Inkerman area. Initial drilling locations are likely to be located within or near SAPEX's ELAs.

1.2 Project Proponent

SAPEX was formed in 2000 as a private company and was listed on the Australian Stock Exchange in 2007.

The corporate goals of SAPEX include conducting exploration for conventional oil and gas deposits in the Arckaringa Basin PEL tenements, conducting a thorough appraisal of the CSG gas potential within the Arckaringa Basin and conducting early appraisal of the CSG gas potential in coal seams identified on PEL120, strategically close to Adelaide.

1.3 About this Document

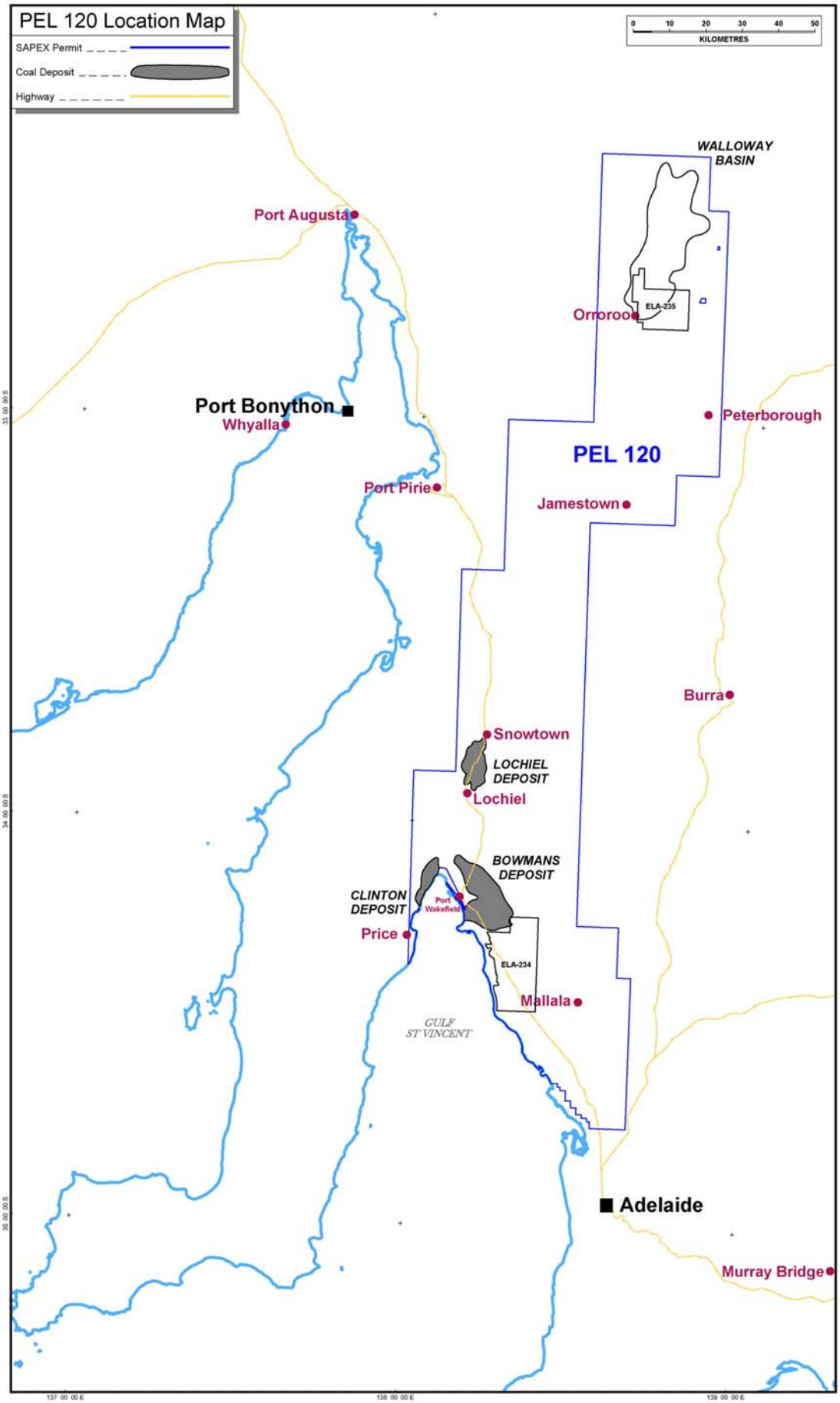
This document has been prepared to fulfil the requirements of an Environmental Impact Report for exploration drilling activities. It has been prepared in accordance with current legislative requirements, in particular Section 97 of the South Australian *Petroleum Act 2000* and Regulation 10 of the *Petroleum Regulations 2000*.

A Statement of Environmental Objectives (SEO) has also been developed in conjunction with this document. The SEO outlines the environmental objectives that SAPEX is required to achieve and the criteria on which the objectives are to be assessed.

This document relates to drilling activities and related well operations carried out in the Walloway Basin and the northern St Vincent Basin coalfields, within SAPEX's PEL 120 licence area (Figure 1).

This document is based on the SAPEX *Arckaringa Basin Exploration Drilling Activities Environmental Impact Report* (RPS Ecos 2007a) and the *South Australia Cooper Basin Operators Environmental Impact Report Drilling and Well Operations* (Santos 2003).

Figure 1: Location of PEL 120



2 Legislative Framework

This section briefly describes the legislative framework that currently applies to petroleum licensing in South Australia.

2.1 Petroleum Act and Regulations

The legislation governing onshore petroleum exploration and production in South Australia is the *Petroleum Act 2000* and *Petroleum Regulations 2000*. Key objectives of the legislation are:

- to protect the natural, cultural, heritage and social aspects of the environment from risks associated with activities governed by the Act
- to provide for constructive consultation with stakeholders, including effective reporting of industry performance to other stakeholders
- to provide security of title for petroleum, geothermal energy, and other resources governed by the Act and pipeline licences.

The Act and Regulations are objective-based rather than prescriptive (McDonough 1999). 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 the 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, and
- 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.

2.2 Statement of Environmental Objectives

As a requirement of Part 12 of the Act, a regulated activity can only be conducted if an approved SEO has been developed. The SEO outlines the environmental objectives that the regulated activity is required to achieve and the criteria upon which the objectives are to be assessed. The SEO is developed on the basis of information provided in an EIR. The EIR is provided by the licensee and contains an assessment of the potential impacts of an activity on the environment.

SAPEX has developed a SEO for drilling activities, based on this EIR. This has been developed as a “generic” SEO, as it covers a relatively broad area of interest in the Walloway and northern St Vincent

Basins rather than a specific well site or sites. However, the SEO does not address all issues relevant to the entire PEL 120 licence area. For example, it does not address issues associated with drilling in towns or suburban areas.

Generic SEOs have been previously prepared by PIRSA, RPS Ecos and Santos for the following regulated activities:

- *SAPEX Arckaringa Basin Exploration Drilling Activities Statement of Environmental Objectives* (RPS Ecos 2007b)
- *Statement of Environmental Objectives for Seismic Operations in the Otway Basin, South Australia* (Cockshell and Langley, 2001)
- *Statement of Environmental Objectives for Pipeline Preliminary Survey Activities in South Australia* (Ecos Consulting (Aust) Pty Ltd 2001)
- *Statement of Environmental Objectives for seismic operations in the Cooper and Eromanga Basins, South Australia* (Cockshell, 1998)
- South Australian Cooper Basin operators. *Statement of environmental objectives: drilling and well operations* (Santos 2003a).
- *South Australian Cooper Basin Operators. Statement of environmental objectives: geophysical operations* (Santos 2006).

2.3 Environmental Impact Report

In accordance with Section 97 of the *Petroleum Act 2000*, an Environmental Impact Report (EIR) must:

- take into account cultural, amenity and other values of Aboriginal and other Australians insofar as those values are relevant to the assessment
- take into account risks to the health and safety of the public inherent in the regulated activities
- contain sufficient information to make possible an informed assessment of the likely impact of the activities on the environment.

As per Regulation 10 of the *Petroleum Regulations 2000*, the EIR must include:

- a description of the regulated activities to be carried out under the licence (including their location)
- a description of the specific features of the environment that can reasonably be expected to be affected by the activities, with particular reference to the physical and biological aspects of the environment and existing land uses
- an assessment of the cultural values of Aboriginal and other Australians which could reasonably be foreseen to be affected by the activities in the area of the licence, and the public health and safety risks inherent in those activities (insofar as these matters are relevant in the particular circumstances)
- if required by the minister - a prudential assessment of the security of natural gas supply
- a description of the reasonably foreseeable events associated with the activity that could pose a threat to the relevant environment, including 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
  - 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.

2.4 EIR / SEO Assessment and Approval

Once the EIR and SEO are submitted to the Department for Primary Industries and Resources, South Australia (PIRSA), an assessment is made by PIRSA to determine whether the activities are to be classified as 'low', 'medium' or 'high' impact. This in turn determines the level of consultation PIRSA will be required to undertake prior to final approval of the SEO.

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

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

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

2.5 Approval to Carry Out a Regulated Activity

Prior to commencing a regulated activity (e.g. exploration drilling), Section 74(3) of the Petroleum 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).

New operators (such as SAPEX) are classified as requiring high level supervision for exploration drilling activities. In order to obtain written approval for exploration drilling, an application and activity notification (in accordance with Regulation 20) must be submitted to the Minister at least 35 days prior to the commencement of activities.

The activity notification 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 PIRSA 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 a generic SEO, 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 sensitive land use or landscape) and proposed measures to minimise impacts to key issues (e.g. low impact techniques for sensitive areas, sensitive locations to avoid or consultation undertaken with landholders to minimise impacts on land use). On-ground environmental investigations would typically be conducted as part of this assessment, particularly where the potential issues are significant or the operation is in a new area.

2.6 Other Legislation

A variety of legislation applies to petroleum exploration activities. Legislation that is particularly relevant to petroleum exploration is listed below (note that this is not a comprehensive list of all applicable legislation).

Commonwealth
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)
Native Title Act 1993
Aboriginal and Torrens Strait Islander Heritage Protection Act 1984

South Australia
Aboriginal Heritage Act 1988
Crown Lands Act 1929
Environment Protection Act 1993
Fire and Emergency Services Act 2005
Heritage Places Act 1993
Local Government Act 1999
National Parks & Wildlife Act 1972
Native Title (South Australia) Act 1994
Native Vegetation Act 1991
Natural Resources Management Act 2004
National Trust of SA Act 1955
Occupational Health, Safety and Welfare Act 1986
Public and Environmental Health Act 1987.

Approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* would be required for activities that impact matters of national environmental significance (e.g. threatened species or communities, Ramsar wetlands, national heritage places). However, the issues that require approval can generally be avoided by appropriate site selection for access tracks and well sites and implementation of field procedures (e.g. flagging and avoiding significant sites).

It is noted that exploration activities that are approved under the Petroleum Act are exempt from requiring approval under the *Native Vegetation Act 1991* for clearance of native vegetation, provided that the activities are in accordance with accepted industry environmental management practices for facilitating the regrowth of native vegetation and there is no practicable alternative involving the clearance of less vegetation or of vegetation that is either less significant or more degraded (see regulation 5(1)(zc) of the *Native Vegetation Regulations 2003*).

3 Proposed Activities

The following section provides an overview of drilling and initial production testing activities.

3.1 Overview

SAPEX plan to carry out exploration drilling for coal seam gas and drilling to assess the suitability of a site for underground coal gasification (UCG). This will involve several different types of drilling, using different rigs that are suitable for:

- Drilling coreholes (and encapsulating the core to capture gas within it) to evaluate coal seam gas potential
- Drilling wells for coal seam gas and potentially for UCG trials.

These types of drilling are collectively referred to as coal seam gas (CSG) drilling throughout this document.

CSG drilling uses rigs which are similar to conventional mineral exploration rigs (see Plate 1) and are much smaller than conventional petroleum drilling rigs (as described in Santos 2003). Separate rigs for completions or workover may also be used following drilling.

All rigs require a clear and stable drill site with adequate access. Typical CSG drill sites usually require minimal earthworks to prepare a suitable drilling platform. Compared to conventional petroleum drilling operations, CSG drilling is generally considered to be a low impact and comparable to mineral exploration drilling in extent of impact.

A detailed description of petroleum drilling activities is contained in the Cooper Basin Drilling and Well Operations EIR (Santos 2003)[1]. An example of typical CSG drilling activities and requirements in provided in Appendix 1.

3.2 Drill Site and Access

3.2.1 Access

Drilling operations are accessed using existing public roads and tracks as much as possible, but may require the construction of a purpose built access track to connect the site to an existing track or road. An access track may not be required where the land can be readily traversed by drilling vehicles and equipment (e.g. cleared paddocks).

The method used for access track construction is dependent upon the terrain in which it is being built and the expected level of use or traffic. In most cases where an access track is required, it is cleared and graded or rolled. Imported material (e.g. gravel) may be used to provide a stable surface.

The number of vehicle movements involved in drilling varies greatly depending on the type of drilling being undertaken. Drilling for coal cores typically involves one truck mounted drilling rig (e.g. 8x4 Volvo with Schramm T660 rig mounted), one support truck with water tank mounted (e.g. MAN 6x6 truck), two 4x4 Toyota Land Cruisers and a caravan for accommodation. Drilling coal seam gas wells would require more vehicle movements, but far less than required for conventional oil or gas drilling.

3.2.2 Drill Site

Drilling operations require the construction of a stable drill pad for the placement of the drilling rig and areas for associated equipment and facilities. These may include generators, fuel and chemical storage, casing and pipe storage or offices and accommodation, depending on the location and drilling requirements.

[1] Available at http://www.pir.sa.gov.au/petroleum/environment/register/seo,_eir_and_esa_reports/drilling_activity_reports

A well lease for CSG drilling generally requires some or all of the following features:

- a stable drill pad for the rig, which may need to be compacted
- a mud sump or sumps for the disposal of drill cuttings and the recirculation of water into the mud system (typically in the order of 10m by 20m by 2 m deep for CSG drilling, depending on the particular rig)
- a flare pit for well control and testing operations, if required
- a lined dam or pit (known as a 'turkey's nest')for the storage of clean water required for drilling operations (lined with plastic (HDPE) to prevent loss of water through seepage), if required
- clear entry and exit points for vehicles.

Rigs used for CSG drilling generally only require a small lease, requiring only a small amount of preparation and compaction of the drill pad. The area required for mineral exploration style rigs for corehole drilling is typically in the order of 20 m x 30 m (see Plate 1). The rigs used for CSG well drilling may require a slightly larger area, which may be in the order of 60m by 40m.

Plate 1: Mineral exploration rig, water truck and support vehicles

(Source: Watson Drilling)

Well lease construction methods are dependent upon the terrain in which it is being built. In most locations topsoil and vegetation is cleared and stockpiled separately for use in restoration. The selection of non-sloping well sites is important in order to avoid the importation of large quantities of borrow material.

3.2.3 Borrow Material

Depending upon the nature of the substrates in a particular well location, borrow material may be required to stabilise the drill pad or to assist in access track construction. It is anticipated that if borrow material is required for a drill site, it will be sourced from existing quarries or borrow pits in the region. New borrow pits would only be constructed if there is no alternative. The location and size of a borrow pit would be determined in consultation with the relevant landholder.

3.2.4 Campsite

It is anticipated that CSG drilling in PEL 120 will not require a full-scale temporary camp to accommodate drilling crews. Where possible, drilling personnel will be accommodated in local townships.

A small campsite or office (typically a caravan or demountable building) may be required at the well site to accommodate a small number of people (expected to be less than 10).

Where they are required, campsites are usually located at or in close proximity to the well site. Construction (earthworks) methods are similar to these for drill pads with the exception that the location of the campsite is flexible and site clearance or compaction is often not required.

Campsites are usually constructed on naturally clear, flat areas, where disturbance of vegetation and surface drainage and the importation of borrow material can be avoided or minimised.

3.3 Drilling and Well Operations

CSG and coals for UCG are typically found at depths of 150 – 750 m (unlike conventional gas, which is typically found at depths of 1,500 – 2,000 m). CSG rigs are usually smaller than those used for conventional oil and gas drilling, and are often mounted on a truck and can be transported and set up more easily.

The initial exploration drilling for CSG planned by SAPEX will be similar to mineral exploration drilling and will aim to collect a core sample and measure gas content. These drillholes would typically not be cased, unless they are likely to intersect artesian aquifers, in which case they will be pre-collared by installing and cementing casing to allow well control to be implemented in the case of a water flow. Drilling muds are likely be used, depending on the nature of the hole. A sump is likely to be required although some types of rigs have mud tanks which capture and recycle drilling muds, reducing the size of the sump that is required. Drilling muds used will be water-based and non-toxic or low toxicity and the sump will not be lined unless the well site is in an area where very shallow aquifers are present.

If early drill holes produce positive results, further drilling will be undertaken to install wells that are capable of producing CSG. In this type of drilling, a well is typically drilled to a depth of between 150 - 750m to intersect the gas bearing coal seams. Steel casing is cemented to the well bore to prevent water from the water table entering the well bore, and from gas entering the water table.

Hydraulic fracture stimulation may be carried out by pumping a sand and water mixture into the coal seam at high pressure until the coal structurally cracks. Fractures propagate horizontally from the well bore, typically in two directions. This operation can produce new fractures or force the pre-existing fractures in the coal seam to enlarge, extend and network. These fractures, deep in the coal seam, are less than one centimetre wide and have no effect on the ground surface. The sand is used to prevent the fractures from closing, once the water pressure is released. The sand in the coal establishes a porous pathway, enabling gas to flow back to the well bore from a larger drainage area.

At the conclusion of fracture stimulation, a work-over rig installs tubing, a pump (if required) and surface facilities (well head, piping and instrumentation, etc) are then installed and completed. The pump may be required to extract excess water from the coal seam for CSG production. The water generated during CSG production (which is outside the scope of this EIR) is typically stored in evaporation ponds.

3.4 Production Testing

If commercial quantities of hydrocarbons are discovered, production testing may be carried out to evaluate the discovery. Production tests may vary in scope and length, and are typically classed as either initial production testing or extended production testing. Testing for UCG at an early stage may be considered to be carried out in a similar fashion to CSG operations.

Initial production testing is short term (typically less than 10 days) and relatively small volumes of water and gas are produced. Gas is typically flared during initial production testing of gas wells. Initial production testing may be undertaken in PEL 120 depending on drilling results, however it is not envisaged that a large amount of initial production testing will be carried out.

Initial production testing is covered by this EIR.

Extended production testing is longer term (typically up to several months) and larger volumes of water may be produced. Extended production testing involves the installation of additional infrastructure and may require the construction of ponds to dispose of water that is produced with the gas.

Extended production testing activities require specific design and planning based on the well site and well flow data. Extended production testing is not covered by this EIR.

Conducting trials of underground coal gasification is not covered by this EIR (or the accompanying SEO) and would require separate assessment and approval.

3.5 Well Abandonment

3.5.1 Abandonment 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 (and install production casing) or to abandon it. If a decision is made to abandon 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 15 m) is set at the surface prior to cutting off the surface casing bowl.

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

3.5.2 Abandonment Following Production

Once a well has reached the end of its productive life a decision is made on whether to abandon the cased well bore or leave it in a suspended state until it can be abandoned. The well is usually cased to total depth or it may have been cased to just above the producing formation. Either way, the well is evaluated individually to design the abandonment program.

The abandonment program usually involves the following:

- All perforated hydrocarbon zones are isolated from other perforated zones with cement plugs and/or bridge plugs.
- The bond logs 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.
- A decision may be made to perforate and squeeze off the aquifer to ensure that there is no crossflow.
- An additional cement plug is placed in the surface casing prior to cutting off the well head below ground level.

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

3.5.3 Well Abandonment During Completions

Wells may also be abandoned during or following completion operations. As is the case for abandonment following production, the main objective of well abandonment operations is to seal the well against fluid migration by undertaking the following activities:

- protecting zones from the uncontrolled migration of fluids
- isolating hydrocarbon producing and injection intervals
- protecting people, livestock and wildlife from the uncontrolled migration of fluids.

All wells that are to be abandoned are subject to individual evaluation prior to abandonment to determine the most prudent abandonment procedure as some zones are in natural hydraulic communication.

3.6 Site Clean-up and Reinstatement

The restoration of well sites and associated access tracks is normally undertaken in stages following the completion of drilling operations.

3.6.1 Initial Restoration

Irrespective of the outcome of the drilling operation, initial well lease clean-up involves:

- fencing the drilling mud sump, unless otherwise agreed with the landholder, immediately following the completion of drilling to prevent stock access and discourage wildlife access
- pumping any additional water from the turkey's nest into the mud sump and removing the turkey's nest liner.

The drilling mud sump will remain fenced until the contents have dried sufficiently to allow the sump to be backfilled without displacing drilling muds and fluids to the soil surface. The time required for the sump contents to dry is dependent upon the size of the sump and seasonal weather conditions but may take several months.

The standard industry practice is to dispose of drilling muds in sumps (as above), however in some circumstances (e.g. in areas of shallow groundwater or sensitive / intensive land use) it may be appropriate to remove drilling muds for disposal off site.

3.6.2 Partial Restoration

When the drilling sump has dried, full or partial restoration of the well site will be undertaken depending upon the outcome of the drilling operations. Partial restoration will be undertaken at well sites that have been successful in discovering commercial quantities of gas, as subsequent operations, such as workover and completion activities, require less space that that which was required for drilling operations. Partial restoration involves:

- backfilling the drilling sump to achieve at least 0.5m cover over mud contents (following drilling operations sufficient freeboard is left to allow for this without creating a raised surface upon restoration)
- partial ripping and respreading of topsoil on excess lease areas to promote revegetation and stabilisation of the lease edges
- backfilling the turkey's nest
- backfilling any additional pits used for loading and offloading earthmoving equipment as well as vent pits (flare pits may be left open for subsequent operations)
- ripping areas used for turnaround
- ripping compacted areas such as the campsite and camp access track, if present.

3.6.3 Final Restoration

Complete well site, access track and borrow pit restoration will be undertaken if the well fails to discover commercial quantities of gas and is plugged and abandoned, or following completion of production of gas reserves from a particular discovery.

Final surface restoration of well sites will involve:

- backfilling all pits including the drilling mud sump, turkey's nest, flare pits
- ripping and recontouring (where appropriate) of well sites, campsites and the respreading of stockpiled topsoil and cleared vegetation to promote revegetation
- ripping the access track to relieve compaction and promote revegetation (where appropriate)
- re-seeding of crops where applicable (dependent upon agreement with landholder)
- removing any windrows to ensure that water flows are not impeded.

Material imported for wellsite construction may be removed off site, depending on the landscape and/or the landholder requirements.

Final restoration of borrow pits will involve:

- returning any overburden to the pit
- battering slopes to prevent collapse
- ripping the floor and sides of the pit
- spreading stockpiled topsoil and vegetation
- ripping (where appropriate) haul roads and tracks to relieve compaction.

Restoration and rehabilitation activities will be undertaken in consultation with, and to the satisfaction of the relevant landholder.

3.7 Associated Activities

3.7.1 Water Supply

Water will be required for both domestic and industrial purposes for drilling and well operations. The quality of the water required is dependent upon the intended use.

Domestic Water Supply

Potable water may be required at the well site (for example, to supply kitchen and ablutions facilities if a camp is required). The source of potable water will depend on the well location, but may it be sourced from the water supply of a nearby town or property and transported to site in a bulk water tanker.

Drilling Water Supply

The amount of water required for drilling operations depends principally upon the depth of the well that is being drilled. Typical volumes for a CSG exploration drill rig vary from 15,000 to 30,000 litres.

Water for drilling operations may be sourced from town water supplies, farm dams or licensed water bores, with the agreement of the owner or supplier. The water supply for a drill site would be chosen on the basis of minimising the distance for the water haul and minimising impacts on water supplies and land use.

3.7.2 Waste Management

A range of wastes are generated during drilling and well operations. Typical wastes are summarised in Table 1.

Table 1: Typical drilling wastes and disposal methods

Waste	Disposal Method
Domestic Waste	
Sewage and grey water	Portable toilet (or on-site septic tank(s) if a camp is required), emptied by licensed contractor and removed off-site for appropriate disposal. Note: The relevant legislation/standards are the *Public and Environmental Health (Waste Control) Regulations 1995* and the *Standard for the Construction, Installation and Operation of Septic Tank Systems in SA*.
Food waste and packaging	Collected at the site for disposal to approved landfill or recycling where possible.
Plastic, glass, cans and paper	Collected at the rig site for disposal to approved landfill or recycling where possible.
Workshop waste (rags, filters)	Approved landfill.
Industrial Waste	
Chemical bags and cardboard packaging materials	Compacted and collected at site for disposal to licensed facility.
Scrap metals	Collected in designated skip for recycling or to licensed facility.
Used chemical and fuel drums	Collected in designated skip for recycling.
Chemical wastes	Approved landfill or return to supplier
Timber pallets (skids)	Recycled or to licensed disposal facility.
Vehicle tyres	Shredded and disposed to approved landfill.

Source: Adapted from Santos (2003)

If campsites are required, the management of sewage wastes will be in accordance with the *Public and Environmental Health (Waste Control) Regulations 1995*.

Domestic wastes (e.g. food waste, packaging, paper, plastics, cans and glass) will stored on site in secure bins or skips prior to their transportation to a licensed waste disposal facility. Recyclable materials will be segregated for transport to a recycling facility where practicable.

The presence of waste can attract wildlife and pest animals and waste may be scattered by the wind and scavenging wildlife. Storage methods will take these issues into account to avoid litter scattering and impacts on wildlife (e.g. rubbish bins or skips will be covered).

All industrial solid wastes created during drilling and well operations will be collected in designated skips for eventual recycling or disposal to an appropriately licensed facility. Other wastes associated with drilling and well operations, including drilling fluids and muds, drill cuttings and any other fluids and waste waters are generally disposed to the excavated drilling sump. The contents of the drill sump are allowed to dry before being covered with fill (with at least at least 0.5 m of cover).

3.7.3 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 will be dependent upon the type of operation.

Diesel storage volumes will also vary depending upon the operation. Diesel storage volumes are usually greatest for drilling operations.

4 Existing Environment

PEL 120 extends from Salisbury and Elizabeth on the Adelaide Plains to north of Orroroo in the Mid North and between Blyth in the Mid North and Price on the Yorke Peninsula and covers an area of approximately 9,600km².

PEL 120 lies within the Northern and Yorke Natural Resource Management (NRM) region which supports a population of approximately 90,000 people. The region covers over 30,000km² and comprises Yorke Peninsula, the Lower, Mid and Upper North, southern Flinders Ranges and parts of the Adelaide Plains and Barossa Valley. Almost 80% of the region is devoted to agricultural production and as a result almost 70% of the region has been cleared of remnant vegetation to support crops and livestock grazing. However the region also supports significant areas of remnant vegetation and contains several declining ecological communities (NYAD INRMC 2003).

As discussed in Section 1.1, SAPEX intends to focus initial exploration activities in the northern St Vincent Basin coalfields (which are located in the central-southern portion of PEL 120 between Mallala, Price and Snowtown) and the Walloway Basin (which is located in the northern portion of PEL 120) and (Figure 1). Consequently the following sections focus predominantly on these regions (referred to as the 'area of interest') rather than the whole of PEL 120.

4.1 Climate

The climate in the region is classified as Mediterranean with cool to mild wet winters and hot dry summers. Conditions vary over the region due to the differentiation in latitude and altitude (NYAD INRMC 2003). Average annual maximum temperatures for northern (Yongala) and central (Snowtown) inland areas of the PEL are around 21°C to 23°C, and 22°C for the coastal areas (Price). Average daily minimum temperatures range from around seven to 10 °C. Temperatures often exceed 30°C and on extreme days can reach the mid 40°C (BOM 2007).

Average annual rainfall at Snowtown, in the centre of the region, is 407 mm. In the central north of the region at Yongala the average annual rainfall is 366 mm. In the southern areas of the region, average annual rainfall at Price is 330 mm and median rainfall is 319 mm. The northern St Vincent Basin coalfield area has a steady winter rainfall pattern with intense thunderstorms occurring in the summer months (Lower North Soil Conservation Board 2003) while the Walloway Basin has a low to medium winter rainfall regime (Goyder Soil Conservation Board 1997).

The prevailing winds in the summer are from the south/south–east with the winter winds swinging through from north to south-west quadrants. Wind strengths are highest is spring/summer, and frequently combine with high temperatures in summer (BOM 2007).

A summary of climate records for Yongala (Station# 019062), Snowtown (Station #021046) and Price (Station #022015) is provided in Table 2 (BOM 2007).

Table 2: Temperature and rainfall records for PEL120

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Yongala													
Mean Daily Max (°C)	30.6	30.0	27.2	21.9	17.1	13.6	12.8	14.4	17.9	21.7	25.6	28.6	21.8
Mean Daily Min (°C)	13.3	13.3	10.7	7.1	4.5	2.8	2.2	2.5	4.0	6.0	9.1	11.5	7.2
Mean Rainfall (mm)	22.7	20.2	16.2	24.7	35.1	39.5	39.6	43.8	38.5	33.7	27.7	24.0	365.6
Median Rainfall (mm)	14.5	10.8	9.2	20.4	30.0	34.8	38.0	43.2	35.1	27.9	21.3	17.2	346.7
Snowtown													
Mean Daily Max (°C)	31.1	30.8	28.2	23.6	19.4	16.2	15.4	16.8	19.7	23.2	26.7	29.2	23.4
Mean Daily Min (°C)	14.6	14.7	12.7	9.9	7.8	6.0	5.2	5.6	6.7	8.6	11.1	13.3	9.7
Mean Rainfall (mm)	18.6	19.0	17.3	29.8	44.4	52.4	49.7	50.2	43.2	37.6	24.8	20.4	406.9
Median Rainfall (mm)	10.8	10.6	11.6	21.1	38.1	47.2	46.5	48.0	42.0	32.4	21.8	14.6	403.4

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Price													
Mean Daily Max (°C)	28.6	28.2	26.2	23.3	19.6	16.5	15.9	17.2	19.9	22.7	24.9	27.0	22.5
Mean Daily Min (°C)	15.7	16.0	14.0	11.2	8.9	7.0	6.1	6.2	7.2	9.2	11.7	13.8	10.6
Mean Rainfall (mm)	14.2	20.4	16.3	26.2	36.7	37.2	38.4	34.9	33.6	31.7	22.0	18.0	329.9
Median Rainfall (mm)	8.6	8.1	10.2	20.8	30.4	33.2	36.0	34.8	28.7	29.0	19.6	17.1	319.5

4.2 Biophysical Environment

PEL 120 covers two biogeographical regions (or bioregions), as defined by the Interim Biogeographic Regionalisation for Australia (IBRA). These bioregions, which are broad landscape units based on major geomorphic features, are:

- Flinders Lofty Block
- Eyre Yorke Block.

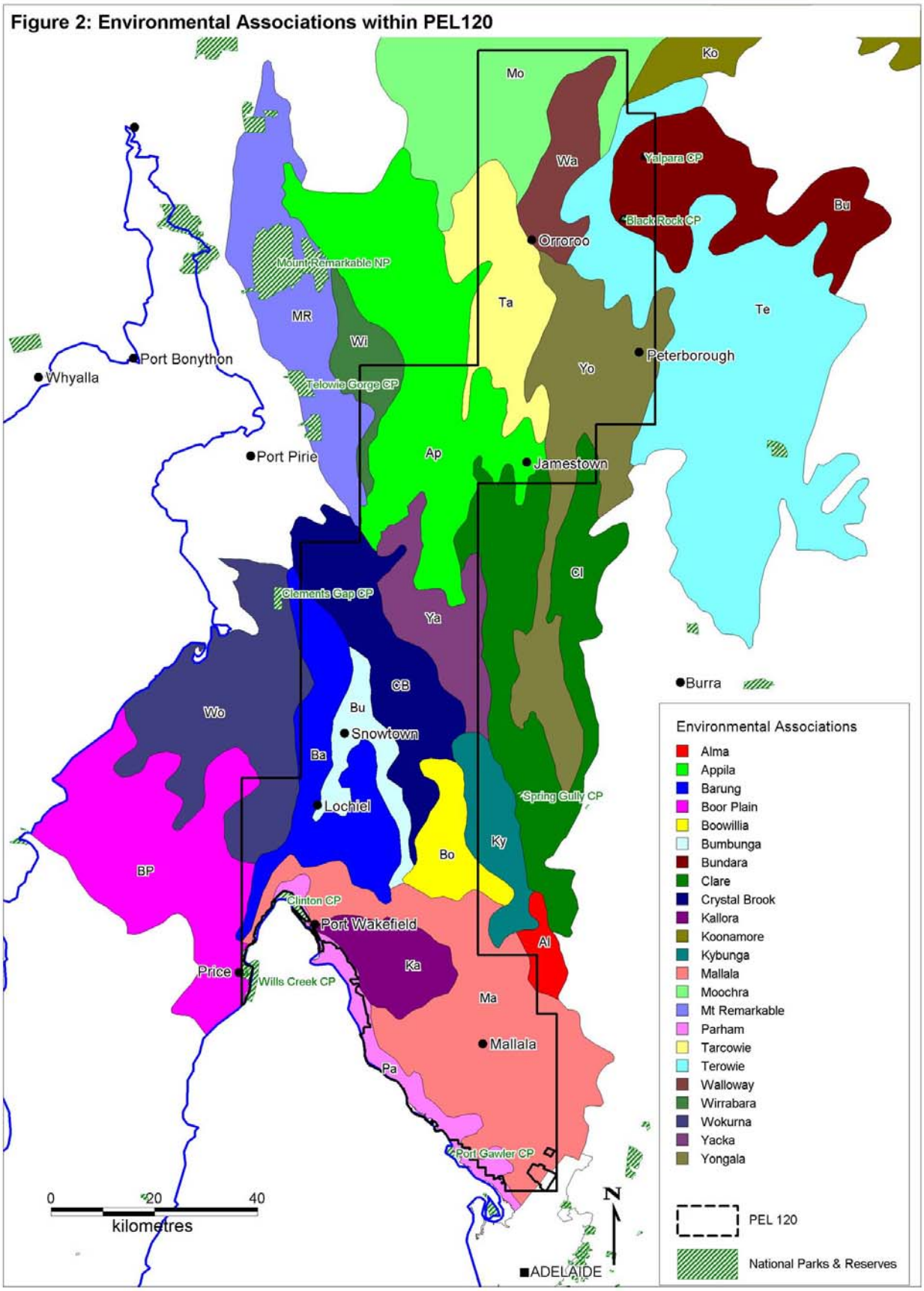
Laut et. al. (1977) further subdivided these bioregions into environmental associations, based on soil, topography, geology and vegetation. The environmental associations found within PEL 120 are summarised in Table 3 and the location of these environmental associations within PEL 120 is shown in Figure 2.

Information on the environmental associations within the area of interest in PEL 120 is provided in the following sections.

Table 3: Environmental Associations in PEL 120

Bioregion	Environmental Region	Environmental Association	Number
Flinders Lofty Block	Eastern Pastoral - Olary Uplands	Terowie	5.2.1
		Bundara	5.2.2
		Koonamore	5.2.7
	Flinders Ranges - Southern Basins & Ranges	Moochra	6.1.4
		Walloway	6.1.5
	Mid North Wheatlands	Tarcowie	3.3.17
		Yongala	3.3.14
		Appila	3.3.16
		Wirrabara	3.3.18
		Mt Remarkable	3.3.19
		Clare	3.3.13
		Yacka	3.3.15
Eyre Yorke Block	Gulf Plains	Crystal Brook	4.6.13
		Bumbunga	4.6.10
		Barung	4.6.11
		Wokurna	4.6.12
		Boor Plain	4.6.3
		Kybunga	4.6.8
		Mallala	4.6.6
		Boowillia	4.6.9
		Kallora	4.6.5
		Parham	4.6.4
		Alma	4.6.7

Figure 2: Environmental Associations within PEL120



4.2.1 Northern St Vincent Basin Coalfields

The northern St Vincent Basin coalfields region includes the following Environmental Associations:

- Barung
- Bumbunga
- Kallora
- Mallala
- Parham.

These environmental associations are all used for livestock grazing and cropping and have been predominantly cleared of native vegetation. A general description of each environmental association, based on the information in Laut et. al. (1977), is provided in the following sections.

4.2.1.1 Barung

The Barung environmental association is located in the north-eastern portion of the northern St Vincent Basin coalfield and covers approximately half of the area of the Lochiel Deposit.

The Barung environmental association is comprised of a series of strike ridges on quartzite and gravelly footslopes. Soils range from shallow, well drained red friable loams with stones on the ridges to moderately deep, well drained hard pedal red duplex soils with stones on the footslopes.

The ridges in this environmental association are primarily used for grazing livestock and the footslopes for cereal cultivation and livestock grazing and are predominantly cleared. Remnant vegetation in the environmental association includes a low open forest of Mallee Box (*Eucalyptus porosa)* and Peppermint Box (*E. odorata).*

4.2.1.2 Bumbunga

The Bumbunga environmental association is located in the north-western portion of the northern St Vincent Basin coalfield and covers approximately half of the area of the Lochiel Deposit.

The Bumbunga environmental association is comprised of a series of low-lying plains with salt lakes and occasional dunes and includes Lake Bumbunga salt lake near Lochiel. Soils range from deep, well drained red crusty duplex soils on the plains, to deep, well drained brownish sands on the dunes. The salt lakes are comprised of deep, imperfectly drained, grey powdery calcareous loams.

The plains in this environmental association are primarily used for cereal cultivation and livestock grazing and are predominantly cleared. The margins of the lake support a low shrubland used for livestock grazing. Remnant vegetation in the environmental association is typically limited to the margins of the salt lakes which support a low chenopod/samphire shrubland dominated by Grey Samphire (*Halosarcia halocnemoides*), Beaded Glasswort (*Sarcocornia quinqueflora*) and Seablite (*Suaeda australis*).

4.2.1.3 Kallora

The Kallora environmental association is located in the southern portion of the St Vincent Basin coalfield and covers part of the area known as the Inkerman area and the Bowmans Deposit.

The Kallora environmental association is comprised of a gently undulating calcrete plain with widespread dunes and occasional salt lakes. Soils range from shallow, well drained brown calcareous loams on the plains to deep, well drained brownish sands on the dunes. The salt lakes are comprised of deep, imperfectly drained, grey powdery calcareous loams.

The plains in this environmental association are primarily used for cereal cultivation and livestock grazing and are predominantly cleared. Remnant vegetation includes occasional open parklands of Red Mallee and a low chenopod/samphire shrubland dominated by Grey Samphire (*Halosarcia halocnemoides*), Beaded Glasswort (*Sarcocornia quinqueflora*) and Seablite (*Suaeda australis*) on the margins of the salt lakes.

4.2.1.4 Mallala

The Mallala environmental association is located in the western and central portion of the St Vincent Basin coalfield and covers the areas of the Beaufort Deposit, the western portion of the Clinton Deposit and part of the Inkerman area.

The Mallala environmental association is comprised of an undulating plain with occasional dunes. Soils range from shallow, well drained brown calcareous loams and moderately deep, well drained hard pedal red duplex soils on the plains to deep, well drained brownish sands on the dunes.

The plains in this environmental association are primarily used for cereal cultivation and livestock grazing and are predominantly cleared. Remnant vegetation includes open mallee comprising Mallee Box, Beaked Red Mallee (*Eucalyptus socialis*), Peppermint Box and Native Pines (*Callitris* spp.). Samphire shrubland/marshes are located along the coastal plain.

4.2.1.5 Parham

The Parham environmental association is located in the south-western portion of the St Vincent Basin coalfield and covers the eastern portion of the Clinton Deposit. However only a small portion of the Parham environmental association is located within PEL 120 as the majority of this environmental association is located within the Clinton Conservation Park which has been excluded from PEL 120.

The Parham environmental association is a coastal complex of tidal flats, coastal dunes, swamps and sandy beaches, backed by a gently sloping plain. Soils on the plains are comprised of deep, imperfectly drained grey duplex soils while the tidal flats are deep, poorly drained, grey, non-cracking plastic clays.

The plains in this environmental association are primarily used for livestock grazing. Remnant vegetation in the environmental association includes low open Mangrove (*Avicennia marina*) woodlands on the tidal flats, an open heath of Coast Daisy-bush (*Olearia axillaris*), Coast Bearded-heath (*Leucopogon parviflorus*) and Coastal Wattle (*Acacia longifolia* var*. sophorae*) on the coastal dunes and chenopod/samphire shrublands of Grey Samphire (*Halosarcia halocnemoides*), Beaded Glasswort (*Sarcocornia quinqueflora*) and Seablite (*Suaeda australis*) on the plains.

4.2.2 Walloway Basin

The Walloway Basin area is covered by the following Environmental Associations:

- Terowie
- Walloway
- Moochra.

These environmental associations lie immediately north and east of “Goyder’s line”, the 250 mm rainfall isohyet that indicates the separation point between lands suitable for cropping and lands suitable for grazing. Consequently, they have been less extensively cleared for agriculture than those to the south. In the northern portion of PEL120 (commencing approximately 10-15 km north of Orroroo), a large proportion of the vegetation cover is native, although it has been degraded by weed invasion, heavy long-term grazing and “pasture improvement” using fertiliser and exotic species.

A general description of each environmental association, based on the information in Laut et. al. (1977), is provided in the following sections.

4.2.2.1 Terowie

The Terowie environmental association is located in the north-eastern corner of PEL 120 and occurs in the eastern portion of the Walloway Basin area.

The Terowie environmental association is a dominated by a series of deeply dissected northerly trending quartzite and siltstone ridges, separated by narrow pediments and colluvial plains. Soils on the ridges and plains are comprised of shallow, well drained, brown calcareous loams and earths, while footslopes have hard pedal red duplex soils.

The principal land use in this environmental association is livestock grazing. As a result, there has been limited broad-scale vegetation clearance and degraded native vegetation comprises much of the vegetation cover. Remnant vegetation in the association includes native tussock sedgelands dominated by Iron-grass (*Lomandra multiflora* ssp. *dura*, *Lomandra effusa*), tall shrublands comprised of Wattle (*Acacia* sp.), Emu bush (*Eremophila* sp.), Hopbush (*Dodonaea* sp.), Senna (*Senna* sp.) and False Sandalwood (*Myoporum platycarpum*) and woodlands of Red Mallee (*Eucalyptus socialis*) and White Mallee (*Eucalyptus gracilis*) over Bluebush (*Maireana* spp.) and Ruby Saltbush (*Enchylanea tomentosa*). River Red-gum (*Eucalyptus camaldulensis*) woodland occurs on drainage lines and floodplains.

4.2.2.2 Walloway

The Walloway environmental association is located in the north-eastern corner of PEL 120 and covers the majority of the Walloway Basin area.

The Walloway environmental association is a series of coalescing fans merging with alluvial plains. Soils are comprised of moderately deep, well drained, hard pedal red duplex soils and with areas of deep, poorly drained, brown self-mulching clays in floodouts.

The principal land use in this environmental association is livestock grazing, with limited cereal cropping. Native vegetation has been extensively cleared around Orroroo, but becomes more prominent further to the north where land is used for grazing. Remnant vegetation includes tall open shrublands of Prickly Wattle (*Acacia victoriae*) with an understorey of Saltbush (*Atriplex vesicaria*), Bluebush (*Maireana* spp.) and grasses, and low chenopod shrublands with Nitre-bush (*Nitraria billardierei*), bindyi (*Sclerolaena*) and samphires (*Halosarcia* spp.) on the plains. River Red-gum (*Eucalyptus camaldulensis*) woodland occurs on drainage lines and floodplains.

4.2.2.3 Moochra

The Moochra environmental association is located in the north-western corner of PEL120 and occurs on the margins of the Walloway Basin area.

The Moochra environmental association consists of strike ridges and intramontane plains with footslopes and fans. Soils on strike ridges are reddish powdery calcareous loams with outcropping rock. Footslopes and fans have moderately deep, well drained hard pedal red duplex soils, while floodplains are typified by reddish siliceous loams.

Livestock grazing is the principal land use, with limited areas of cereal cropping. Vegetation cover is predominantly degraded native vegetation. Remnant vegetation includes low open shrublands of Native Pine (*Callitris* sp.), tall open shrublands of Red Mallee (*Eucalyptus socialis*), Wattles (*Acacia* spp.), Emu bush (*Eremophila* sp.), Hopbush (*Dodonaea* sp.) and Senna (*Senna* sp.), low open woodlands of Black Oak (*Casuarina pauper*), Bullock Bush (*Alectryon oleifolius*) and False Sandalwood (*Myoporum platycarpum*) and low chenopod shrublands with Nitre-bush (*Nitraria billardierei*) and Black Bluebush *(Maireana pyramidata*). River Red-gum (*Eucalyptus camaldulensis*) woodland occurs on drainage lines and floodplains.

4.3 Significant Flora and Fauna

A number of significant flora and fauna species are known to occur in PEL 120. Information on key species is provided below and a comprehensive list of rare or threatened species found in PEL 120 is provided in Appendix 2.

4.3.1 Threatened Ecological Communities

There are two threatened ecological communities present within PEL 120:

<u>Peppermint Box Grassy Woodland</u>

Peppermint Box (*Eucalyptus odorata*) Woodlands are found in isolated patches across South Australia, generally on more fertile soils, however the main stronghold of this species is in the Mt Lofty

Ranges (southern and northern) and in the southern Flinders Ranges. Due to the agricultural activity in these regions these woodlands have been largely modified and cleared and remaining areas are small and/or atypical and/or degraded (Graham *et. al*. 2001). Grazing has also prevented the regeneration of the overstorey species to the extent that large areas of healthy, regenerating trees are rare (DEWHA 2008).

Peppermint Box Grassy Woodlands of South Australia are listed as critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Iron-grass Natural Temperate Grassland

The Iron-grass Natural Temperate Grasslands occur primarily within the Flinders-Lofty Block Bioregion. The main extant patches lie in the area between Clare and Peterborough. However, patches extend into the Kanmantoo, Eyre–Yorke Block and Murray–Darling Depression Bioregions. The grasslands generally occur on gentle slopes of low hills above 380 metres above sea level on loam to clay-loam soils. Surface pebbles are common at some sites and shale or sandstone rocky outcrops may also be present (DEWHA 2008).

This community has been heavily cleared and in most of the areas that remain, grazing and pasture-improvement have effectively removed the characteristic native, perennial tussock grasses, herbs and shrubs, leaving many areas dominated by exotic weeds (DEWHA 2008).

Iron-grass Natural Temperate Grasslands are listed as critically endangered under the EPBC Act.

4.3.2 Threatened Fauna

Significant fauna species identified as occurring in the areas of interest in PEL 120 are discussed below.

Pygmy Bluetongue

The Pygmy Bluetongue (*Tiliqua adelaidensis*) is endemic to the Mid-North of South Australia and is currently limited in distribution to just south of Burra, northwards to just south of Peterborough with additional records from near Blyth and the South Hummocks. The Pygmy Bluetongue is only found in temperate native grasslands and requires spider holes for shelter and breeding sites (Graham et. al. 2001).

Pygmy Bluetongues' have recently been found east of Jamestown, east of the Brownhill Range, around Peterborough and in the Hummocks Range near Kulpara however it is believe that they could be found in most unploughed native grasslands in the region (pers.comm. J.Schofield 2008). The area of interest overlaps the current known range of Pygmy Bluetongues.

Pygmy Bluetongues are listed as endangered under the EPBC Act and endangered under the South Australian *National Parks and Wildlife Act 1972* (NPW Act).

Flinders Ranges Worm-lizard

The Flinders Ranges Worm-lizard (*Aprasia pseudopulchella*) is endemic to the Flinders Ranges, Mid North and Yorke Peninsula. It is moderately common in grazing land in the Mid North, surviving well in moderately disturbed habitats. It prefers to burrow in loose sand and soil, often in association with leaf litter and the root systems of arid shrubs. It is also occasionally found under ground debris and logs or in ant or termite nests (Graham *et. al*. 2001).

There is one record of the Flinders Ranges Worm-lizard occurring in PEL 120, approximately 1km east of Crystal Brook outside the area of interest.

The Flinders Ranges Worm-lizard is listed as vulnerable under the EPBC Act but is not listed under the NPW Act.

Krefft's Tiger Snake

Krefft's Tiger Snake (*Notechis ater ater*) is only found in the Southern Flinders Ranges and occurs across a range of habitats from the upper reaches of local rivers to coastal areas in patches of better riparian vegetation. The species has been recorded in the catchments of the Broughton River and Rocky River (Graham *et. al.* 2001).

There is one historical record (1950) of Krefft's Tiger Snake occurring in PEL 120, along the Broughton River, 8km south-west of Crystal Brook, outside the area of interest.

Krefft's Tiger Snake is listed as vulnerable under the EPBC Act but is not listed under the NPW Act.

Plains-wanderer

The Plains Wanderer (*Pedionomus torquatus*) is endemic to and resides in open native Tussock grasslands where they feed on seeds (particularly grass and saltbush seeds) and ground dwelling insects (Graham *et. al*. 2001).

There are five records of the Plains Wanderer occurring in PEL 120. The most recent record is 5km south-west of Nantawarra (recorded in 1991), the remainder are historical records from Windsor (1937), Wildhorse Plains (1935), Dublin (1990) and Redhill (1900), within the area of interest.

The Plains Wanderer is listed as vulnerable under the EPBC Act and endangered under the NPW Act.

Australian Painted Snipe

The Australian Painted Snipe (*Rostratula australis*) is usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled. It nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats, feeding on invertebrates, such as insects and worms, and seeds (DEWHA 2008).

There are five records for the Australian Painted Snipe in PEL 120, one from Redhill and four from the Salisbury Wetlands and Dry Creek Saltfields.

The Australian Painted Snipe is listed as vulnerable under the EPBC Act and NPW Act.

Orange-bellied Parrot

The Orange-bellied Parrot (*Neophema chrysogaster)* is endemic to south-eastern Australia. Formerly, the species' range in South Australia extended from Adelaide, and possibly Yorke Peninsula, to the southeast through the Coorong. The Orange-bellied Parrot is now rarely recorded in large numbers from west of the Murray River in South Australia. The parrot can be found in a wide range of habitats including Eucalypt forest (in the breeding range) saltmarshes, coastal dunes, pastures, shrublands, estuaries and beaches, usually within ten kilometres of the coast (DEWHA 2008). There are no records of the Orange-bellied Parrot occurring in PEL 120.

The Orange-bellied Parrot is listed as critically endangered under the EPBC Act and endangered under the NPW Act.

4.3.3 Threatened Flora

A summary of significant flora species identified as occurring in PEL 120 is provided in Table 4. These species are predominantly found in areas of remnant vegetation.

Table 4: Significant flora species identified as occurring in PEL 120

Species	Conservation Status		Database Record in PEL	Comment
	EPBC Act (Cwlth)	NPW Act (SA)		
Spiny Everlasting *Acanthocladium dockeri*	CE	E	Yes	Endemic to the Northern Agricultural District. Species found in road and rail reserves growing in association weed invaded and highly modified grassland habitats (Graham et. al. 2001). Three records: two from between Jamestown and Gladstone and one from north of Blyth.
Large-club Spider-orchid *Caladenia macroclavia*	E	E	Yes	Found in mallee woodlands in sandy-loam soils over limestone. One record (1978) west of Nantawarra.
Inland Green-comb Spider-orchid *Caladenia tensa*	E	-	Yes	Three records: two from near Peterborough in remnant vegetation and one from Balaklava.
Slender Bell-fruit *Codonocarpus pyramidalis*	V	E	Yes	One record (1969) from a watercourse near Carrieton.
A hop-bush *Dodonaea subglandulifera*	E	E	Yes	Species restricted to semi-arid mallee area. Two populations in the NAD, one 5km NE of Wallaroo and one 10km ENE of Eudunda (Graham *et. al.* 2001). One record (1932) from the Peterborough golf course
Bead Samphire/ Glasswort *Halosarcia flabelliformis*	V	V	Yes	Found on coastal salt marshes. Eight records from Port Prime/Webb Beach.
Silver Daisy-bush *Olearia pannosa subsp. pannosa*	V	V	Yes	Found in mallee habitats in heavier soils in Mallee Woodland or Forest communities (Graham *et. al*. 2001). One record from the South Hummocks Ranges near Kulpara and seven records from the Narien Ranges west of Peterborough.
Pale Leek-orchid *Prasophyllum pallidum*	V	R	Yes	Found to occur primarily on gently sloping south-west to west facing slopes of broad ridges and in sandy soils (Graham *et. al*. 2001). One record (1981) from Kangaroo Flat NW of Gawler.
Mt Bryan Greenhood *Pterostylis despectans*	E	E	Yes	Only known to occur in an area of <1ha at Mt Bryan. Found in Peppermint Box Woodland with a sparse herbaceous understorey (Graham *et. al.* 2001). Numerous records at Mt Bryan.
Halbury Greenhood *Pterostylis sp. Halbury*	E	E	Yes	Found in Southern Cypress Pine Open Woodland on clay loam over clay soils (Graham et. al. 2001).
Large-fruit Groundsel *Senecio macrocarpus*	V	V	Yes	Found growing on southern Yorke Peninsula in Sedgeland surrounded by *Melaleuca* species (Graham et. al. 2001). Three records near Tarcowie.
Large-flower Groundsel *Senecio megaglossus*	V	E	Yes	Found on the west, south-west and east facing slopes of gorges, mostly among rocky outcrops and also in sandhills, creeklines and creek banks on soils ranging from clay-loam to clay (Graham et. al. 2001). Two records (1980's) between Orroroo and Peterborough.
Murray Swainson-pea *Swainsona murrayana*	V	V	Yes	One record at Orroroo.
Yellow Swainson-pea *Swainsona pyrophila*	V	R	No	Found in the Eyre and Yorke Peninsula botanic regions. In the southern part of its range, found in sandy or sandy-clay loams in mallee scrub, usually occurring after dire or other disturbance. Predicted to occur in area by EPBC Act Predicted Matters Search Tool (searched Dec. 2007).

CE = Critically Endangered, E = Endangered, V = Vulnerable, R = Rare

4.4 Water Resources

4.4.1 Surface Water

Surface water features in the region include rivers, creeks and salt lakes. The majority of the rivers and creeks in the region are ephemeral and drain into gulf waters. Some lagoons (salt lakes) occur where drainage is severely restricted.

The main drainage features found within PEL 120 include:

- Wakefield River
- Broughton River
- Lake Bumbunga.

The Wakefield River is located approximately 100 km north of Adelaide and has a catchment area of 690 km². The Wakefield River flows in a southerly direction through Auburn before turning west to flow through Balaklava and into the Port Wakefield estuary. The western portion of the Wakefield River passes through the northern St Vincent Basin coalfield area (Favier *et al.* 2000).

The catchment of the ephemeral Broughton River extends from the Yackamoorundie Range, east of Yacka to Redhill and Merriton before draining into the Spencer Gulf at Port Davis, 20 km south of Port Pirie. The major tributaries of the Broughton River are the Rocky River, the Yackamoorundie Creek and Crystal Brook (West Broughton SCB 1992).

Lake Bumbunga is large salt lake located on the eastern side of the Hummock Range at Lochiel on the relatively flat, poorly drained Condowie Plain. As there is no external drainage, most run-off water from the area accumulates in the lake (Hummocks SCB 1995).

4.4.2 Groundwater

There are a number of different types of groundwater aquifer systems (both shallow and deep) in the Northern and Yorke NRM region. The region's groundwater systems are classified into three distinct groundwater provinces relating to the type of flow system and the surrounding parent rock material (Dooley *et al*. 2001 cited in NYAD INRMC 2003):

- Local and intermediate flow systems in fractured rock and sedimentary infill are found in the Mid North region and on central Yorke Peninsula. These include the Walloway Basin as well as the Para Wurlie and Carribie Groundwater Basins, Booborowie Irrigation Area and part of the Barossa Valley Irrigation Area, Clare Valley, Willochra Basin and Spring Creek Zone (NYAD INRMC 2003).
- Regional and intermediate flow systems in sand/clay aquifers include the St Vincent and Pirie groundwater basins, a portion of the Northern Adelaide plains irrigation area, and Napperby/Nelshaby/ Baroota Irrigation Areas.
- Local flow systems in Permian sediments occur on southern Yorke Peninsula (Henschke 2001 cited in NYAD INRMC 2003), which is outside the area of interest.

The groundwater systems are used for livestock, irrigation and domestic purposes. These also support a number of water dependent ecosystems (NYAD INRMC 2003).

4.5 Heritage

4.5.1 Indigenous Heritage

The majority of the area encompassed by PEL 120 has been subject to long term and extensive disturbance through past agricultural land use, which is likely to have had a dramatic effect upon the preservation of any indigenous heritage materials that might have been located in the area. Some landforms or features (e.g. watercourses) are more likely to contain a high concentration of Aboriginal archaeological sites.

4.5.2 Historical Heritage

Non-indigenous heritage in the PEL 120 region dates back to the development of the Upper North in the late 1800s. Many of the historical heritage sites in the region are associated with agricultural expansion or mining enterprises and as a result historical sites include a variety of built heritage (e.g. farm houses, settlements, artefacts and agricultural implements, surveyed towns).

4.6 Land Use

The primary land use in the PEL 120 region is agriculture, with other industries such as mining, forestry, viticulture, horticulture and tourism also occurring in the region. PEL 120 also contains numerous towns and suburban areas (discussed in Section 4.7).

The Black Rock Conservation Park and the Yalpara Conservation Park and defence land at Edinburgh are encompassed within the general PEL 120 footprint but have been excluded from the licence area. The Clinton Conservation Park and defence lands around Port Wakefield border the licence area but have also been excluded.

Wills Creek Conservation Park is located within PEL 120 (on Yorke Peninsula, south of Port Clinton and the Clinton coal deposit). This park was gazetted in December 2006 and petroleum exploration activities (including drilling) are not permitted in the park. SAPEX will not be undertaking any exploration activities in Wills Creek Conservation Park.

The dominant land use in the Walloway Basin and the northern St Vincent Basin is agriculture, with extensive areas of land used for cereal cropping and livestock grazing. Horticulture and viticulture also occur.

Other land use in the region includes tourism, centred around the coastal areas, and a small amount of mining, including a trial coal pit at the Bowman's deposit.

4.6.1 Native Title

The Kaurna Peoples Native Title Claim (Tribunal file no. SC00/1) and the Nukunu Native Title Claim (Tribunal file no. SC96/5) overlap PEL 120. Native title has been extinguished across most of the land in the region as it is held under freehold title.

4.7 Socio-Economic

4.7.1 Population Centres

PEL 120 includes parts of metropolitan Adelaide (e.g. Salisbury and Elizabeth) which are excluded from this EIR and accompanying SEO.

Outside metropolitan Adelaide the Lower North and Yorke Peninsula (North) districts support a population of over 14,000 people (ABS 2006).

The northern St Vincent Basin coalfield area is located within the areas of the Wakefield Regional Council, the District Council of Yorke Peninsula, the District Council of Barunga West and the District Council of Mallala. The Walloway Basin is located within the District Council of Orroroo Carrieton.

Other local government areas which are covered by PEL 120 but are outside the areas where initial exploration is planned include:

- District Council of Peterborough
- District Council of Mt Remarkable
- Northern Areas Council
- Regional Council of Goyder
- Port Pirie Regional Council
- Light Regional Council.

The larger towns in the region within PEL 120 include Balaklava (population 1,626), Peterborough (population 1,689), Jamestown (population 1,407), Orroroo (population 543), Port Wakefield (population 476), Snowtown (population 405), Mallala (population 737) and Two Wells (population 717) (ABS 2007).

Other smaller townships or population centres in proximity to the areas of interest include:

- Lochiel
- Port Clinton
- Bowmans
- Beaufort
- Wild Horse Plains
- Dublin.

4.7.2 Infrastructure

Major road and rail links pass north and south through the region. The Princes Highway links Adelaide to Port Augusta and the main national road transport routes north to Darwin (Stuart Highway) and west to Perth (Eyre Highway). The Adelaide-Crystal Brook section of the Adelaide-Darwin Railway also passes through the region as part of the primary freight and passenger rail route between South Australia and the Northern Territory.

A network of local roads both sealed and unsealed, link farms and small settlements with the more significant transport routes.

5 Environmental Hazards and Consequences

This section of the EIR identifies and discusses potential environmental hazards and their consequences resulting from drilling operations in PEL 120. The subsequent sections of the EIR then outline the measures that will be implemented to manage the hazards (Section 6) and provide a risk assessment of drilling and well operations (Section 7).

5.1 Hazards

A hazard is defined as "a source of potential harm" (Australian/New Zealand Standard AS/NZS 4360:2004 *Risk management*).

The environmental hazards associated with drilling activities that have potential to result in the most prominent environmental consequences (as previously identified in Santos 2003) are identified as:

- earthworks associated with well site and access track construction and reparation, including excavations
- vehicle movement
- blowout or kick
- explosion or fire
- equipment or tubular failure
- down hole problems
- casing or cement failure
- loss of radioactive source down hole
- emissions vented from drill stem testing and production testing
- spills or leaks associated with drilling procedures, storage of oil, fuels and chemicals, refuelling operations and high pressure hydraulic systems
- spills from storage and disposal of drilling and completion fluids
- disposal of domestic and chemical waste and contaminated soil
- extreme weather conditions.

The hazards associated with various drilling activities are summarised in Table 5.

5.2 Consequences

Potential environmental consequences of drilling are summarised in Table 5. The key potential environmental consequences also associated with the above hazards are:

- visual impact
- loss of vegetation and habitat
- loss of crops or pasture
- introduction and or spread of weeds, pest plants or animals
- soil erosion and disturbance to natural drainage patterns
- soil compaction/disruption/deflation, wheel tracks
- contamination of soil, groundwater and/or watercourses
- damage to crops or pasture or property/infrastructure
- crossflow between aquifers or reduction in pressure in aquifers
- loss of reserves and reservoir pressure
- atmospheric pollution
- noise disturbance
- disturbance of Aboriginal, cultural or natural heritage sites
- disturbance, injury or death to native fauna
- disturbance, injury or death to livestock.

Table 5: Hazard and consequence classifications for drilling activities

Drilling Activity	Hazard	Consequence
Well site and access track construction	Earthworks Vehicle movement Spills and leaks Excavations	Contamination of soil, surface water Loss of vegetation and habitat Soil erosion and disturbance of natural drainage patterns Soil compaction/disruption/deflation, wheel tracks Dust generation Soil inversion Impact and/or damage to cultural/heritage sites Disturbance to native fauna Disturbance to stock Introduction and spread of weeds Visual impact Damage to infrastructure Facilitation of third party access Noise generation
Drilling Operations, including Well Completion	Vehicle movement Rig moves	Contamination of soil, surface water Soil compaction/disruption/deflation, wheel tracks Dust generation Disturbance to native fauna Disturbance to stock Introduction and spread of weeds Damage to infrastructure Noise generation Road hazard / disturbance to local road users
	Blowout or kick Equipment or tubular failure Down hole problems Casing or cement failure	Contamination of soil, surface water or groundwater Crossflow, aquifer contamination or reduction in pressure in aquifers Uncontrolled release of water and/or hydrocarbon to surface Disturbance to native fauna Disturbance to stock Atmospheric pollution
	Explosion or fire	Loss of vegetation and habitat Damage to crops or pasture or property Contamination of soil, surface water or groundwater Crossflow, aquifer contamination or reduction in pressure in aquifers Uncontrolled release of water and/or hydrocarbon to surface Disturbance to native fauna Disturbance to stock Atmospheric pollution
	Drill pipe failure	Temporary restricted control over well fluids and circulation system
	Loss of containment of gas while testing	Disturbance to native fauna Disturbance to stock Atmospheric pollution

Drilling Activity	Hazard	Consequence
	Spills or leaks associated with: ▪ drilling procedures ▪ storage of oil, fuels and chemicals ▪ refuelling operations ▪ storage and disposal of drilling fluids	Contamination of soil, surface water or groundwater Loss of vegetation and habitat Loss of crops or pasture Disturbance to native fauna Disturbance to stock Atmospheric pollution Disruption to land use
	Flaring of gas during testing Emissions vented from drill stem testing and production testing	Atmospheric pollution
	Disposal of fluids to excavated pits during well testing & clean-up	Contamination of soil, surface water or groundwater Loss of vegetation and habitat Loss of crops or pasture Disturbance to native fauna Disturbance to stock
	Loss of radioactive source down hole	Contamination of groundwater (aquifer)
	Extreme weather conditions	Contamination of soil, surface water or groundwater Damage to infrastructure
Waste Handling and Disposal	Disposal of domestic and chemical waste Sewage management Disposal of drill cuttings and muds	Contamination of soil, surface water and groundwater Soil inversion Loss of vegetation and habitat Loss of crops or pasture Dust generation Soil erosion/ disturbed drainage patterns Visual impact Litter Attraction of scavenging animals (both native and pest species)
Water supply / Aquifer Use	Depletion of artesian and sub-artesian aquifers Spills and leaks	Depletion of artesian and sub-artesian aquifers Loss of water (wastage)
Fuel & chemical handling & storage	Spills and leaks	Contamination of soil, surface water and groundwater Loss of vegetation and habitat Loss of crops or pasture Disturbance to native fauna Disturbance to stock
Campsites and associated supplies	Vehicle movement Earthworks Spills and leaks Disposal of domestic and chemical waste Fire	Contamination of soil, surface water and groundwater Soil inversion Loss of vegetation and habitat, Disturbance to native fauna Introduction and spread of weeds Disturbance to stock Soil compaction/disruption/deflation, wheel tracks Dust generation Soil erosion/ disturbed drainage patterns

Drilling Activity	Hazard	Consequence
		Visual impact Litter Fire damage to vegetation and habitat Noise generation Road hazard / disturbance to local road users
Well site and access track and campsite restoration	Earthworks Vehicle movement Spills and leaks	Contamination of soil, surface water Soil inversion Disturbance to native fauna Disturbance to stock Introduction and spread of weeds Visual impact Damage to infrastructure Impact and/or damage to cultural/heritage sites Noise generation Dust generation
Monitoring of selected locations	Vehicle movement	Soil compaction/disruption/deflation, wheel tracks Loss of vegetation and habitat Loss of crops or pasture Dust generation Introduction and spread of weeds Impact and/or damage to cultural/heritage sites Damage to infrastructure

5.3 Discussion of Key Hazards

5.3.1 Earthworks associated with Well Site & Access Track Preparation

The type and severity of the potential impacts of preparation of access tracks and well sites is dependent to a certain extent on the terrain and land use in the area where the activities are being carried out. Earthworks generally result in the disturbance of soil cover (vegetation, rocks) and structure and expose soils to wind and water erosion.

5.3.2 Vehicle Movement

The movement of heavy vehicles (e.g. trucks, bulldozers, drill rigs, supply trucks) to and from a well site can lead to the damage of vegetation/crops, the generation of dust and/or the compaction of soil, damage to infrastructure (e.g. roads) and collision with wildlife and/or stock.

Vehicles, especially trucks, also have the potential to cause a hazard to other road users. Rig moves for CSG drilling typically involve one truck mounted drilling rig, one support truck with a water tank), a caravan for accommodation and two light vehicles. Additional loads may be required for additional camp buildings, supplies and equipment (as discussed in Section 3.2.1).

The major roads in the region carry a relatively high level of traffic including heavy vehicles associated with road freight and farming machinery. The additional traffic on major roads due to petroleum exploration is not likely to be significant. Use of minor roads and tracks requires careful management (e.g. planning of routes, setting and observance of appropriate speed limits, use of signage where appropriate) in order to minimise the risk and potential disturbance to other road users and landholders.

5.3.3 Vegetation Clearance

The clearance of native vegetation for well site and access track will generally be avoided through the selection of well sites in previously cleared or disturbed areas and the utilisation of existing access

tracks. In some areas (e.g. the grazing lands in the far north of PEL120) the vegetation consists predominantly of degraded native vegetation and it may not be possible to completely avoid clearing native vegetation. However, sites would be selected to avoid removal of significant vegetation (e.g. large trees, listed plant species, listed plant communities or important fauna habitat) if cleared areas are not present.

Native vegetation clearance can result in the loss of vegetation and fauna habitat, siltation of drainage lines, dams and watercourses, destabilisation of creek crossings or watercourses, weed invasion and damage to heritage sites. Vegetation clearance may also impede the movement of fauna, particularly small mammals or reptiles across cleared areas. Clearance of introduced pasture or crops can result in some of these impacts (e.g. siltation, weeds) but is unlikely to impact fauna and heritage sites.

5.3.4 Down-hole Operations

The type and severity of potential impacts of down hole activities during drilling and completion is dependent on factors such as geological location down hole, whether there is casing cemented in competent formation, down hole conditions, condition of equipment on surface, condition of tubulars, safety awareness and pressures encountered.

The primary hazard associated with down hole activities is a blowout, which would result in loss of containment of gas, produced water and drilling fluids, possible crossflow between aquifers, loss of pressure of aquifers and loss of reservoir pressures and possibly an explosion or fire. Blowouts are not common – for example, there has never been a drilling blowout that has reached the surface in the Cooper and Eromanga basins in South Australia. There are considerable safety measures to avoid a drilling blowout including guidelines, procedures, safety practices, design considerations, well control equipment and certification of trained individuals in drilling.

The chance of a blowout in completion activities is considerably less because the well is cased. Therefore, the well bore is in a stable condition and down hole pressures are fairly well known.

Other hazards associated with down hole operations are a loss of radioactive source down hole. When the wells are 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 what the characteristics of the formation are. If the tool is lost down hole, it is retrieved immediately in most cases. However, if it not possible to retrieve the tool it is cemented in the hole to isolate it from adjacent formations.

Drilling fluids in the down hole environment have the potential to invade freshwater aquifers and cause contamination. Constituents of drilling muds are generally non-toxic or have a low effective chronic toxicity at the concentrations present in the drilling mud. Detailed study has shown that although this is an area of concern, drilling fluid impact is not a major component of potential down-hole problems, and that the main consequence of drilling fluid loss is reservoir formation damage rather than an irreversible contamination of the aquifer (Mavroudis 2001, cited in Santos 2003).

5.3.5 Waste Management

The improper storage and disposal of waste products including:

- domestic waste
- chemical waste
- sewage
- produced formation water
- contaminated soil

can result in litter, impacts on fauna and stock, soil contamination, water contamination and risks to human health.

The risk of soil and shallow groundwater contamination associated with the disposal of drilling fluids, cuttings and other fluids associated with completion activities (e.g. frac gels) to the unlined earthen drilling sump is considered low. This is due to the low toxicity associated with additives (Egis 2001) and the presence of fine bentonite clays which form a relatively impervious mud cake in the base of

drilling sumps. These techniques are generally accepted industry standard practice for disposal of non-oil based drilling mud systems cuttings.

5.3.6 Spills and Leaks

Spills or leaks are key hazards associated with drilling operations and the handling and storage of hazardous substances (including oil, fuel, chemicals, drilling fluids, production water).

Spills or leaks may occur as a result of the failure of equipment or human error associated with the following activities:

- drilling operations (including casing or cement failure, equipment or tubular failure)
- storage or transport of oil, fuels and chemicals (including failure of storage tanks)
- storage and disposal of drilling and completion fluids (e.g. produced water)
- refuelling operations
- use of high pressure hydraulic systems.

Unplanned emissions of hydrocarbons, hydrogen sulphide, over-pressured fluids, from the well, including blow out, can cause significant environmental damage by fire and by contamination.

Spills or leaks can result in the contamination of soil or water (both surface and groundwater) which in turn may lead to impacts on vegetation, fauna, wildlife and people. The loss and subsequent ignition of some hazardous substances may also lead to an explosion or fire.

As indicated in the Sections 6 and 7, appropriate management measures can (and will) be implemented during planning and conduct of operations, to ensure that these hazards do not result in significant environmental risks.

5.3.7 Disturbance to Livestock and Land Use

The presence of a drill rig and drilling personnel and the associated vehicle movements have the potential to disturb livestock, landholders and land use activities. Close liaison is carried out with landholders during the planning and conduct of drilling operations, to ensure that disturbance (e.g. to crops, pasture, stock grazing and movement) is minimised. Appropriate access routes to drill sites are chosen in consultation with landholders and any deterioration of property tracks or infrastructure as a result of drilling-related traffic is rectified.

Although the Conservation Parks in the region are excluded from PEL 120 (or do not have exploration access, in the case of Wills Creek Conservation Park), indirect impacts to these parks could occur if drilling was carried out in close proximity to the boundary. Consultation with DEH would be carried out if this was likely to be the case and appropriate management measures would be developed to avoid significant impacts.

In certain circumstances, landholders have rights to compensation under the Petroleum Act. 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.

5.3.8 Borrow Pits

Borrow material may be required for use on the stabilisation of well sites, access tracks and campsites, depending upon the nature of the substrates at each location. Where possible borrow material will be sourced from existing quarries or borrow pits in the region to minimise impacts on the region. However the construction of a new borrow pit may be required if there is no alternative. Borrow pits may present a hazard to land users or bogging hazard to stock and wildlife.

Borrow material is generally not moved over large distances. However, there is the potential for weed species to be moved along with the construction material from the borrow site to the well site.

6 Environmental Risk Management

This section summarises the management measures that will be undertaken during drilling and well operations to minimise environmental risks.

6.1 Landholder Consultation

Prior to undertaking exploration activities on a property, contact will be made with the relevant landholder to discuss the planned activities and the best approach to minimising the impact of those activities on the landholder and the land use.

Discussions may include the following issues:

- Potential impacts to crops
- The management of stock
- Potential water sources
- Potential sources of wellsite construction materials (if required)
- Potential weed issues
- Implications of property certification (e.g. Organic, pathogens).

6.2 Access Track Construction

To minimise the impact of access track construction the following actions will be taken:

- Existing roads and tracks will be utilised as far as is practicable to avoid the creation of parallel and multiple access tracks.
- Track width will be restricted to the minimum necessary.
- Sites of natural, scientific, Aboriginal or non-Aboriginal heritage significance will be avoided.
- Clearance of native vegetation, especially the removal of trees and larger shrubs will be avoided wherever possible and minimised where unavoidable.
- Significant vegetation (e.g. large trees, significant species and plant communities (see Appendix 2), good quality remnants) will be avoided.
- Watercourse crossings will be constructed so as to maintain water flows (e.g. culverts may be installed).
- Earthmoving equipment that is not free of potential weed sources (e.g. soil or plant material) will be cleaned before starting work at the site.
- Locations requiring steep cuts or fills will be avoided.

6.3 Well Site Selection

Well sites will not be constructed on sensitive areas such as salt lakes or steep slopes or in locations where they are likely to impact the marine environment.

To minimise the environmental impact of well sites the following actions will be taken:

- Proposed well locations will be plotted on maps and aerial photographs to allow initial assessment of environmental, access, heritage / native title and landowner issues.
- Proposed well sites will be inspected to make an assessment of potential issues and to determine the best location and orientation of the well site and access tracks, campsite (if required).
- Proposed well sites will be inspected to determine the need for additional fill material and where required determine the most appropriate source of the fill.
- The Heritage Branch of DEH will be consulted where appropriate to ascertain whether sites are located within the work areas and provide advice on protecting the place's heritage value.
- Cultural heritage surveys will be carried out with relevant Aboriginal groups where there is a likelihood of cultural heritage material occurring.
- Sites identified of known scientific, natural, Aboriginal or non-Aboriginal heritage significance will be completely avoided where possible.
- In the event that drilling at a non-indigenous or natural heritage site or area is proposed, permission to do so will be obtained from the relevant authority.

6.4 Well Site Construction

To minimise the environmental impact of the construction of well sites, access tracks, camps and borrow pits, the following actions will be taken:

- Well sites will be located and orientated so as to take into account natural drainage patterns (creeks, flood plains and salt lakes) and vegetation and to avoid significant cut and fill.
- Well sites will be constructed to the minimum size required for the safe operation of the drill rig.
- Earthmoving equipment that is not free of potential weed sources (e.g. soil or plant material) will be cleaned before starting work at the site
- Surface levelling and clearance of native vegetation shall be avoided wherever possible or minimised.
- Significant vegetation (e.g. large trees, significant species (see Appendix 2), good quality remnants) will be avoided.
- Cleared topsoil and vegetation will be stockpiled adjacent to the well site/camp site/borrow pit and separately from fill removed from sumps or pits.
- Sumps will be of sufficient size to contain mud discharges and shall be located so as not to impede or pollute surface drainage. Sumps will also be of sufficient depth to have adequate freeboard at the completion of operations to allow for at least 0.5 m cover of clean fill.
- Where they are required, flare pits will have a suitable fire break around the perimeter.
- Borrow material, if required, will be sourced locally, preferably from existing borrow pits.
- Campsites, if required, will be located adjacent to existing access tracks or roads, utilising areas with sparse vegetation, on well drained land.

6.5 Management of Drilling Operations

To minimise the environmental impact of well drilling operations the following actions will be taken:

Drilling Mud Sumps and Flare Pits

- All drill cuttings, muds and drill fluids will be contained within designated mud sumps with adequate freeboard at the completion of operations to allow for a 0.5m cover of clean fill.

Drilling and Completion Activities

- Drill rig, ancillary and any testing equipment to comply with Regulations, meet relevant industry standards and be “Fit for Purpose”.
- Casing design carried out to meet worst case expected loads and environmental conditions determined for the specific geology intercepted by the well. Details of work to be performed are set out in the Drilling Program.
- Casing set in accordance with design parameters and cemented to surface with visible return.
- Blow out prevention precautions / well control equipment in place in accordance with defined procedures and appropriate to the expected downhole conditions.
- Plugs will be installed between aquifers to prevent mixing and uncontrolled flow to the surface.

Well Abandonment

- Isolation barriers will be set in place to ensure that crossflow, contamination or pressure reduction does not occur.
- There will be no provision for cross-flow behind casing between aquifers, and between aquifers and hydrocarbon reservoirs unless approved by DWLBC.

Vehicle Movement

- All vehicles will be required to remain on designated roads and access track or parking areas.
- Where practicable materials will be transported to and from well sites in bulk.
- Where appropriate, temporary signage will be erected on access tracks at intersections with public roads.

Weeds

- Vehicles and equipment involved in drilling operations must be clean when entering the region (i.e. they must not carry potential weed sources such as soil and plant material).
- Vehicles or equipment will be washed down if they pose is a significant risk of weed introduction or spread (e.g. they have been in contact with soil in a known area of weed infestation).

- Any weed outbreaks at the well site or access will be controlled, in consultation with appropriate personnel (e.g. landholder, NRM Board officers).

6.6 Fuel and Chemical Storage and Handling

The following actions will be taken:

- All fuel, oil and chemicals will be stored in bunded areas in accordance with appropriate standards, including AS 1940 and EPA guidelines.
- Hazardous materials will be transported and disposed of in accordance with appropriate standards and legislative requirements, including the Australian Dangerous Goods Code and EPA guidelines and licensing requirements.
- Appropriate spill response equipment will be available on site.
- Staff and contractor training in spill management will be provided.
- Appropriate MSDS (Material Safety Data Sheets) will be available on site for all fuels and chemicals used on site.

6.7 Well Site Reinstatement

To minimise the environmental impact of the reinstatement of well sites, access tracks, camps and borrow pits, the following actions will be taken:

- All rubbish will be removed from the site.
- Drilling sumps and waste pits will be allowed to dry out before being backfilled with at least 0.5m of fill.
- All excess infrastructure will be removed from the site.
- Excess fill materials will be removed.
- Sites will be re-contoured to restore pre-existing drainage lines.
- Where appropriate, compacted areas will be ripped.
- Stockpiled topsoil and vegetation will be respread over disturbed areas.
- Access roads, borrow pits, well leases and campsites are to be restored and rehabilitated to attain the highest achievable Goal Attainment Scaling (GAS) rating, as defined in the SEO.

6.8 Pollution and Waste Management

To avoid the pollution of soil or water:

- All operational equipment will be inspected and maintained in accordance with industry-accepted standards and product operational requirements.
- Fuel and oil spills will be reported, and treated accordingly in consultation with the landholder (e.g. chemically treated or bio-remediated, ground ripped, or contaminated material removed).
- Putrescible domestic wastes (e.g. food waste, paper) created at campsites will be stored on site prior to transportation to a licensed waste disposal facility
- Rubbish (including plastics, cans, glass) will be recycled where possible or transported a licensed waste disposal facility.
- Campsite wastewater will either be collected on-site or disposed of off-site by a licensed waste contractor or receive onsite treatment for disposal onto land (well away from watercourses or infrastructure). The disposal method for wastewater will be undertaken in compliance with the *Standard for the Construction, Installation and Operation of Septic Tank Systems in South Australia*, or be to the satisfaction of the Department of Health.
- Markers and litter will not be left in the work area after completion.
- Drill cuttings will be returned to the hole or disposed of in the drilling sump.
- Vehicles will travel at slow speed in the vicinity of dwellings.

6.9 Environmental Management System

Drilling operations in PEL 120 will be undertaken in accordance with the principles of an Environmental Management System (EMS). An EMS is a key tool in the management of the proponent and associated contractors' environmental responsibilities, issues and risks. An EMS also provides a framework for the coordinated and consistent management of environmental issues by ensuring the.

- establishment of environmental policy

- identification of environmental risks and legal and other requirements relevant to drilling 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.

SAPEX and its contractors' operating standards will follow or lead accepted best practice and industry-accepted standards. Ongoing audits of the EMS and associated systems will be conducted on a regular basis to ensure that systems are maintained and being successfully implemented.

Key components of an EMS are discussed in the following sections.

6.9.1 Environmental 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 also including safety procedures. The induction shall include notification of environmental objectives and environmental requirements and include the distribution and explanation of any site specific environmental material.

A record of induction and attendees will be maintained.

6.9.2 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 it applies, and that there will be a rapid and effective response in the event of a real emergency occurring.

6.9.3 Environmental Monitoring and Audits

Ongoing 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 programs will be designed to assess:

- compliance with regulatory requirements
- visual impact of the operations
- impact upon flora and fauna and general biodiversity
- site contamination
- site revegetation following program completion and any restoration activity
- potential future problems.

6.9.4 Incident Management, Recording and Corrective Actions

SAPEX and its contractors will 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. Such review should be undertaken at least annually. The system will also provide a mechanism for recording 'reportable' incidents, as defined under the *Petroleum Act 2000* and associated regulations.

6.9.5 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 SAPEX.

External reporting (e.g. incidents, annual reports) will be carried out in accordance with Petroleum Act requirements and the SEO.

7 Environmental Risk Assessment

Environmental risk is the chance of something happening that will result in impact to an aspect of the environment. Risk is measured in terms of the consequences of an event and their likelihood.

Given appropriate management measures (i.e. those identified in Section 6), most risks can be avoided or reduced to a level that is as low as reasonably practical (ALARP). This is a risk of something happening that is considered to have a minimal impact and which will recover. However, in some cases there may still be 'residual' risks that remain after management measures have been implemented.

An environmental risk assessment of SAPEX's proposed drilling activities has been undertaken to evaluate the level of environmental risk associated with various activities. It provides a framework for assessing risk management priorities and options based on the level of each assessed risk. The risk assessment is described in this section.

The environmental risk assessment was conducted using methodology based on AS/NZ 4360:2004 *Risk Management*.

The first stage of the risk assessment involved identifying the activities that may be a source of risk (hazards) and the possible associated environmental impacts (consequences). The hazards and consequences associated with drilling activities in the area of interest have been summarised in Table 5 in Section 5.

Once the consequences were identified, the severity of the consequences (Table 6) and the likelihood of the consequences occurring (Table 7) were allotted. A risk matrix (Table 8) was then used to undertake an environmental risk assessment of each consequence and determine a risk ranking. Results of the risk assessment are presented in Table 9.

Each phase of the risk assessment process is further discussed in the following sections.

7.1 Hazards and Consequences

Primary environmental hazards and the key potential environmental consequences associated with drilling operations in PEL 120 are identified in Sections 5.1 and 5.2.

To determine the level of risk associated with various hazards and potential consequences, both the likelihood and severity of hazards, and their associated consequences, have to be considered. Categories of likelihood and severity have been determined using subjective estimates of whether or not a particular event or outcome will occur. Drilling operations for petroleum and mineral exploration have been undertaken across South Australia for many years and as a result the environmental hazards and existing management measures are generally well understood. As a consequence the likelihood and severity of consequences of the majority of drilling activities can be confidently predicted based on past experience and professional judgement.

Both the likelihood and severity of consequences have been assessed in the context of the management practices that are currently applied to reduce the level of risk associated with identified hazards and potential consequences.

7.1.1 Severity of Consequences

Environmental consequences can be categorised from negligible to catastrophic (Table 6). These consequences are adapted from the definitions in Santos (2003) (which were based upon definitions in Stoklosa (1999)) and AS/NZS 4360:2004, but have been expanded to incorporate impacts to environmental values such as flora, fauna and biomass and the socio-economic environment.

Table 6: Severity of consequences

Category of Effect	Qualitative Description of Environmental Effects	
	Natural environment	**Socio-economic environment**
Negligible	Possible incidental impacts to flora & fauna in a locally affected land system but no ecological consequence. Possible incidental impacts to aquifers associated with the oil and gas formation without ecological consequence.	Community is aware of operations and concerns have been addressed
Minor	Changes to the abundance or biomass of biota, and existing soil and/or water quality in the affected land system, but no changes to biodiversity or ecological function. Aquifers have a small amount of exposure from other sources of fluids, negligible volume movement in or out of formations or aquifers. No measurable change to aquifer water quality or pressure in local area.	Temporary disturbance to the community.
Moderate	Changes to the abundance or biomass of biota, and existing soil and/or water quality in the affected land system, with local changes to biodiversity but no loss of ecological function. Detectable change to aquifer water quality and pressure in the local area.	Longer term disturbance able to be managed with communication to affected community
Major	Substantial changes to the abundance or biomass of biota, existing soil and/or water quality in the affected land system with significant change to biodiversity and change of ecological function. Eventual recovery of ecosystem possible, but not necessarily to the same pre-incident conditions. Substantial changes to aquifer water quality and pressure in the local area (i.e. local drawdown adjacent to the gas well or field).	Significant effect which can be mitigated by extensive rehabilitation and negotiation with community
Catastrophic	Irreversible and irrecoverable changes to abundance/biomass or aquifers in the affected area. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions. Widespread effect of reduction in aquifer pressure (i.e. reduced flow from bores in locations remote from operations). Contamination of aquifers remote from operations.	Significant and long lasting negative economic and social effects.

The distinction between temporary and long-term impact depends on many factors, but is ultimately a value judgement based on scientific evaluation and the level of community acceptance. These factors are generally related to climatic events, differing terrain units, vegetation units and timing of activities/operations. Dependent on these factors, a general guideline is that the community should expect recovery from drilling impacts after about two to five years when current techniques are employed. Impacts that are irreversible or are expected to take significantly longer to recover are defined as ‘long-term impacts’.

7.1.2 Likelihood of occurrence

The likelihood of potential environmental consequences occurring was qualitatively assessed and categorised according to the criteria outlined in Table 7. This table is based on Table 4(A) of HB 203:2004 (AS/NZS 2004c).

Table 7: Assessment of likelihood

Likelihood	Description
Almost certain	Is expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possible	Could occur
Unlikely	Could occur but not expected
Rare	Occurs only in exceptional circumstances

7.2 Risk Assessment

The level of risk has been determined by combining the likelihood and the severity of consequences using a risk matrix. Table 8 shows the risk matrix that has been used in this risk assessment. This matrix is based on example matrices provided in AS/NZ 4360:2004 and supporting documentation.

Table 8: Risk matrix

		SEVERITY OF CONSEQUENCE				
		Negligible Effect	**Minor Effect**	**Moderate Effect**	**Major Effect**	**Catastrophic Effect**
LIKELIHOOD	**Almost certain**	MEDIUM	HIGH	HIGH	VERY HIGH	VERY HIGH
	Likely	LOW	MEDIUM	HIGH	HIGH	VERY HIGH
	Possible	LOW	MEDIUM	MEDIUM	HIGH	HIGH
	Unlikely	LOW	LOW	MEDIUM	MEDIUM	HIGH
	Rare	LOW	LOW	MEDIUM	MEDIUM	HIGH

The objective of the risk assessment process is to separate the minor acceptable risks from the major risks and to provide data to assist in the evaluation and management of risks.

7.2.1 Results

A summary of the risk levels for drilling activities is provided in Table 9. This risk assessment takes into account the mitigation methods and practices described earlier within this EIR.

It should be noted that this risk assessment is based upon the following assumptions:

- Where possible wellsites will be located upon cleared or disturbed ground away from native vegetation and watercourses
- Drilling activities will not require on-site accommodation camps for drilling personnel
- New borrow pits will not be required.

The results of the risk assessment indicate that the risk levels for drilling activities are classified as either ‘Low’ or ‘Medium’. No high or very high risks were identified. This indicates that with appropriate planning and management (in accordance with previous sections of this EIR), environmental risks are not at an unacceptable level.

Table 9: Summary of impacts and risk levels for drilling operations[2]

Activity	Hazard	Potential consequence	Severity	Likelihood	Risk
Well site and access track preparation	*Earthworks* *Excavations* *Vehicle movement*	Loss of vegetation and habitat	Minor	Possible	Medium
		Soil erosion and disturbance to natural drainage patterns	Minor	Possible	Medium
		Soil inversion	Minor	Possible	Medium
		Soil compaction/disruption/deflation, wheel tracks	Minor	Possible	Medium
		Dust generation	Negligible	Likely	Low
		Noise generation	Negligible	Likely	Low
		Disturbance to native fauna	Negligible	Possible	Low
		Disturbance to stock	Negligible	Possible	Low
		Introduction and spread of weeds	Major	Unlikely	Medium
		Visual impact	Minor	Unlikely	Low
		Damage to infrastructure	Minor	Unlikely	Low
		Impact and/or damage to cultural/heritage sites	Moderate	Rare	Medium
		Facilitation of third party access	Minor	Unlikely	Low
	Spills and leaks	Contamination of soil, surface water	Minor	Unlikely	Low
Drilling Operations, including Well Completion	*Vehicle movement* *Rig moves*	Contamination of soil, surface water	Minor	Possible	Medium
		Soil compaction/disruption/deflation, wheel tracks	Minor	Possible	Medium
		Dust generation	Negligible	Likely	Low
		Disturbance to native fauna	Negligible	Possible	Low
		Disturbance to stock	Negligible	Possible	Low
		Introduction and spread of weeds	Major	Unlikely	Medium
		Damage to infrastructure	Minor	Unlikely	Low

[2] Assumes all activities avoid significant vegetation as described in Section 4 and Section 6.

Activity	Hazard	Potential consequence	Severity	Likelihood	Risk
		Noise generation	Minor	Unlikely	Low
		Road hazard / disturbance to local road users	Minor	Possible	Medium
	Blowout or kick *Equipment or tubular failure* *Down hole problems* *Casing or cement failure*	Contamination of soil, surface water or groundwater	Minor	Unlikely	Low
		Crossflow, aquifer contamination or reduction in pressure in aquifers	Moderate	Unlikely	Medium
		Uncontrolled release of water and/or hydrocarbon to surface	Moderate	Rare	Medium
		Disturbance to native fauna	Negligible	Unlikely	Low
		Disturbance to stock	Negligible	Possible	Low
		Atmospheric pollution	Negligible	Unlikely	Low
	Explosion or fire	Loss of vegetation and habitat	Major	Unlikely	Medium
		Damage to crops or pasture or property	Major	Unlikely	Medium
		Contamination of soil, surface water or groundwater	Moderate	Unlikely	Medium
		Crossflow, aquifer contamination or reduction in pressure in aquifers	Minor	Unlikely	Low
		Uncontrolled release of water and/or hydrocarbon to surface	Moderater	Rare	Medium
		Disturbance to native fauna	Major	Unlikely	Medium
		Disturbance to stock	Major	Unlikely	Medium
		Atmospheric pollution	Moderate	Unlikely	Medium
	Drill pipe failure	Temporary restricted control over well fluids and circulation system	Negligible	Possible	Low
	Loss of containment of gas while testing	Disturbance to native fauna	Minor	Unlikely	Low
		Disturbance to stock	Minor	Unlikely	Low
		Atmospheric pollution	Minor	Unlikely	Low
	Spills or leaks associated with: ▪ *drilling procedures* ▪ *storage of oil, fuels and chemicals*	Contamination of soil, surface water or groundwater	Moderate	Unlikely	Medium
		Loss of vegetation and habitat	Minor	Unlikely	Low
		Loss of crops or pasture	Minor	Unlikely	Low

Activity	Hazard	Potential consequence	Severity	Likelihood	Risk
	▪ *refuelling operations* ▪ *storage and disposal of drilling fluids*	Disturbance to native fauna	Minor	Unlikely	Low
		Disturbance to stock	Minor	Unlikely	Low
		Atmospheric pollution	Minor	Unlikely	Low
		Disruption to land use	Minor	Unlikely	Low
	Flaring of gas during testing *Emissions vented from drill stem testing and production testing*	Atmospheric pollution	Negligible	Likely	Low
	Disposal of fluids to excavated pits during testing and clean-up	Contamination of soil, surface water or groundwater	Minor	Unlikely	Low
		Loss of vegetation and habitat	Minor	Unlikely	Low
		Loss of crops or pasture	Minor	Unlikely	Low
		Disturbance to native fauna	Minor	Unlikely	Low
		Disturbance to stock	Minor	Unlikely	Low
	Loss of radioactive source down hole	Contamination of groundwater (aquifer)	Moderate	Unlikely	Medium
	Extreme weather conditions	Contamination of soil, surface water or groundwater	Minor	Unlikely	Low
		Damage to infrastructure	Minor	Unlikely	Low
Waste Handling and Disposal	*Disposal of domestic and chemical waste* *Sewage management* *Disposal of drill cuttings and muds*	Contamination of soil, surface water and groundwater	Moderate	Unlikely	Medium
		Soil inversion	Minor	Unlikely	Low
		Loss of vegetation and habitat	Minor	Unlikely	Low
		Loss of crops or pasture	Minor	Unlikely	Low
		Dust generation	Negligible	Unlikely	Low
		Soil erosion/ disturbed drainage patterns	Minor	Unlikely	Low
		Visual impact	Minor	Unlikely	Low
		Litter	Minor	Unlikely	Low
		Attraction of scavenging animals (both native and pest species)	Negligible	Possible	Low

Activity	Hazard	Potential consequence	Severity	Likelihood	Risk
Water supply	*Depletion of artesian and sub-artesian aquifers*	Depletion of artesian and sub-artesian aquifers	Major	Unlikely	Medium
	Spills and leaks	Loss of water (wastage)	Moderate	Possible	Medium
Fuel & chemical handling & storage	*Spills and leaks*	Contamination of soil, surface water and groundwater	Minor	Unlikely	Low
		Loss of vegetation and habitat	Minor	Unlikely	Low
		Loss of crops or pasture	Minor	Unlikely	Low
		Disturbance to native fauna	Minor	Unlikely	Low
		Disturbance to stock	Minor	Unlikely	Low
Campsites and associated supplies	*Vehicle movements*	Soil compaction/disruption/deflation, wheel tracks	Minor	Unlikely	Low
		Dust generation	Negligible	Likely	Low
		Visual Impact	Minor	Unlikely	Low
		Disturbance to native fauna	Negligible	Possible	Low
		Disturbance to stock	Negligible	Possible	Low
		Introduction and spread of weeds	Major	Rare	Medium
		Road hazard / disturbance to local road users	Minor	Unlikely	Low
	Camp site *Disturbance of vegetation and habitat*	Loss of vegetation and habitat	Minor	Unlikely	Low
		Soil erosion and disturbance to natural drainage patterns	Minor	Unlikely	Low
		Noise generation	Negligible	Likely	Low
		Visual Impact	Minor	Unlikely	Low
	Disposal of domestic and chemical waste *Spills and leaks*	Soil inversion	Minor	Unlikely	Low
		Contamination of soil, surface water, groundwater	Minor	Unlikely	Low
		Litter	Minor	Possible	Medium
		Visual Impact	Minor	Unlikely	Low
	Fire	Fire damage to vegetation and habitat	Major	Rare	Medium

Activity	Hazard	Potential consequence	Severity	Likelihood	Risk
Well site and access track restoration	*Earthworks* *Vehicle movement*	Soil inversion	Minor	Possible	Medium
		Dust generation	Negligible	Likely	Low
		Noise generation	Negligible	Likely	Low
		Disturbance to native fauna	Negligible	Unlikely	Low
		Disturbance to stock	Negligible	Possible	Low
		Introduction and spread of weeds	Major	Rare	Medium
		Visual Impact	Minor	Possible	Medium
		Damage to infrastructure	Minor	Unlikely	Low
		Impact and/or damage to cultural/heritage sites	Moderate	Rare	Medium
	Spills and leaks	Contamination of soil, surface water	Minor	Unlikely	Low
Monitoring	*Vehicle movement*	Loss of vegetation and habitat	Minor	Unlikely	Low
		Loss of crops or pasture	Minor	Unlikely	Low
		Soil compaction/disruption/deflation, wheel tracks	Minor	Unlikely	Low
		Dust generation	Negligible	Unlikely	Low
		Introduction and spread of weeds	Major	Rare	Medium
		Damage to infrastructure	Minor	Unlikely	Low
		Impact and/or damage to cultural/heritage sites	Minor	Unlikely	Low

8 Consultation

SAPEX will conduct targeted consultation with relevant interested parties, predominantly during planning for specific exploration programs. This consultation will assist SAPEX in identifying potential impacts and the best form of mitigation or management measures.

SAPEX is committed to maintaining effective communication and good relations with all stakeholders.

8.1 Key Stakeholders

The following stakeholders have been identified as having a direct interest in drilling activities in PEL 120:

- State regulatory agencies (Department of Primary Industries & Resources, Environment Protection Authority, Department for Environment & Heritage)
- Landholders
- Local government (local councils, Natural Resource Management Board).

Local government will be consulted where necessary.

SAPEX has not undertaken any consultation with the relevant landowners at this time. It is intended that consultation with the potentially affected landowners will be undertaken as part of the planning and approval process prior to commencement of drilling operations.

Close liaison will be carried out with landholders directly affected by drilling activities to ensure that activities are planned and carried out to minimise impacts to land use activities. Land occupiers will be formally notified prior to entry for exploration activities in accordance with Petroleum Act requirements and SAPEX will continue to work closely with landholders throughout the duration of its exploration programs.

8.2 On-going Consultation

SAPEX aims to continue to engage stakeholders for the duration of its exploration activities to ensure that all potential concerns are identified and appropriately addressed. Stakeholder correspondence will be registered and documented to ensure that issues are appropriately addressed.

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10 Abbreviations

BOM	Bureau of Meteorology
CSG	Coal seam gas
DEH	Department for Environment and Heritage (South Australia)
DEWHA	Department of the Environment, Water, Heritage and the Arts (Commonwealth) (formerly the Department of the Environment and Heritage)
DWLBC	Department of Water, Land & Biodiversity Conservation (South Australia)
EIR	Environmental Impact Report prepared in accordance with Section 97 of the South Australian *Petroleum Act 2000* and Regulation 10
ELA	Exploration Licence Application
EMS	Environmental Management System
EPA	Environment Protection Authority (South Australia)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
NPW Act	*National Parks and Wildlife Act* 1972 (South Australia)
NRM	Natural Resource Management
PEL	Petroleum Exploration Licence
PIRSA	Primary Industries and Resources, South Australia
SCB	Soil Conservation Board
SEO	Statement of Environmental Objectives
UCG	Underground Coal Gasification

11 Glossary

Blow-out or Kickback – when well pressure exceeds the ability of the wellhead valves to control it. Gas flow freely at the surface.

Casing Strings – steel tubing that lines a well after it has been drilled. It is formed from sections of steel tube that have been screwed together.

Drill Pipe – lengths of steel pipe screwed together to form a continuous pipe extending from the drilling rig to the drilling bit at the bottom of the hole. Rotation of the drill pipe and bit causes the bit to bore through the rock.

Drill Stem Tests – conventional method of testing a formation to determine potential productivity before installing production casing in a well. A testing tool is attached to the bottom of the drill pipe and placed opposite the formation to be tested which has been isolated by placing packers above and below the formation. Fluids in the formation are allowed to flow up through the drill pipe by establishing an open connection between the formation and the surface.

Production Casing – steel pipe threaded together and cemented into a well to prevent the wall of the hole from collapsing and to provide a means of extracting gas from the well.

Well Head – steel equipment installed at the surface of the well containing an assembly of heavy duty hangers and seals. The wellhead is used to support the weight of the casing strings hung from it and to contain the well pressure.

Appendix 1:

Example of CSG Drilling Activities and Requirements

LINC ENERGY EXPLORATION DRILLING SAPEX NOTES

Introduction

Linc Energy uses the following procedure for exploration drilling activities. Our current procedure for cultural heritage clearance, hazard assessment, preparation of sites, landholder consultation, property access and conduct, drilling, and geophysical logging are as follows.

Individual drill sites and holes are determined by the anticipated depth of drilling required and general site logistics. Most relate to current predictions of the target coal seams and site specific issues.

Landholder Consultation

Prior to entrance onto any property landholders must be contacted and informed. The site Exploration Manager or Site Senior Executive are the only persons authorised for landholder dealings. No other Linc Energy employee is to contact landholders without prior approval. Landholders are to be informed of the location of the drill holes on their property and if possible shown their location. This practice allows the landholder to inform Linc Energy of any sensitive issues such as cropping and preferred access points that drilling has potential to cause a negative impact upon. There is a limited ability to move sites according to landholder preferences and the site geologist must be involved in this decision making process. Landholders must be informed of the different parties that will be accessing their land and any potential impacts. This includes the drill crew and geologist, earthmoving companies and geophysical loggers. Every effort will be made to promote good landowner relations. To date Linc Energy has excellent relations with local landowners.

Property Access and Conduct

Impact minimisation is fundamental when entering properties within Linc Energy Permit areas. Access points such as gates must be left in the same state as they were found. If a gate is shut it is the Linc energy employee or contractors obligation to shut the gate when proceeding and leaving a property. It is an unacceptable practice to leave gates open if the person is only going to be a short time or there is a person in a car a few minutes behind them who will shut the gate. Such practices lead to confusion and have potential to negatively impact the landholder which has the follow on effect to negatively impact Linc Energy.

Cultural Heritage Clearance

All drill sites must have cultural heritage approval before any drilling or site preparation is performed. Before any activity begins on a drill site Exploration Manager or Site Senior Executive must be informed and give approval. If any artifacts or potential aboriginal significant areas (such as scar trees or burial grounds) are found after cultural heritage has taken place all work is to be shut down immediately and the traditional owners informed.

Hazard Assessment

Prior to any activities being carried out drill sites must be assessed for potential hazards. In particular hazards may include:

- Power lines
- Water Pipelines
- Previous drill sites with casing extruding from ground
- Communication cables
- Noxious Weeds
- Overhead Trees and branches
- Steep gradients
- Fire Risk

No site is to be drilled whereby hazards exist that have potential to put people in danger of injury. JSEAS are to be conducted on any observed hazard and drilling may only commence after the risk is reduced to acceptable levels.

Drill Site and Access

Drilling operations are accessed using existing public roads and tracks as much as possible, but may require the construction of a purpose built access track to connect the site to an existing track or road. An access track may not be required where the land can be readily traversed by drilling vehicles and equipment (e.g. cleared paddocks).
The construction method used for access track construction is dependent upon the terrain in which it is being built and the expected level of use or traffic. In most cases where an access track is required, it is cleared and graded or rolled. Imported material (e.g. gravel) may be used to provide a stable surface.

The number of vehicle movements involved in drilling varies greatly depending on the type of drilling being undertaken. Drilling for coal cores typically involves one truck mounted drilling rig (e.g. 8x4 Truck with Schramm 650i rig mounted), one support/rod truck with water tank mounted (e.g. 6x6 truck), one or two 4x4 Toyota Land Cruisers. In remote regions an additional caravan for accommodation and messing plus an additional trailer mounted ablutions block may be required.

Site Preparation and Layout

Site preparation may only take place after the landholder has been informed, cultural heritage clearance has been given approval and the site has been deemed non-hazardous. Site preparation is site-specific and each site will need to be assessed to in order to define the degree of preparation required. Whereby a site is inaccessible by a drilling rig, tracks must be graded in order to establish accessibility. Drilling rig accessibility is best determined by the drilling supervisor. Track grading is currently contracted in house with Linc Energy owned and operated backhoe. Any track grading must be approved by Exploration Manager or Site Senior Executive. The average are of disturbed ground during drilling will be kept to a minimum which on average is approximately 60m x 40m pad for rig and trucks with a turning circle.

Due to the potential methane gas risks associated with many target coal seams, drilling will be conducted using mud. As such each drill site requires the emplacement of mud pits. Mud pits are dug and approximately 10m x 20m pit. Mud pits are to be emplaced according to the instructions of the drilling supervisor or driller. Mud pits are to be filled with water only from approved water sources (if unsure the site manager is to be consulted). Hazards such as overhanging branches must be eliminated. Locational information such as the drilling rig, water truck and parking areas should all be taken into account during the site preparation stage. Emergency escape routes in case of fire or flood as well as prevailing wind direction are also to be factored in. Site preparation should begin at least several days before completion of the previous drill hole otherwise there will be delays.

Drilling

Each drill hole is to be drilled using mud. Drilling on mud overbalances the hole creating the affect of pressurisation and thus reduces the chance of gas kicks. Due to the risks associated with methane gas within coal seams this is the safest form of drilling. Drilling on air has the affect of under balancing the hole which in turn creates a much higher risk of explosive levels of methane reaching the surface. Smoking on the drilling rig is prohibited. Smoking is permitted at a minimum distance of 15 meters from the drilling rig/hole.

Drilling matters pertaining to the geology of the hole such as drilling depths are under the control of the site geologist. Chip samples are to be laid out in 1 meter intervals. The driller is required to keep accurate depth information and pass this onto the geologist when required. Non-geological aspects of drilling are under control of the drilling supervisor. All holes are to be cemented to a minimum of 20 meters above the target coal seams.

Geophysical Logging

All Drill Holes are to be logged to a minimum of Density, Caliper, Gamma and Verticality. Currently the geophysical logging is contracted out to Coal Seam Wireline. Coal Seam Wireline has several other contracts within the area and should be contacted by the site geologist several days before hole completions. Due to their other logging commitments in the area small delays are expected at some point throughout the drilling program. Two copies will be requested of all hard copy logs and electronic LAS files submitted following logging.

Individual Drill site Information

Prior to drilling a list of the holes planned for exploration program will be made from the target generated desk study. Data required for these studies are previous drilling logs, regional and local geology structure. Public Mines information open reports, company information and any non destructive investigation such as geophysics, airborne, remote sensing, etc.

Mapping

A Mapped list is ordered according to landholder and contains information regarding location, site access, hole type, coal seam predictions (top depths) and any individual comments/special requirements relating to the hole. In general coring depths and general anticipated coal seam predictions according to the consistency of information in the area. An example of a hole prediction is as follows:

Property: Polzin
Location: 270493 E 7020904 N
Access: 16 Mile Haul Road, via main gate painted red opposite church.
Type: Core Hole
A Seam Prediction: 100m
B Seam Prediction: 111m
Comments: Predictions correlate with desk study.

Mapping will identify lease boundaries, cultural features, roads, landowners, fences and property boundaries. A hole plan will be overlaid with holes numbers RC### for rotary chip holes and LC### for cored holes.

Drilling and Well Operations

Criteria adopted for “coal seams suitable for UCG exploitation” are as follows:

- Thickness of individual coal seam exceeds 3 metres
- Thickness of individual coal seam greater than 1.0 metre IF another coal seam with thickness exceeding 3 metres, is separated from the subject seam by less than 0.5 metres of rock parting.
- Maximum parting thickness between workable seams less than 1.0 metre
- Aggregate ash content is less than 40 per cent
- Minimum depth to top coal seam 100 metres.
- No maximum depth.

UCG drilling rigs are usually smaller than those used for conventional oil and gas drilling, and are often mounted on a truck and can be transported and set up more easily. Plate 1 shows a typical Truck mounted UCG rig.

Plate 1. Schramm 650i Drilling Rig

The initial exploration drilling for will aim to collect cored coal samples and collect samples for laboratory analysis. These drill holes would typically not be cased, unless they are likely to intersect artesian aquifers, in which case they will be pre-collared by installing and cementing casing to allow well control to be implemented in the case of a water flow. Drilling muds are likely be used, depending on the nature of the hole. A sump is likely to be required although some types of rigs have mud tanks which capture and recycle drilling muds, reducing the size of the sump that is required. Drilling muds used will be water-based and non-toxic or low toxicity and the sump will not be lined unless the well site is in an area where very shallow aquifers are present.

Site Clean-up and Reinstatement

The restoration of well sites and associated access tracks is normally undertaken in stages following the completion of drilling operations.

Initial Restoration

Irrespective of the outcome of the drilling operation, initial well lease clean-up involves:

- fencing the drilling mud sump immediately following the completion of drilling to prevent stock access and discourage wildlife access
- pumping any additional water from the turkey's nest into the mud sump and removing the turkey's nest liner.

The drilling mud sump will remain fenced until the contents have dried sufficiently to allow the sump to be backfilled without displacing drilling muds and fluids to the soil surface. The time required for the sump contents to dry is dependent upon the size of the sump but can be months to dry.

The standard industry practice is to dispose of drilling muds in sumps (as above), however in some circumstances (e.g. in areas of shallow groundwater or sensitive / intensive land use) it may be appropriate to remove drilling muds for disposal off site.

Final Restoration

Complete well site, access track and borrow pit restoration will be undertaken following completion of exploration. Final surface restoration of well sites will involve:

- backfilling all pits including the drilling mud sump, turkey's nest, flare pits and vent pits
- ripping and recontouring (where appropriate) of well sites, campsites and the respreading of stockpiled topsoil and cleared vegetation to promote revegetation
- ripping the access track to relieve compaction and promote revegetation
- re-seeding of crops (dependent upon agreement with landholder)
- removing any windrows to ensure that water flows are not impeded.

Water Supply

Water will be required for both domestic and industrial purposes for drilling and well operations. The quality of the water required is dependent upon the intended use.

Domestic Water Supply

Potable water may be required at the well site (for example, to supply kitchen and ablutions facilities). The source of potable water will depend on the well location, but may it be sourced from the water supply of a nearby town or property and transported to site in a bulk water tanker.

Drilling Water Supply

The amount of water required for drilling operations depends principally upon the depth of the well that is being drilled. Typical volumes for exploration drill rig varies from 15,000 to 30,000 liters to fill the mud sumps.

Water for drilling operations may be sourced from town water supplies, farm dams or licensed water bores, with the agreement of the owner or supplier. The water supply for a drill site would be chosen on the basis of minimising the distance for the water haul and minimising impacts on water supplies and land use.

Appendix 2:

Rare or Threatened Species Recorded in PEL 120

Rare or Threatened Species in PEL 120

A search of the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) database and the South Australian Department for Environment and Heritage (DEH) databases has identified the following rare or threatened flora and fauna species as being present or likely to occur within PEL120. A number of species listed under the migratory provisions of the EPBC Act were identified as occurring in the region by DEH during consultation on the EIR and are also listed in the table.

Where an entry in the table is based on a predicted occurrence in the EPBC database rather than an actual record, it has been marked with the symbol "#".

Species Name[3]	**Common Name**	**Conservation Status**[4]	
		Cwlth (EPBC)	**SA (NPW Act)**
Mammals			
Trichosurus vulpecula	Common Brushtail Possum		Rare
Amphibians			
Pseudophryne bibronii	Brown Toadlet		Rare
Reptiles			
Aprasia pseudopulchella	Flinders Worm Lizard	Vulnerable	
Emydura macquarii	Macquarie Tortoise		Vulnerable
Notechis ater ater	Krefft's Tiger Snake	Vulnerable	
Tiliqua adelaidensis	Pygmy Blue-tongue Lizard	Endangered	Endangered
Varanus varius	Tree Goanna		Rare
Vermicella annulata	Common Bandy-Bandy		Rare
Birds			
Acanthiza iredalei	Slender-billed Thornbill	Vulnerable	Vulnerable
Actitis hypoleucos	Common Sandpiper		Rare
Anas rhynchotis	Australasian Shoveler		Rare
Anhinga melanogaster	Darter		Rare
Arenaria interpres	Ruddy Turnstone		Rare
Ardea ibis	Cattle Egret		Rare
Ardea intermedia	Intermediate Egret		Rare
Ardeotis australis	Australian Bustard		Vulnerable
Biziura lobata	Musk Duck		Rare
Botaurus poiciloptilus	Australasian Bittern		Vulnerable
Burhinus grallarius	Bush Stone-curlew		Rare
Cacatua leadbeateri	Major Mitchell's Cockatoo		Rare
Calidris acuminata	Sharp-tailed sandpiper	Migratory	

[3] The symbol # indicates that a species has been predicted as likely to occur in PEL 120 but has not actually been recorded in PELs.

[4] Where the status of a species is listed as "ssp" the NPWSA status applies to a subspecific level, but the resolution of the record in BDBSA is at a species level.

Species Name[3]	Common Name	Conservation Status[4]	
		Cwlth (EPBC)	SA (NPW Act)
Calidris alba	Sanderling		Rare
Calidris ferruginea	Curlew sandpiper	Migratory	
Calidris melanotos	Pectoral Sandpiper		Rare
Calidris ruficollis	Red-necked stint	Migratory	
Calidris subminuta	Long-toed Stint		Rare
Calidris tenuirostris	Great Knot		Rare
Cereopsis novaehollandiae	Cape Barren Goose		Rare
Charadrius leschenaultii	Greater Sand Plover		Rare
Charadrius mongolus	Lesser Sand Plover		Rare
Cladorhynchus leucocephalus	Banded Stilt		Vulnerable
Climacteris affinis	White-browed Treecreeper		Rare
Corcorax melanorhamphos	White-winged Chough		Rare
Coracina papuensis	White-bellied Cuckoo-shrike		Rare
Coturnix chinensis	King Quail		Endangered
Coturnix ypsilophora	Brown Quail		Vulnerable
Diomedea exulans	Wandering Albatross	Vulnerable	Vulnerable
Egretta garzetta	Little Egret		Rare
Elanus scriptus	Letter-winged Kite		Rare
Falco hypoleucos	Grey Falcon		Rare
Falco peregrinus	Peregrine Falcon		Rare
Falcunculus frontatus	Crested Shrike-tit		Rare
Gallinago hardwickii	Latham's Snipe		Rare
Gerygone olivacea	White-throated Gerygone		Rare
Glossopsitta pusilla	Little Lorikeet		Endangered
Grus rubicunda	Brolga		Vulnerable
Haematopus fuliginosus	Sooty Oystercatcher		Rare
Haliaeetus leucogaster	White-bellied Sea-Eagle		Endangered
Heteroscelus brevipes	Grey-tailed Tattler		Rare
Ixobrychus minutus	Little Bittern		Endangered
Lichenostomus cratitius	Purple-gaped Honeyeater		ssp
Limosa lapponica	Bar-tailed Godwit		Rare
Limosa limosa	Black-tailed Godwit		Rare
Manorina flavigula	Yellow-throated Miner	Ssp	ssp
Melanodryas cucullata	Hooded Robin		ssp
Melithreptus gularis	Black-chinned Honeyeater		Vulnerable
Microeca fascinans	Jacky Winter, Brown Fly-catcher		ssp
Myiagra cyanoleuca	Satin Flycatcher		Endangered
Myiagra inquieta	Restless Flycatcher		Rare
Neophema elegans	Elegant Parrot		Rare

Species Name[3]	Common Name	Conservation Status[4]	
		Cwlth (EPBC)	SA (NPW Act)
Neophema chrysogaster#	Orange-bellied Parrot	Critically Endangered	Endangered
Neophema chrysostoma	Blue-winged Parrot		Vulnerable
Neophema petrophila	Rock Parrot		Rare
Northiella haematogaster	Blue Bonnet		ssp
Numenius madagascariensis	Eastern Curlew		Vulnerable
Numenius phaeopus	Whimbrel		Rare
Oxyura australis	Blue-billed Duck		Rare
Oriolus sagittatus	Olive-backed Oriole		Rare
Pachycephala inornata	Gilbert's Whistler		Rare
Pandion haliaetus	Osprey		Endangered
Pedionomus torquatus	Plains-wanderer	Vulnerable	Endangered
Petroica multicolor	Scarlet Robin		ssp
Philomachus pugnax	Ruff		Rare
Pluvialis fulva	Pacific Golden Plover		Rare
Pluvialis squatarola	Grey plover	Migratory	
Plectorhyncha lanceolata	Striped Honeyeater		Rare
Plegadis falcinellus	Glossy Ibis		Rare
Podiceps cristatus	Great Crested Grebe		Rare
Porzana tabuensis	Spotless Crake		Rare
Rostratula benghalensis	Painted Snipe, Australian Painted Snipe	Vulnerable	Vulnerable
Stagonopleura guttata	Diamond Firetail		Vulnerable
Sterna albifrons	Little Tern		Endangered
Sterna nereis	Fairy Tern		Endangered
Sterna hirundo	Common Tern		Rare
Stictonetta naevosa	Freckled Duck		Vulnerable
Strepera versicolor	Grey Currawong		ssp
Tringa glareola	Wood Sandpiper		Rare
Tringa nebularia	Common greenshank	Migratory	
Turnix varia	Painted Button-quail		Rare
Xenus cinereus	Terek Sandpiper		Rare
Flora			
Acacia montana	Mallee Wattle		Rare
Acacia spilleriana	Spiller's Wattle		Endangered
Acanthocladium dockeri	Spiny Everlasting	Critically Endangered	Endangered
Anogramma leptophylla	Annual Fern		Rare
Aristida australis			Rare
Asperula syrticola	Southern Flinders Woodruff		Rare

Species Name[3]	Common Name	Conservation Status[4]	
		Cwlth (EPBC)	SA (NPW Act)
Atriplex eichleri	Eichler's Saltbush		Rare
Austrodanthonia laevis	Smooth Wallaby-grass		Rare
Austrodanthonia tenuior	Short-awn Wallaby-grass		Rare
Austrostipa gibbosa	Swollen Spear-grass		Rare
Austrostipa petraea	Flinders Range Spear-grass		Rare
Austrostipa pilata	Prickly Spear-grass		Vulnerable
Bothriochloa macra	Red-leg Grass		Rare
Brachyscome basaltica var. gracilis	Swamp Daisy		Rare
Brachyscome ciliaris var. subintegrifolia			Rare
Caladenia macroclavia	Large-club Spider-orchid	Endangered	Endangered
Caladenia tensa	Inland Green-comb Spider-orchid, Rigid Spider-orchid	Endangered	
Choretrum glomeratum var. chrysanthum	Yellow-flower Sour-bush		Rare
Codonocarpus pyramidalis	Slender Bell-fruit	Vulnerable	Endangered
Crassula sieberiana	Sieber's Crassula		Endangered
Cryptandra sp. long hypanthium (C.R. Alcock 10626)	Long-flower Cryptandra		Rare
Cullen parvum	Small Scurf-pea		Vulnerable
Danthonia carphoides var. carphoides (NC)	Short Wallaby-grass		Rare
Daviesia benthamii ssp. humilis	Mallee Bitter-pea		Rare
Derwentia decorosa	Showy Speedwell		Rare
Dianella longifolia var. grandis	Pale Flax-lily		Rare
Diuris behrii	Behr's Cowslip Orchid		Vulnerable
Dodonaea subglandulifera		Endangered	Endangered
Eragrostis infecunda	Barren Cane-grass		Rare
Eremophila subfloccosa ssp. Glandulosa (R.Bates 32961)	Green-flower Emubush		Rare
Eucalyptus percostata	Ribbed White Mallee		Rare
Haegiela tatei	Small Nut-heads		Rare
Halosarcia flabelliformis	Bead Samphire, Bead Glasswort	Vulnerable	Vulnerable
Hovea purpurea	Tall Hovea		Rare
Juncus homalocaulis	Wiry Rush		Vulnerable
Juncus radula	Hoary Rush		Vulnerable
Leptinella reptans	Creeping Cotula		Rare
Leptorhynchos elongatus	Lanky Buttons		Rare
Logania saxatilis	Rock Logania		Rare
Maireana rohrlachii	Rohrlach's Bluebush		Rare
Maireana decalvans	Black Cotton-bush		Endangered

Species Name[3]	Common Name	Conservation Status[4]	
		Cwlth (EPBC)	SA (NPW Act)
Maireana excavata	Bottle Fissure-plant		Vulnerable
Myoporum parvifolium	Creeping Boobialla		Rare
Olearia pannosa ssp. cardiophylla	Velvet Daisy-bush		Rare
Olearia pannosa ssp. pannosa	Silver Daisy-bush	Vulnerable	Vulnerable
Olearia picridifolia	Rasp Daisy-bush		Rare
Ozothamnus scaber	Rough Bush-everlasting		Vulnerable
Phebalium glandulosum ssp. glandulosum	Glandular Phebalium		Endangered
Poa drummondiana	Knotted Poa		Rare
Podolepis jaceoides	Showy Copper-wire Daisy		Rare
Podolepis muelleri	Button Podolepis		Vulnerable
Prasophyllum pallidum	Pale Leek-orchid	Vulnerable	Rare
Pterostylis despectans	Mt Bryan Greenhood	Endangered	Endangered
Pterostylis sp. Halbury (R.Bates 8425)	Halbury Greenhood	Endangered	Endangered
Ptilotus erubescens	Hairy-tails		Rare
Pycnosorus chrysanthes			Endangered
Pycnosorus globosus	Drumsticks		Vulnerable
Rumex dumosus var. (NC)	Wiry Dock		Rare
Santalum spicatum	Sandalwood		Vulnerable
Sclerolaena muricata var. villosa	Five-spine Bindyi		Rare
Senecio macrocarpus	Large-fruit Groundsel	Vulnerable	Vulnerable
Senecio megaglossus	Large-flower Groundsel	Vulnerable	Endangered
Solanum eremophilum	Rare Nightshade		Rare
Swainsona fuscoviridis	Dark Green Swainson-pea		Rare
Swainsona murrayana	Murray Swainson-pea	Vulnerable	Vulnerable
Swainsona procumbens	Broughton Pea		Vulnerable
Swainsona pyrophila#	Yellow Swainson-pea	Vulnerable	Rare
Swainsona sericea	Silky Swainson-pea		Endangered
Thysanotus tenellus	Grassy Fringe-lily		Rare
Trachymene thysanocarpa	Native Parsnip		Rare
Vittadinia australasica var. oricola	New Holland Daisy		Vulnerable
Wurmbea latifolia ssp. latifolia	Broad-leaf Nancy		Vulnerable
Zoysia macrantha ssp. walshii	Manila Grass		Rare

Threatened Ecological Communities

Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia - Critically Endangered

Iron-grass Natural Temperate Grassland - Critically Endangered

Appendix 3:

Consultation Submissions and Responses

No.	Agency or Individual	Issues Raised or Comments Made	Response
1.	DTEI	No objections made (overall impact on DTEI network considered to be negligible)	Acknowledged
2.	DWLBC – Develop't Planning Group	All activity undertaken under this proposal should conform to the *Petroleum Act 2000* and *Environmental Protection Act 1993* in accordance with the Statement of Environmental Outcomes.	Acknowledged.
3.	DWLBC – Develop't Planning Group	The PEL lies within the Northern and Yorke Natural Resources Management (NRM) Board area. As such, PIRSA Petroleum must take into consideration issues raised within the current Northern and Yorke Agricultural District Initial Natural Resource Management Plan (INRM Plan). Although there is no Water Allocation Plan (WAP) relevant to this area, matters of water management, relevant soil conservation plans, relevant animal and plant control board plans are all contained within the INRM Plan. The SEO and EIR appear to be consistent with the INRM Plan nevertheless the Department offers the following comments as assessed against the Northern and Yorke Agricultural District INRM Plan.	Acknowledged. The issues raised in the current Northern and Yorke Agricultural District Initial Natural Resource Management Plan (INRM Plan) were taken into consideration in preparation of the EIR.
4.	DWLBC – Develop't Planning Group	EIR Page 26 - acknowledges 'introduction and or spread of pest plants or animals' as a potential environmental consequence of drilling and page 31 states that 'there is the potential for weed species to be moved along with the construction material from the borrow site to the well site.' These issues are to be addressed by consultation with landholders, cleaning of machinery and consultation with NRM Board officers. This consultation should occur in advance and at the level of the Board's General Manager as well as with individual officers.	Noted. The SEO (Objective 3 "Guide to How…") has been amended to include: "Appropriate consultation regarding weeds undertaken in advance with landholders and NRM Board officers / General Manager." (Note: Consultation with landholders and the NRM board regarding treatment of any weed outbreaks is already included under Objective 3).
5.	DWLBC – Native Vegetation Group	EIR Section 5.3.3 Vegetation Clearance - should recognise listed plant communities as examples of significant vegetation.	Acknowledged. Section 5.3.3 of EIR has been amended to reflect this.
6.	DWLBC – Native Vegetation Group	EIR Section 6.2 - 5th dot point should read "Significant vegetation (e.g. large trees, significant species and plant communities (see Appendix 2), good quality remnants) will be avoided."	Acknowledged. Section 6.2 of EIR has been amended to reflect this.
7.	DWLBC – Native	SEO Objective 2 (page A1-2) - "Significant remnant vegetation has not been cleared without specific consultation with PIRSA, Native	Although PIRSA has delegated authority and direct consultation is not required under the Native Vegetation Act, this criteria has been inserted as a safety

No.	Agency or Individual	Issues Raised or Comments Made	Response
	Vegetation Group	Vegetation Council and DEH prior to activity approval." - as NVC has given delegated authority to PIRSA, may need to recognise that here, as the delegation should mean that direct consultation with the NVC is not required [unless the proposed activity is outside Reg 5(1)(zc)].	mechanism to provide added protection to areas of significant remnant vegetation.
8.	DWLBC – Native Vegetation Group	Is the DEH referred to the state DEH or federal?? If EPBC Act issues are involved, will need to refer to AG DEWHA prior to activity approval.	The DEH referred to is the state Department for Environment and Heritage. A footnote has been added to the table to clarify this. It is expected that drilling activities will be located and carried out to avoid impact to matters that are protected under the Commonwealth EPBC Act. If this is not the case, they would certainly be referred to the Commonwealth Department (DEWHA).
9.	DEH	EIR Section 3.6.3 - Ripping of access tracks should also be "where appropriate" as this action can be detrimental to the recovery for some soil types.	Acknowledged. Section 3.6.3 of EIR has been amended to reflect this and the SEO (Objective 4 "Guide to How…") has also been amended.
10.	DEH	EIR Section 6.3 - Consultation on non-Aboriginal heritage sites should be undertaken with the Heritage Branch of DEH. There are places entered in the State Heritage Register in the area covered by the PEL. Once final locations for work programs are identified, contact should be made with the Heritage Branch to ascertain whether sites are located within the work areas and provide advice on protecting the place's heritage value.	Acknowledged. This is reflected in the SEO (Objective 1 "Guide to How…") and has been added to Section 6.3 of the EIR.
11.	DEH	EIR - General Indirect impact to parks – as one of the prospects covered by the EIR is adjacent to the Clinton Conservation Park, the issue of indirect impacts and management measures should have been covered in the EIR.	Acknowledged. Added "Although the Conservation Parks in the region are excluded from PEL 120 (or do not have exploration access, in the case of Wills Creek Conservation Park), indirect impacts to these parks could occur if drilling was carried out in close proximity to the boundary. Consultation with DEH would be carried out if this was likely to be the case and appropriate management measures would be developed to avoid significant impacts." This requirement has also been added to the SEO (Objective 2) as a "Guide to How…"

No.	Agency or Individual	Issues Raised or Comments Made	Response
12.	DEH	EIR - General The possibility of impacts to coastal environments should have been addressed in the report. Saltmarsh and mangrove areas are located within one of the licence target areas. These areas provide important nursery, breeding and spawning habitats for commercial and recreational fish species – DEH request to be consulted if any activities have the potential to impact on these areas.	Noted. Added words shown in italics to Section 6.3: "Well sites will not be constructed on sensitive areas such as salt lakes or steep slopes *or in locations where they are likely to impact the marine environment."* These words have also been added to the SEO (Objectives 2 and 6) as a "Guide to How…" In the event that exploration activities are planned to be undertaken in close proximity to coastal environments (i.e. mangroves or saltmarshes) SAPEX will undertake consultation with relevant stakeholders including DEH. Reference to consultation regarding saltmarsh and mangrove areas has been added to SEO as discussed below in relation to Objective 2.
13.	DEH	EIR Appendix 2 - A number of shorebird and marine animal species have been identified by this Agency in addition to those listed. These species are: ▪ *Calidris acuminate* Sharp-tailed sandpiper (EPBC listed) ▪ *Calidris ferruginea* Curlew sandpiper (EPBC listed) ▪ *Tringa nebularia* Common greenshank (EPBC listed) ▪ *Pluvialis squatarola* Grey plover (EPBC listed) ▪ *Calidris ruficollis* Red-necked stint (EPBC and NPWA listed) ▪ *Charadrius ruficapillus* Red-capped plover (EPBC and NPWA listed) ▪ *Recurvirostra novaehollandiae* Red-necked avocet (EPBC and NPWA listed)	Acknowledged. These species, which are listed under the migratory provisions of the EPBC Act (and were thus outside the original scope of Appendix 2, which dealt with rare or threatened species) have been added to Appendix 2 of the EIR. No NPWA listing for *Charadrius ruficapillus* and *Recurvirostra novaehollandiae* could be found in the current schedules. Their EPBC listing is as marine species, which is only relevant in Commonwealth marine areas. These species have consequently not been added to the EIR.
14.	DEH	SEO Objective 2 - Under 'guide to' - DEH may be able to provide advice on Vegetation Heritage Agreements (VHA) if surveys have been carried out within specified VHAs. Though a policy of avoidance should be followed in the first instance.	Noted.
15.	DEH	SEO Objective 2 - Under 'guide to' – Where talking about VHAs, should also reference coastal vegetation such as saltmarshes.	Acknowledged. Objective 2 'Guide to' has been modified to include saltmarshes.
16.	DEH	SEO Objective 2 - Re-use of PIRSA field guide (2002) as an assessment criteria – the field guide referenced relates to a region with differing land systems components and climatic conditions. Question whether this is an appropriate guide to measure the recovery of vegetation in the Northern and Yorke region, particularly if clearance of coastal species is undertaken. Also a current version of the document should have been included with the draft SEO to enable assessment of the document's applicability.	Noted. Although it was developed for the Cooper Basin, the field guide has a reasonably generic approach that can be used for other areas and has been used in the past for Yorke Peninsula (e.g. it is used in the SEO for PEL 73, Stansbury Basin). However, it has been decided to include a specific set of Goal Attainment Scaling criteria in this SEO as an Appendix rather than use the PIRSA Field Guide. These criteria have been based on the PIRSA Field Guide and other SEOs and modified slightly for the PEL 120 region.

No.	Agency or Individual	Issues Raised or Comments Made	Response
17.	DEH	SEO Objective 4 - For "No construction activities to be carried out on salt lakes or steep slopes landforms…" to reflect the impacts that may occur if activities carried on boggy coastal soils, should also avoid carrying out of activities in these areas.	Acknowledged. Objective 2 'Assessment criteria' has been modified to reflect this.
18.	DEH	SEO Objective 6 - Re use of PIRSA Field Guide – appropriateness.	See response to regarding SEO Objective 2 above.
19.	DEH	SEO Objective 11 - Re use of PIRSA Field Guide – appropriateness.	See response to regarding SEO Objective 2 above.
20.	EPA	EIR Section 3.2.2 Turkey's Nest - EPA agrees with inclusion of a plastic (HDPE) liner in Turkeys' nest design	Acknowledged
21.	EPA	EIR Section 3.2.4 Campsite - No information is provided for the proposed waste and wastewater management for the campsites, if they are required. This information must be provided in the EIR. The following management techniques must be employed where a campsite is established: ▪ Waste generation at well sites and associated camps is considered to be an environmental risk by the EPA due to the consolidation of staff and operational activities in one location for a period of time. Waste recovery, reuse and recycling should be maximised. Containers subject to deposit legislation, along with other plastics, cans and glass are recyclable and should be segregated on site and transported to a licenced waste transfer facility. Clean paper and cardboards should also be managed in this manner. ▪ All other material at these sites, including putrescible wastes, must be collected, segregated and disposed of at an approved Waste Transfer Facility. ▪ Following treatment via an approved sewage management system, wastewater must be removed from the site by a licensed waste transporter in order to comply with Clause 11 of the *Environment Protection (Water Quality) Policy 2003*: *11 – General obligation to avoid discharge etc into waters* *(1) A person who is undertaking an activity, or is an occupier of land, must take all reasonable and practicable measures (not being measures that themselves cause environmental harm) to avoid the discharge or deposit of waste from that activity or land—* *(a) into any waters; or* *(b) onto land in a place from which it is reasonably likely to enter*	Waste and wastewater management for all activities (including campsites) is covered under Section 3.7.2 *Waste Management* and Section 6.8 *Pollution and Waste Management*. Section 3.7.2 states: "Domestic wastes (e.g. food waste, packaging, paper, plastics, cans and glass) will stored on site in secure bins or skips prior to their transportation to a licensed waste disposal facility. Recyclable materials will be segregated for transport to a recycling facility where practicable." See paragraph above. Section 6.8 of the EIR states that: "Campsite wastewater will either be collected on-site or disposed of off-site by a licensed waste contractor or receive onsite treatment for disposal onto land (well away from watercourses or infrastructure). The disposal method for wastewater will be undertaken in compliance with the *Standard for the Construction, Installation and Operation of Septic Tank Systems in South Australia*, or be to the satisfaction of the Department of Health. " Thus SAPEX will comply with Clause 11 of the *Environment Protection (Water Quality) Policy 2003* by ensuring that, if campsites are used and waste water is discharged onto land, it will be well away from any place from which it is reasonably likely to enter any waters. Section 3.7.2 of the EIR and the "Guide to how..." for Objective 9 in the SEO reflects this wording. It is noted that removal of treated waste water from campsites may not be

No.	Agency or Individual	Issues Raised or Comments Made	Response
		any waters (including by processes such as seepage or infiltration or carriage by wind, rain, sea spray, or stormwater or by the rising of the water table), *and, in taking those measures, must apply the waste management hierarchy.* ▪ Wastewater must not be discharged to an evaporation pond or buried on site.	practical if drilling occurs at remote sites in the north of the permit. Noted. This is not contemplated in the EIR or SEO.
22.	EPA	EIR Section 3.3 Drilling and well Operations – This information indicates that the use of mud tanks or drilling mud sumps may be used, dependent on the type of drill rig employed. The Authority's preference is for mud tanks to be used.	Noted.
23.	EPA	EIR Section 3.4 Production Testing – No detail is provided in relation to the construction of a sump or flare pit should these be required for initial production testing. This information should be included in the EIR. The EPA's requirement's for construction are as follows: ▪ Sump and flare pits should be managed to minimise the environmental impact of such facilities. The Authority recommends these be lined with a High density Polyethylene (HDPE) liner with a minimum thickness of 2mm. The hazard and consequence classification for seismic activities, line surveying (second row) should also include the consequence of contamination to soil and surface water. These amendments should be made in the EIR, the EIR reviewed thoroughly accordingly and the amendments subsequently addressed in the SEO.	The construction of sumps is covered in Section 3.3. of the EIR which states "Drilling muds used will be water-based and non-toxic or low toxicity and the sump will not be lined unless the well site is in an area where very shallow aquifers are present." Flare pits are generally not lined with HDPE due to the high levels of heat that can be generated. In sandy soils the flare pit may be lined with clay, particularly if there is a likelihood of carry-over of liquid hydrocarbons. There is a low likelihood of hydrocarbon carry over from UCG or CSG wells. Not applicable to the drilling EIR Acknowledged
24.	EPA	EIR Section 3.6.1 Initial Restoration – if water from the turkey's nest is likely to be contaminated with hydrocarbons or other listed pollutants (see Part B Schedule 1 of the Environment Protection Act), it should not be transferred into the mud sump; rather this material should be removed by a licensed waste contractor. Alternatively it may be allowed to evaporate & the remaining residue removed by a licensed waste contractor prior to recovery of the HDPE liner.	The turkey's nest dam is used for the storage of clean drilling water and would not contain hydrocarbons. All drilling fluids including muds and water are generally disposed of to the drilling sump or tank, in accordance with standard industry practice. It is acknowledged that petroleum exploration drilling muds may contain low levels of hydrocarbons (if they are encountered during drilling) however this is not likely for CSG or UCG drilling. Drill stem tests or initial production tests may also produce low volumes of formation water, which are typically disposed of to the drilling sump after passing through a separator tank. Some hydrocarbons may remain in this water after separation, however this is again not likely for CSG or UCG drilling.

No.	Agency or Individual	Issues Raised or Comments Made	Response
			At the conclusion of drilling operations the sump is permitted to dry out and is then backfilled and the site reinstated. The residue in the sump is not removed as it is both impracticable and costly to remove. As indicated in section 5.3.5 of the EIR, the risk of soil or shallow groundwater contamination associated with the accepted industry practice of disposal of these fluids to the unlined earthen drilling sumps has been previously evaluated and is considered to be low. The presence of fine bentonite clays (which allow the formation of a relatively impervious mud cake in the base of drilling sumps) and the low effective toxicity associated with drilling additives are the basis for the utilisation of bury and cover techniques.
25.	EPA	EIR Section 3.7.2 Waste Management – The Authority would like to make SAPEX aware that the disposal of any waste water from campsite kitchen facilities etc are not to be disposed of within a drilling mud sump (if a sump is used rather than a preferred mud tank.) Only drilling mud and water from drilling activities should be disposed of within this infrastructure. All other waste waters must be collected and removed from the site by a licensed waste transporter for appropriate disposal.	Acknowledged. Standard industry practice prevents the mixing of drilling fluids and domestic waste water. Campsite waste water management facilities will be maintained separately to the drilling facilities. Refer to comments on EIR Section 3.2.4 above regarding the disposal of waste water from campsites.
26.	EPA	EIR Section 3.7.3 Fuel and Chemical Storage – This section does not adequately address the risk these materials pose to the environment and their proposed method of storage and management to minimise those risks. The Authority considers this information as a vital inclusion within the EIR and provides the following information in relation to its requirements: ▪ Liquid storage facilities must be constructed in accordance with the EPA Guideline 080/04 Bunding and Spill Management. ▪ Appropriate and adequate spill management material must be adjacent to all liquid storage facilities and areas that liquids are utilised in order to effectively and efficiently clean-up any spills that may occur. ▪ Staff and contractor training in spill management must be provided. These amendments should be made in the EIR, the EIR reviewed thoroughly accordingly & the amendments subsequently addressed in the SEO.	The risk posed by these materials and required management measures are dealt with in Sections 5 and 6 of the EIR and under Objectives 4 and 6 of the SEO. In particular: ▪ EIR Section 6.6 *Fuel and Chemical Storage and Handling* states that "fuel, oil and chemicals will be stored in bunded areas in accordance with appropriate standards, including AS 1940 and EPA guidelines" and the SEO (Objective 4 "Guide to How…") specifically refers to EPA Guideline 080/07 *Bunding and Spill Management.* ▪ EIR Section 6.6 and SEO Objectives 4 and 6 ("Guide to How…") state: "Appropriate spill response equipment is available on site". ▪ Training in spill management is implied by EIR Section 6.9.1 however a specific reference has been added to EIR Section 6.6. and SEO Objectives 4 and 6 (in the "Guide to How…").
27.	EPA	SEO This document should be reviewed in line with the recommended amendments for the EIR. Additionally the following should be reviewed: ▪ All references to Fuel and Chemical Storage and Handling should	Acknowledged. SEO has been amended accordingly (added to Objective 4 and 6 "Guide to

No.	Agency or Individual	Issues Raised or Comments Made	Response
		include the provision of training of spill management procedures for all staff and contractors.	How…").

Abbreviations: EPA – Environment Protection Authority; DEH – Department for Environment and Heritage; DTEI – Department for Transport, Energy and Infrastructure; DWLBC – Department of Water, Land and Biodiversity Conservation.

Note: No issues were raised by the following stakeholders:

- Planning SA
- Aboriginal Affairs and Reconciliation Division, Department of Premier and Cabinet