Officer Basin Energy Pty Ltd

PELs 81 and 253
Environmental impact report: geophysical operations in the Officer Basin, South Australia

Officer Basin dune system

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1 SUMMARY

An environmental impact report (EIR) for Officer Basin Energy Pty Ltd's (OBEPL) geophysical operations within Petroleum Exploration Licenses (PELs) 81 & 253 in the South Australian region of the Officer Basin has been prepared in accordance with current legislative requirements. The EIR provides information on this area's physical, biophysical and social environment, together with a basic description of how geophysical operations are to be conducted in the region.

Geophysical operations carry inherent low environmental risks. An environmental risk assessment has been conducted for the various activities to establish the level of risk and consequence of these activities. These risks, together with the corresponding risk-minimisation strategies, are detailed for the various activities that occur during geophysical operations. These strategies will be employed from the planning phase through to the eventual post-operational rehabilitation of the areas impacted by these activities.

Based on this risk assessment, a list of environmental objectives will be compiled. This list will form the basis of the statement of environmental objectives (SEO).

The information contained in this document has been compiled from numerous datasets, reports of prior operations in the Cooper and Eromanga Basin region and knowledge of ongoing environmental monitoring of these earlier operations. As the Cooper, Eromanga and Officer Basins are all arid environments, it is considered that the impacts of operations are likely to be similar. Also included is information on the various aspects of the effects of geophysical operations on flora and fauna as well as scientific studies of the environment in the Officer Basin region and surrounds.

2 INTRODUCTION

This EIR has been constructed in accordance with the South Australian *Petroleum Act 2000* (the Act) and the *Petroleum Regulations 2000* (the Regulations) for the operations as described here within by Officer Basin Energy Pty Ltd.

2.1 Officer Basin Energy Pty Ltd

Officer Basin Energy Pty Ltd (OBEPL) is an Australian company wholly owned by Officer Basin Energy Inc., a Calgary-based private company and incorporated in Canada. OBEPL is the sole licensee and operator of petroleum exploration licences (PEL) 81 and 253. The Petroleum & Geothermal Group of the Department of Primary Industries and Resources South Australia (PIRSA) granted these exploration licences to OBEPL on June 25, 2007.

2.2 Location

PELs 81 and 253 are located within the South Australian sector of the onshore Officer Basin. The licence areas extend from the west of Coober Pedy and Marla in the north of the state to the border of the Mamungari Conservation Park (formerly the Unnamed Conservation Park). The majority of the Maralinga Tjarutja (MT) Lands and part of the Woomera Prohibited Zone are located within the licence areas. The licence areas can be seen in Figure 1 below.

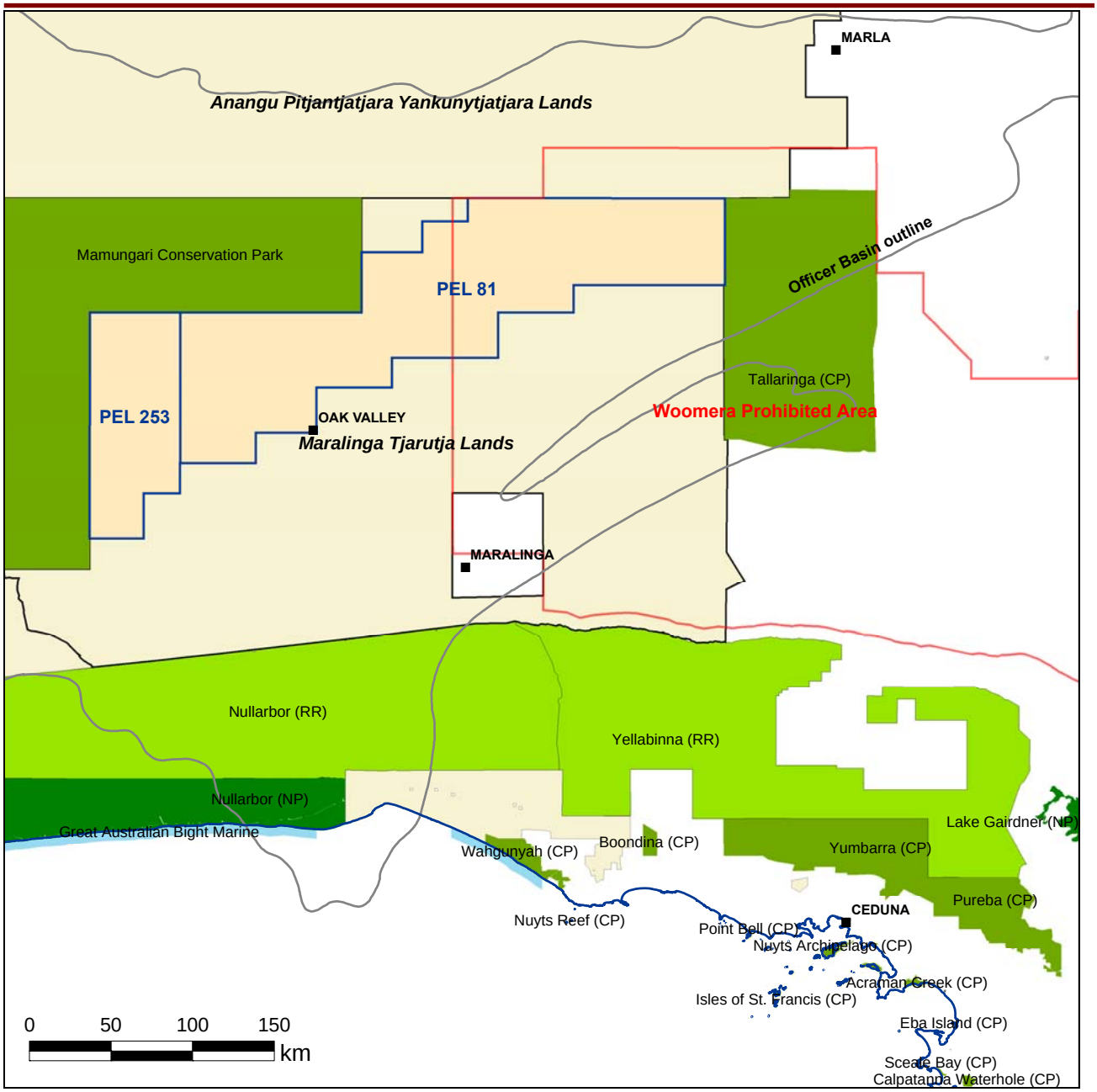

Figure 1 OBEPL licence areas, western South Australia.

2.3 Summary of petroleum exploration history

A comprehensive history of petroleum exploration in the Officer Basin region is contained in chapter 3 of the publication *The Petroleum Geology of South Australia Volume 3: Officer Basin* (Morton & Drexel 1997).

The search to date of the Officer Basin has been sparse and <7200 km of seismic data has been recorded and only 30 wells deeper than 500 m drilled. Only 12 of the ~70 drillholes are petroleum exploration wells of sufficient depth to enable the stratigraphy to be pieced together. Core and wireline logs from mineral, groundwater and stratigraphic drillholes, especially in the east of the basin, provide useful data. Wildcat exploration has been limited but the potential of the region is such that it deserves more attention, especially given that the logistical problems and land access issues can be overcome. The current interest demonstrates that the Officer Basin is now regarded as having significant petroleum potential.

Petroleum exploration in the Officer Basin began in the 1960s, initially by Exoil, Conoco and Outback Oil. Seismic, aeromagnetic and gravity surveys were carried out and seven stratigraphic and two wildcat wells were drilled. Minor hydrocarbon shows were encountered in Denman 1 on the southern Murnaroo Platform. The Department of Mines and Energy (DME) continued sporadic exploration until 1979 when Byilkaoora 1 stratigraphic well intersected significant oil bleeds in the Observatory Hill Formation. Stimulated by this discovery, Comalco carried out extensive mineral and petroleum exploration from 1980-89, including over 2500 kilometres (km) of seismic (mainly weight-drop, see Figure 2), five wildcat wells and 20 deep mineral holes. Drillholes were extensively cored and most had wireline logs; however they were of poor quality. Comalco exploration significantly improved understanding of the geology and petroleum potential of the northeast Officer Basin. Amoco briefly explored an adjacent area in the mid-1980s, carrying out 235 km of Vibroseis and tying Munyarai 1 to Ungoolya 1. In 1993, AGSO recorded a 550 km seismic transect (explosive source) across the Murnaroo Platform and Birksgate Sub-basin. In the same year, DME recorded 378 km of Vibroseis in the Marla area.

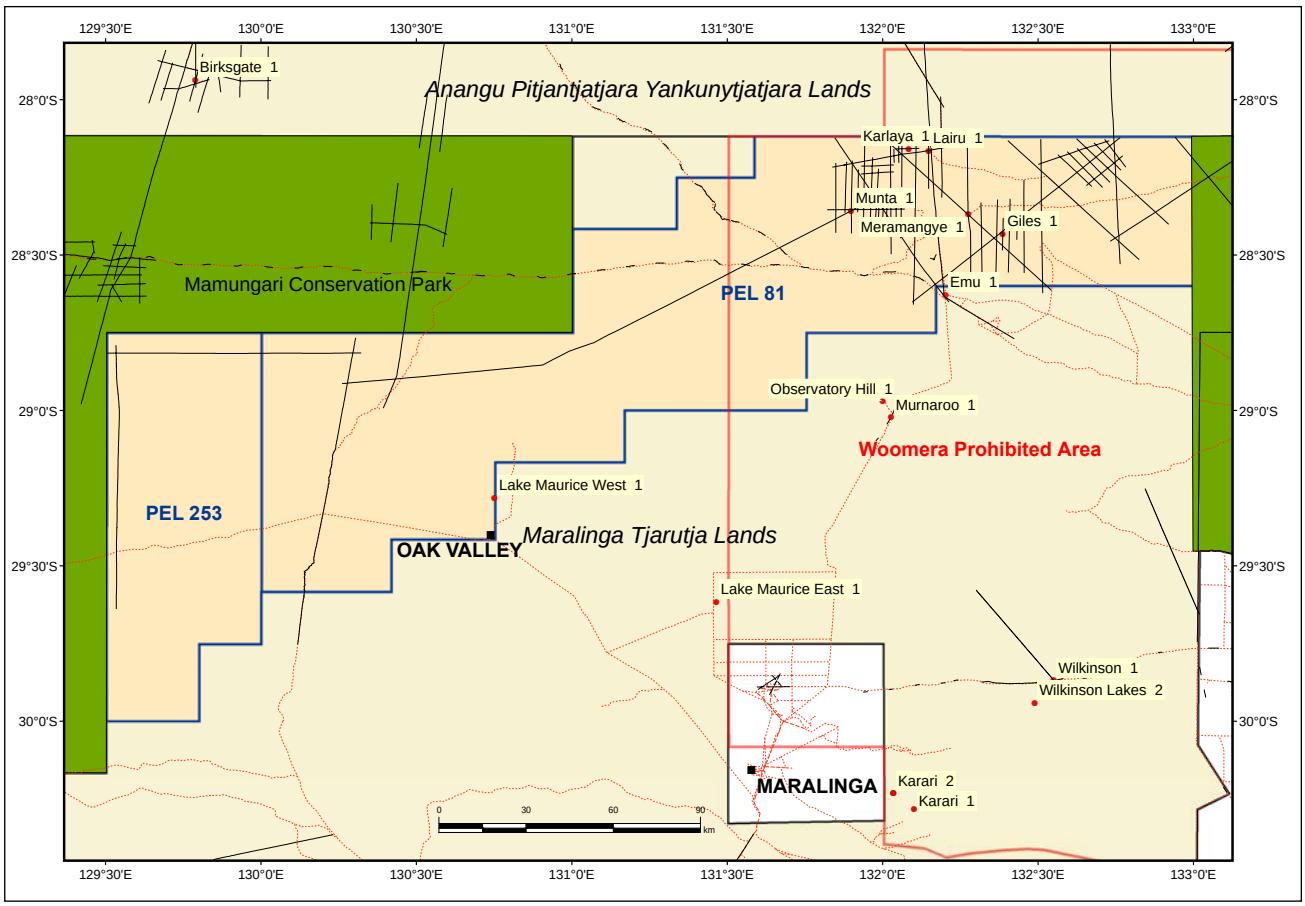

Figure 2 OBEPL licence areas, western South Australia.

2.5 Petroleum resource rationale

No commercial oil and gas production exists in the program area or the Officer Basin. Numerous shows of oil and gas have been recorded in government sponsored stratigraphic holes, mineral bores and shallow slimhole cored holes east of the program. These shows indicate the presence at some time of an active petroleum system that obviously generated significant volumes of oil. Hydrocarbon maturation studies have indicated that much of the Officer Basin is currently mature for the generation of oil (see

Table 1). Near the Musgrave Complex on the north side of the basin, the few drill tests that have been done indicate a section that is over mature for oil and potentially even over-mature for natural gas (Tingate and McKirby, 2003).

Table 1 Assessment of potential petroleum reserves by Officer Basin formations

Play	Probability that the ultimate potential will exceed the stated value million kilolitres (million barrels)					
	90%		50%		10%	
Arcoeillinna	3.3	(20.6)	10.8	(68.1)	27.8	(174.9)
Ouldburra	29.4	(185.1)	85.1	(535.5)	209.9	(1320.4)
Relief	6.3	(39.8)	30.3	(190.7)	95.0	(597.8)
Murnaroo	21.7	(136.7)	69.1	(434.6)	210.4	(1323.7)
Tarlina	18.6	(117.2)	63.7	(400.6)	186.1	(1170.7)
Pindyin	18.0	(113.2)	62.6	(394.1)	172.9	(1087.4)
Total	**236.4**	**(1486.9)**	**399.0**	**(2510.0)**	**674.0**	**(4239.6)**

Source: Morgan 1997

Resources of this magnitude are significant to address Australia's oil importation imbalance. Australia is presently estimated to be importing approximately 70% of its oil requirements.

2.6 Legislative outline

This document fulfils the requirements of an EIR for geophysical operations and has been prepared in accordance with current legislative requirements, in particular, with Section 97 of the *Act* and Regulation 10 of the Regulations. Additionally, the *Act* and Regulations require the development and implementation of a statement of environmental objectives (SEO). A SEO has been produced and is based on the information contained in this document. This EIR and the SEO were subject to a review through an appropriate consultation process (see Appendix 1). The comments and responses from the EIR and the SEO consultation are addressed in Appendix 2.

Relevant legislation is listed in Appendix 3.

3 LEGISLATIVE FRAMEWORK

This section briefly describes the legislative framework that currently applies to regulated activities in South Australia under the *Act*.

This EIR has been compiled in accordance with the *Act*, Regulations and in consultation with PIRSA and other relevant agencies.

3.1 Petroleum Act and Regulations 2000

The legislation governing onshore petroleum exploration and production in South Australia is the *Petroleum Act 2000* and *Petroleum Regulations 2000*, proclaimed September 25th 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; and
- 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 co-operatively 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) a naturally occurring underground accumulation of a regulated substance; or
(b) a source of geothermal energy; or
(c) 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:

(a) petroleum; or
(b) hydrogen sulphide; or
(c) nitrogen; or
(d) helium; or
(e) carbon dioxide; or
(f) any substance declared by regulation to be a substance to which the *Act* applies.

Regulated activities, as defined in section 10 (1) of the *Act*, are:

(a) exploration for petroleum or another regulated resource; or
(b) 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; or
(c) production of petroleum or another regulated substance; or
(d) utilisation of a natural reservoir to store petroleum or another regulated substance; or
(e) production of geothermal energy; or
(f) construction of a transmission pipeline for carrying petroleum or another regulated substance; or
(g) operation of a transmission pipeline for carrying petroleum or another regulated substance.

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.

PIRSA, Ecos and Santos have developed generic SEOs for the following regulated activities. The content of this document have been influenced by the content of these SEOs and their companion EIRs.

- Statement of environmental objectives for seismic operations in the Otway Basin; South Australia (Kane 2007).
- 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).
- South Australian Cooper Basins Operators' Statement of environmental objectives: drilling and well operations (Santos 2006b).
- South Australian Cooper Basin Operators' Statement of environmental objectives: geophysical operations (Santos 2006c).
- Statement of environmental objectives for seismic operations in the Cooper and Eromanga Basins, South Australia (Cockshell, 1998).

3.2 Environmental impact report

In accordance with Section 97 of the *Act*, OBEPL must:

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

As per Regulation 10 (1) of the *Regulations*, the EIR must include:

(a) a description of the regulated activities to be carried out under the licence (including their location); and

(b) -

(i) 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; and

(ii) 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); and

(iii) if required by the minister — a prudential assessment of the security of natural gas supply; and

(c) a description of the reasonably foreseeable events associated with the activity that could pose a threat to the relevant environment, including-

(i) information on the following:

(A) events during the construction stage (if any), the operational stage and the abandonment stage; and

(B) events due to atypical circumstances (including human error, equipment failure or emissions, or discharges above normal operating levels); and

(ii) information on the estimated frequency of these events; and

(iii) an explanation of the basis on which these events and frequencies have been predicted; and

(d) an assessment of the potential consequences of these events on the environment, including;

(i) information on the following:

(A) the extent to which these consequences can be managed or addressed; and
(B) the action proposed to be taken to manage or address these consequences; and
(C) the anticipated duration of these consequences; and

(ii) an explanation of the basis on which these consequences have been predicted; and

(e) a list of all owners of the relevant land [see Appendix 1]; and

(f) 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.

3.3 Assessment and approval

Once the EIR and draft SEO are submitted, 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 are subjected to a process of internal government consultation on the EIR and draft SEO prior to approval. For medium impact activities, the EIR and draft SEO are subject to a public consultation process, with comment sought for a period of at least 30 business days, while 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 Environmental Register is accessible to the community from the PIRSA website.

4 EXISTING ENVIRONMENT

The Officer Basin is a large, deep east-west orientated basin comprised predominantly of sandstone, but also of siltstone and shale and, to a lesser extent, limestone and halite (salt).

The Great Victoria Desert is the dominant landform in both the South Australian and Western Australian sectors of the Officer Basin. The Great Victoria is the largest Australian desert and according to most sources it is approximately 424,400 km^2 (163,900 $miles^2$) in size. If this figure were correct, the Great Victoria Desert would be the eighth largest desert in the world. However, other sources estimate its size at 348,750 km^2 (134,655 $miles^2$) and 250,000 $miles^2$. If the last figure were correct, the desert would be the third largest in the world, after the Sahara and the Arabian Deserts.

The Great Victoria Desert is an extremely arid region of uniformly dry climate. A small southwestern part of the Basin encroaches onto the Nullabor Plain, which has a similar dry

and uniform climate to the rest of the basin. The area of the proposed seismic program contains a limited range of land systems that are defined by geological, geomorphologic, aeolian and hydrological influences.

This section provides an outline of the Officer Basin's regional climatic conditions, biophysical and social environments, including indigenous heritage, and land use. It should be noted that the collection and documentation of flora and fauna in the South Australian sector of the Great Victoria Desert has been patchy and sparse. Consequently, status and habitat requirements for some species within the area are poorly understood.

Landsat (Figure 3) and topographic (Figure 4) depictions of the area can be seen below. Land unit associations are sourced from Laut et al (1977).

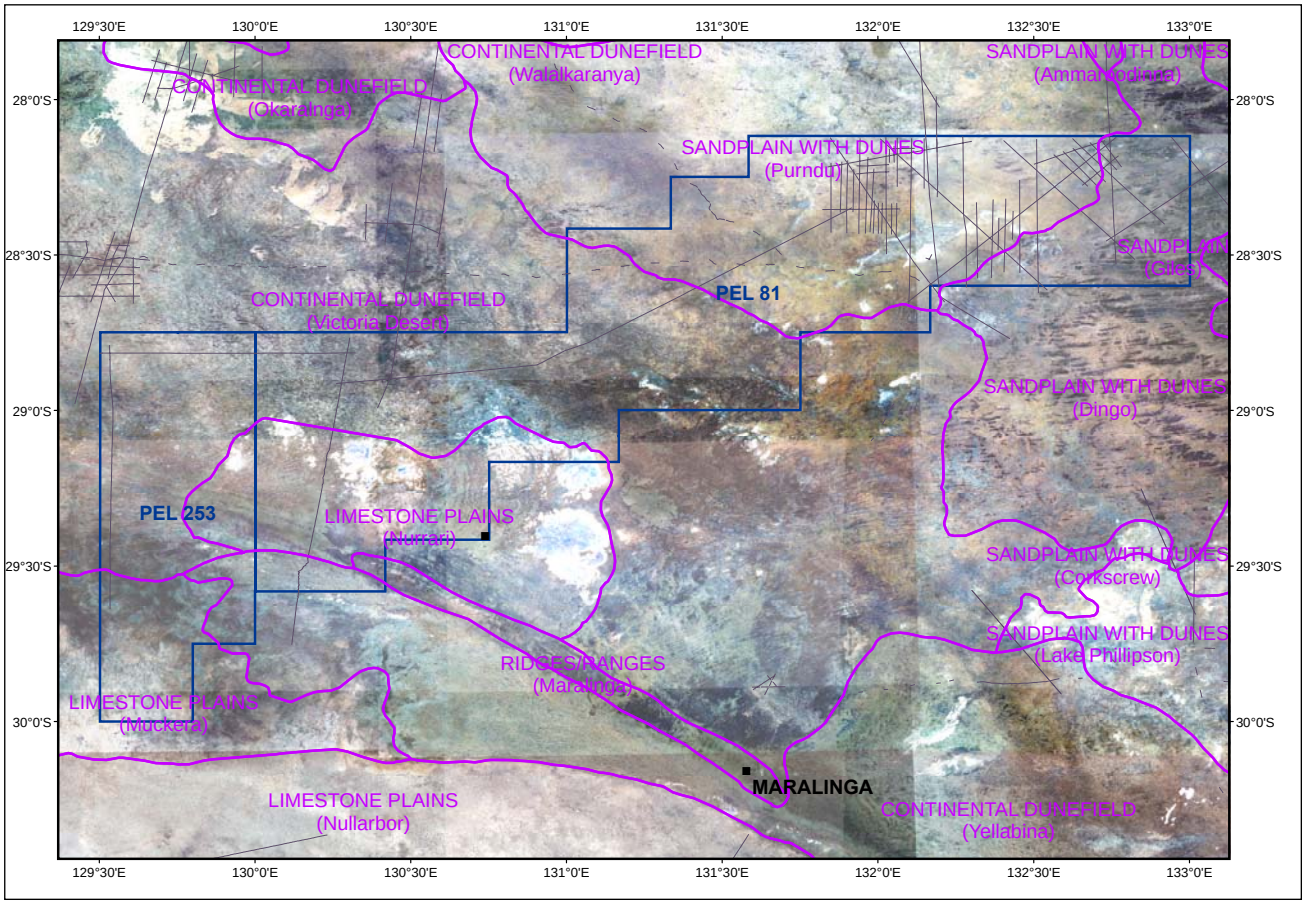

Figure 3 Landsat imagery with land unit associations of the Officer Basin.

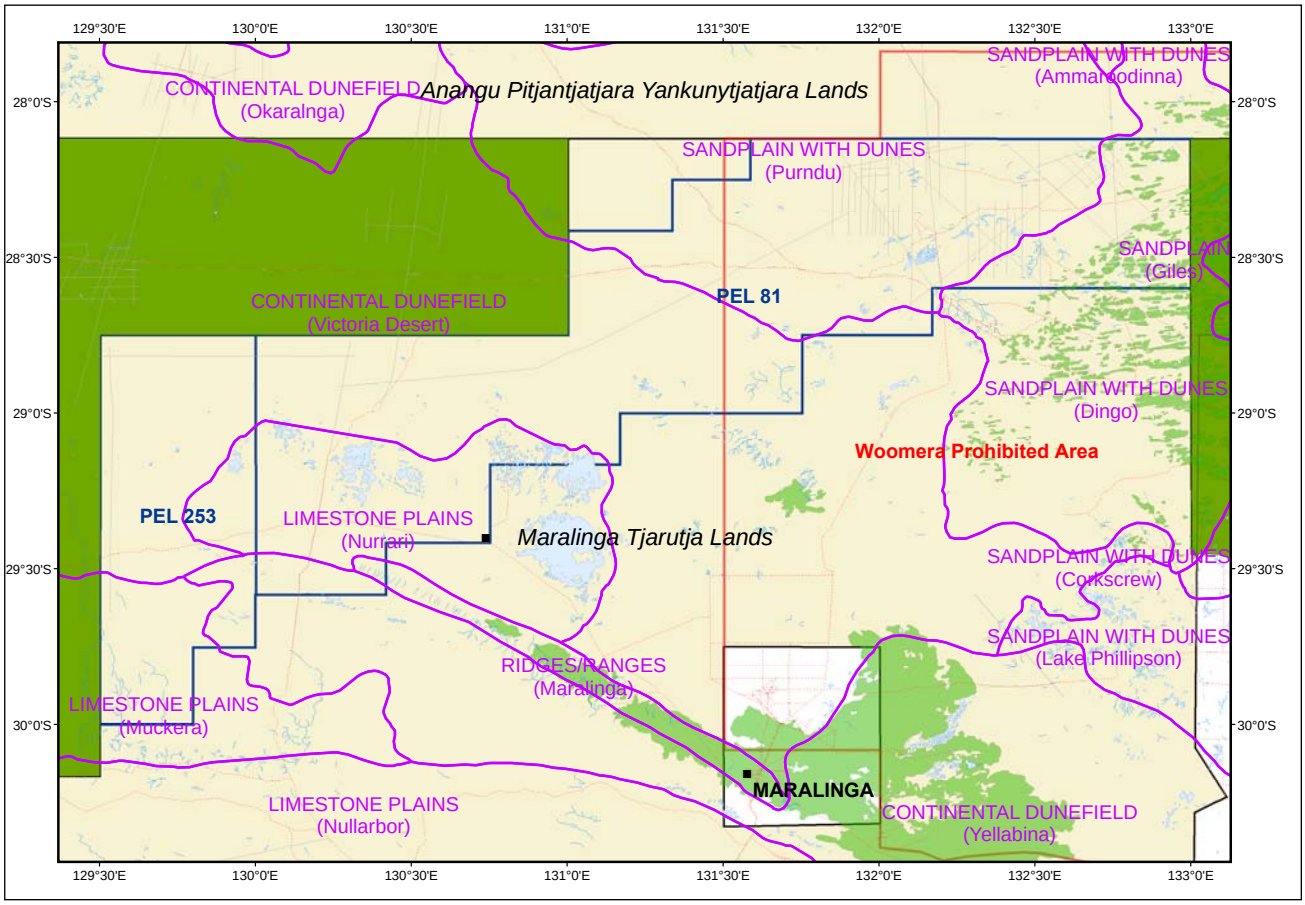

Figure 4 Topographic map with land unit associations of the Officer Basin.

4.1 Climate

Climate data for the survey area has been sourced from data recorded at weather stations located around the desert periphery, such as Maralinga, Giles, Ernabella, Ceduna, Coober Pedy and Cook (Shephard 1995).

There is considerable daily and seasonal variation in temperature. Winter daytime temperatures are mild to warm. The normal range is 18 to 23^{O} C (64 to 75^{O} F). Winter does not last long and by late September temperatures are generally hot again. The extreme south records a few colder days each winter as it is affected by frontal activity. Frost is by no means rare, and in parts of the Great Victoria Desert even common. Night temperatures may drop to around or below freezing point in winter also. Summer daytime temperatures are hot. People normally avoid travel during summer as the area is remote, the roads are four-wheel drive tracks only and there is very little surface water. People have died in this region after their vehicles have broken down.

The mean annual rainfall of the Great Victoria Desert is officially classed as low (ranging from 150mm in the south to 200 mm in the north). However, in a practical sense, the desert's rainfall is unpredictable, erratic and highly variable from year to year. Rain in the Great Victoria Desert comes from three main weather patterns. Winter rainfall is associated with frontal activity across southern Australia, while summer rains may occur from either isolated thunderstorms or rain bearing depressions. The latter rains tend to be heavy. Finally, thunderstorms are surprisingly high in many of the desert regions of Australia although such events are isolated and unpredictable.

Mean annual evaporation rates are high and vary from 2.5 to 3 metres in the southern part of the desert to near 4 metres on the desert's northern edge.

4.2 Biophysical environment

The major land systems in the proposed project area of the Officer Basin are:

- dune fields;
- playa (salt) lakes; and
- plains – stony surfaces.

Each of these land systems has its own unique physical features representing geology, landform, soils, hydrology, flora and fauna. The different land systems are described based on geology, landform and soils. Climate has been described previously while flora and fauna are discussed in the following sections.

4.2.1 Dune fields

The dune fields of the Great Victoria Desert dominate the program area and are the greatest obstacle to conducting the proposed program due to the dune size, composition and extent. One of the best descriptions of the dune fields of the Great Victoria Desert is published in Greenslade et al (1986) and follows below.

> *"The dune system of the Great Victoria Desert is one of the largest in Australia. The dunes are of the longitudinal type. In plan appearance they comprise a dune ridge which is often elongated for many kilometres in the general direction of the influential wind. The dunes of the survey area in general tend west-east although in some areas a considerable variation in alignment within a few degrees from east does occur, due to the underlying topography. The influence of topography is clearly evident along the Maralinga Rise where rising ground results in convergence and considerable modification of the alignment of dunes. Although the dunes are generally aligned parallel with one another, and separated by corridors, they are frequently joined in Y-junctions, with the V part facing upwind. The distance separating dunes varies considerably. In general, interdune corridors are 300-500 m apart, taller dunes having the wider corridors.*
>
> *In cross section, the dunes are composed of a broad plinth below a single narrow crest, although two crests are also common. The base of the plinth is generally no more than 100 m wide. In height the dunes vary between 2 - 20 m. Sand drifts along the dune crest are common; the drifts observed being small with occasional large drifts that partially bury shrubs and trees. Few drifts were seen on the dune plinths which were characteristically well-vegetated and stable. Lichens, which in some places covered large areas of the dune surface, contribute to this stability. Most of the dunes are red in colour due to hematite staining of the sand grains; very occasionally dunes composed of white sands were encountered.*
>
> *Recently Wasson & Hyde (1983) quantified variables regarded as important for the development of dune types and concluded that sand availability was a very important factor and that longitudinal dunes occur where there is little sand and winds are variable. An 11 year record of wind data is available for Maralinga, approximately 70 km southeast of the program area. "*

Extensive surface exposures of calcrete and silcrete materials occur in the program area. These are shown on geological maps and are frequently seen exposed within interdune corridors and in places forming extensive undulating dune-free surfaces several kilometres in length. Graphical representations of dune systems are seen in Figure 5 and Figure 6.

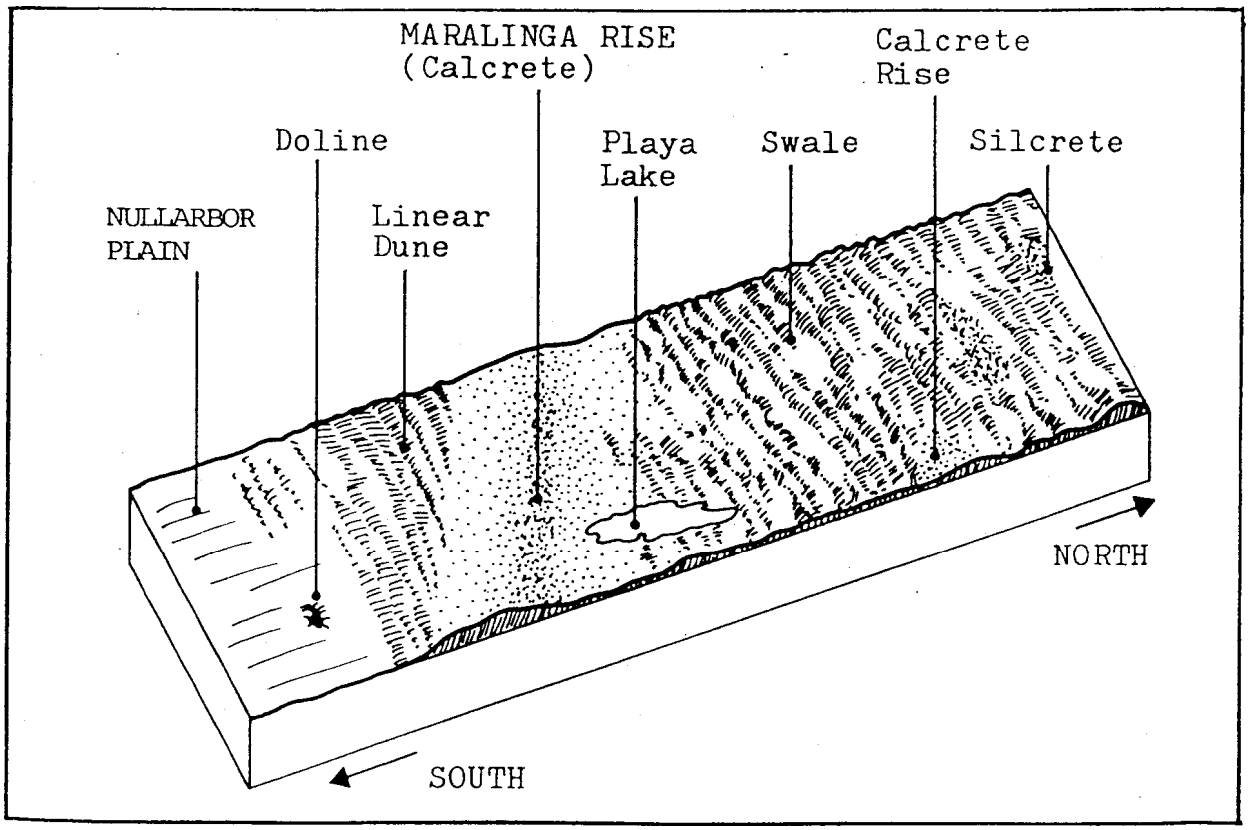

Figure 5 North-south surface section through the western program area

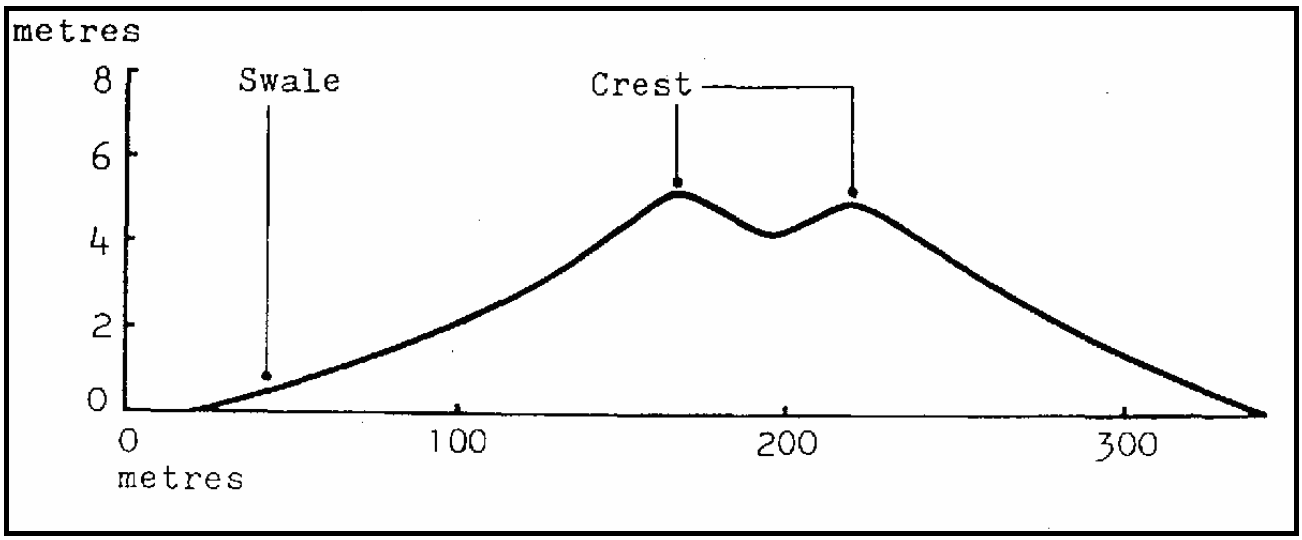

Figure 6 A typical profile of Officer Basin dunes

4.2.2 Playa lakes

Playa-lake systems in the desert include the Nurrari and Wyola Lakes and Lakes Dey-Dey and Maurice. The exposed surface of these lakes generally consists of dry clay, silt or sand, veneered with a salty or gypsiferous crust. Many playa lakes have lee-side dunes

(lunettes) on their eastern margin. Small claypans and salinas may also form in interdune corridors as a result of ephemeral runoff from dunes.

4.2.3 Plains – stony surfaces

Extensive surface exposures of calcrete and silcrete materials occur in the Great Victoria Desert region. These are shown on geological maps and can be seen exposed within interdune corridors and in places forming extensive undulating dune-free surfaces several kilometres in extent. Ferritic nodule spreads appear to be less widely distributed. Silcrete generally occurs as stony gibber spreads. Stones are in most cases angular and varnished, 2-8 cm in diameter. An intact silcrete layer has been reported near Observatory Hill. Two forms of calcrete occur in the survey area, banded and pisolitic, with banded calcrete being the most common. Calcrete pisolites have been observed south of the Bringyna Native Well). Calcrete is widespread and bluebush indicates that calcrete is present.

A representation of this system can be seen in Figure 7 below.

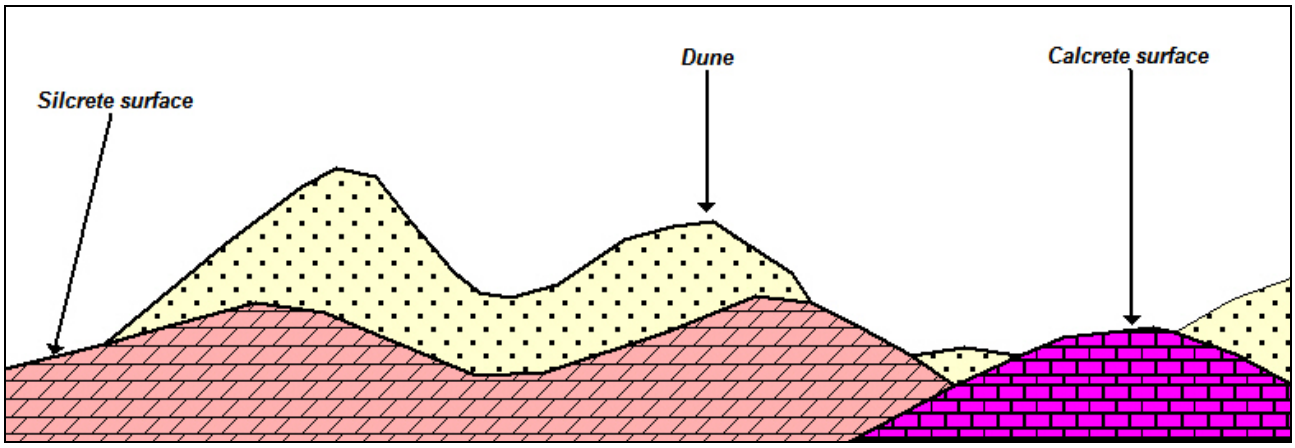

Figure 7 Complex relief formed by a combination of calcrete, silcrete and dunes, typical in some parts of the Officer Basin

4.3 Flora

The landscape is comprised of flats, hard flats, sand flats and dunes. Most of the vegetation consists of woodlands and shrublands with a grass understorey. Native flora is associated with each of the named areas and is listed below. As a consequence of no pastoral industry being established in the area very little exotic flora has been introduced.

The flats support Mulga (*Acacia aneura var.aneura*), Narrow-leaved Hopbush (*Dodonaea viscosa ssp. angustissima*) and Emubushes (*Eremophila spp*.) with an understorey of Bandicoot Grass (*Monachather paradoxa*) and Kerosene/Mulga Grass (*Aristida contorta*).

The hard flats support Mulga (*Acacia aneura var.aneura*), Rock Emu-bush (*Eremophila freelingii*) and Tar Bush (*E. neglecta*) with an understorey of perennial grasses such as Needle-leaved Threeawn (*Aristida capillifolia*), Cotton Grass (*Digitaria brownie*) and Neverfail Grass (*Eragrostis setifolia*) and annual grasses such as Kerosene/Mulga Grass (*Aristida contorta*) and Spear Grass (*Stipa spp*.). Small swampy depressions support dense Mulga (*Acacia aneura var.aneura*) Woodland, with Emu-bushes and Sennas (*Senna spp*.). After the rains, Kerosene/Mulga Grass (*Aristida contorta*) and Round-leaf Parakeelya (*Calandrinia remota*) grow in abundance.

The sand flats support Marble Gum (*Eucalyptus gongylocarpa*), Mulga (*Acacia aneura var.aneura*), Narrow-leaved Hopbush (*Dodonaea viscosa ssp. angustissima*), Emubushes (*Eremophila spp*.), Bird's Eye (*Cassia spp*.) and Native Fuchsia (*Eremophila spp*.) with an understorey of Hard Spinifex (*Triodia basedowii*), Bandicoot Grass (*Monachather paradoxa*) and Kerosene/Mulga Grass (*Aristida contorta*).

The dunes (east west trending sand dunes) support Hard Spinifex (*Triodia basedowii*), Needlebush (*Hakea spp*.), Grevillea and Mallee eucalypts with a ground cover of Woollybutt (*Eragrostis eriopoda*), Woollybutt Wanderrie (*Eriachne helmsii*) and Tall Kerosene Grass (*Aristida holathera*) (Marla-Oodnadatta SCB 2002).

The interdune lows support Marble Gum (*Eucalyptus gongylocarpa*) and Mulga (*Acacia aneura var.aneura*) with an understorey of Hard Spinifex (*Triodia basedowii*), Kerosene/Mulga Grass (*Aristida contorta*) and Neverfail Grass (*Eragrostis setifolia*).

4.3.1 Significant flora species

A defined area search of the Commonwealth Department of the Environment and Water Resources' database identified Austrostipa nullanulla (Club Spear-grass) as being as being a threatened species in terms of both the *Commonwealth 1999 EPBC Act* and *State 1972 NPWS Act* that could occur in the area.

4.4 Fauna

Even though there is a lack of available water sources, the dune fields (which are the dominant land form in the survey area) provide an important habitat for a range of wildlife including a variety of birds (Appendix 4) mammals (Appendix 5) and reptiles (Appendix 6).

Exotic fauna in the survey region are predominately mammals and include well established foxes (*Vulpes vulpes*), dingoes (*Canis lupus dingo*), cats (*Felis catus*) and camels (*Camelus dromedarius*) (Strahan 1995). Native mammals include the endangered sandhill dunnart (*Sminthopsis psammophila*), the endangered marsupial mole (*Notoryctes typhlops*), and the vulnerable mulgara (*Dasycercus cristicauda*) (Strahan 1995). Common species include the short-beaked echidna, fat-tailed dunnart and the spinifex hopping mouse.

Only native bird life is readily evident. The endangered chestnut-breasted whiteface (*Aphelocephala pectoralis*) is found in the eastern regions (Blakers *et al.* 1984, Brouwer and Garnett 1990, Hilton-Taylor 2000), the scarlet-chested parrot (*Neophema splendida*) has a large central population and the malleefowl (*Leipoa ocellata*) is vunerable and sparsely distributed throughout the South Australian portion of the bioregion (Morton *et al*. 1995). Amongst the most common species are the zebra finch *(Taeniopygia guttata),* budgerigar (*Melopsittacus undulates*), rufous whistler (*Pachycephala rufiventris*), hooded robin (*Melanodryas cacullata*) and brown falcon (*Falco berigora*).

Native reptiles are diverse and prevalent throughout the bioregion and include dragons (*Diporiphora linga*), skinks (*Lerista elongata* and *Lerista puncticauda*) and snake lizards (*Delma fraseri*). The dragons are considered endemic to the eastern portion of the bioregion (Morton *et al.* 1995). More than 100 species of reptile have been recorded and the notable reptilian predators are the perentie (*Varanus giganteus*) and Gould's goanna (*Varanus gouldii*) (Cogger 2000). Common species include the dwarf bearded dragon, (*Pogona barbata*), crested dragon (*Ctenophorus cristatus*), thorny devil (*Moluch horridus*),

fat-tailed gecko (*Diplodactylus conspicillatus)* and spinifex snake-lizard (*Delma butleri*) (Shephard 1995).

4.4.1 Significant fauna species

The following tables resulted from a defined area search of the Commonwealth Department of the Environment and Water Resources' database for matters protected by the *1999 EPBC Act*.

Endangered Species	Species Type	Type of Presence
Notoryctes typhlops Yitjarritjarri, Southern Marsupial Mole	Mammal	Species or species habitat may occur within area
Sminthopsis psammophila Sandhill Dunnart	Mammal	Species or species habitat may occur within area

Vulnerable Species	Species Type	Type of Presence
Dasycercus cristicauda Mulgara	Mammal	Species or species habitat may occur within area
Acanthiza iredalei iredalei Slender-billed Thornbill (western)	Bird	Species or species habitat may occur within area
Leipoa ocellata Malleefowl	Bird	Species or species habitat may occur within area
Egernia kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Reptile	Species or species habitat may occur within area

Migratory Species	Species Type	Type of Presence
Leipoa ocellata Malleefowl	Bird (Terrestrial)	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater	Bird (Terrestrial)	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Bird (Wetland)	Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Bird (Wetland)	Species or species habitat may occur within area

4.5 Social environment

The Officer Basin region has broad indigenous cultural and historical significance. Current land uses throughout the area include both cultural and natural environment conservation. The region remains generally undeveloped in terms of infrastructure and roads.

4.5.1 Aboriginal cultural heritage

The Maralinga Tjarutja (MT) people have occupied the region for up to 24,000 years (Shephard 1995) and were constrained by their arid environment to live a hunter/gatherer life style. This necessitated living in small family groups ranging over a large area to gather

food and using their long acquired knowledge to efficiently exploit the resources of their land.

The MT Lands are rich in both sites of both archaeological and spiritual heritage and there are examples of middens, artefact scatter and campsites. All personnel are to be made aware of the law and restrictions of the *Aboriginal Heritage Act 1988* and OBEPL and its contractors obligations under the land access and production agreement for petroleum exploration and production between OBEPL and MT.

4.5.2 General cultural heritage

The Maralinga sites are of particular social significance for two groups in the Australian community. The sites are the focus of concern by the Aboriginal people of the region who were denied access to sites of traditional significance, discouraged from a traditional lifestyle and movement across the area and who were dispossessed by the use of the range and may have suffered adverse health effects from exposure to radioactive contamination. For ex-service personnel and others employed at the range the sites are also of significance, especially for those who now regard themselves as nuclear veterans and believe that adverse health effects have resulted from their service during the test program. These sites are also of some social significance to the general Australian community. This aspect is reflected in the numerous books, films and press reports, both at the time of the tests and subsequently.

The Maralinga Village site has generally been cleared of buildings although numerous foundations and the road system remain. Only about five buildings and three water tanks remain and a few modern structures have been introduced. The airfield remains and was a major collection point for rainwater for the village; one building remains at the airfield. The Forward Area contains an extensive track network; minor relics from the period of use; other earthworks associated with the tests; firing pads from the minor trials; and plinths marking the major explosion sites.

4.5.3 Land use

MT owns the freehold title to the land and uses it exclusively.

4.5.3.1 Pastoral land use

There are no pastoral activities in the area of proposed activities.

4.5.3.2 Conservation

The region contains two conservation reserves. These are the Tallaringa Conservation Park and the Mamungari Conservation Reserve (formerly known as the Unnamed Conservation Park). It is prohibited to enter these reserves, and will be strictly enforced by both the operator and by PIRSA as the regulating authority.

4.5.3.3 Oil and gas production

There are no petroleum activities in the area of proposed activities apart from OBEPL itself. There are however several adjacent applications by other parties adjacent to the OBEPL licences.

4.5.4 Socio-economic

Apart from the MT community there are no other residents in the Maralinga Lands. Some tourism, principally 4WD travellers along the Anne Beadell Highway, which runs between

Coober Pedy and Laverton, is present. Some tourist activity occurs at Maralinga Village, with an increase expected as a visitor centre is planned for the site.

5 DESCRIPTION OF GEOPHYSICAL OPERATIONS

OBEPL has obligations with respect to all geophysical operations conducted within its petroleum exploration licences in the Officer Basin pursuant to the *Act*.

Section 5.1 of this report provides a technical description of specific components of typical seismic operations that are covered by this EIR and the accompanying SEO including line preparation, surveying, recording, uphole drilling/logging and restoration (Santos 2006a).

Other geophysical operations are much less intensive than seismic operations and involve much smaller crews and little line preparation. However, key aspects are still the traversing of ground by vehicles, personnel and equipment.

Cultural and heritage clearance because of its nature is not included in the SEO and EIR. This work precedes all geophysical activities. This work was commenced in early June 2007.

This EIR and SEO apply only to activities relating to post cultural clearance geophysical operations and are as follows:

- Establishment of photo monitoring sites on programmed lines and tracks.
- Line and access track preparation.
- Line surveying (starts just after line preparation.
- Recording (seismic).
- Campsites and associated supplies.
- Uphole drilling and logging (during or after recording phase, as and when required).
- Monitoring and auditing of selected locations (pre and post line preparation and post restoration).
- Line access track and campsite restoration where required (after completion of recording and uphole drilling/logging).

5.1 Description of seismic operations

The following description of seismic operations is sourced from the South Australian Cooper Basin Operators' EIR for geophysical operations (Santos 2006a).

5.1.1 Seismic method

Seismic data acquisition provides the explorer with the ability to 'image' below the surface and identifies areas where oil and gas may have accumulated. The seismic method uses vibrator energy sources which produce sub-acoustic sound waves, which travel into the earth and are then reflected from subsurface geological structures (see Figure 8). The returning reflections are recorded in a digital format and subsequently computer processed to produce a 'cross-section' of the sedimentary layers of the Earth's crust.

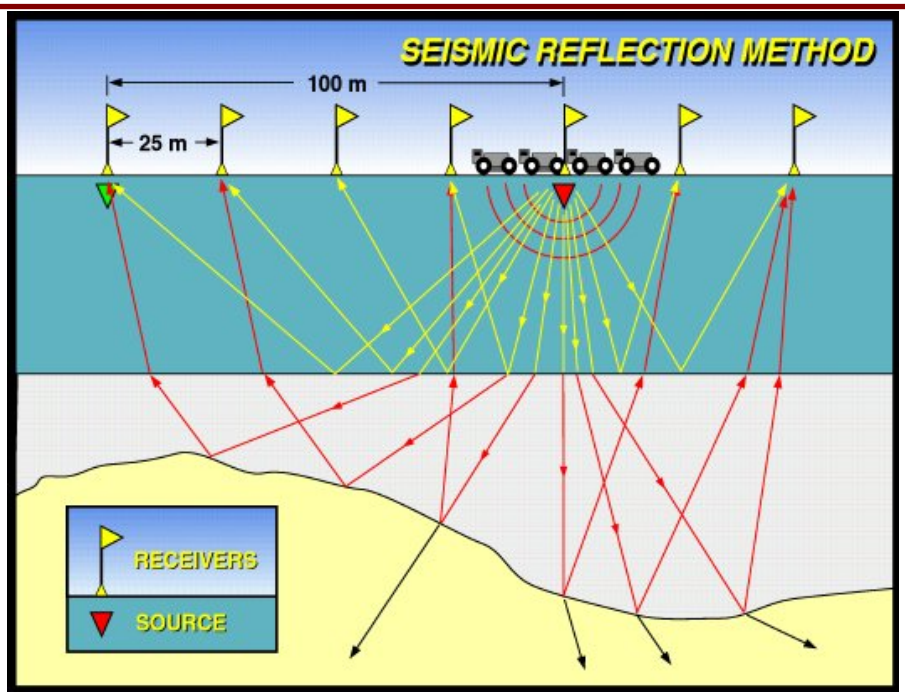

Figure 8 The principle of the seismic method

5.1.2 Planning

OBEPL uses available existing data to produce a seismic program. Gravity, magnetics, Landsat and existing seismic data are all used to this end. Environmental factors are also included while a cultural and heritage clearance report may also be used in the planning the location of seismic lines. This information will be collated by OBEPL to assist in planning a proposed survey.

As an example of planning, OBEPL have proposed a 2007 seismic program that is plotted onto topographic maps and high-resolution satellite images for these planning considerations. This proposed 2D seismic program comprises lines up to 100 km in length and spaced about 20 km apart.

Figure 9 below shows an example of the proposed line layout for the 2007 seismic program.

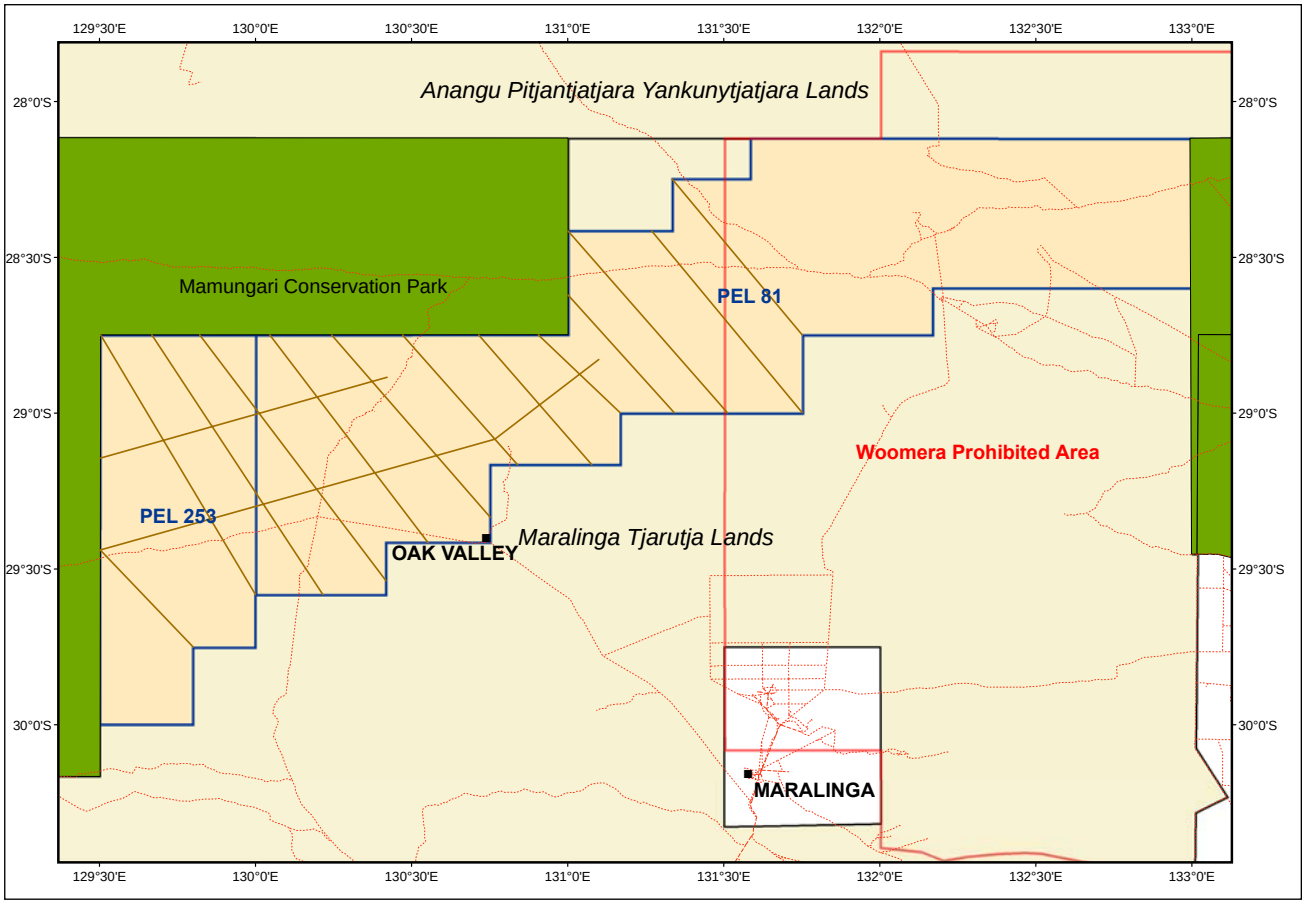

Figure 9 Map of the proposed seismic program in PELs 81 and 253.

5.1.3 Cultural heritage clearance

Whilst this is the first field activity to occur on a seismic survey, it is considered to be part of the planning process for the survey and thus is not covered by the *Petroleum Act 2000*. The personnel and vehicle requirements vary from project to project. Light 4WD vehicles are normally used and generally any of the vehicles pass only once over a given section of ground.

The results of the cultural and heritage survey provide the basis for a final program map that the line preparation contractor and seismic data acquisition contractors will use.

5.1.4 Line and access track preparation

Once the line positions for an entire project have been cleared by the cultural heritage group(s), the line preparation crew can commence work. This team operates from a central campsite. This site may be moved every few days. The camp, on average, accommodates 13 personnel (including surveyors) for 2D surveys and 17 for 3D surveys. The camp units are trailer mounted for easy mobility. Campsites are set up where possible on sites previously used or in areas naturally devoid of vegetation and always adjacent to any existing tracks to minimise impact on the terrain between the camp and tracks.

The line preparation crew usually operate simultaneously on different lines, characteristically using two D6 or D7 bulldozers for 2D surveys and four in 3D surveys. Daily production of prepared line is ~30 km and ~60 km respectively (i.e. 15 km/dozer), though this varies with terrain. The dozers will simply walk with the blade up in easily traversable terrain, with the marks of the tracks being sufficient for the surveyors to follow.

The line position and alloawable tolerances for weaving the line around vegetation etc, are pre-programmed into geographical positioning system (GPS) units housed in the dozers. These GPS units are kinematic dual frequency units that allow the dozer operators to get real time position fixes. These are plotted on a pilot display that also indicates the weaving tolerances for the dozer operators. The dozers weave around vegetation stands and on open ground the machines weave every 75-100 m to reduce visual impact.

Blade work is kept to a minimum and generally restricted to sand dunes and floodplain crabhole country. Grader work is likewise kept to a minimum. Graders are mainly used in floodplain crabhole country to smooth the tracks. A method successfully used has been the 'rill kill' attachment (coiled wire rope) fitted to the blades to minimise windrow development.

All machine operators are given environmental inductions at regular intervals. OBEPL have contracted MT to undertake the line preparation. MT will not require cultural heritage training. Dozer operators are required to keep a very close watch for cultural heritage sites that may have been missed during the clearance survey. Any additional sites discovered are flagged and detoured as above.

Any sensitive environmental features such as wetlands and salt lakes are prepared without the use of heavy machinery. Light brush cutting or slashing is used in the thick vegetation zones of wetland areas to prepare 1-1.5 m wide lines for foot or small vehicle access only. An example of this in an analogous land system in a different basin can be seen in Figure 10.

Figure 10 Line preparation showing weaving and minimal cutting.

This example is from the Eromanga Basin but demonstrates the line clearing techniques that will be adopted by OBEPL in the Officer Basin.

Access tracks are prepared to the same specification as the seismic lines.

A matrix of machinery use for the various landforms is shown on a scale of 0-5, where 0 represents zero application (low effort) and 5 represents more or less constant blading or slashing (high effort). The matrix can be seen in Table 2 below.

Table 2 Land system preparation requirements matrix

Landform	Dozer Blading	Grader work	Brush cutters/ slashing
Dunes	5	2	0
Dune corridors	1	1	0
Stony plains	0	0	0
Significant wetlands	0	0	4
Clay pans/salt lakes (no access allowed)	0	0	0
Creek crossing	2	2	1

5.1.5 Line surveying

Surveying commences shortly after line preparation. The field surveyors use real time kinematic GPS receivers to position receiver points only for 2D surveys. Surveyors insert metal pins with numbered plastic tags to indicate the points. Selected points are marked by with a wooden stake. Markers protrude about 0.3 m above ground level. All of these markers are removed on completion of the recording phase. Line detours are often marked with biodegradable flagging, which is also removed. Each survey team (one surveyor in a light 4WD vehicle) generally makes only one pass over any given section of line. Back tracking possibly occurs in areas where vehicle access routes have deviated from the true line position and markers have to be inserted on foot. Permanent markers or monuments will be established on all lines at a spacing of 5 kilometres.

5.1.6 Recording

Recording usually commences several weeks after the start of line preparation. This operation is the largest part of the seismic operation in terms of personnel and vehicles. A recording crew's strength would normally be 34 personnel and 16 vehicles for 2D operations. These figures vary with recording technique, terrain and season.

Work commences with the laying of cable and deployment of geophone bundles from light 4WD vehicles (see Plate 1). Geophone strings normally consist of 24 interconnected geophones and are dropped off at each receiver station. These strings are looped onto metal hangers for ease of handling. The geophones are then pulled off the hanger and planted in the ground by personnel on foot. Once planted, the string (typically 30 or 37.5 m in length to match the distance between receiver points) is connected to a 'take out' on the recording cable.

Plate 1 Light 4WD laying cables.

The recording cable is spooled out from the side of the vehicle and offset to one side of the line to prevent damage from following vehicles (see Figure 11).

Recording in 2D mode would normally commence when ~8 km of cable and geophones have been laid. This layout is termed 'the spread' and a pre-selected 'live' section of it

picks up the acoustic energy reflected from subsurface layers, converts it to electrical energy and transmits it to the instrument recording truck.

The instrument recording truck that collects, decodes and amplifies these signals, sets up at a suitable location ~100 m from the spread and connects to it. Once the instruments and spread have been satisfactorily tested, recording is ready to commence.

The acoustic energy source is normally an array of three or four truck-mounted vibrator units electronically synchronised to vibrate in phase with each other. They line up along a source line, a few metres apart, centred on a source point. Each unit, on command from the instrument truck, inputs one or more frequency sweeps into the ground at each source point. Each sweep lasts for several seconds. 3 or 4 seconds of reflected data are recorded. The source points are typically 30 or 37.5 m apart. On completion of one source point the set of vibrators quickly move to the next source point.

The live section of spread is ~4.5 km in length. This is the only part of the spread where signal is recorded for any given source position. The live spread is moved (controlled by the recording truck operator) as the vibrators move up. As spread becomes redundant behind the vibrators (back end of line) it is picked up and transported to the front end of the line. This cycle continues until the line is completed. The recording truck may move once or twice during the day to keep pace with the spread.

All operational vehicles (included vehicles engaged in any uphole drilling operations) stay on the prepared line. The exceptions being parked vehicles, spare vibrators, vibrator service truck and instrument truck, all of which have to park off line to avoid causing noise on the spread and interference with line traffic.

Along any single line the following vehicle passes can be expected to occur during normal operations:

Vibrators	1 pass for each truck
Instrument truck	1 pass
Light vehicles	15-20 passes in total
Vibrator service truck	1 pass

5.1.7 Camp sites and associated supplies –preparation and abandonment

There are generally only two campsites in operation: line preparation/survey camp and main camp. The former was briefly explained in the line preparation section. The main camp houses (see Plate 2) the recording crew, crew management team and the recording and mechanical back up teams. Campsites are sited on ground conducive to camping, but never on clay pans or salt lakes. Camps are located as near as practical to existing tracks or roads to avoid the need for clearance of native vegetation and subsequent disturbance to animal habitats. The campsite is located on a previously disturbed area wherever possible.

Plate 2 A typical main camp for seismic operations

2D seismic projects result in frequent camp moves but with tenure lasting only a few days. As the majority of these vehicles transit from camp to the adjacent road and back at least once per day, and some several times, the routes from camp are clearly defined to restrict wheel track impact.

Some campsites may require multiple access routes to minimise the potential of bull dust creation. Vehicles are restricted to the perimeter of the camp and parking areas are also defined. As water resources in the OBEPL license areas are scarse, water for the camp will be trucked in (most probably from Coober Pedy).

Wastewater from laundry, showers and kitchen is piped to a suitable area that is devoid of vegetation and is located no less than 50 metres from the perimeter of the camp. Food scraps are disposed of in accordance with the most appropriate procedure. Recyclable materials are segregated on camp and regularly transported to a designated licensed landfill site.

Campsites require the provision of systems for the management of sewage wastes, which must be managed in accordance with the *Public and Environmental Health (Waste Control) Regulations 1995*.

Drip trays are positioned at the refuelling bowser and mechanical workshop to eliminate fuel and oil ground contamination. Any chemicals are stored appropriately in accordance with South Australian Environmental Protection Agency (EPA) guidelines for "*Bunding and spill management June 2007*". Any uncontained spillage is chemically treated and the ground ripped. Once the campsite has been vacated, rehabilitation is undertaken, including ensuring no rubbish or other items are left in situ and, when necessary and terrain permitting, the area is tyne ripped to remove compaction and wheel tracks. Shoulders of adjacent formed tracks are reinstated.

5.1.8 Uphole drilling and logging

This component of seismic surveying consists of truck-mounted uphole drilling rig(s) and logging vehicle(s), plus support water tanker trucks when mud drilling. Examples of uphole drilling operations can be seen in Plate 3. The support camp may house six trailers or more. The rig normally drills 4¾ inch diameter holes that vary in depth from project to project. Most holes are in the 30–90 m range. Holes are drilled using mud, air or water injection as required. Below ground sumps are not used (NB In the case of the proposed OBEPL survey no uphole program is planned).

Plate 3 Drilling of upholes (left) and data logging (right).

Distance between upholes can vary considerably depending on operator requirements. Immediately as a hole is drilled the drill rig moves off and a logging vehicle moves in to record seismic measurements in the hole. This involves the lowering of a probe (down hole geophone) to the bottom of the hole and triggering a heavy weight that drops from the back of the truck to produce an acoustic impulse. The time it takes this impulse to reach the probe is recorded on a set of electronic instruments housed in the logging vehicle (usually a 4WD light vehicle). This process is repeated as the probe is gradually moved up the hole. A picture is thus built up of successive travel times through the near surface layers that provide information on their thickness and velocity - vital information for correcting the Vibroseis™ seismic data.

On completion of logging the drill cuttings are returned to the hole and the hole is capped. Surplus cuttings are then either spread to minimise visual impact or removed in the case of sensitive areas. In some areas, the colour of the cuttings is markedly different from the ground surface and spreading of cuttings exacerbates visual impact rather than minimise it. Removal of cuttings reduces this impact, but trials of adding colouring agent to the drilling mud may assist in this regard.

5.1.9 Line/access track and campsite restoration

The majority of seismic lines & access tracks and camp sites do not require restoration work as one of the main objectives is to prepare and utilise them in a way that will facilitate rapid natural recovery. However, instances that can give rise to restoration are:

- wheel ruts caused after wet periods;
- windrows not fully removed by grader rill kill;
- windrows removed at intersection of lines and public tracks;
- compaction of top soil at camp sites;
- public access tracks to be reshouldered where necessary;
- heavily trafficked routes between camp sites and nearest public track;
- access tracks that have turned to bulldust due to extensive seismic traffic; and
- water course channel infill and or natural flow restriction.

Normally a single dozer or grader or one of each is all that is required to carry out the restoration work. Methods used for rehabilitation include:

- ripping of compacted areas with bulldozer rear tynes;
- windrow material pushed onto line and smoothed;
- public road windrows reinstated;
- wheel rut material used to infill affected areas; and
- affected watercourse channels and creek banks reinstated.

5.1.10 Post-survey monitoring and auditing

Prior to, during and subsequent to geophysical operations, assessments (some voluntary) are to ensure that operations have been conducted in compliance with the SEO and any other regulatory requirements. These assessments can be implemented in a number of different ways.

The following briefly describes the method utilised successfully in recent years.

Prior to the commencement of any survey a number of environmental monitoring points (EMPs) are selected to give a balanced representation of the various landform and vegetation types encountered. The location of these points is subject to ground conditions such as flooded wetlands and salt lakes that cannot be accessed.

The EMPs are coordinated and marked with star droppers prior to the start of line preparation. Photographs are taken at these locations along the proposed line direction to give a view of the terrain prior to line-preparation. All photographs are optimally taken with a 50 mm lens for consistent comparison. The process is repeated after line preparation and again after recording. The EMPs are then photo-monitored over the ensuing four-year period (minimum) to give a visual representation of the recovery process. The revisit intervals are generally one year, two years and four years (eight years if further visits are deemed necessary).

Goal attainment scaling (GAS) audits, as defined and described in the SEO, are a mandatory requirement of the SEO and are conducted after recording on representative sections of line and at the environmental monitoring point locations. One person and one 4WD light vehicle normally complete both of these activities.

An example of the systematic operation of photomonitoring can be seen in Figure 11.

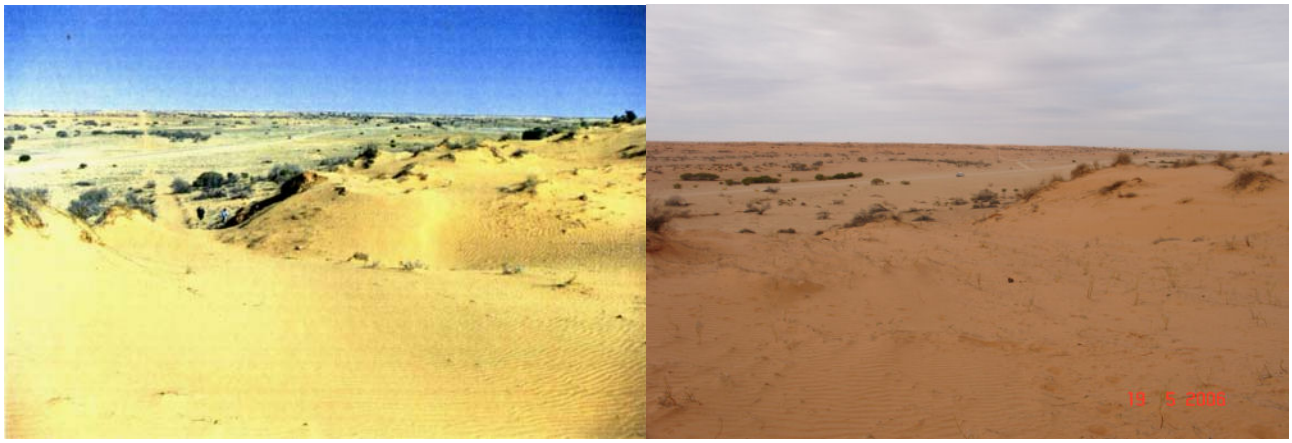

Figure 11 An example of the use of photomonitoring of specific locations
A dune cut immediately after recording and four years after recording

5.2 Other geophysical surveying operations

Other geophysical surveys do not have the same extent of operations as seismic surveying. Most use 4WD vehicles or are done on foot and involve taking some measurement along traverses, like 2D seismic traverses but more like activities involved in 'Line Surveying' as above. Measurements can be of a passive nature, such as measurement of gravity, magnetic or electromagnetic fields or involve input of some signal into the earth, such as small electrical or electromagnetic signals.

5.3 Current standard operating procedures used to minimise impacts

In order to mitigate the risk and potential impacts of geophysical operations detailed in this EIR and to achieve the objectives of the SEO, the following industry standard recommended procedures are detailed.

5.3.1 Terrain

In order to mitigate the risks and potential impacts of geophysical operations detailed in this EIR and to achieve the objectives of the SEO, the following recommended procedures are detailed.

5.3.1.1 Wheel tracks

- Where possible, existing tracks, roads or seismic lines are used for access.
- Off line driving for the main crew is banned. No bush bashing or short cuts are permitted.
- Campsites are positioned close to existing roads where possible.

5.3.1.2 Wheel ruts

- Operations are shut down during wet weather or flooding and only restarted once potential for extensive damage has passed.
- Unavoidable damage is reported and repaired on completion of work.
- No vehicles are allowed on salt lakes other than specialised low-pressure wide profile tyre vehicles.
- It is not proposed to traverse or otherwise work on playa lakes.

5.3.1.3 Compaction

- Following in previous off-line wheel tracks is banned.
- Unavoidable compaction is reported and ripped on completion of work, where appropriate.
- As few campsites as possible are used; the aim is to share existing sites if possible.
- Campsites are ripped if necessary on completion of work.

5.3.1.4 Erosion

- Blade work is banned on stony plains.
- Minimal blade work is permitted elsewhere e.g. sand dunes and crabhole floodplains.
- All windrows are removed either during or on completion of work.
- Dune side cuts are minimised.
- Removed sand is ramped to the side of dune cuts, as opposed to the base of the dune.
- Creek bank vegetation is left intact and detours sought if too dense to pass through.

5.3.1.5 Bulldust

- Susceptible tracks are avoided. If not possible then track is reinstated after rain.

5.3.1.6 Visual amenity

- Lines are prepared to a single blade width (only ~4-5 m).
- Lines are smoothly weaved at least every 75-100 m about the general line of traverse and stands of vegetation.
- Lines are doglegged at road and track crossings, preferably around vegetation.
- Dozers are walked with blade up wherever possible.
- Cuts are minimised at dune crests and base of dunes.
- Dune side cuts are minimised.
- Dune cuts are offset.
- No cutting is done on dunes adjacent to public roads.

5.3.1.7 Natural drainage

- It is noted that only very localised drainage exists in the area of operations.
- Any windrows or other disturbance to drainage patterns are removed.
- Camps should not be established near lakes.
- All windrows are removed either during or on completion of work.
- No blading in loose ferricrete plains.

5.3.2 Native vegetation

- Off-line driving is banned. No bush bashing or short cuts are permitted.
- Vegetation is removed only when absolutely necessary and is avoided by weaving lines through vegetated areas.
- Root stock, topsoil and seeds are left on line during line preparation.
- All vehicles are thoroughly cleaned to prevent the introduction of weeds into the survey area.

5.3.3 Native fauna/habitat

- Upholes are capped and backfilled to prevent injury or death to wildlife.
- No heavy line preparation machinery is used in wetlands areas.
- Natural drainage channels are left clear at line crossings.
- All vehicles are thoroughly cleaned to prevent the introduction of weeds into the survey area.
- Crew members will not keep camp pets.

5.3.4 Pollution

- Bunding is used to contain hazardous materials.
- No refuelling occurs outside designated refuelling/servicing areas.
- Spills or leaks of any kind are immediately reported and clean up actions initiated.
- Appropriate spill response equipment is available on site.
- Oil spills areas are ripped to an appropriate depth.
- Records of spill events and corrective actions are maintained in accordance with company procedures and are available for audit.
- Camp wastewater is disposed of in drainage channels to areas that are located away from locations where playa lakes may form.

- It is important that wastewater is not allowed to freely permeate the soil *(EPA 509/04 Guidelines)*.
- Wherever practical, biodegradable and non-recyclable rubbish should be transported to licensed waste facilities.
- All plastics, metals and other recyclable materials should be segregated and regularly transported to a licensed waste transport facility.
- Mobile chemical toilets are used on all camps,
- Degraded toilet waste is disposed in accordance with *Public and Environmental Health (Waste Control) Regulations 1995*.
- There is a zero tolerance rule with regard to markers and litter left in work area after completion.
- Drill cuttings are returned to upholes or removed for dump disposal.
- Vehicles travel at slow speed in the vicinity of any camps, dwellings or other populated locations.

5.3.5 Third party access

- No line preparation is carried out on dunes adjacent to public roads.
- Lines are doglegged at road and track crossings preferably using existing vegetation as a screen.
- Windrows/shoulders on public tracks are reinstated on completion of work.
- Lines adjacent to public roads may be blocked with timber as an access deterrent.

5.3.6 Cultural heritage

- Lines are cleared by appropriate MT representatives prior to commencement of line preparation.
- Sites of cultural significance are flagged and lines deviated around them.
- Line preparation personnel and crew supervisors (when required) will receive cultural heritage training prior to commencing work.

6 ENVIRONMENTAL HAZARDS AND CONSEQUENCES

This chapter identifies and assesses potential environmental hazards and their consequences resulting from geophysical operations in the Officer Basin. These are identified to enable assessment of environmental risks and as regulatory and management requirements (Section 7).

A hazard is considered to be any source of potential environmental harm, or a situation or event with potential to cause loss (Joint Australian/New Zealand Standard AS/NZS 4360:2004, Risk management). To identify hazards, the various activities associated with each stage of the seismic operation were considered along with the events that could lead to a hazardous situation. The possible consequences of such events were also identified and assessed. Hazards from other geophysical operations can be viewed as a subset of the seismic set.

Where possible, environmental hazards and potential consequences have been identified and assessed on the basis of existing information on the magnitude (e.g., quantity of waste) and/or frequency of activities associated with geophysical operations. However, this information is not available with regard to all activities and associated hazards. Where this is the case, environmental hazards and subsequent consequences have been identified on the basis of the experience of petroleum industry personnel.

6.1 Hazards

Based on available information, environmental hazards that have potential to result in the most prominent environmental consequences are identified as:

- earthworks associated with line and access track preparation and reparation;
- vehicle movement;
- seismic source activation;
- spills or leaks associated with storage of oil, fuels and chemicals, refuelling operations and high pressure hydraulic systems
- disposal of domestic and chemical waste; and
- uphole drilling.

6.2 Consequences

Key potential environmental consequences associated with the above hazards are:

- visual impact;
- contamination of soil, surface and/or ground water;
- soil erosion and disturbance to natural drainage patterns;
- soil compaction/disruption/deflation, wheel tracks, wheel ruts, bulldust generation, airborne dust;
- noise generation;
- loss of native vegetation and habitat;
- introduction and or spread of weeds, pest plants, animals and pathogens;
- disturbance, injury or death to native fauna;
- disturbance to Aboriginal and non-Aboriginal cultural heritage sites;
- damage to landholder infrastructure; and
- third party access to seismic lines.

6.3 Hazards and consequences by activity

The various seismic activities are tabulated in Table 3 indicating hazard and consequence classifications associated with each.

Table 3 Hazard and consequence classifications for seismic activities

Seismic activity	Hazard	Potential consequences
Line and access track preparation	Earthworks, vehicle movement, spills, excavations	Contamination of soil Site disturbance Loss of vegetation and habitat Soil erosion/disturbed drainage patterns Soil compaction/disruption/deflation, wheel tracks, dust Noise generation Damage to cultural sites Disturbance to native fauna Disturbance to stock Spread of weeds Visual impact Damage to landholder infrastructure Facilitation of third party access
Line surveying	Vehicle movement	Disturbance to native fauna Disturbance to stock Spread of weeds Risk to third parties
Recording	Vehicle movement, vibrator movement, spills	Contamination of soil Soil erosion/disturbed drainage patterns Soil compaction/disruption/deflation, wheel tracks, dust Noise generation Disturbance to native fauna Disturbance to stock Spread of weeds Visual impact Damage to landholder infrastructure
Campsites and associated supplies	Vehicle movement, spills, waste disposal, fire	Contamination of soil Loss of vegetation and habitat Soil compaction/disruption/deflation, wheel tracks, dust Noise generation Soil erosion/disturbed drainage patterns Visual impact Fire destruction of vegetation and habitat
Uphole drilling and logging	Spills, waste disposal, uphole drilling activity	Contamination of soil Soil compaction/disruption/deflation, wheel tracks, dust Noise generation Disturbance to native fauna Spread of weeds Visual impact Damage to landholder infrastructure Uncontrolled discharge or contamination of aquifers
Line and access track restoration.	Earthworks, vehicle movement, spills	Contamination of soil Disturbance to native fauna Spread of weeds Visual impact Damage to landholder infrastructure
Monitoring of selected locations	Vehicle movement	Soil compaction/disruption/deflation, wheel tracks, dust Noise generation Damage to landholder infrastructure

6.4 Access track preparation

Unlike the drilling and well operations and production and processing operations, the preparation of access tracks is not a normal practice for seismic operations. Access routes may be required in areas of no existing roads or previous seismic, well or production activity, but this normally does not require the same degree of preparation as for drilling operations.

Environmental hazards associated with access track preparation include movement of heavy vehicles, earthworks, vegetation clearance, spills associated with fuel storage and waste disposal. Moss and Low (1996) identified the following potential consequences resulting from hazards associated with access track preparation:

- erosion;
- compaction of soils;
- changes to the land profile;
- water diversion;
- visual impact;
- fauna impacts;
- dust;
- noise;
- spread of pest plants;
- damage or loss of vegetation and habitat;
- waste disposal; and
- site contamination.

These hazards and their associated potential consequences are discussed below.

6.4.1 Movement of heavy vehicles

Movement of heavy vehicles (e.g. trucks, graders and bulldozers) during preparation of the access tracks is an environmental hazard as there is a possibility that vehicles may inadvertently damage vegetation, generate dust and/or compact soil other than that which is required operationally if not appropriately managed.

The type and severity of potential impacts of preparation of access tracks and survey lines is dependent to a certain extent on the land system in which the activities are being carried out. Disturbance to soils in some land systems can lead to substantial erosion by water while other systems, such as dune fields, are generally more resilient and less likely to suffer any long-term impacts from soil disturbance (Fatchen and Woodburn 2000). Following an examination of 35 seismic lines that traversed dune fields in the Cooper Basin, SEA (1999) concluded that natural rates of erosion on dunes were not accelerated as a result of disturbance to the soil surface. Any sensitive environmental regions such as wetlands are prepared without the use of heavy machinery. Due to their instability and erosion potential when disturbed, any steep slopes and escarpments are avoided. The potential impacts of specific earthwork activities on different land systems in the Officer Basin are summarised in Table 4.

Table 4 Impacts associated with line/access track preparation in typical Officer Basin land systems

Land system	Preparation of survey lines/access tracks
Plains-stony fields	Damage or loss of vegetation and habitat Erosion Compaction of soils Visual impact
Dunefields	Damage or loss of vegetation and habitat Erosion Disturbance to cultural heritage sites (dune fields near waterholes are typically of high cultural significance)
Salt lakes	Not applicable (grading is not permitted on salt lakes)

6.4.2 Vegetation clearance

The clearance of vegetation during access track preparation cannot be entirely avoided. Such activity can result in loss of vegetation and faunal habitat, siltation of natural drainage lines and watercourses, destabilisation of creek crossings, weed invasion and damage to cultural heritage sites. Vegetation clearance may also impede the movement of fauna, particularly small mammals or reptiles across cleared areas (Moss & Low 1996).

During the preparation of survey lines and access tracks, particular care should be taken to ensure that minimal vegetation is cleared in heavily wooded areas. Campsites should be located at the nearest available naturally clear area.

7 ENVIRONMENTAL RISKS AND MANAGEMENT STRATEGIES

7.1 Risk assessment and management

An environmental risk is the chance that an environmental consequence will occur as a result of a hazardous situation or event (see section 6). Given appropriate management measures (i.e. those identified in Section 5), most risks can be avoided or reduced to a level that is as low as reasonably practical. This is a risk of something happening that is considered to have a minimal impact and which will recover. These parameters are defined within the goal attainment scaling system (as defined in the SEO). However, in some cases there may still be 'residual' risks that remain after management measures have been implemented.

Environmental risk assessment evaluates the level of environmental risk associated with various operations and activities and provides a framework for assessing risk management priorities and options based on the level of each assessed risk.

The main components of the environmental risk assessment process are illustrated Figure 12.

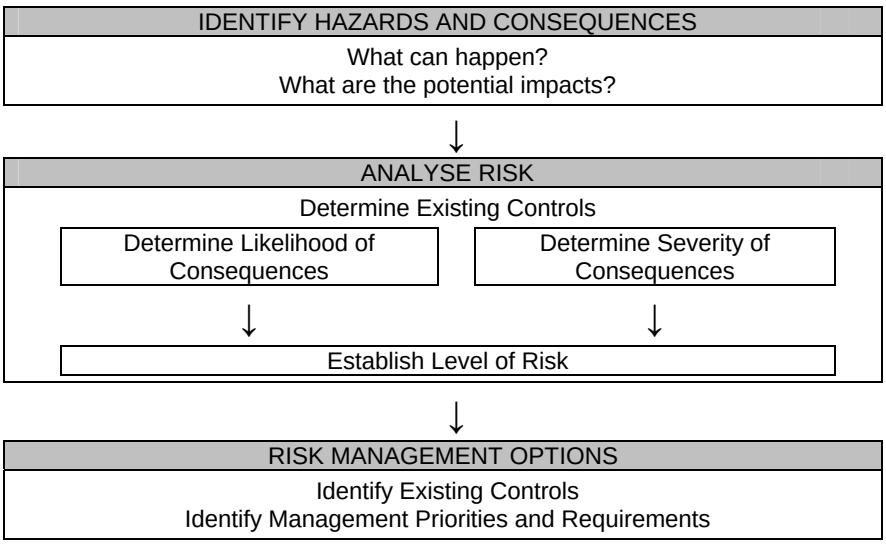

Figure 12 Framework for environmental risk assessment

Risk assessment may be undertaken to various degrees of refinement depending upon the information and data available. Where possible, the frequency and severity of potential environmental consequences have been assessed on the basis of existing information. However, this information is not available with regard to all activities and associated

consequences. Therefore a qualitative (i.e. descriptive) risk assessment process was considered to be the most appropriate method to adopt. This approach uses descriptive scales to describe the likelihood of consequences (i.e. virtually certain to virtually impossible) and their severity (i.e. negligible to disastrous) and has been derived from Stoklosa (1999) and the AS/NZS 4360:20004 Standard for risk management.

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

7.1.1 Environmental hazards and consequences

Primary environmental hazards and the key potential environmental consequences associated with geophysical operations in the South Australian Officer Basin are identified in Sections 6.1 and 6.2.

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. Seismic and other geophysical surveying has been undertaken in various sedimentary basins for many years. Hence, environmental hazards and existing management measures are well understood and, as such, both likelihood and severity of consequences can be confidently predicted based on operating experience and professional judgement, such as Fatchen and Woodburn (2000).

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.

7.1.1.1 Assessment of severity

Environmental consequences can be categorised from negligible to disastrous using the qualitative methodology described by Stoklosa (1999; see Table 5). These consequences are based upon definitions contained in AS/NZS 4360:2004, but have been expanded to incorporate impacts to environmental values such as flora, fauna and biomass.

Table 5 Severity of consequences

Severity	Qualitative description of environmental consequences
Negligible	Possible incidental impacts to flora and fauna in a locally affected land system but without ecological consequence.
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. Land system has a small amount of change but no long-term impact that will alter the terrain surface.
Major	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. Land system surface has changes that may cause long-term impacts.
Severe	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 terrain surface that will alter the terrain surface and drainage patterns.
Disastrous	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 impact upon the terrain surface and drainage patterns.

7.1.1.2 Assessment of likelihood

The likelihood of potential environmental consequences occurring was qualitatively assessed and categorised according to the criteria outlined in Table 6.

Table 6 Likelihood of consequences

Likelihood of occurrence	Qualitative description of exposure
Virtually impossible	Has almost never occurred, but conceivably could
Rare	Has occurred a few times worldwide
Unlikely	Not likely during operation lifetime
Likely	Likely to occur during operation lifetime
Virtually certain	Includes continuous emissions

Operation lifetime is relative to the geophysical operations. Companies are responsible for each geophysical program. For due diligence purposes, the life of a geophysical program for this report will be 10 years.

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 operations. Dependent on these factors, a general guideline is that the community should expect recovery from seismic impacts in South Australia after about five to ten 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 Environmental risk assessment

Severity and likelihood of consequences are combined to produce a level of risk for any given hazard.

Table 7 shows an environmental risk assessment matrix that compares likelihood and severity of environmental consequences arising from the operations. The severity of consequence is dependent on the receiving environment. However, in most cases this does not alter the risk matrix outcome.

The risk assessment described and detailed takes into account the mitigation methods and practice described earlier within this EIR.

Table 7 Matrix for the assessment of risk for petroleum exploration activities

			LIKELIHOOD OF CONSEQUENCE				
			1	2	3	4	5
			Virtually Impossible	Rare	Unlikely	Likely	Virtually Certain
SEVERITY OF CONSEQUENCE	E	Negligible Effect	LOW	LOW	LOW	LOW	LOW
	D	Minor Effect	LOW	LOW	MEDIUM	MEDIUM	MEDIUM
	C	Major Effect	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH
	B	Severe Effect	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH
	A	Disastrous Effect	MEDIUM	MEDIUM	HIGH	HIGH	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.

Table 8 Summary of impacts and risk levels for seismic operations

Activity	Hazard	Potential Consequence	Severity	Likelihood	Risk
Line & access track preparation	*Earthworks*	Loss of native vegetation and habitat	Minor	Likely	Medium
		Soil erosion and disturbance to natural drainage patterns	Minor	Rare	Low
		Noise generation	Negligible	Likely	Low
		Airborne dust	Negligible	Likely	Low
		Disturbance to native fauna	Minor	Rare	Low
		Introduction and spread of weeds, pests and pathogens	Major	Rare	Medium
		Visual Impact	Minor	Likely	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Impact &/or damage to significant Aboriginal sites	Major	Unlikely	Medium
		Third party access resulting in third parties getting lost	Minor	Rare	Low
	Vehicle movements	Introduction and spread of weeds, pests and pathogens	Major	Rare	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Airborne dust	Negligible	Likely	Low
		Fire damage to vegetation and habitat	Major	Rare	Medium
	Spills and leaks	Contamination of soil, groundwater, water courses	Minor	Rare	Low
Line Surveying	*Vehicle movements*	Introduction and spread of weeds, pests and pathogens	Major	Rare	Medium

Activity	Hazard	Potential Consequence	Severity	Likelihood	Risk
		Damage to landholder infrastructure	Minor	Rare	Low
		Impact &/or damage to significant Aboriginal sites	Major	Unlikely	Medium
		Airborne dust	Negligible	Likely	Low
Recording	*Vehicle movements*	Introduction and spread of weeds, pests and pathogens	Major	Rare	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Wheel tracks, wheel ruts, bulldust generation, airborne dust	Negligible	Likely	Low
		Visual impact	Minor	Unlikely	Medium
		Impact &/or damage to significant Aboriginal sites	Major	Rare	Medium
		Fire damage to vegetation and habitat	Major	Rare	Medium
	Vibrator Operations	Soil compaction, wheel tracks, wheel ruts, airborne dust	Negligible	Likely	Low
		Noise generation	Negligible	Likely	Low
		Disturbance to native fauna	Minor	Rare	Low
		Introduction and spread of weeds, pests and pathogens	Major	Rare	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Impact &/or damage to significant Aboriginal sites	Major	Rare	Medium
	Spills and leaks	Contamination of soil, groundwater, water courses	Minor	Rare	Low
Campsites & associated supply logistics	*Vehicle movements*	Wheel tracks, wheel ruts, bulldust generation, soil compaction, airborne dust, visual impact	Negligible	Likely	Low
		Noise generation	Negligible	Likely	Low
	Impact upon vegetation & habitat	Loss of vegetation, damage to tree root structures	Minor	Rare	Low
		Fire damage to vegetation and habitat	Major	Rare	Medium
	Spills and leaks	Contamination of soil, groundwater, water courses	Minor	Rare	Low
	Disposal of domestic and chemical waste	Contamination of soil, groundwater, water courses	Minor	Rare	Low
Uphole drilling & logging	*Disposal of chemical waste*	Contamination of soil, groundwater, water courses	Minor	Rare	Low
	Spills and leaks	Contamination of soil, groundwater, water courses	Minor	Rare	Low
	Uphole drilling activity	Contamination of soil, groundwater, water courses	Minor	Rare	Low

Activity	Hazard	Potential Consequence	Severity	Likelihood	Risk
		Uncontrolled discharge of artesian aquifer	Minor	Rare	Low
		Injury to/loss of native fauna	Minor	Rare	Low
		Visual impact, noise generation, airborne dust	Negligible	Likely	Low
		Impact &/or damage to significant Aboriginal sites	Major	Virtually impossible	Medium
	Vehicle movements	Introduction and spread of weeds, pests and pathogens	Major	Rare	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Wheel tracks, wheel ruts, bulldust generation, airborne dust	Negligible	Likely	Low
		Impact &/or damage to significant Aboriginal sites	Major	Rare	Medium
Line & Access track restoration	*Earthworks*	Noise generation	Negligible	Unlikely	Low
		Disturbance to native fauna	Minor	Rare	Low
		Introduction and spread of weeds, pests and pathogens	Major	Rare	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Impact &/or damage to significant Aboriginal sites	Major	Unlikely	Medium
	Vehicle movements	Introduction and spread of weeds, pests and pathogens	Major	Rare	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Impact &/or damage to significant Aboriginal sites	Major	Unlikely	Medium
		Airborne dust	Negligible	Likely	Low
	Spills and leaks	Contamination of soil, groundwater, water courses	Minor	Rare	Low
Monitoring/ Auditing	*Vehicle movements*	Damage to landholder infrastructure	Negligible	Rare	Low
		Impact &/or damage to significant Aboriginal sites	Major	Rare	Medium

7.2 Management of environmental risks

7.2.1 Management systems

Management systems should be a key tool in the management of operators' environmental responsibilities, issues and risks in the Officer Basin. Management systems provide a framework for the coordinated and consistent management of environmental issues by ensuring the:

- establishment of an environmental policy;
- identification of environmental risks and legal and other requirements relevant to geophysical operations;
- setting of appropriate environmental objectives and targets;

- establishment of a structure and program to implement the environmental policy and achieve objectives and targets, including the development of procedures and 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;
- training which includes specific induction training for staff, contractors and visitors to areas of operation; and
- the preparation of training materials such as manuals and standard operating procedures documentation and emergency response management

The operators' geophysical operating standards should follow or lead accepted best practice and industry-accepted standards. Ongoing audits of systems should be regularly conducted using a risk-based approach to ensure that systems are maintained and operations are undertaken in accordance with industry-accepted practices.

7.2.2 Emergency response, contingency planning and training

In the course of normal operations, there is always the potential for environmental incidents and accidents to occur. It is therefore important that all operators within the South Australian Officer Basin have developed emergency response plans to guide actions to be taken to minimise the impacts of accidents and incidents. Emergency response drills should be undertaken at least annually 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. Emergency response plans must 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 would also include the facilitation of fire danger season restrictions and requirements.

7.2.3 Environmental monitoring and audits

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

Monitoring programs are designed to assess:

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

7.2.4 Environmental incident management and recording

Operators must have systems 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 should also provide a mechanism for recording 'reportable' incidents, as defined under the *Petroleum Act 2000* and associated regulations

7.2.5 Environmental monitoring and audits

Operators must implement internal and external reporting procedures to ensure that environmental issues and/or incidents are appropriately responded to. Internal reporting should cover:

- number, severity and close out status of incidents;
- monthly summaries of incidents;
- progress against key performance indicators;
- audit schedule and findings;
- works in progress;
- site and task force meetings; and
- external meetings and/or liaison with key stakeholders (i.e. PIRSA).

7.2.6 Inspection and maintenance activities

All operational equipment should be inspected and maintained in accordance with industry accepted standards and product operational requirements.

Contracting companies will also have their own inspection and maintenance procedures.

7.2.7 Pest plant and animal control

Pest plant and animal control is considered to be not a major land management issue in the area. While the region is considered to be relatively free of pest plant species, the operators have the potential to introduce weed species into the region as a result of movement of vehicles and equipment. In particular caltrop (*Tribulus terretris*), buffel grass (*Cenchrus ciliaris*), horehound (*Marrubium vulgare*) and onion weed (*Asphodelus fistulosus*) are weeds with a higher likelihood of being encountered and transported by geophysical operations.

It is essential that:

- where relevant, weed management strategies are developed by operators to ensure that vehicles and equipment are washed down if moving from areas of known weed infestations;
- operators consult with relevant authorities; and
- weed control measures are implemented as required.

Pest animals that might be encountered in the Officer Basin include, but are not limited to, rabbits, feral cats and camels.

7.2.8 Continuous improvement

Auditing and monitoring results drive continual improvement. Management systems should be used to drive the process of continuous improvement.

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APPENDICES

Appendix 1 List of key stakeholders

South Australian Government departments	Department of Primary Industries and Resources SA Department for Environment and Heritage Department of Water, Land and Biodiversity Conservation Environment Protection Authority
Landowners (those who hold property that will be entered during the course of the survey)	The MT Peoples are the only landowners.
Department of Defence	For entry into the Woomera Prohibited Area.
Other petroleum or mineral tenement holders	If it is proposed that a licence/tenement is to be entered during the course of a regulated activity, the respective licencees will be notified.

Appendix 2 Stakeholder comments and responses

Stakeholder & Document Reference	Stakeholder Comment	Editors' Response
Maralinga Tjarutja	**M/T is very satisfied with the SEO and no changes are necessary from our perspective.**	Noted
	The most important point from a legal perspective as advised by Johnston Withers (M/T legal advisors) is that if any conditions of the Land Access and Production agreement for Petroleum Deed (signed by OBE on 19th June 2007) are breached, it will also deemed to be a breach of the SEO.	Noted
	The SEO is a comprehensive document that incorporates all aspects of the environment as defined under Section 4(1) of the *Petroleum Act 2000.*	Noted
	The SEO also incorporates the core objectives of the Act to minimise harm and risk to people and undertake activities in an environmentally sustainable manner.	Noted
Department of Water, Land and Biodiversity Conservation	All activities undertaken under this proposal should conform to the *Petroleum Act 2000* and *Environmental Protection Act 1993* and in accordance with the Statement of Environmental Objectives.	Noted
	All chemicals must be stored appropriately (i.e. in lined bunded areas). Bunded areas must have freeboard to hold a 1 in 100 year, 24 hr rainfall event.	EIR amended to cover appropriate storage of chemicals.
	Comments on Alinytjara Wilurara Natural Resources Board – Need for PIRSA to consult for medium impact activities and recommendation to refer to local NRM Plan.	Geophysical operations are assessed as being low level impact activities. Noted and agreed.
	Issues raised within Alinytjara Wilurara Initial Natural Resource Management Plan have been considered within the SEO/EIR.	Noted.
	The SEO and EIR appear to be consistent with Northern and Yorke Integrated Management Plan.	Noted.
	The Native Vegetation Council has been invited to make separate comment.	Noted.
EIR 7.2.7	EIR and SEO should highlight caltrop, buffel grass, onion weed and horehound as weeds with higher likelihood of being encountered and transported by geophysical vehicles.	EIR has been amended to include notes regarding these weeds. Whilst the comment mentions geophysical vehicles, it does not imply that geophysical vehicles have any greater potential for spreading weeds than any other vehicles entering the survey area (Plant and Management Control Group DWLBC).
	In general the risk of introduction of pest plants and animals has been adequately considered and managed	Noted.
Environmental Protection Agency	The Authority is in agreeance with the Low Environmental Impact classification of the application provided by PIRSA	Noted.
	This document lacks detail pertaining to the issues of waste management wastewater management and pollution control:-	Noted: Refer to the following comments
	Waste Management Disposal of waste material such as paper, cardboard and food scraps via burning is not desirable. Rather, this material should be buried at an appropriate location and depth (as is reasonably practicable) in order to prevent exposure of waste by fauna or wind/water erosion. Once covered the site should also be compacted to further minimise the risk of future exposure.	Noted Company procedures are in place to manage the waste in the most practical and appropriate manner after undertaking a site-specific risk assessment and considering EPA guidelines. EIR section 5.3.4 amended accordingly
		.

Stakeholder & Document Reference	Stakeholder Comment	Editors' Response
EPA (Continued)	All plastics, metal and other recyclable materials should be segregated on site and regularly transported to a licensed waste transport facility.	EIR section 5.3.4 amended accordingly.
	Wastewater Management More detail required regarding the construction and management of the proposed evaporation ponds for the disposal of wastewater from laundry, showers and kitchen activities.	EIR amended to include reference to EPA Guideline 509/4.
	EPA is of the opinion that Dept of Health should comment on aspect of disposal of toilet waste.	Department of Health advised that toilet waste must be disposed of in accordance with *Public and Environmental Health (Waste Control) Regulations 1996*. This legislation is cited in the EIR.
	It is important that wastewater is not allowed to freely permeate the soil and in particular, an evaporation pond should not be constructed close to areas where Playa Lakes may form.	EIR sections 5.1.7 and 5.3.4 amended accordingly.
	Pollution Control Review EIR to ensure risk of contamination due to storage of liquids in workshops and refuelling facilities is more adequately addressed. Details in SEO are not clearly linked to the EIR	EIR updated to reflect SEO - EIR 5.3.4 Pollution section includes SEO section on Fuel Storage and Handling (Obj 4)
	The SEO should be reviewed in line with recommended amendments for the EIR. Information pertaining to fuel and chemical storage is not clearly linked to the EIR.	EIR amended see above note.
	General Information EPA Guideline 388/02 is to be provided to Officer Basin Energy.	Supplied to OBE as suggested by EPA
	Documentation provided does not include provision of an induction manual for contracted staff. An induction manual should be used for all staff and contractors involved in the proposed operations, including standard operating procedures and emergency management.	EIR 7.2.1 Management Systems & 7.2.2 Emergency response, contingency planning and training. Inductions, training in SOPs and emergency management are an integral part of company and contractor management systems. Specific reference to inductions and induction manuals has been added to these sections.
Department for Environment and Heritage (DEH) EIR Sections 4.3 & 4.4	No mention is made of any up-to-date ecological/biological surveys within the Officer Basin, other than Kutsche and Lay 2007, which only provides information on vegetation in the area. More up-to-date information should be obtained on biodiversity within this area.	Peter Copley Senior Ecologist DEH advised that there is no up to date information available for the survey area. OBEPL will be encouraged to undertake floral and faunal sampling.
EIR Sections 5.1.7 & 5.1.8	Mention should be made here of where water will be obtained for the purposes of the camp and for drilling.	NB. No upholes are planned for the forthcoming survey Water for camp will be trucked in from Coober Pedy.
EIR Sections 5.1.7 & 5.1.8	The type of sump, i.e. aboveground or belowground, to be used with uphole drilling should be identified.	Below ground sumps are not used in uphole operations. NB. No upholes are planned for the forthcoming survey
EIR Section 5.1.9	The rehabilitation techniques that are described may not be appropriate for the environment within Officer Basin	
	Rehabilitation should be carried out to the satisfaction of the landowner, and techniques designed with consideration for the environment in which they are carried out.	Rehabilitation will be carried out to satisfaction of Maralinga/Tjarutja.
Appendices 4, 5 & 6 **DEH (Continued)**	Species that are of regional, state and national conservation significance should be identified. A number of the species listed within these appendices are not common and	These Appendices have been amended and retitled:- "A selection of birds, fauna and reptiles known to occur in OBEPL PELs" . Uncommon species have been excised

Stakeholder & Document Reference	Stakeholder Comment	Editors' Response
	therefore the title for each appendix is misleading.	from the appendices.
	The source of the data within these appendices should be identified.	Source has been added.
	Species lists of vegetation should be included, particularly identifying species of conservation significance**.**	It is not a specific requirement of the *Petroleum Act 2000 or Regulations* that species lists be included in EIRs. A search of the Commonwealth Department of Environment database that relates to the *EPBC Act 1999* provided one listing of rare, vulnerable and endangered flora for the OB license areas. This example has been included in the EIR.
Environmental Significance Assessment	DEH supports the assessment that those impacts covered by this environmental significance assessment (ESA) can be of low significance if managed correctly. DEH provides the following comments in relation to the ESA:	Noted
Soil impacts	Uphole drilling and logging vehicle movement should address possible contamination of soil from a) drill spoil, and b) uncontrolled artesian flows. Objectives should address measures aimed at minimising impacts to surface soil and surrounding vegetation.	NB. No upholes are planned for the forthcoming survey a) Drill cuttings are returned to hole or removed from the site b) N/A - Uncontrolled artesian flows – No artesian aquifers have been found during any previous drilling operations in the survey area.
Soil Impacts (also Flora Impacts) EIR 5.3.2 & 5.3.3 spread of weeds	Question the assumption that the predictability of the *size, scope or duration* of a weed outbreak would be high should one occur. Any prediction would be dependent on a number of variables, such as the type of weed introduced and other environmental factors, which will lead to a level of uncertainty in the assessment. The assessment of small with the cumulative effects of the introduction and spread of weeds should be re-assessed. The introduction/spread of weeds may begin as a small infestation, but there is potential for it to become a major problem.	Noted and ESA Amended Environmental significance assessment amended. Impact mow rated as Medium for this specific element. Overall assessment of impact of activity remains as LOW
Flora Impacts EIR 5.3.3 line & access track preparation	Other potential consequences where vegetation is cleared may be a reduction of species diversity and loss of biodiversity.	Section 6.2 Consequences has been amended.
EIR 5.3.3 uphole drilling and logging	Uphole drilling and logging vehicle movement should address loss of vegetation with respect to below-ground sumps (if there is any possibility these may be used). Objectives should address measures aimed at minimising impact on vegetation.	NB. No upholes are planned for the forthcoming survey Section amended – vehicles associated with upholes confined to seismic line (as an enabling procedure for objective minimising impact on vegetation). No below ground sumps are used in uphole drilling for seismic operations.
Fauna Impacts EIR 5.3.3 line & access track preparation	Frequency of this consequence should be re-assessed, as it is likely that there is some uncertainty in predictions relating to fauna injury/death.	Vehicles associated with uphole drilling operations are confined to seismic lines from the current survey. No offline trafficking is allowed.
EIR 5.3.3 uphole drilling and logging	Objectives aimed at minimising injury to or death of fauna should be investigated in relation to below-ground sumps (if these will be used).	N/A Below ground sumps are not used in uphole drilling activities.
Community Resource Impacts EIR 5.3.1.6 campsites and associated supplies site preparation	Could be better worded as campsites and associated supplies site preparation and abandonment.	Amended
Statement of Environmental Objectives	The following comments are provided for general information and are specific to the objectives and criteria. The majority of the assessment criteria are considered suitable for reporting on appropriate management of key impacts identified within the EIR,	Noted

Stakeholder & Document Reference	Stakeholder Comment	Editors' Response
DEH (Contiued)	though additional comments have been provided which should improve the demonstration of the achievement of the objectives.	
2.1 Scope - Para 2	Strategies to avoid accidental transgression by employees and contractors into parks, particularly Mamungari Conservation Park, should be identified in this paragraph.	Noted – SEO has been amended to include a statement which stresses the requirement to include this information at induction training sessions.
2.1 Scope - Para 3	Strategies to make contractors aware of sensitive areas, such as wetlands, should be identified in this paragraph.	Noted – SEO has been amended to include a statement which stresses the requirement to include this information at induction training sessions.
Appendix 1 - Objective 1	The two latter comments under Assessment Criteria appear to be how the objective should be achieved rather than assessment criteria.	The MT Peoples – the primary stakrholders- are satisfied with and have agreed to the assessment criteria for operations.
Objective 2	The latter comment under Assessment Criteria appears is probably more appropriate in the comments column.	The MT Peoples are satisfied with and have agreed to the assessment criteria for operations.
Objective 3	Domestic Camp Animals The assessment criterion: No domestic camp animals permitted appears to be how the objective should be achieved rather than assessment criteria. Assessment criteria, such as no road kill evident or no injured or dead native fauna as a result of operations or domestic camp animals may be better assessment criteria. The assessment criterion no domestic camp animals then becomes a suitable guide for achieving the objective. The guides for achieving the objectives should not be limited to just this one.	The MT Peoples are satisfied with and have agreed to the assessment criteria for operations. Camp animals are strictly forbidden.
	Fire Fighting The assessment criterion: Fire fighting equipment is readily available and sufficient personnel trained appears to be how the objective should be achieved rather than assessment criteria. The assessment criteria should be more along the lines of no fires started by employees or contractors as a result of operations. The assessment criterion fire fighting equipment is readily then becomes an appropriate guide for achieving the objective. The guides for achieving the objectives should not be limited to just this one.	The MT Peoples are satisfied with and have agreed to the assessment criteria for operations. Fire fighting procedures are an integral part of the Terrex management system. Initiation of unplanned fire is a reportable or serious incident. As a result, the objective to minimise disturbance as a result of fire is closely linked to the ability of Terrex and other contractors to be prepared for and action an appropriate response to any such incident.
	Waste Management There should be assessment criteria for waste management.	'No survey or camp litter remains' covers camp area issues of general waste management and litter disposal. Other management issues (such as recycling) are highly variable, dependent on location/facilities.
Appendix 3 - 2nd column	Line preparation crew should be provided with up-to-date species lists and be able to identify their habitats. They should be made particularly aware of species of conservation significance.	M/T who are custodians of the area where the survey is located have been contracted to undertake the line preparation element of the survey. It is not considered necessary or appropriate to give the owners of the land species list. NB. This is not done in any other area where seismic surveys are carried out in Australia. PIRSA will recommend OBEPL provide information to relevant Terrex staff on species and habitat recognition during induction sessions and tool box meetings.
	DEH (region) has requested that they be involved in monitoring activities in conjunction with PIRSA where lines are within proximity to reserves.	Noted. Navigation data will be supplied to PIRSA to validate that no intrusion into Reserves has occurred. Standard operating procedures when setting out lines by professional surveyors should ensure that Reserves will not be intruded upon by the seismic survey. Should a situation present where there may be a possibility that an intrusion did occur, PIRSA is able to assess this as part of any aerial inspection.
	A representative from the Mamungari Conservation Park Board should also be involved in these monitoring activities.	Mr Chris Dodd, Mr Geoffrey Queama and Mr Tommy Baker who are Maralinga Tjarutja members on the Mamungari Conservation Park Board, are also key stakeholders for the survey and as such are closely involved with the survey and will be involved in monitoring the survey activities on M/T lands.
	DEH would appreciate receiving any copies of audits and monitoring reports that are	Noted – Audit and monitoring reports are public documents in terms of the *Petroleum*

Stakeholder & Document Reference	Stakeholder Comment	Editors' Response
	provided from Officer Basin.	*Act 2000* and will be supplied to DEH as per this request.

Appendix 3 List of relevant legislation

South Australia

Aboriginal Heritage Act 1988
Dog and Cat Management Act 1995
Environment Protection Act 1993
Fire and Emergency Services Act 2005
Heritage Places Act 1993
Maralinga Tjarutja Land Rights Act 1991
National Parks and Wildlife Act 1992
National Trust of SA Act 1995
Natural Resources Management Act 2004
Native Vegetation Act 1991
Occupational Health, Safety and Welfare Act 1985
Petroleum Act 2000
Public and Environmental Health Act 1987
Public and Environmental Health (Waste Control) Regulations 1995
Wilderness Protection Act 1978

Commonwealth

Environment Protection and Biodiversity Conservation Act 1999
Aboriginal and Torres Straight Island Heritage Protection Act 1984

Appendix 4 A selection of birds known to occur in OBEPL's PELs

COMMON NAME	SCIENTIFIC NAME
Brown falcon	*Falco berigora*
Crested pigeon	*Ocyphaps lophotes*
Ringneck Parrot	*Barnardius zonarius*
Mulga parrot	*Psephotus varius*
Red-capped robin	*Petroica goodenovii*
Hooded robin	*Melanodryas cucullata*
Rufous whistler	*Pachycephala rufiventris*
Grey shrike-thrush	*Collurincincla harmonica*
Crested bellbird	*Oreoica gutturalis*
Willie wagtail	*Rhipidura leucophrys*
White-browed babbler	*Pomatostomus superciliosus*
Splendid fairy-wren	*Malurus splendens*
Variegated fairy-wren	*Malurus lamberti*
Chestnut-rumped thornbill	*Acanthiza uropygialis t*
Southern whiteface	*Aphelocephala leucopsis*
Spiny-cheeked honeyeater	*Acanthogenys rufogularis*
Yellow-throated miner	*Manorina flavigula*
Singing honeyeater	*Lichenostomus virescens*
Grey-fronted honeyeater	*Lichenostomus plumulus*
White-fronted honeyeater	*Phylidonyris albifrons*
Mistletoebird	*Dicaeum hirundinaceum*
Black-faced woodswallow	*Artamus cinereus*

Source: Shephard 1995

Appendix 5 A selection of mammals known to occur in OBEPL's PELs.

COMMON NAME	SCIENTIFIC NAME
Short-beaked echidna	*Tachyglossus aculeatus*
Kultarr	*Antechinomys laniger*
Ooldea dunnart	*Sminthopsis ooldea*
Fat-tailed dunnart	*Sminthopsis crassicaudat*
Stripe-faced dunnart	*Sminthopsis mocroura*
Wongai ningaui	*Ningaui ridei*
Western pygmy possum	*Cercartetus concinnus*
Western grey kangaroo	*Macropus fuliginosus*
Euro	*Macropus robustus*
Red kangaroo	*Macropus rufus*
Sandy inland mouse	*Pseudomys hermannsburgensis*
Bolam's mouse	*Pseudomys bolami s*
Mitchell' hopping-mouse	*Notomys mitchelli*
Spinifex hopping-mouse	*Notomys alexis*
White-striped mastiff-bat	*Tadarida australis*
Little mastiff bat	*Mormopterus planiceps*
Lesser long eared bat-	*Nyctophilus geoffroyi*
Gould's wattled bat	*Chalinolobus gouldii*
Western broad-nosed bat	*Scotorepens balstoni*
Little broad- nosed bat	*Scotorepens greyii*
Little cave eptesicus	*Vespadelus finlaysoni*

Source: Shephard 1995

Appendix 6 A selection of reptiles known to occur in OBEPL's PELs.

COMMON NAME	***SCIENTIFIC NAME***
Spadefoot Frog	*Neobatrachus pictus*
Spadefoot Frog	*Neobatrachus centralis*
Spiny-tailed Gecko	*Diplodactylus ciliaris*
Fat-tailed Gecko	*Diplodactylus conspicillatus*
Jewelled Gecko	*Diplodactylus elderi*
formerly part D. vittatus, Wood Gecko	*Diplodactylus granariensis*
Crowned Gecko	*Diplodactylus stenodactylus*
Tree Dtella	*Gehyra variegata*
Bynoe's Gecko	*Heteronotia binoei*
Beaded Gecko	*Lucasium damaeum*
Knob-tailed Gecko	*Nephrurus laevissimus*
Central Knob-tailed Gecko	*Nephrurus levis*
Southern Knob-tailed Gecko	*Nephrurus stellatus*
Beaked Gecko	*Rhynchoedura ornata*
Spinifex Legless lizard	*Delma australis*
Fraser's Legless lizard	*Delma fraseri*
Burton's Snake lizard	*Lialis burtonis*
Common Scalyfoot	*Pygopus lepidopodus*
Hooded Scalyfoot	*Pygopus nigriceps*
Clay's Dragon	*Ctenophorus clayi*
Crested Bicycle Dragon	*Ctenophorus cristatus*
Mallee Dragon	*Ctenophorus fordi*
Military Dragon	*Ctenophorus isolepis*
Central Netted Dragon	*Ctenophorus nuchalis*
Painted Dragon	*Ctenophorus pictus*
Long-snouted Dragon	*Gemmatophora longirostris*
Thorny Devil	*Moloch horridus*
Small Bearded Dragon	*Pogona minor*
Lined Earless Dragon	*Tympanocryptis lineata*
Desert Pygmy Goanna	*Varanus eremius*
Pygmy Mulga Goanna	*Varanus gilleni*
Sand Goanna	*Varanus gouldii*
Black-headed Pygmy Goanna	*Varanus tristis*
Sloping-headed Skink	*Cryptoblepharus plagiocephalus*
Titan Skink	*Ctenotus atlas*
Brooks' Skink	*Ctenotus brooksi*
Lea's Skink	*Ctenotus leae*
Leonard's Skink	*Ctenotus leonhardii*
Leopard Skink	*Ctenotus pantherinus*
Fourteen-lined Skink	*Ctenotus quattuordecimlineatus*
Regal Skink	*Ctenotus regius*
Shomburgk's Skink	*Ctenotus schomburgkii*

COMMON NAME	***SCIENTIFIC NAME***
Desert Skink	*Egernia inornata*
Broad-banded Sandswimmer	*Eremiascincus richardsonii*
Two-legged Skink	*Lerista bipes*
Desert Lerista	*Lerista desertorum*
Lipped Skink	*Lerista labialis*
Mueller's Skink	*Lerista muelleri*
Grey's Skink	*Menetia greyi*
Boulenger's Snake-eyed Skink	*Morethia boulengeri*
Butler's Snake-eyed Skink	*Morethia butleri*
Dark Snake-eyed Skink	*Morethia obscura*
Gilled Blue Tongue	*Tiliqua branchialis*
Western Blue Tongue	*Tiliqua occipitalis*
Shingle-back	*Trachydosaurus rugosus*
Blind Snake	*Ramphotyphlops australis*
Blind Snake	*Ramphotyphlops bituberculatus*
Blind Snake	*Ramphotyphlops endoterus*
Boulenger's Snake-eyed Skink	*Morethia boulengeri*
Butler's Snake-eyed Skink	*Morethia butleri*
Dark Snake-eyed Skink	*Morethia obscura*
Gilled Blue Tongue	*Tiliqua branchialis*
Western Blue Tongue	*Tiliqua occipitalis*
Shingle-back	*Trachydosaurus rugosus*
Blind Snake	*Ramphotyphlops australis*
Blind Snake	*Ramphotyphlops bituberculatus*
Blind Snake	*Ramphotyphlops endoterus*
Yellow-faced Whip Snake	*Demansia psammophis*
Western Black-naped Snake	*Neelaps bimaculatus*
Mulga Snake	*Pseudechis australis*
Ringed Brown Snake	*Pseudonaja modesta*
Western Brown Snake	*Pseudonaja nuchalis*
Desert Banded Snake	*Simoselaps bertholdi*
Narrow-banded Snake	*Simoselaps fasciolatus*
Half-girdled Snake	*Simoselaps semifasciatus*
Hooded Snake	*Unechis monachus*

Source: Shephard 1995