Beach Petroleum

Environmental Impact Report:

Cooper Basin Petroleum Production Operations

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BEACH PETROLEUM

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DOCUMENT CONTROL SHEET

ENV538 – Beach Petroleum Production EIR

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1 Introduction

Beach Petroleum Ltd (Beach) is a public Australian Company based in Adelaide, South Australia and listed on the Australian Stock Exchange Ltd. Beach holds a number of Petroleum Exploration Licences in the Cooper Basin, South Australia. In 2002, Beach's petroleum exploration program in the Cooper Basin proved successful, with oil discoveries at Sellicks and Aldinga wells. Beach Petroleum has been producing oil at two wells under extended production testing and has applied for a production licence at one of these wells (the Sellicks facility). Beach is likely to undertake production testing at one or more additional wells in late 2003.

Petroleum production operations in South Australia are administered under the Petroleum Act, 2000 by the Department of Primary Industries and Resources (PIRSA).

This document fulfils the requirements of an Environmental Impact Report (EIR) for Beach Petroleum's production operations and has been prepared in accordance with current legislative requirements, in particular, with Section 97 of the South Australian *Petroleum Act 2000* and Regulation 10 of the *Petroleum Regulations 2000*. The Act and Regulations also require the development and implementation of a Statement of Environmental Objectives (SEO). A draft SEO has been prepared in conjunction with this document.

This EIR addresses Beach Petroleum's current and proposed production operations in the South Australian Cooper Basin. The scope of this EIR is discussed in Section 1.2.

1.1 Beach Petroleum

Beach Petroleum Ltd is a publicly listed oil and gas company based in Adelaide, South Australia. Beach was established in the early 1960s by the late Dr Reg Sprigg, a highly regarded Australian oilman, geologist, explorer and conservationist. Prior to founding Beach, Dr Sprigg acted as technical advisor to Santos Limited, now one of Australia's largest oil and gas companies.

Beach is primarily focused upon the Cooper/Eromanga Basin of South Australia and Queensland. During the 2002/2003 financial year Beach's share of production totalled 907 thousand barrels of oil equivalent (kboe), equivalent to an average production rate of approximately 2,485 boe per day. The majority of this production occurs at Beach's south-west Queensland facilities.

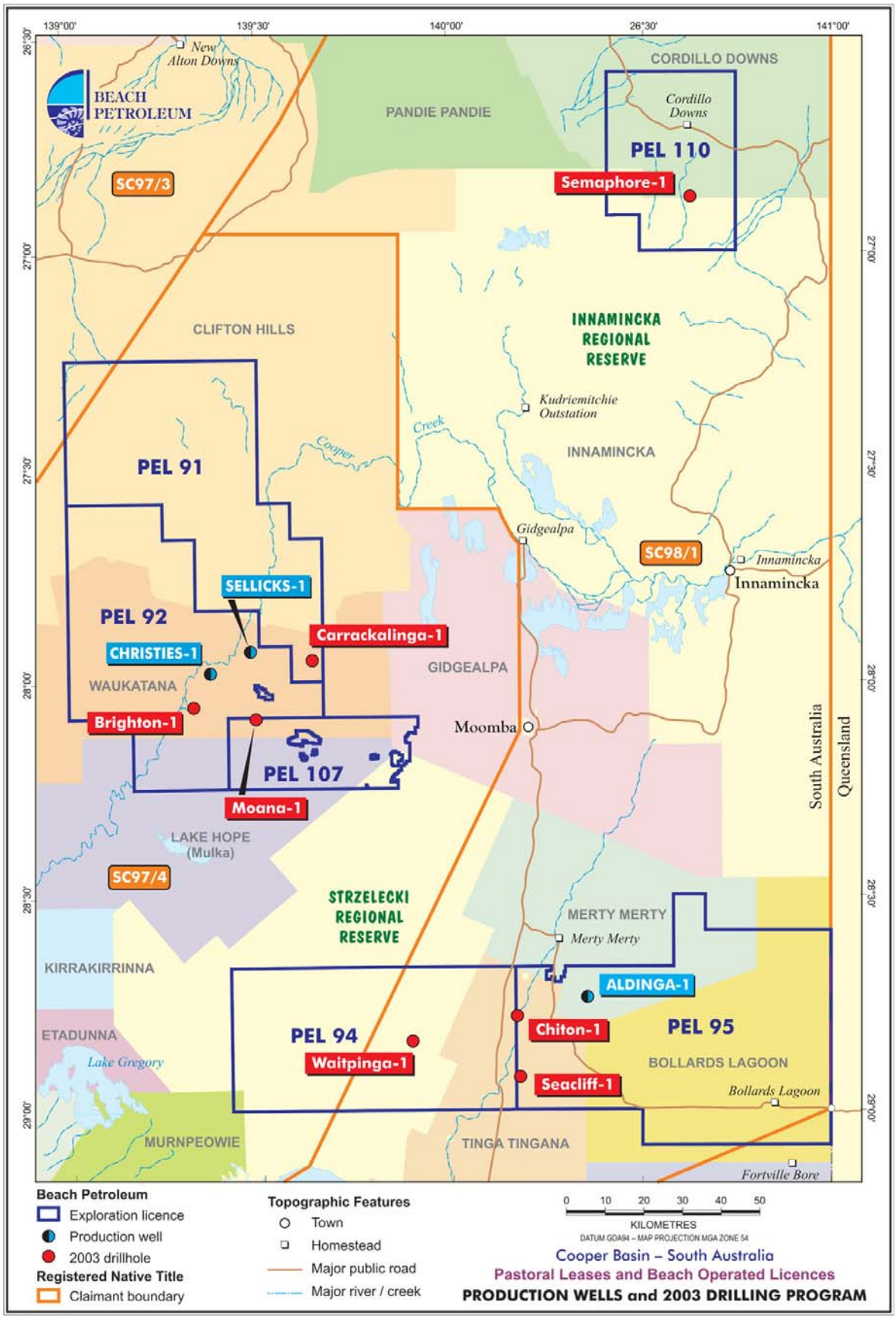
1.1.1 South Australian Cooper Basin Operations

Beach Petroleum has interests in a number of Petroleum Exploration Licence (PEL) areas in the South Australian Cooper Basin, as shown in Figure 1. Beach currently holds one Petroleum Production Licence for the Sellicks facility (PPL 204). The Aldinga facility is currently producing oil under extended production testing. The Christies-1 well (PEL 92) was drilled in June 2003 and is expected to commence production testing by October 2003.

Technical details of Beach Petroleum's production operations are outlined in Section 3.

Beach Petroleum also undertakes exploration activities (e.g. survey, seismic, drilling) within the Cooper Basin, which are carried out under separate SEOs (and therefore are not considered further in this document).

Figure 1: Beach Petroleum Cooper Basin Operations



1.1.2 Environmental Management

Policy

Beach Petroleum Ltd is committed to the protection of the environment through the implementation sound management practices. Beach will conduct its activities to ensure compliance with all applicable laws, regulations and standards and the protection of the environment from pollution and damage.

Beach Petroleum's commitment is outlined in the Environmental Policy, which is contained in Appendix 1.

The Beach Petroleum Environmental Management System (EMS) and Production Operations Manual (POM) provide the framework within which environmental responsibilities in South Australia are managed.

Beach environmental management systems will continue to evolve in response to executive management reviews, changing technology, industry practices, regulatory requirements, research, monitoring, and community expectations.

Environmental Management System

With over 40 years experience in oil exploration and production, Beach recognises that the achievement of sound environmental management should be place high among its corporate priorities. Progressive planning and appropriate environmental management systems have enabled Beach to achieve sound environmental outcomes in its other operations and will continue to underpin its approach to future activities.

Beach is committed to attaining exception environmental performance via the fulfilment of the following principles:

- application of best industry practices to ensure that environmental performance is amongst industry leaders
- aiming for continual improvement in environmental management by setting and reviewing achievable objectives and targets
- communicating openly with community and government sectors on environmental issues and performance
- actively complying with relevant legislation and regulations
- preserving and protecting all aspects of the natural environment through the effective use of resources
- respecting the rights of traditional owners by valuing cultural heritage and avoiding historically significant sites, and
- training and making all levels of staff and contractors aware of their environmental responsibilities in achieving conformance with the Environmental Policy.

Further information on the Beach EMS is provided in Section 5.8.1.

Production Operations Manual

The POM is the reference manual for Beach production Supervisors and Production Operators controlling well production operations of onshore wells in South Australia. The purpose of the POM is to:

- illustrate the guidelines, procedures and controls required during production of oil wells
- provide sufficient information to ensure that production operations are conducted with environmentally and safety orientated procedures

- provide a guide for relevant personnel on the procedures to be followed to ensure that a consistent, thorough and uniform approach is adopted to facilitate delivery of hydrocarbon product to point of sale
- provide sufficient information to allow a Production Supervisor to supervise and monitor production operation control standards and reporting, and
- provide sufficient information to allow the Production Operator to operate, monitor and report on production operations.

The POM does not replace sound production practices and should reflect industry best practice.

Further detail on the POM is provided in Section 5.8.3.

1.1.3 Petroleum Resource Rationale

Beach conducts all petroleum exploration and production activities in a manner that preserves and protects all aspects of the natural environment through the effective use of resources.

1.2 About this document

This document fulfils the requirements of the Environmental Impact Report under Section 97 of the *Petroleum Act* 2000 and Regulation 10 of the *Petroleum Regulations 2000* (refer Section 2.1) and has been prepared in conjunction with the development of Beach's Statement of Environmental Objectives for Petroleum Production Operations in the Cooper and Eromanga Basin.

Generic information in this report has been based on the EIR developed by Santos Ltd for production and processing operations in the Cooper Basin (Santos 2003). Santos is the predominant organization in oil and gas exploration and production in the Cooper Basin. Beach Petroleum's production operations are generally analogous to a small subset of Santos' operation. Consequently, the information on environmental risks and impacts gathered over more than 30 years of operations in the Cooper Basin that is presented in the Santos EIR forms a sound basis for this Beach Petroleum EIR.

1.2.1 Scope

This EIR addresses environmental risks and impacts associated with Beach Petroleum's production operations in the Cooper and Eromanga Basin. Site specific information is provided on current and proposed activities at the Sellicks, Aldinga and Christies sites.

However, this EIR has been written to address potential risks and impacts of production operations in all land systems in the Cooper Basin, in order to develop a SEO that will address all foreseeable activities over the next five years. This will avoid the need for repeated revision and re-approval of the SEO.

Significant changes to production operations in the future (e.g. production at new sites) will need to be assessed against this EIR and the SEO to demonstrate that the EIR and SEO are applicable. This assessment would be submitted to PIRSA as a component of the Activity Notification, as required by Regulations 19 and 20 of the *Petroleum Regulations 2000* for operators such as Beach that are classified as high-level official supervision. In some cases it may be necessary to produce a bridging document or brief EIR to supplement this EIR if it does not adequately address risks and impacts associated with the change.

The sites addressed specifically in this EIR are located outside the Innamincka and Strzelecki Regional Reserves. While risks and impacts of production operations are not different inside Regional Reserves, any future production operations inside Regional Reserves will require additional approval of the Production Licence and SEO from the Minister for Environment.

Beach's operations that are specifically covered by this EIR include:

- production facility construction, operation, maintenance and abandonment
- formation water disposal construction, operation, maintenance and abandonment
- flowline construction, operation, maintenance and abandonment
- road construction, operation, maintenance and abandonment
- oil spill risk, spill site restoration and emergency response, and
- waste management and land treatment.

This EIR and SEO do not apply to exploration activities, drilling activities and sub-surface well/reservoir infrastructure. These activities are covered by the SEO for Seismic Operations in the Cooper and Eromanga Basins South Australia (PIRSA 1998) and the SEO for Drilling and Well Operations in the Cooper / Eromanga Basin – South Australia (PIRSA 2000). The PIRSA Drilling and Well operations SEO will soon be superseded by the Cooper Basin Operators Drilling and Well Operations SEO (Santos 2003a) which is currently in draft form for public consultation.

Consequently the following activities are excluded from this EIR and SEO:

- well site and access track construction
- drilling
- well completion
- pre-wellhead production
- artificial lift (including beam pumps, jet pumps and electronic submersible pumps)
- down hole abandonment
- restoration of well sites and access tracks, and
- seismic operations.

2 Regulatory Framework

This section briefly describes the legislative framework for petroleum licensing in South Australia.

2.1 Petroleum Act and Regulations 2000

Petroleum production activities are governed by the *Petroleum Act 2000*. The key objectives of the *Petroleum Act 2000* 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.

Environmental Impact Report

As a requirement of the *Petroleum Act 2000* and *Petroleum Regulations 2000*, Beach is required to submit an EIR for South Australian Cooper Basin production operations.

In accordance with Section 97 of the Act, the EIR must:

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

Regulation 10 outlines the information that must be provided in an EIR. Table 1 summarises these requirements and outlines which sections of this document provide the relevant information.

Table 1: Information Required in an EIR (Regulation 10)

EIR Requirement	Chapter Reference
A description of the activities to be carried out under the licence (including their location)	3
A description of the specific site features of the environment that can reasonably be expected to be affected by the activities	4
An assessment of the cultural values of Aboriginal and other Australians that can reasonably be expected to be affected by the activities	4.4
Identification and assessment of foreseeable environmental hazards that could potentially be associated with the activities (including events during the construction, operational and abandonment stage as well as atypical events)	5
An assessment of the potential consequences of environmental hazards on the environment (extent, duration and proposed mitigation measures)	5
An explanation of the basis on which the consequences of hazards have been predicted	5
Information on consultation undertaken during the preparation of the EIR	6

This document fulfils the requirements of an EIR as outlined in the Act and Regulations.

Statement of Environmental Objectives

Part 12 of the Act requires that an approved SEO must be in place before Beach can conduct a regulated activity. A draft SEO has been submitted in accordance with this regulation and has been developed on the basis of information provided in this EIR. 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.

Assessment and Approval

Once the EIR (and accompanying SEO) is submitted to PIRSA, the agency assesses the document as to whether the activities are to be classified as low, medium or high impact. This in turn determines the level of consultation required prior to final approval of the SEO.

- **Low Impact activities** do not require public consultation, and an SEO may be approved after internal government approval.
- **Medium Impact activities** require a public consultation process for the EIR and proposed SEO, with comment sought for a period of at least 30 business days.
- **High Impact activities** are required to be assessed 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.

Regulated activities that are carried out in Innamincka or Strzelecki Regional Reserves must also have their SEO formally approved by the Minister for Environment and Heritage.

Once the approval process is complete, all documentation, including EIR and SEO, must be entered on an environmental register. This public register resides on the PIRSA internet so that community access is readily available, which will facilitate an openness, transparency and accountability in the decision making process (McDonough, 2000).

2.2 Other Legislation

A number of additional environmental approvals may be required under Commonwealth and South Australian legislation. These are outlined in Table 2.

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

Native Title is discussed further in Section 4.4.

Table 2: Additional Environmental Approvals

Agency	Legislation	Issue
Commonwealth		
Environment Australia	*Environment Protection and Biodiversity Conservation Act 1999*	Assessment and approval required if activities will significantly impact matters of national environmental significance, including: ▪ wetlands of international importance (Ramsar wetlands) ▪ listed threatened species and communities, and ▪ listed migratory species (for example JAMBA and CAMBA)
Commonwealth	*Native Title Act 1993*	Intersection of registered Native Title claims
South Australia		
Environment Protection Authority (EPA)	*Environment Protection Act 1993*	▪ General environmental duty to avoid causing environmental harm ▪ Establishment of landfill site for waste disposal ▪ Transport of prescribed wastes or substances ▪ Storage or production of large volumes of petroleum (2000m^3 storage or 20 tonnes per hour production)
Department for Aboriginal Affairs and Reconciliation	*Aboriginal Heritage Act 1988*	Permission to destroy Aboriginal relic
Department for Environment and Heritage (DEH)	*Heritage Act 1993*	Permission to destroy/disturb archaeological relic
Department for Water, Land and Biodiversity Conservation (DWLBC) DEH	*Native Vegetation Act 1991* *National Parks & Wildlife Act 1972*	Removal of native vegetation Undertaking regulated activities in Regional Reserves
DWLBC	*Water Resources Act 1997*	Sourcing water
PIRSA	*Mining Act 1971*	Borrow pits

3 Production Operations

This chapter provides a technical description of Beach Petroleum production operations in the Cooper Basin. Production operations have been grouped into the following categories:

- production facilities
- produced formation water disposal
- flowlines
- road construction and maintenance
- transport (of oil), and
- waste management.

3.1 Production Facilities

Beach Petroleum has two facilities in the Cooper Basin that are currently producing oil: Sellicks and Aldinga. A further facility is proposed to be established at the Christies-1 well by October 2003. The location of these facilities is indicated in Figure 1.

Currently, the production facilities are each receiving oil from one well. However, it is likely that additional wells in these fields will be drilled nearby, and flowlines installed to gather oil from these additional well(s).

In the future, oil may also be transported from production facilities by pipelines. The facility would then include oil transfer pumps and piping to load oil into the pipeline (although the transmission pipeline itself would require separate approval under the *Petroleum Act 2000* if it traverses land not covered by a production licence).

A typical oil production facility consists of:

- gathering and manifold system from the oil well(s)
- inlet manifold system
- water separator tank(s)
- skimmer tank
- processed oil storage tanks
- oil transfer pumps
- drains and sump
- utilities (instrument air, electric power generation, fuel gas and fuel oil systems) at selected facilities
- office, amenities and accommodation block (at selected facilities e.g. Sellicks)
- telemetry and communications system
- emergency shutdown and control systems
- waste water treatment facilities, including interceptor pits, holding ponds and evaporation ponds
- chemical injection system for corrosion prevention and emulsion breaking
- lined and bunded tanker load-out area, and
- perimeter fencing.

Electrical power for the facility and the nearby oil fields is provided by electrical generation equipment at the site. Water for the Sellicks facility is currently obtained from Lycium nearby. Appropriately licensed water bores may be installed at facilities in the future.

Artificial lift (e.g. beam pumps, jet pumps and electric submersible pumps) may be used on oil wells. Consequently, pumps and high pressure flowlines may be located within the boundary of a production facility. Flowlines are covered by this document, but artificial lift is addressed in the Drilling and Well Operations EIR and SEO (Santos 2003a,b).

Figure 2 shows a schematic layout of the Sellicks facility.

Processes

The oil produced at Beach Petroleum's wells is expected to be typical of Cooper Basin crude, which is generally light (API 40-60).

Oil well site facilities receive fluids from oil producing well(s), separate the gas and water from the oil, and then transfer the processed oil to storage tanks. This oil is currently transported by truck from the facility. Currently, oil from Sellicks and Christies is transported to Moomba and sold to Santos, and oil from Aldinga is transported either to Moomba or Beach's facilities in south-west Queensland.

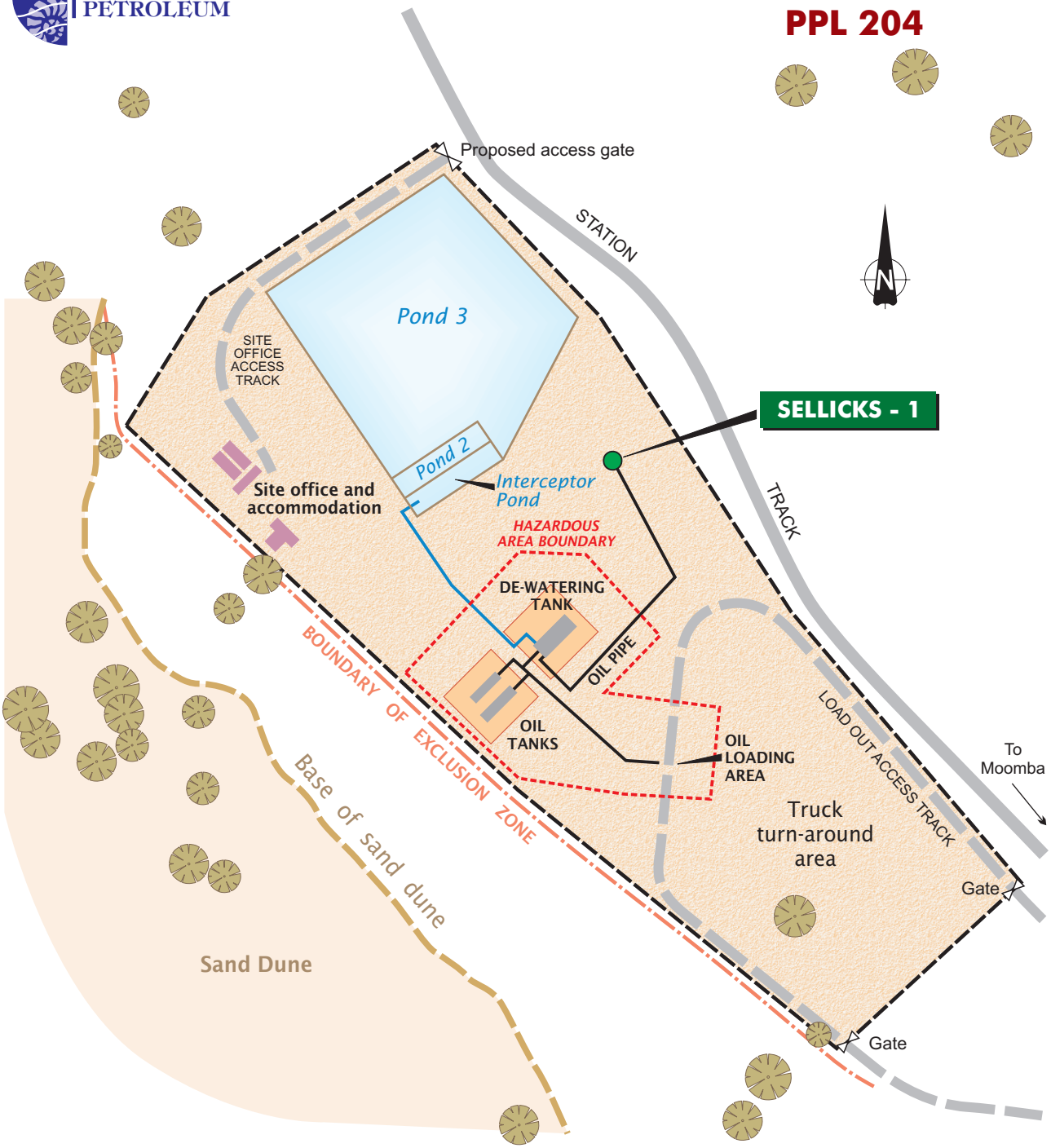
The water content of liquid produced from an oil well can vary from 0 to 100%. Based on Beach's current and expected production rates, the volume of liquid removed at a production facility could potentially range from 50 to 4000 bbls per day.

Management of produced formation water, domestic and other wastes, contaminated soil and temporary product storage pits are discussed in Sections 3.2 and 3.6.

Figure 2: Schematic Layout of the Sellicks facility

BEACH PETROLEUM

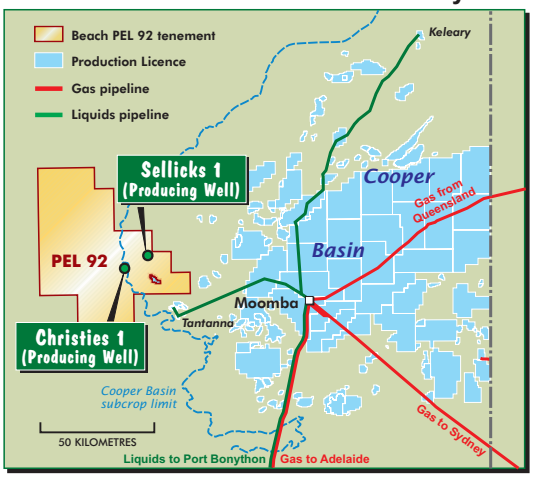
Cooper Basin - South Australia
SELLICKS OIL FACILITY
PPL 204



0 100
METRES
(approximate)

- Facility boundary fence
- Tree / shrub
- Building
- Oil storage tank

Locality Plan



GeoTech Graphics 602-2917

3.2 Produced Formation Water

When oil is pumped to the surface it is accompanied by varying quantities of water. Once the petroleum products have been removed at the facility the remaining water is disposed of. This water is known as produced formation water (PFW).

Once PFW is separated from oil it undergoes primary treatment and is then transferred to a lined interceptor pit. From this point there are two options for treatment and disposal of the water, either disposal to evaporation ponds or injection/infiltration to near surface aquifers. The depth of potential aquifers in the area is approximately 6 - 20m for shallow (perched) water tables or 100-150m or more (Eyre formation).

Produced formation water passes via a pipe system into an interceptor pond where any entrained hydrocarbons are recovered by manual skimming or vacuum truck (refer Section 3.6). The separated water is processed (refer Section 3.2) to achieve an oil in water content of:

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

The above oil in water content criteria are based on recommended standards that have been provided by PIRSA for formation water ponds in the South Australian Cooper Basin (Santos 2003).

3.2.1 Treatment Process

Primary Treatment

This can be either physical (gravity) separation or chemical treatment (emulsion breakers) where needed. Chemical treatment enhances PFW separation and aims to maximise hydrocarbon recovery prior to disposal. Primary treatment takes place in vessels and tanks (the separation plant) located in the vicinity of the PFW disposal facility. Water is discharged from the base of the tanks to a lined interceptor pit in the disposal system.

Interceptor Pits

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

Water exits the interceptor pit by an underflow pipe to prevent hydrocarbons on the surface moving further into the system. Any water leaving an interceptor pit should have a concentration of not more than 30 mg/L of hydrocarbon.

Evaporation Systems

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

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

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

Infiltration Systems

Disposal of PFW by infiltration requires the excavation of a pit through clay layers into permeable material. Water discharged to the pit infiltrates into permeable sub-surface layers or shallow aquifers.

This method is not currently used by Beach, although it has previously been trialled by Santos. Because it poses a risk of uncontained groundwater contamination, it is necessary to carry out rigorous testing of water quality both in the infiltration pit and at nearby groundwater bores.

Secondary Use of PFW

As PFW is a potentially contaminated process by-product, its use for secondary purposes such as road construction, dust stabilisation or livestock watering is strictly controlled. Prior to secondary use, monitoring results must have shown that the concentration of hydrocarbons in the water is consistently lower than 10mg/L.

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

3.2.2 Beach PFW Treatment Facilities

Beach currently treat produced formation water at the Sellicks facility. It is likely that PFW treatment will be required at Aldinga and Christies in the near future. A summary of produced formation water disposal facilities and their sizes is provided in Table 3.

At the Sellicks facility, PFW from the separator tank currently passes to an interceptor pit and then through a holding pond to a holding/evaporation pond, which is approximately 1ha in area. A second evaporation pond, approximately 20ha in area, is proposed to be constructed in late 2003, to accommodate higher PFW flows resulting from full production. Further detail and assessment of this pond is provided in Sections 4.2.1 and 5.2.

Table 3: Beach Produced Formation Water Treatment Facilities

Facility	Current area (m^2)	Proposed area (m^2)
Aldinga	0	To be determined; possibly interdunal
Sellicks	~10,000	~200,000
Christies	0	To be determined

3.3 Flowlines

Flowlines are low pressure pipelines that transport oil from wellheads to production and storage facilities within a production licence area. Higher pressure flowlines (up to 3500 psi) may also be used in association with jet pumps to provide artificial lift (refer Santos 2003b).

Pipelines that are extended beyond the area encompassed by one or more production licences are classified as transmission pipelines and require separate approval under the *Petroleum Act 2000*.

Flowlines are constructed of steel or glass reinforced epoxy (GRE) and typically range in size from 60mm to 90mm (2 3/8 to 3 1/2 inches) external diameter. They can be installed above or below ground. In the Cooper Basin, steel flowlines are usually located on supports above ground, to avoid corrosive soils.

All flowline design and construction is undertaken in accordance with the following Australian Standards:

- AS 4041 – 1998: Pressure Piping
- AS 2885.2 – 1997: Pipelines - Gas and Liquid Petroleum - Design and Construction
- AS 1978 – 1987: Pipelines - Gas and Liquid Petroleum - Field Pressure Testing

Beach is currently developing and refining procedures and guidelines for flowline design and construction which will be incorporated into the POM.

Adherence to design standards minimises the risk of flowline failure, which may have serious environmental implications in sensitive locations such as on floodplains. Design standards which aim to protect flowline integrity and prevent loss of oil/condensate to the environment include:

- design of the flowline to have an appropriate diameter and wall thickness for the operating pressure requirements
- specification of appropriate mitigation measures (as identified in a risk assessment of the flowline) such as installation of heavier wall thickness pipe where it is buried under rivers, creeks and roadways
- on floodplains and under creeks, it may be necessary to use concrete weighting to counter the buoyancy of the flowline when the soil is saturated with water
- use of high integrity external coating and cathodic protection devices for buried steel pipe to protect against corrosion
- aboveground flowlines must be supported to maintain them clear of corrosive soils
- installation of overpressure protection devices to prevent line rupture:
  - a high pressure shut down valve to isolate the well from the flowline
  - a pressure safety valve (PSV) designed to relieve the pressure above design operating pressure of the flowline
- liquid flowlines may be equipped with thermal PSVs and check valves to prevent line rupture as a result of temperature induced expansion
- PSVs and flowline bleed points shall be provided with sumps or drums of sufficient capacity to contain discharged fluids, and
- if required, launching and receiving facilities for pipe cleaning devices (referred to as pigs) shall be constructed to contain minor spills during removal/insertion of pigs and with a sump for draining the receiver/launcher prior to opening. Pigs are typically not used on flowlines.

Route Selection, Survey and Site Preparation

Surveys are undertaken and a preferred route alignment is selected according to evaluation criteria, such as constructability, environmental sensitivity, safety and cost. The centreline is established and engineering aspects of construction finalised.

For buried flowlines the right-of-way (ROW) is cleared with topsoil and vegetation stockpiled separately. During construction of above ground flowlines the construction easement may be cleared, but not

graded. Above ground flowlines often require a narrower easement and so result in reduced disturbance to vegetation and topsoil.

Flowline Construction

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

Pipe is transported to the flowline easement in sections and typically laid end-to-end adjacent to the trench on raised skids (typically wooden blocks with sandbags placed on top) to protect the pipe coating from damage. This process is known as 'pipe stringing'. In the case of above ground flowlines, sections of steel pipe are laid out on raised skids adjacent to the eventual flowline supports.

Steel pipes are welded in lengths (of up to one-kilometre or more) in accordance with Australian Standard 2885.2 – 1995. Each weld is radiographed to test for compliance to specifications. GRE pipes are typically joined by threaded joins with O-ring seals.

The joined pipe sections are lowered into the trench (using side-boom tractors for steel pipe or larger diameter GRE pipe). Sideboom tractors are also used to lower welded steel flowline sections onto pipe supports for above ground flowlines, which are installed so that they are positioned approximately 100mm above the ground surface. Above ground flowlines are buried under roads, on floodplains and at river and channel crossings.

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

Flowline Testing

The integrity of flowlines is verified using hydrostatic testing conducted in accordance with the SAA Code for Field Pressure Testing of Pipelines (Australian Standard 1978 - 1987). During hydrostatic testing the flowline is capped with test manifolds, filled with water and pressurised in accordance with the standard.

The use of biocides and chemicals with hydrostatic test water may be required under some circumstances to prevent internal corrosion of the flowline. Hydrostatic test water may be sourced from existing Beach water bores or from creeks or waterholes with sufficient water flows[1]. Produced formation water may also be utilised as a water source provided that it is adequately treated with biocide to remove potential for bacterial contamination of the flowline.

Disposal of hydrostatic test water, which contains biocide and other chemicals, may be into existing lined and fenced evaporation ponds, or to specifically constructed pits sited to prevent the contamination of surface or near surface waters.

Site Restoration

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

[1] Water sourcing licence may be required.

Operation

Flowline operation and maintenance provide for continued monitoring and safe operation of the flowline, as outlined in AS 2885.3–2001: Pipelines - Gas and liquid petroleum - Operations and maintenance. Inspection and monitoring of flowlines are carried out and the operating procedures followed ensure that they are operated within their design capability.

3.4 Road construction and maintenance

The majority of roads throughout the Cooper Basin are constructed and maintained by Santos. Beach Petroleum currently maintain approximately 40km of access roads to production wells and facilities, some of which are also station tracks.

Where possible, existing roads, station tracks and exploration well access tracks will be utilised and maintained where appropriate. However it is expected that a limited amount of road construction may be required for Beach Petroleum production operations, for example to provide more direct access to wells such as Christies and thus avoid or minimise crossings of watercourses such as the Cooper Creek.

Once surveys are complete and a preferred road alignment is selected, a road is constructed according to the land system(s) it will pass through. In most cases the easement is cleared and graded but under some circumstances the easement may be rolled (e.g. in gibber plains or where the terrain is naturally flat and susceptible to erosion when disturbed). Table 4 provides information on the road construction methods applied to land systems in the Cooper Basin (taken from Santos 2003).

Table 4: Road Construction Methods for Land Systems in the Cooper Basin

Construction Method	Landsystem					
	Wetlands	Floodplains	Gibber Plains	Tablelands	Dunefields	Salt Lakes
Avoid construction on landsystem						•
Utilise naturally cleared areas	•	•	•	•	•	
Avoid steep slopes			•	•	•	
Weave road between trees and large shrubs	•	•	•	•	•	
Clear and grade easement	•	•			•	
Roll easement			•	•		
Cap road surface with clay or similar borrow material	•	•		•	•	
Culverts or similar devices installed on drainage line crossing	•	•		•	•	

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

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

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

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

Borrow pits vary considerably in dimension depending upon the quality and quantity of material contained in them, however the typical size of borrow pits is approximately 3, 000 m^2.

Site selection, environmental management and restoration of borrow pits is undertaken in accordance with Beach procedures (e.g. *New Well Locations – Clearance, construction and restoration guidelines*). Existing borrow pits are used in preference to new ones where appropriate.

In the event that damage occurs to public roads, as a result of Beach operations, maintenance activities will be undertaken to restore and maintain the road at an acceptable standard (as a minimum to pre-existing standard).

3.5 Transport

Oil from production facilities is currently transported by tankers, either to Moomba or to other Beach facilities (e.g. in south-west Queensland). Oil is currently sold at the facility, and transport is the responsibility of the buyer (e.g. transport of oil from Sellicks is currently undertaken by Santos). In the future Beach may engage a suitably trained, experienced and licensed contractor to transport oil.

Tanker load out areas will be lined and bunded to contain any spills.

Oil is typically transported in dual trailer road tankers with a capacity of 60,000 litres. There may be several tankers per day travelling from a producing well along access roads and in some cases along public roads. Currently approximately 10 tankers per week are used to collect oil from the Sellicks facility, which is transported on private roads to Moomba and 1 tanker per week collects oil from the Aldinga wellhead for transport to Queensland or Moomba via public roads.

Access roads in the Cooper Basin may cross creek beds, including the Cooper and Strzelecki Creeks. These creeks are generally dry; the lower Cooper flows once every 2-5 years, and flows in the Strzelecki occur even less frequently. The current access to the Christies well crosses Cooper Creek, in an area where the creek is very broad and there is no well defined main channel. Tankers transporting oil from the Aldinga site to Moomba will cross the Strzelecki Creek causeway while travelling on the Cameron Corner road.

3.6 Waste Management

Beach recognises that waste management is an important issue and consideration which will continue to be incorporated into construction, operation and abandonment phases of development. Beach strives to prevent pollution by reducing the use of energy, water, material resources, and recycling waste where possible. To achieve these goals Beach continually assesses product usage and production processes to achieve sustainable production by reducing waste emissions at the source.

Beach is responsible for the management of all wastes it generates and for its disposal in accordance with regulatory requirements and industry standards. Waste from operations is generated from two main

streams; operation waste and domestic waste (Table 5 and Table 6), volumes of waste will be recorded and reported annually to PIRSA.

Table 5: Typical Waste Streams - Operation Waste

Waste Type	Disposal
Gaseous Waste	▪ Vented – gas, CO_2, H_2S, CO ▪ Generator and vehicle emissions
Produced Formation Water	▪ Interceptor pits and then to evaporation ponds/ infiltration basins
Oily Sludge	Sludge pit, then to: ▪ LTU, then landfill; or ▪ Recovered to process
Tank Bottom Sludges	▪ Sludge pit and then to LTU or recovered to process
Pig-Receiver/ Slugcatcher Scale	▪ Rust scale and sludge to sludge pit and then to LTU
Contaminated Soil	▪ Treated with fertilisers in situ ▪ Stockpiled at Landfarm for use in LTUs
Hydrotest Water	▪ Recycled for each hydrotest section ▪ Evaporation pond
Used Chemical Drums	▪ Licensed Waste Depot and recycled where possible
Chemical Waste	▪ Licensed Chemical Waste Depot
Scrap Metal	▪ Recycled where possible or added to landfill
Timber Pallets (Skids)	▪ Recycled where possible
Vehicle Tyres	Waste Depot: ▪ Shredded and added to land fill
Asbestos	▪ No current asbestos waste ▪ Asbestos waste depot

Table 6: Typical Waste Streams - Domestic Waste

Domestic Waste	Disposal
Storm water runoff (camp)	▪ Runoff to vegetation
Sewage	▪ Treated at facility in Envirocycle/Biocycle. Treated liquid to infiltration pit
Grey water	▪ Treated at facility in Envirocycle/Biocycle or to infiltration pit
Food waste, paper and plastic	▪ Incinerated, remainder to land fill ▪ Stored in 44 Gallon drums
Glass and Cans	▪ Landfill
Workshop Waste (rags, filters)	▪ Incinerated, remainder to landfill

3.6.1 Landfill – Domestic Waste

Beach does not currently operate landfill sites in South Australia. Any waste disposed to landfill is taken to appropriately licensed landfills (e.g. Moomba, south-west Queensland).

If landfill sites were required to be developed in the future, they would be sited in a suitable, stable area, distant from watercourses or floodplain areas. Landfill areas would be operated in accordance with EPA guidelines. Soil and groundwater monitoring would be undertaken. The site would be covered and fenced with an appropriate material to prevent the spread of rubbish from the site by wind. The fencing would also need to be stock and wildlife proof. Rubbish would be buried immediately to facilitate degradation and reduce offensive odours and aesthetic impacts.

Establishment of a landfill site would require approval by the EPA and consultation with PIRSA.

3.6.2 Land Treatment / Soil Remediation Areas

Beach Petroleum's operations currently produce little oily waste. Minor spills in lined bunded areas have been treated *in situ* with fertiliser. However, in future it is likely that oily sludge or contaminated soil from spills will need to be removed and treated.

Beach do not currently have a land treatment area in South Australia. The main options for treatment and disposal of oily sludge and contaminated soil are removal to Beach Petroleum's soil remediation areas in Queensland or to the Santos land treatment unit in Moomba.

It is possible that Beach will need to establish a land treatment site for soil remediation at some stage. A land treatment site would treat oily waste by mixing with existing soil, with the aim of breaking down oil by evaporation, photochemical processes and biological action of naturally occurring soil micro-organisms. Once hydrocarbons are broken down, soil would be transported by truck to appropriate disposal location.

If required, a land treatment site would be located away from watercourses, floodplains or areas of shallow groundwater. Establishment of a land treatment site would require approval by PIRSA and the EPA. The land treatment site would be an impermeable, bunded and fenced area, which would require strict monitoring and reporting conditions. Licensing requirements would need to be confirmed with PIRSA and EPA.

3.6.3 Temporary Product Storage Pits

Product storage pits may be required to temporarily store product from a flowing well during some production operations. This practice is avoided if possible however it may be required for emergency purposes.

These pits would be constructed in accordance with procedures being developed for the Production Operations Manual (refer Section 5.8.3) that will detail requirements for planning, location and operation of pits (e.g. to ensure safety and avoid/minimise impacts to vegetation, heritage, soil and water).

Product stored in the pits would be either removed by vacuum truck for reprocessing or disposal to a land treatment area, or flared in the pit. Pits would be lined, with an adequate layer of soil to prevent damage to the lining during product flaring. On completion, contaminated soil would be removed for remediation and the pit backfilled.

Establishment of a temporary product storage pit would require approval by PIRSA.

4 Existing Environment

The Cooper Basin covers a total area of 130,000km² of which approximately 50,000km² lies within north-eastern South Australia. It is an arid environment, with the climate characterised by hot dry summers, mild dry winters and low and variable rainfall.

The environment of the Cooper Basin has been extensively reviewed in the SACBJV Production and Processing EIR (Santos 2003). It presents detail on the following aspects of the Cooper Basin environment:

- climate
- soils and landform
- hydrology
- flora and fauna
- geology and hydrogeology
- aquifer use
- Aboriginal and non-Aboriginal heritage
- land use, and
- socio-economic environment.

The information presented in Santos (2003) is not repeated in this document. This chapter provides site specific detail is on the environment within Beach Petroleum's exploration leases and production operation areas.

4.1 Land Systems

Beach Petroleum's PELs contain the six major land systems found in the Cooper Basin. They are:

- dunefields
- floodplains
- wetlands
- salt lakes
- tablelands, and
- gibber plains.

These land systems are defined by geological, geo-morphological and hydrological influences. The distribution of these land systems across the Cooper Basin is shown in Figure 3.

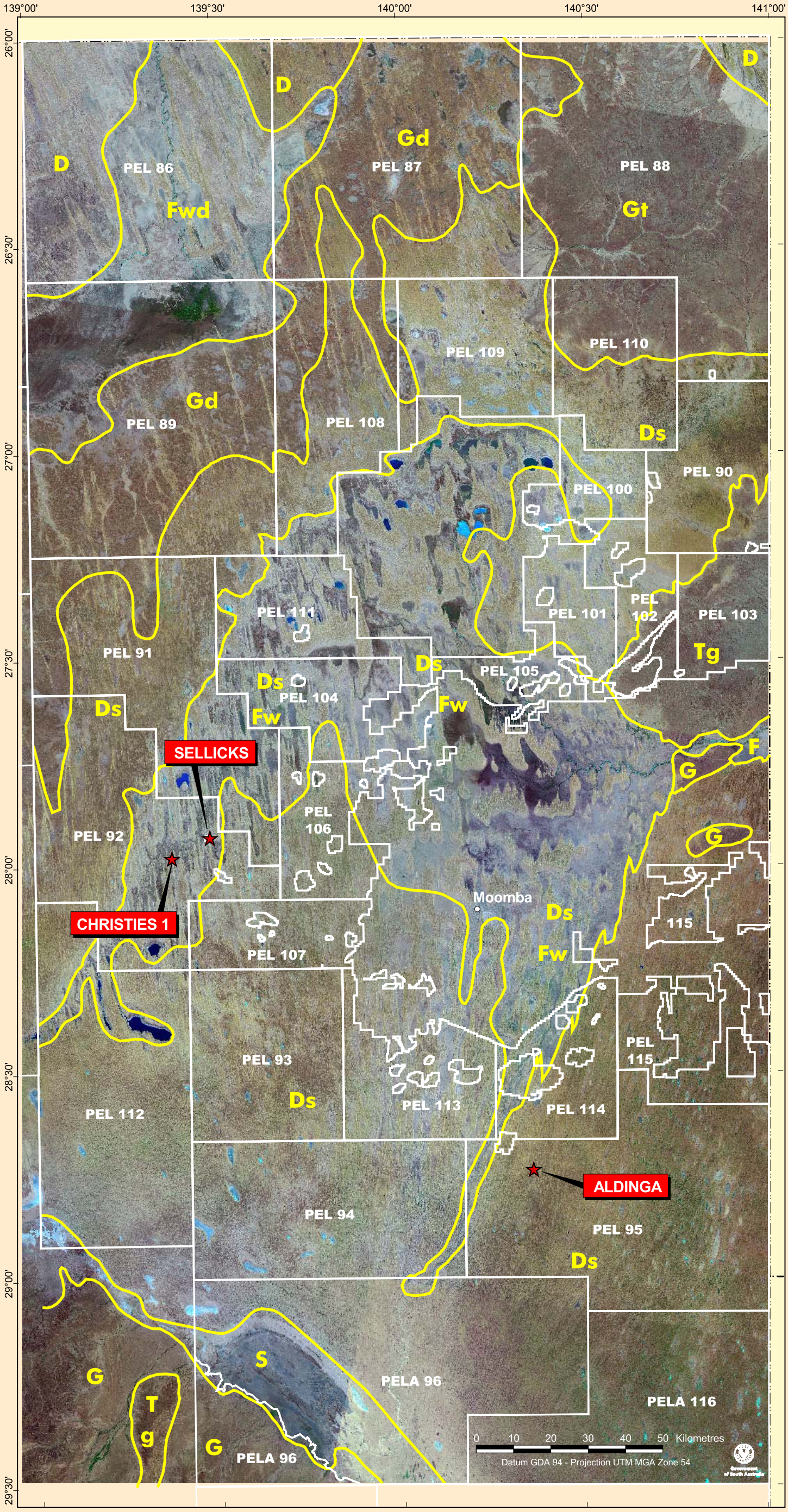
Figure 3: Land Systems, PELs and Beach Facilities in the Cooper Basin

BEACH PETROLEUM

Cooper Basin - South Australia

BEACH PETROLEUM OIL PRODUCTION FACILITIES

PRIMARY INDUSTRIES AND RESOURCES SA



DESCRIPTION
Generally parallel dunes of red or yellow sands of height 5-20 m separated by flat interdune corridors which are often sandy, but due to limited internal drainage also often contain claypans. In inter-dune corridors where infiltration is limited salt lakes are sometimes present. In the Cooper Basin in the dunes trend approximately north-south.

COMMONLY SUB-DOMINANT LAND SYSTEMS
Salt lake Floodplain Gibber plain

SOILS
Dunes: red-yellow siliceous sands
Swales: red massive earths or grey self-mulching cracking clays

VEGETATION
Dunes: tall shrubland of marpoo, white-wood and hakea, and hummock grass-land of spinifex and sandhill canegrass
Swales: chenopod shrubland and grassland

DESCRIPTION
The extensive flood-out areas adjacent to Cooper Creek, Strzelecki Creek, Wilson River and the Diamantina River. The floodplains are periodically inundated when the creeks and rivers overflow their banks. They are characterised by grey sediments which are deposited on the plains by floodwaters. In places, dunes are either co-dominant or occasionally present.

COMMONLY SUB-DOMINANT LAND SYSTEMS
Dunefield Wetland Salt lake

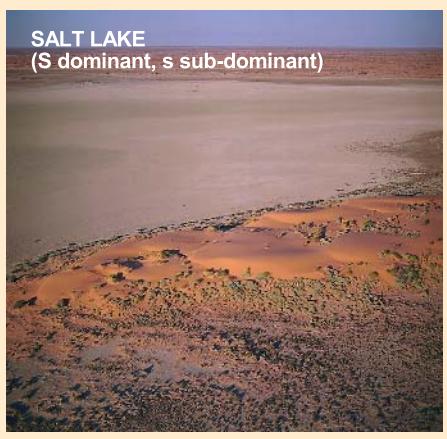
SOILS
Grey self-mulching cracking clays

VEGETATION
Open woodland of river red gum, coolibah and gidgee with an understorey of lignum, chenopod shrubland and grasses

DESCRIPTION
The channels, waterholes, swamps and lakes associated with Cooper Creek, Strzelecki Creek, Wilson River and Diamantina River. Some of the waterholes always contain water, but the channels, swamps and lakes are frequently dry. They are located on or close to the main watercourses an are therefore inundated more frequently than the surrounding floodplain.

SOILS
Grey self-mulching cracking clays

VEGETATION
Open woodland of river red gum, coolibah with an understorey of lignum and chenopod shrubland



DESCRIPTION
Terminal lakes or pans of varying sizes where evaporation has resulted in the concentration of soluble salts as a surface crust. They are periodically inundated, but are usually dry

SOILS
Salty overlying grey self-mulching cracking clays

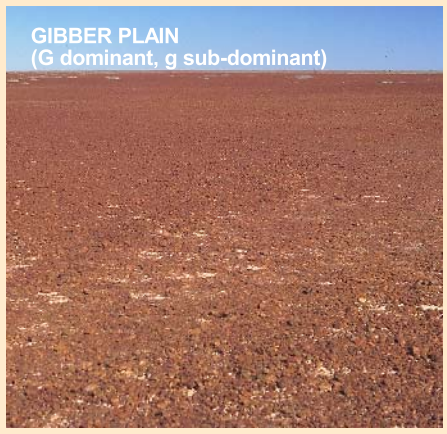
VEGETATION
Chenopod shrubland or completely bare

DESCRIPTION
Uplifted and eroded gibber plains that have resulted in the formation of low, but steep silcrete capped hills, escarpments and mesas and extensive gibber covered footslopes. The tablelands are separated by undulating gibber plains. The highly polished stones or gibbers are usually embedding in a clayey crust, thereby protecting the underlying soil from erosion

COMMONLY SUB-DOMINANT LAND SYSTEMS
Gibber plain

SOILS
Slopes: crusty red duplex soils and brown self-mulching cracking clays
Rises: reddish powdery calcareous loams

VEGETATION
Slopes: low tall open shubland
Drainige lines: low woodland of mulga, red mulga and gidgee
Plains: low open shrubland and open



DESCRIPTION
An undulating stony plain, sometimes with the occasional small dune or small silcrete capped mesa. The highly polished stones or gibbers are usually embeddedin a clayey crust, thereby protecting the underlying soil from erosion

COMMONLY SUB-DOMINANT LAND SYSTEMS
Tableland Dunefield

SOILS
Crusty red duplex soils

VEGETATION
Plains: low open shrubland and open grassland of Mitchell grass
Drainage lines: low woodland of gidgee and mulga

LAND SYSTEMS and PETROLEUM EXPLORATION LICENCES

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Dunefields are widely spread throughout the South Australian Cooper Basin. Dunefields are the dominant land system within Beach Petroleum PELs. The EPBC (Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*) listed threatened Dusky Hopping Mouse has been recorded from dunefields near the Strzelecki Creek.

Floodplain – the Cooper Creek floodplain covers the central third of the basin and intersects most Beach PELs. It includes the Coongie Lakes system to the north and the Strzelecki Creek floodplain that feeds Lake Blanche in the south. The Cooper Creek floodplain occurs in close association with the dunefields of the basin. Woodlands in floodplain areas constitute important habitat for many bird species, including raptors. Flooding frequencies decrease from annual in the upper Cooper and Coongie Lakes to once every 2-5 years or more in the lower Cooper Creek (refer Santos 2003).

Wetlands – the Cooper Basin contains an array of wetlands, fed by flows from the Cooper Creek. Beach PELs intersect both the Coongie Lakes and the Strzelecki wetland systems, which have been included in the directory of nationally important wetlands. The Coongie Lake system is also listed under the Ramsar Convention as a wetland of international importance to waterfowl (Morton *et al.* 1995, Blackley *et al.* 1996). Numerous species of migratory birds listed under the EPBC Act utilise these areas.

Salt lakes and salt pans of varying sizes are dotted throughout the basin and Beach PELs. In these lakes excess evaporation in interior basins leads to the concentration of soluble salts as a surface crust.

Tablelands are commonly known as dissected residuals or breakaways. They are characterised by a silcrete surface that has been eroded to form low but steep escarpments, mesas, buttes and extensive gibber covered foot slopes (Santos 1997).

Gibber Plain – throughout the Cooper Basin there are vast expanses of flat to gently undulating gibber covered plains and downs such as the Sturt Stony Desert and the Innamincka or Wadi Wadi Dome (Santos 1997). Gibber Plain is found within the more northern Beach PELs (PEL 91 and PEL 110).

The sensitivity of each land system to disturbance depends upon its basic characteristics of geology, landform, soils, hydrology, flora and fauna. The Santos EIR (Santos 2003) discusses each land system in detail with respect to these characteristics.

The environment within Beach Petroleum PEL areas is summarised in Table 7.

Table 7: Land Systems and Environmental Features in Beach PELs

PEL	Land System(s)	Significant Environmental Features
91	Dunefield, floodplain, wetland, salt lake, gibber plain	Cooper Creek, Ramsar area
92	Dunefield, floodplain, wetland, salt lake, gibber plain	Cooper Creek, Ramsar area
94	Dunefield, floodplain	Strzelecki Creek, Dusky Hopping Mouse (EPBC), Strzelecki Regional Reserve
95	Dunefield, floodplain	Strzelecki Creek, Dusky Hopping Mouse (EPBC), Strzelecki Regional Reserve
107	Dunefield, floodplain	Cooper Creek floodplain (margins)
110	Dunefield, gibber plain	Innamincka Regional Reserve
116 (Application)	Dunefield	Dusky Hopping Mouse (EPBC)

Beach is confident that significant impacts to listed threatened species, communities and migratory species that are likely to occur in the Cooper Basin region (refer Santos 2003) can be avoided, due to the nature and limited area of production activities and the management measures in place.

4.2 Beach Production Facilities – Environment Description

4.2.1 Sellicks

The Sellicks facility is located on Waukatana station, which is part of Mungeranie station. It is located in a floodplain land system, approximately four kilometres from the main channel of Cooper Creek. The site is located on a flat flood-out area, which extends north, east and south of the site. The site is flanked by a low, gently rising sand dune to the west. Soils on the flood-out area are grey friable, self-mulching silty clay loam. The soil profile is homogeneous and extends to a depth of at least 3m.

The site lies within the ten-year flood boundary of the Cooper Creek. Flooding of the site can be expected to occur, on average, at intervals of two to five years. Anecdotal evidence and watermarks on trees suggests recent floods have reached a height of 30-50cm on the floodplain, but that major floods have been much higher.

Vegetation at the site is dominated by a low open shrubland of chenopods (including bindyi, *Sclerolaena* spp. and fan saltbush, *Atriplex annulata*) and grasses such as mulka (*Eragrostris dielsii*) and rat-tail couch (*Sporobolus mitchellii*). Slightly higher ground contains coolibah (*Eucalyptus coolibah*), lignum (*Muehlenbeckia florulenta*) and nitre bush (*Chenopodium nitrariaceum*). No species of particular conservation significance were recorded at the site. If such species are present, they are associated with common habitat and can be expected to be widespread in the region.

Aboriginal heritage clearances have indicated that the flood-out area does not contain material of heritage significance. However, the sandy rise and low sand dune to the west and north-west is known to be of Aboriginal heritage significance and access to this area by Beach personnel is restricted.

Proposed PFW Pond

The proposed evaporation pond would be located to the east of the facility, on adjacent level ground, as shown in Figure 4 and Plate 1. This area is vegetated by low open chenopod shrubland and fringed by open coolibah woodland. The location has been chosen to minimise impacts to vegetation and avoid impacts to known Aboriginal heritage sites to the west of the facility.

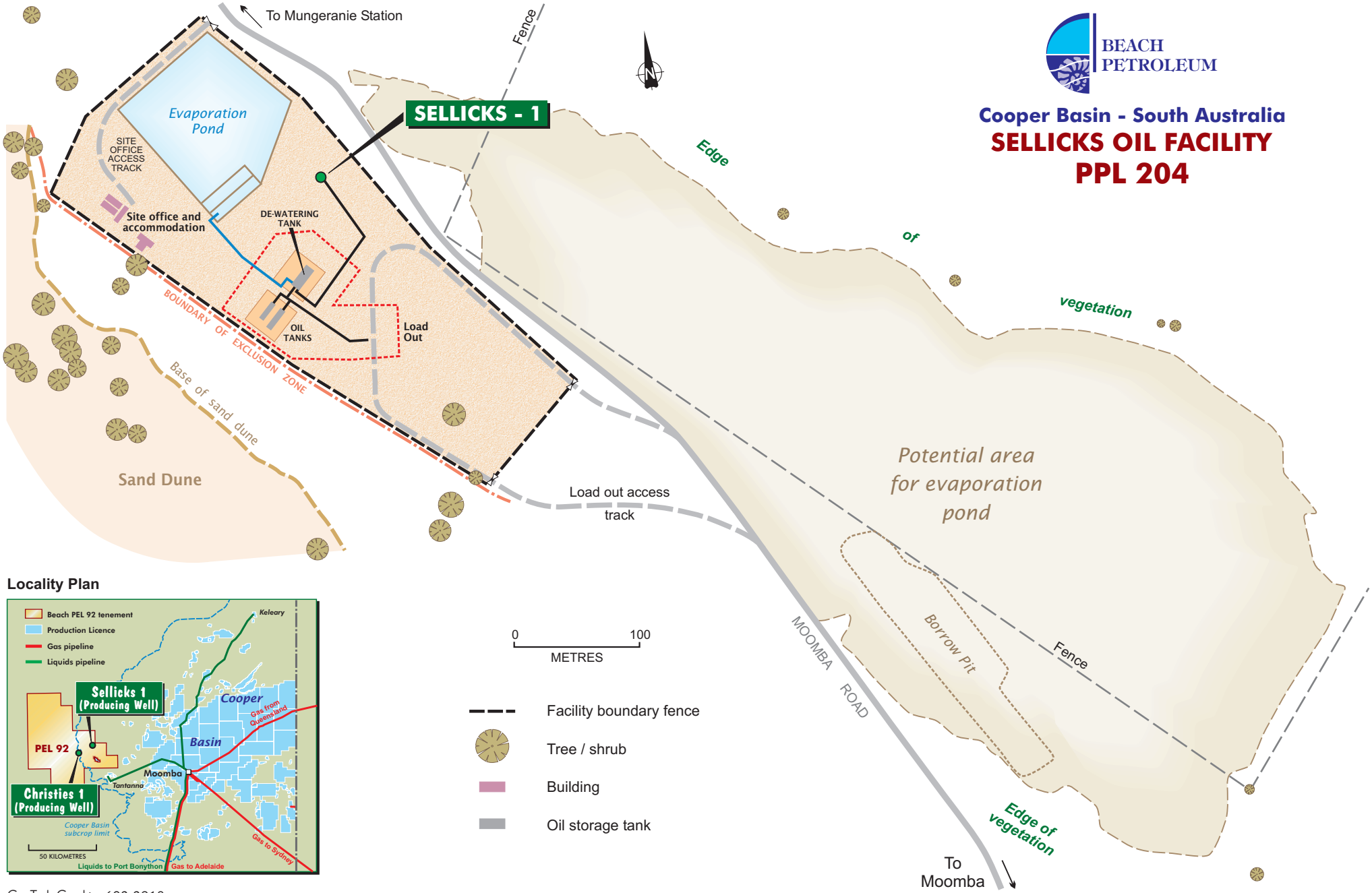
Plate 1: Sellicks area with proposed evaporation pond area in foreground, facing north-west

Figure 4: Plan of Sellicks Facility and Environs

BEACH PETROLEUM

Cooper Basin - South Australia

SELLICKS OIL FACILITY
PPL 204



Locality Plan

GeoTech Graphics 602-2918

4.2.2 Aldinga

The Aldinga facility is located in an expansive dunefield land system, approximately 15km east of the Strzelecki Creek. The site is located in a sandy swale, which slopes gently to the south. It is bounded by sand dunes on the north, west and east sides of the drill pad.

Soils in the swale are medium to coarse grain sand with clay lenses. At the time of inspection, minor earthworks to rehabilitate and reduce the area of drill pad and turkeys nest were yet to be undertaken. Soils on and adjacent to the drill pad showed evidence of erodibility.

The Aldinga site is distant from any watercourses or drainage systems and not subject to flood inundation.

Vegetation in the swale is dominated by an open shrubland of elegant wattle (*Acacia victoriae*), chenopods and grasses, while the adjacent sand dunes are dominated by marpoo (*Acacia ligulata*) chenopods and grasses. No species of particular conservation significance were recorded at the site. If such species are present, they are associated with common habitat and can be expected to be widespread in the region.

The sand dunes to the north, east and west of the site are currently designated as Aboriginal heritage "no-access" areas.

The Aldinga facility is located on Merty Merty Station.

Plate 2: Aldinga site, showing beam pump and sand dune to west of well

4.2.3 Christies

The Christies site is located on the edge of a dunefield land system. A flood-out area of the Cooper Creek extends from the northern limits of the well site to the channel of Cooper Creek, located approximately 2.5km to the north. The site is located adjacent to a north-south running dune, on the

dune slopes and sandy swale. Soils on the site are fine-grained, yellow siliceous sands, which tend towards a sandy clays in the lower depressions areas (e.g. near access road).

Although the site is adjacent to a flood out area, the elevation of the site above the floodplain (at least 1-2m), the sandy soil and the lack of floodplain plant species indicate that inundation of the site is an uncommon event. It is possible that inundation of the site may occur in extreme Cooper Creek flood events.

The site is vegetated by an open shrubland dominated by marpoo (*Acacia ligulata*), sandplain wattle (*Acacia murrayana*), chenopods and grasses. No species of particular conservation significance were recorded at the site. If such species are present, they are associated with common habitat and can be expected to be widespread in the region.

An area to the north of the site is currently designated as a heritage no-go area.

The Christies site is located on Waukatana station, which is part of Mungeranie station.

Plate 3: Aerial photograph of Christies well site (during drilling), facing north

4.3 Land Use and Tenure

The major land uses in Beach Petroleum PELs in the Cooper Basin are pastoralism, oil and gas exploration production, conservation and tourism. Detailed information on land use and land tenure is provided in the Santos Environmental Impact Report: Production and Processing Operations (2003).

Pastoral Properties

The main pastoral enterprise in the region is beef cattle production on native pasture. Pastoral properties and landholders within the Beach operational area are outlined in Table 8.

Table 8: Pastoral Properties within Beach PELs

Station	Landholder / Manager
Merty Merty	Rieck
Bollards Lagoon	Rieck
Tinga Tingana	Ogilvy
Murnpeowie	Barnes
Lake Hope (Mulka)	Santos Ltd (property is part of Mulka station)
Waukatana	Betts (property is part of Mungeranie)
Gidgealpa	Santos Ltd
Clifton Hills	Weston
Cordillo Downs	Brooke

There are currently four properties that have achieved certification by the National Association for Sustainable Agriculture Australia (NASAA) for organic beef production and there are several producers at the conversion stage. Beach operates or holds PELs on several properties that have either obtained a level of certification or are in the process of conversion to NASAA Organic Beef Exporters (OBE). These include Bollards Lagoon, Merty Merty, Mungaranie and Cordillo Downs. The OBE guidelines identify the maximum levels of chemicals allowable in soil, consistent with allowing organic certification for beef exports.

All landholders in the Beach operational region are also certified under the Cattle Care Quality Assurance system. Cattle Care is an initiative of the Cattle Council of Australia and places emphasis on minimising the risk of chemical contamination, bruising and hide damage and ensuring that herds are effectively managed and improved. In particular, the contamination of property and livestock by organochlorines and other persistent chemicals must be minimised, and contaminated cattle identified. Prevention of bruising and hide damage puts the onus on landholders to manage the property carefully and reduce the risk of damage from foreign bodies.

On these properties any spill sites will be fenced to exclude stock access and no fertiliser will be added in the site remediation process without permission of the landholder.

Conservation

The main conservation reserves in the region are Innamincka Regional Reserve and Strzelecki Regional Reserve[2]. Regional Reserves are areas proclaimed for the purpose of conserving wildlife, natural or historical features while allowing responsible use of the area's natural resources (including oil and gas production). Both these reserves fall within Beach PELs.

Part of the Cooper Creek system has been proclaimed as the Coongie Lakes Wetland of International Importance under the Ramsar Convention. This Ramsar wetland is defined by Lake Moorayepe to the north, the Queensland border at the crossing of Cooper Creek to the east, and a point south west of Lake Hope. It is estimated that the Coongie Lakes Wetlands Ramsar area covers 30% of the known oil and gas resources within the South Australian portion of the Cooper Basin (DEHAA 1999). The Coongie Lakes and adjacent area, and the Cooper Creek Floodplain are both registered on the National Heritage Register.

[2] The extension of Strzelecki Regional Reserve onto Tinga Tingana station has not yet formally been transferred to the reserve.

Consultation will be undertaken with DEH, DWLBC and other relevant stakeholders with regards to minimising the identified potential impacts of production operations on the reserve.

Following the completion of production operations the affected areas of the reserve will be rehabilitated to an appropriate standard following consultation with regulators and other relevant stakeholders.

Oil and Gas Production

The actual area of land utilised for gas production is small, but the supporting infrastructure extends throughout much of the central and north eastern portion of the Cooper Basin in South Australia (Marree Soil Conservation Board 1997). Producing oil and gas fields are spread through pastoral lands, regional reserves and the Ramsar wetlands.

The predominant petroleum company in the area is Santos Ltd, operating a large number of wells, a total of 24 gas and oil satellites, the Moomba petroleum processing plant and associated infrastructure.

4.4 Native Title

There are currently three Native Title Claims in the South Australian Cooper Basin. Details of each claim are presented in Table 9.

Table 9: Native Title Claims in the South Australian Cooper Basin

Title	Location	Approx. Size (km²)	Native Title Tribunal Status	Representative
Yandruwandha/ Yawarrawarrka Native Title Claim	North east corner of South Australia (SA) extending south to Lake Blanche. Includes PELs 94, 95 and 100	40,304	Registered	Aboriginal Legal Rights Movement Inc.
The Edward Landers Dieri People's Native Title Claim (now known as the Ngayana Dieri Karna Native Title Claimant Group)	From Marree in the south to Cameron Corner in the east, to Hodden Corner in the north east, following the Qld border to Lake Teetatobie, south west of Gypsum Cliff, west to Lake Eyre, south to Marree. Includes PELs 91, 92, 94 and 107	87,733	Finalised – dismissed	Aboriginal Legal Rights Movement Inc.
Wangkangurru / Yarluyandi Native Title Claim	Northern SA and Quaeensland. Includes north-western corner of PEL 91	95,869	Registered	Carpentaria Land Council Aboriginal Corp, Aboriginal Legal Rights Movement Inc.
Dieri Mitha	An area in the north-east part of SA including Lake Eyre, parts of the Simpson Desert, the Warburton River and Cooper Creek region and Lake Blanche	119,445	Not accepted for registration	Aboriginal Legal Rights Movement Inc.

Beach Petroleum have Native Title agreements with the Yandruwandha/ Yawarrawarrka and the Edward Landers Dieri People's Native Title claimant groups, and maintain a good working relationship with the groups. Before Beach conducts activities within Native Title Claims, representatives from the relevant group are engaged to undertake work area clearances.

5 Environmental Risks – Assessment and Minimisation

There are a range of potential environmental risks inherent in petroleum production operations. This chapter provides an assessment of environmental risks associated with Beach Petroleum's operations in the Cooper Basin. Section 5.1 provides an overview of the risk assessment methodology. Sections 5.2, 5.3, 5.4, 5.5, 5.6 and 5.7 contain descriptions of hazards and tabular summaries of risk assessments and management strategies for Beach Petroleum's operations and activities in the Cooper Basin. Each risk assessment table outlines:

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

5.1 Overview of Risk Assessment Process

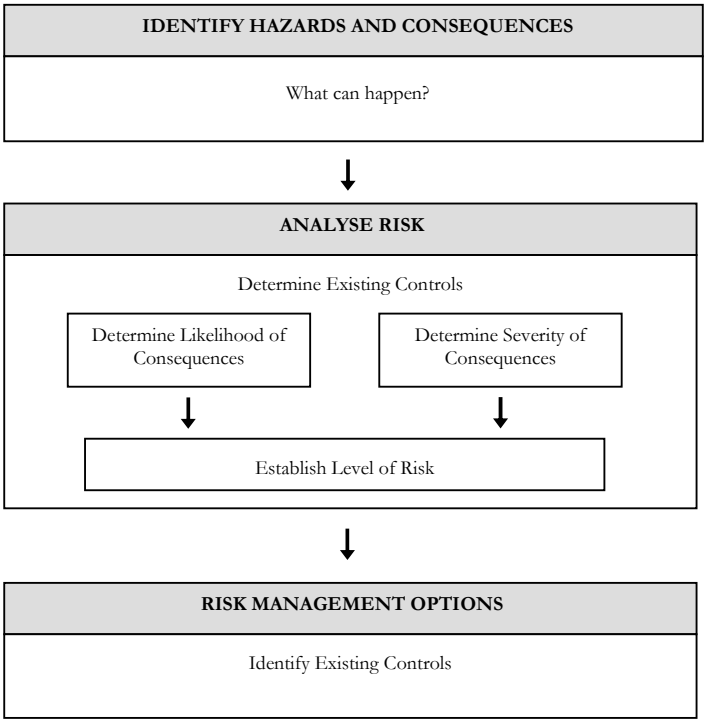
Environmental risk assessment is the process of identifying environmental hazards, analysing the likelihood and severity of the potential consequences and determining the resulting level of risk.

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.

Given appropriate management measures, most risks can be avoided or reduced to a level that is acceptable or as low as reasonably practical (ALARP). However, in some cases there may still be 'residual' risks that are retained 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 in Figure 5 (after Stoklosa 1999).

Figure 5: Framework for Environmental Risk Assessment



Risk assessment may be undertaken to various degrees of refinement depending upon the information and data available. In this assessment, the frequency and severity of potential environmental consequences have been assessed on the basis of existing information and operating experience. Because quantitative information is not available with regard to all activities and associated consequences, 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). It has been derived from Stoklosa (1999) and the Australian/New Zealand Standard for risk management (AS/NZS 4360:1999).

The phases of the risk assessment undertaken in this report are further discussed in the following sections.

5.1.1 Identification of Hazards and Consequences

A hazard is considered to be any source of potential environmental harm, or a situation or event with potential to cause loss (AS/NZS 4360: 1999). To identify hazards, the various activities associated with each aspect of operations (e.g. production facilities, flowlines) were considered. The events that could lead to a hazardous situation and the possible consequences of these events were then identified.

Where possible, environmental hazards and potential consequences have been identified and assessed using existing information on the magnitude and/or frequency of activities and incidents associated with Beach Petroleum's Cooper Basin operations. However, this information is not available for many aspects of the operations. Where this is the case, environmental hazards and possible consequences have been evaluated on the basis of petroleum industry experience, particularly Santos Ltd's long term operation in the Cooper Basin.

The environmental hazards that have potential to result in the most significant environmental consequences in the Cooper Basin are:

- storage and disposal of wastes (e.g. PFW and oil sludge)
- accidental spills or leaks associated with:
  - flowline failure
  - transport or storage of oil, fuels and chemicals
- disposal of domestic and chemical waste and contaminated soil
- emissions vented from facilities, and
- earthworks and vegetation clearing associated with flowline and road construction.

Key potential environmental consequences associated with the above hazards are:

- contamination of soil, groundwater and/or watercourses
- atmospheric pollution
- soil erosion and disturbance to natural drainage patterns
- disturbance to Aboriginal and non-Aboriginal cultural heritage sites
- loss of native vegetation and habitat
- introduction and/or spread of weeds, pest plants, animals and pathogens
- disturbance or injury to native fauna, and
- personnel injury or loss of life.

5.1.2 Assessment of Likelihood

The likelihood of occurrence of potential environmental consequences have been qualitatively assessed and categorised according to the criteria outlined in Table 10. In this report, the likelihood of occurrence of environmental consequences has been assessed in the context of current management practices and planned revisions to environmental procedures and the EMS (refer Section 5.8).

Table 10: Categories of Likelihood

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

5.1.3 Assessment of Severity

Environmental consequences can be categorised from negligible to disastrous, using the qualitative methodology described by Stoklosa (1999) and are outlined in Table 11. These consequences are based upon definitions contained in AS/NZS 4360, but have been expanded to incorporate impacts to environmental values such as flora, fauna and biomass of biota.

In this report, the severity of environmental consequences has been assessed in the context of current management practices and planned revisions to environmental procedures and the Environmental Management System (refer Section 5.8).

Table 11: Categories of Severity

Severity	Qualitative Description of Environmental Consequences
Negligible	Possible incidental impacts to flora and fauna in a locally affected environmental setting but without ecological consequence. Possible minor and temporary changes to soil and water quality in a locally affected environmental setting.
Minor	Changes to the abundance or biomass of biota, and existing soil and/or water quality in the affected environmental setting, but no changes to biodiversity or ecological function.
Major	Changes to the abundance or biomass of biota, and existing soil and/or water quality in the affected environmental setting, with local changes to biodiversity but no loss of ecological function.
Severe	Substantial changes to the abundance or biomass of biota, and existing soil and/or water quality in the affected environmental setting with significant change to biodiversity and change of ecological function. Eventual recovery of ecosystem possible, but not necessarily to the same pre-incident conditions.
Disastrous	Irreversible and irrecoverable changes to abundance/biomass in the affected environmental setting. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions.

5.1.4 Determination of Risk

The likelihood and severity of consequences of a given hazard are combined to produce a level of risk. Table 12 shows an environmental risk matrix that defines the levels of risk used in the assessment. It is based on Stoklosa (1999).

Table 12: Matrix Defining Levels of Risk

			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

5.2 Production Facilities

There are a number of environmental hazards associated with the operation of oil (or gas) production facilities. They include production of atmospheric emissions (via fugitive, flare and venting sources), loss of containment of oil and storage of chemicals and fuels and are outlined in Table 13.

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

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

Quantitative estimates for fugitive emissions and combustion by-products are not available.

There is the potential for accidental spills or leaks of small amounts of process chemicals (e.g. PFW emulsion breakers), cleaning chemicals or fuels during storage or handling and use. Accidental spills/release of oils may also occur as a result of flowline failure or leaks from equipment such as the inlet header, pipeline connection or plant valves. There is also a potential for accidental overflow of oil storage tanks at production facilities.

Leaks, spills and overflows can potentially lead to localised contamination of soil within the plant site and may be a potential ignition source for fire. The risks associated with leak or spill hazards are minimised through appropriate storage and containment and implementation of storage and handling procedures. All chemicals and fuels (including oil storage tanks and waste sump oil pits) are stored on impervious bunded surfaces.

Flooding of surrounding floodplain and/or watercourses can lead to contamination of soil and water, particularly if flood levels are high enough to overflow bunded areas. Flooding is likely to occur within the lifetime of facilities such as Sellicks that lie within the 10 year flood boundary of the Cooper Creek. Severity of consequences is minimised by shutting down and cleaning up facilities in advance of Cooper Creek flooding (which can be predicted several months in advance) as outlined in Table 13.

Some Beach facilities (e.g. Sellicks) have, or will have, accommodation and offices to house employees working at the facility. The primary hazards associated with these facilities are the storage of domestic waste and sewage. These hazards are dealt with in Section 5.7.

Table 13: Production Facility Risk Assessment

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Explosion or fire at the production facility	▪ Danger to health and safety of employees, contractors and possibly the public ▪ Contamination of soil and/or watercourse ▪ Atmospheric pollution ▪ Burning vegetation and habitat	▪ All production facilities are designed and constructed in accordance with relevant standards ▪ Safety, testing, maintenance and inspection procedures are implemented ▪ Establishment of appropriate emergency/spill response procedures for explosion or fire ▪ Personnel are trained to supervise and instruct individuals entering area to conduct work ▪ Appropriate fire fighting equipment at all production facilities ▪ Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works ▪ Safe smoking areas away from equipment or activity ▪ Erection of fencing and signage to delineate restricted/hazardous areas ▪ Petrol vehicles to be excluded from restricted areas ▪ Immediate clean up and remediation to minimise contamination to soil/water	**Major**	**Unlikely**	**Medium** Risk inherent in nature of operations, however it has been reduced to As Low As Reasonably Practical (ALARP) by management measures

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Flooding of surrounding floodplain / watercourses ***All facilities***	▪ Contamination of soil, surface water and/or groundwater ▪ Damage to infrastructure (e.g. evaporation ponds) ▪ Access to contaminants by stock and wildlife	▪ Production operations will cease in event of flood inundation. In floodplain land system, the following steps will be undertaken: ▪ Satellite imagery and upstream flood levels used to predict when floodwaters will reach the facility (generally take 3 months to reach lower Cooper) ▪ Storage tanks and flowlines drained, purged and filled with water to reduce buoyancy ▪ Interceptor pit skimmed to remove oil ▪ Oil removed from temporary storage pits ▪ Fuel tanks drained, engines and all hydrocarbons (e.g. fuel and lubricants) removed off-site ▪ Office/accommodation units tied down ▪ Previous major floods of the Cooper have inundated oil fields in the Cooper Basin with no significant environmental impacts	**Negligible**	**Unlikely**	**Low**
Flooding of surrounding floodplain / watercourses ***Sellicks facility***	▪ *As above* ▪ Alteration/restriction of natural flooding patterns in broader area	▪ Facility shut down and secured prior to flooding, as described above ▪ Floodwaters would seep gradually into the area due to the flat topography and distance from the creek (4km). Flooding can be predicted well in advance ▪ Facility has been elevated above the floodplain – interceptor pit, evaporation pond and storage tank bunds are approximately 1m above the floodplain and office/accommodation block is 30cm above the floodplain ▪ In event of large flood overflowing banks of interceptor pit and PFW ponds, dilution of contents would result in very low concentrations of hydrocarbons in flood waters across the Sellicks site[3]	***Minor***	***Likely*** (In major Cooper Creek flood i.e. once every 2-5 years or longer)	***Medium***

[3] Dilution calculations indicate that flooding 1.5m deep over the Sellicks site could result in hydrocarbon concentrations of approximately 5 mg/L over the facility area. This would be further diluted as it spreads away from the site over a larger area and breaks down. *Assumptions:* Sellicks facility area 50ha, interceptor pit 0.05ha, holding ponds 1ha, evaporation pond 20ha. Pit and holding ponds 1m deep, evaporation pond 0.5m deep, hydrocarbon concentrations 50 mg/L in interceptor pit and 30 mg/L in PFW ponds. Note: PIRSA criteria (refer Santos 2003) for allowable hydrocarbon concentration is 30mg/L in bunded ponds is and 10mg/L in water entering a natural disposal area (e.g. free form evaporation pond).

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
		▪ Restriction of flood flows minimised by siting of proposed large pond to allow passage of flood waters and small size of pond relative to area of floodplain in Sellicks vicinity			
Spills or leaks associated with chemical and fuel storage and handling	▪ Contamination of soil and/or watercourse ▪ Access to contaminants by stock and wildlife	▪ Implementation of appropriate chemical and fuel storage and handling procedures (e.g. bunding and signage) in accordance with relevant standards, including AS1940 and the Australian Dangerous Goods Code (ADG) ▪ Regularly educate staff of product, review and monitor chemical and fuel storage, including signage/labelling, proper packing and tie downs ▪ Establishment of appropriate emergency/spill response procedures ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness ▪ Immediate clean up and remediation to minimise contamination to soil/water ▪ Fencing of contaminated areas if threat is posed to stock or wildlife ▪ Maintain a register of spills and/or leaks and implement corrective actions based on analysis of spill events	**Negligible**	**Unlikely**	**Low**
Tanker Load-out	▪ Contamination of soil and/or watercourse ▪ Access to contaminants by stock and wildlife	▪ Tanker load-out in lined area, with appropriate bunding to contain spills ▪ *As above*	**Negligible**	**Likely**	**Low**
Fugitive emissions of methane and organic carbon	▪ Release of greenhouse gases contributing to climatic warming	▪ Record and report volumes ▪ Continual review and improvement of operations ▪ Very low levels of gas associated with current facilities	**Negligible**	**Likely**	**Low**
Venting of CO_2, H_2S, and CO	▪ Release of greenhouse gases contributing to climatic warming ▪ Atmospheric emissions	▪ Continual review and improvement of operations ▪ Very low levels of gas associated with current facilities	**Negligible**	**Likely**	**Low**

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Venting of gas	▪ Release of greenhouse gases contributing to climatic warming ▪ Atmospheric emissions	▪ Record and report volumes ▪ Continual review and improvement of operations ▪ Very low levels of gas associated with current facilities			
Flaring of hydrocarbons	▪ Release of greenhouse gases contributing to climatic warming ▪ Atmospheric pollution	▪ Record and report volumes ▪ Continual review and improvement of operations ▪ Very low levels of gas associated with current facilities, currently no flaring of gas	**Negligible**	**Likely**	**Low**
Loss of containment of oil outside area designed to contain spills (pipe rupture or leaks from plant equipment)	▪ Danger to health and safety of employees, contractors and possibly the public ▪ Contamination of soil, and/or watercourse ▪ Access to contaminants by stock and wildlife ▪ Loss of vegetation and fauna habitat	▪ All pipelines are designed, constructed and operated in accordance with relevant standards including inspections and maintenance ▪ Appropriate areas (e.g. separator and storage tanks) bunded and lined to contain spills ▪ Personnel are trained to supervise and instruct individuals entering area to conduct work ▪ Establishment of appropriate emergency/spill response procedures for explosion or fire ▪ Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works ▪ Immediate clean up and remediation to minimise contamination to soil/water ▪ Maintain a register of spills and/or leaks and implement corrective actions based on analysis of spill events ▪ Fencing of contaminated areas if threat is posed to stock or wildlife ▪ Preiodic review and exercise of response equipment and procedures to ensure preparedness	**Minor**	**Unlikely**	**Medium** Risk reduced to As Low As Reasonably Practical (ALARP) by management measures
Access and activity of personnel outside designated facility area / work areas	▪ Damage to vegetation and habitats ▪ Damage to cultural heritage sites	▪ Training and induction of all personnel and visitors includes information on restricted areas and activities ▪ Vehicle access restricted to designated roads and areas ▪ Erection of fencing and signage to delineate restricted areas	**Negligible**	**Likely**	**Low**

5.3 Produced Formation Water

The most significant hazard associated with the operation of petroleum production facilities is the storage and treatment of large volumes of produced formation water (PFW). PFW can be highly saline and contain chemicals (both natural and added), residual hydrocarbons and some naturally occurring heavy metals. A preliminary analysis of Sellicks PFW is presented in Table 14. As production of water increases at Beach facilities, monitoring will generate further water quality data.

Table 14: Analysis of Sellicks Produced Formation Water

Analysis	Component	Result	Unit
General data	pH	7.4	pH units
	Total dissolved solids (by EC)	6600	mg/L
	Conductivity	11400	uS/cm
	Dissolved solids by calculation	6710	mg/L
Cations	Calcium	155	mg/L
	Magnesium	24.0	mg/L
	Potassium	51.2	mg/L
	Sodium	2260	mg/L
Anions	Bicarbonate	775	mg/L
	Chloride	3780	mg/L
	Fluoride	1.6	mg/L
	Sulphate	<15.0	mg/L
Nutrients	Nitrate as nitrogen	0.003	mg/L
	Nitrite as Nitrogen	<0.005	mg/L
	Silica - Reactive	48	mg/L
	Nitrate + Nitrite as N	0.008	mg/L
	Nitrate + Nitrite as NO_3	0.04	mg/L
Metals	Arsenic – Total	<0.001	mg/L
	Iron – Total	48.0	mg/L

Potential contamination of soil and groundwater may result from leaks in separation tanks, interceptor ponds and bunded or free form evaporation ponds. Subsurface movement can also lead to mounding of PFW outside of evaporation ponds.

The potential environmental consequences associated with PFW disposal include:

- contamination of soil and near surface aquifers by any carried over hydrocarbon or process chemicals or naturally occurring metals
- the contamination of soil and associated vegetation with salts and metals naturally occurring, but concentrated in the PFW, and
- ingestion of contaminants by native fauna or stock.

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

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

The appropriate approach for determining site specific water quality criteria is currently under review by Santos, PIRSA and the EPA.

Table 15: PFW Storage and Disposal Risk Assessment

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Storage and disposal of PFW at production facilities	▪ Contamination of soil and/or groundwater ▪ Access to contaminants by stock and wildlife ▪ Salinisation of adjacent areas ▪ Death of adjacent vegetation	▪ Site ponds appropriately[4] to minimise potential impacts ▪ Construct ponds using appropriate materials and suitable design criteria for washboard angles, depths etc ▪ Ensure that interceptor pits are appropriately lined ▪ Skim interceptor pits ▪ Ensure that tanks are well maintained and regularly emptied ▪ Do not overfill evaporation ponds ▪ Monitor ponds for surrounding upwelling of PFW ▪ Monitor and audit evaporation pond sludge and water annually ▪ Periodic review of PFW and implementation of audit recommendations: ▪ Fence off contaminated water sources ▪ Repair any damaged fences or gates ▪ Maintain a register of spills and/or leaks and remediate	**Minor**	**Rare** Potential for loss of containment (and therefore likelihood of the consequences) is considered rare	**Low**
Flooding of surrounding floodplain / watercourses	*Refer to Production Facility Risk Assessment (Table 13)*				

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

5.4 Flowlines

Flowline Construction

Environmental hazards associated with flowline construction include movement of heavy vehicles, earthworks, vegetation clearance, fire, spills associated with chemical and fuel storage and waste disposal. Flooding (of the Cooper Creek floodplain and associated watercourses) is also considered to be potential environmental hazard for flowline construction.

Horizontal directional drilling and associated fluids are not considered to be hazards as this method of construction is unlikely to be required for flowline construction activities in the Cooper Basin.

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

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

Wetlands are avoided under most circumstances when planning flowline routes as they are often of high ecological value and sensitivity. Salt lakes are also avoided as rehabilitation is difficult to undertake and they are therefore likely to be severely scarred by flowline construction activities. The potential impacts of specific earthwork activities on different landsystems in the Cooper Basin are summarised in Table 16.

Table 16: Impacts Associated with Earthworks in Various Cooper Basin Landsystems

Landsystem	Activity/Hazard			
	Grading	**Trenching and Backfilling**	**Excavation/Digging (eg. borrow pits)**	**Soil Stockpiling**
Wetlands	N/A	N/A	N/A	N/A
Floodplains	▪ Soil erosion (wind and water) ▪ Soil compaction ▪ Disturbance of natural drainage systems (construction easement restricted to 8m at creek crossings) ▪ Disturbance to cultural heritage sites (generally low density of sites in floodplains)	▪ Disturbance of natural drainage systems (construction easement restricted to 8m at creek crossings) ▪ Inversion of the soil profile ▪ Disturbance to cultural heritage sites (generally low density of sites in floodplains) ▪ Impeded fauna movement	▪ Soil erosion (wind and water) ▪ Disturbance of natural drainage systems ▪ Disturbance to cultural heritage sites (generally low density of sites in floodplains)	▪ Disturbance of natural drainage systems (e.g. saltation) ▪ Soil erosion (wind and water)

Landsystem	Activity/Hazard			
	Grading	**Trenching and Backfilling**	**Excavation/Digging (eg. borrow pits)**	**Soil Stockpiling**
Gibber Plains	N/A	▪ Soil erosion (particularly susceptible to water erosion eg. severe gullying) ▪ Disturbance of natural drainage systems (eg. siltation) ▪ Inversion of the soil profile ▪ Disturbance to cultural heritage sites ▪ Impeded fauna movement	▪ Soil erosion (particularly susceptible to water erosion eg. severe gullying) ▪ Disturbance of natural drainage systems (eg. siltation) ▪ Inversion of the soil profile ▪ Disturbance to cultural heritage sites	▪ Soil erosion (wind and water) ▪ Disturbance of natural drainage systems ▪ Inversion of the soil profile
Tablelands	N/A	▪ Soil erosion (particularly susceptible to water erosion eg. severe gullying) ▪ Soil compaction ▪ Disturbance of natural drainage systems (eg. siltation) ▪ Inversion of the soil profile ▪ Disturbance to cultural heritage sites ▪ Impeded fauna movement	N/A	▪ Soil erosion (wind and water) ▪ Disturbance of natural drainage systems ▪ Inversion of the soil profile
Dunefields	▪ Soil erosion (wind and water erosion) ▪ Disturbance to cultural heritage sites (dunefields near waterholes are typically of high cultural significance)	▪ Soil erosion (wind and water erosion) ▪ Disturbance to cultural heritage sites (dunefields near waterholes are typically of high cultural significance) ▪ Inversion of the soil profile ▪ Impeded fauna movement	▪ Soil erosion (wind and water erosion) ▪ Disturbance to cultural heritage sites (dunefields near waterholes are typically of high cultural significance) ▪ Inversion of the soil profile	▪ Soil erosion (wind erosion) ▪ Inversion of the soil profile
Salt Lakes	N/A	N/A	N/A	N/A

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

Other activities along the construction easement, such as vegetation clearing, can result in loss of vegetation and fauna habitat, siltation of natural drainage lines and watercourses, destabilisation of creek crossings, weed invasion and damage to cultural heritage sites. Vegetation clearance may also impede the movement of fauna within the construction zone. Particular care is taken to ensure that minimal vegetation is cleared in Coolibah woodland during easement preparation. The easement is minimised to 8m in any heavily wooded areas.

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

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

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

Flowline construction generates very little waste. Many materials such as pipe off cuts, rope spacers and timber skids can be reused or recycled. All remaining waste materials are removed from the work area and disposed of at an appropriately licensed landfill.

Flowline Operation

The primary hazard associated with the flowline operation is the loss of containment of oil or high pressure natural gas. During 2000 Santos reported 19 oil spill incidents with a cumulative volume of $30m^3$ of crude oil spilt in the Cooper Basin region (Santos 2003). Accidental spills and leaks may result from flowline failure, which may be caused by:

- heavy vehicle traffic (e.g. collision with an above ground flowline)
- corrosion of the flowline (external or internal)
- natural events which stress the flowline (e.g. flood / earthquake)
- overpressure, or
- metallurgical or construction faults.

Regular inspection of flowlines and monitoring of the performance of cathodic protection devices on buried steel flowlines is undertaken, to ensure that protection levels are adequate. Major flowlines are also regularly pigged to remove water and sludge that accumulates at low points within flowlines. Sludge often supports sulphide reducing bacteria that are a significant cause of internal corrosion of flowlines in the Cooper Basin.

Above ground flowlines are regularly inspected to ensure that they do not come into contact with the ground as a result of soil movement or failure of pipe supports. Where contact occurs 'long line corrosion cells' may form and result in rapid pitting of the pipe and possible flowline rupture.

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

In dry environments, such as dunefields and gibber, the impacts associated with an oil spill are mainly localised, as oil is easier to contain and recover in dry conditions. However, the environmental consequences of oil spills in more sensitive wet environments, like the Cooper and Strzelecki Creeks and surrounding floodplains and wetlands, are potentially significant. Of primary concern are flood conditions that can potentially spread oil over large distances and throughout highly sensitive ecosystems. Santos Ltd is undertaking studies to determine consequences of oil spills in both dry and wet conditions and developing appropriate remediation guidelines (Santos 2003).

Fire and explosion are also possible hazards associated with flowline operation. A fire or explosion along a flowline can pose a danger to personnel, contractors and possibly the public and can potentially produce significant amounts of atmospheric emissions.

Table 17: Flowline Construction Risk Assessment

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Earthworks (e.g. clearing of construction easement, grading, trenching and backfilling)	▪ Injury or death of fauna/stock in construction zone ▪ Introduction and/or spread of weeds ▪ Long term disturbance to natural drainage patterns ▪ Significant damage to third party infrastructure ▪ Soil erosion and siltation of watercourses ▪ Inversion of soil profile ▪ Disturbance to cultural heritage sites	▪ Minimise environmental impact by appropriate route selection to minimise or avoid sensitive land systems, vegetation and cultural heritage sites ▪ Minimise vegetation disturbance, and plan construction avoid vegetated areas ▪ Avoid significant or priority[5] vegetation and ensure proposed routes have been scouted for significant vegetation and wildlife habitats by appropriately trained and experienced personnel ▪ Use existing easements where possible ▪ Liaise with landowners regarding notification and management of works and site issues including livestock management ▪ Observe procedures and guidelines for the identification, management and protection of cultural heritage sites including obtaining heritage clearances by Native Title groups ▪ When establishing line of sight, trim vegetation rather than clearing where possible ▪ Where possible conceal line of sight along access tracks to minimise visual impact ▪ Where possible trim vegetation rather than clearing ▪ Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations ▪ Minimise impacts to fauna by leaving trenched areas open for as little time as possible ▪ Utilise trench plugs and fauna ladders (sticks etc.) to facilitate the movement of fauna out of and across trench ▪ Reinstate construction areas including construction easement as soon as possible ▪ Rip areas of compacted soil (except on gibber	**Negligible / Minor** (Depending on the nature of the consequences – e.g. introduction aggressive noxious weed compared to spread of existing common weed)	**Rare / Unlikely** (Strict implementation of these Management strategies reduce the likelihood of occurrence)	**Low / Medium**
	▪ Dust generation ▪ Soil compaction of the easement ▪ Temporary disruption to land use (e.g. grazing and recreation) ▪ Impeded fauna movement through construction zone ▪ Damage to native vegetation ▪ Temporary loss of visual amenity ▪ Disruption to land use (e.g. grazing and recreation)		**Negligible**	**Virtually Certain**	**Low**

[5] Wiltshire and Schmidt (1997). Summarised in PIRSA's *Field guide for the environmental assessment of newly abandoned seismic lines in the Cooper and Eromanga Basins, South Australia.*

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
		plains and tableland environments) ▪ Respread topsoil and stockpiled vegetation ▪ Restore borrow pits ▪ Restore natural contours to minimise impacts to natural drainage patterns ▪ Stockpile cleared vegetation and respread following construction to facilitate revegetation ▪ Remove waste to minimise visual impact			
Movement of heavy machinery and vehicles along construction easement and access tracks	▪ Dust generation ▪ Soil compaction ▪ Soil erosion ▪ Damage to native vegetation ▪ Injury or death of native fauna ▪ Disturbance to cultural heritage sites ▪ Introduction and/or spread of weeds ▪ Damage to third party infrastructure ▪ Disruption to land use (e.g. grazing and recreation) ▪ Increased public access to remote areas	▪ Use existing cleared areas for laydowns and turn-arounds ▪ Liaise with landowners regarding notification and management of works and site issues including livestock management ▪ Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations ▪ Drive only on access tracks and construction easement ▪ Rip areas of compacted soil (not on gibber plains and tablelands)	**Negligible**	**Likely**	**Low**
Spills or leaks associated with chemical and fuel storage and handling	▪ Contamination of soil, and/or watercourse ▪ Access to contaminants by stock and wildlife	▪ Implementation of appropriate chemical and fuel storage and handling procedures (e.g. bunding and signage) in accordance with relevant standards, including AS1940 and the Australian Dangerous Goods Code (ADG) ▪ Regularly educate staff of product, review and monitor chemical and fuel storage, including signage/labelling, proper packing and tie downs ▪ Establishment of appropriate emergency/spill response procedures ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness ▪ Immediate clean up and remediation to minimise contamination to soil/water	**Negligible**	**Unlikely**	**Low**

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
		▪ Fencing of contaminated areas if threat is posed to stock or wildlife ▪ Maintain a register of spills and/or leaks and implement corrective actions based on analysis of spill events			
Ignition of fire along construction easement	▪ Disturbance to cultural heritage sites ▪ Loss of vegetation and fauna habitat ▪ Release of particulate emissions to the atmosphere ▪ Disruption to land use (e.g. grazing and recreation)	▪ Operation under bushfire permit requirements ▪ Safe smoking areas away from equipment or activity ▪ Personnel are trained to supervise and instruct individuals entering area to conduct work ▪ Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works ▪ Appropriate fire fighting equipment on-site ▪ Petrol vehicles to be excluded from construction sites ▪ Emergency response procedures should contain a bushfire scenario ▪ Safety, testing, maintenance and inspection procedures are implemented ▪ Immediate clean up and remediation to minimise contamination to soil/water	**Minor**	**Rare**	**Low**
Disposal of hydrotest water	▪ Contamination of soil and/or watercourse ▪ Loss of or damage to vegetation and fauna habitat as a result of soil or water contamination ▪ Soil erosion / scouring	▪ Use of biocides and toxic chemicals are kept to a minimum and where practicable UV-degradable biocides (e.g. TPHS) shall be used ▪ Disposal of hydrostatic test water, which contains biocide and other chemicals, may be into existing lined and fenced evaporation ponds, or to specifically constructed pits sited to prevent the contamination or surface or near surface waters	**Negligible**	**Unlikely**	**Low**

Table 18: Flowline Operation Risk Assessment

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Explosion or fire along an oil flowline	▪ Contamination of soil, and/or watercourse ▪ Atmospheric pollution ▪ Loss of vegetation and fauna habitat ▪ Disruption to land use (e.g. grazing)	▪ All flowlines are designed and constructed in accordance with relevant standards ▪ Safety, testing, maintenance and inspection procedures are implemented ▪ Establishment of appropriate emergency/spill response procedures for explosion or fire ▪ Personnel are trained to supervise and instruct individuals entering area to conduct work ▪ Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works ▪ Safe smoking areas away from equipment or activity ▪ Petrol vehicles to be excluded from flowline sites	**Minor** Due to the low volatility and flammability of oil the potential for explosion or fire is considered low, and therefore the potential severity of the consequence minor	**Unlikely**	**Medium** Risk reduced to As Low As Reasonably Practical (ALARP) by management measures
Spill or leak associated with flowline failure to land	▪ Contamination of soil, and/or watercourse ▪ Disruption to land use (e.g. grazing) ▪ Damage to vegetation and habitat ▪ Access to contaminants by stock and wildlife	▪ All flowlines are designed, constructed and operated in accordance with relevant standards ▪ Safety, testing, maintenance and inspection procedures are implemented ▪ High pressure flowlines associated with jet pumps have pressure monitoring/shutdown in case of leak ▪ Establishment of appropriate emergency/spill response procedures for spills or leaks to soil and water ▪ Immediate clean up and remediation to minimise contamination to soil/water ▪ Fencing of contaminated areas if threat is posed to stock or wildlife ▪ Regularly educate staff of product, review and monitor chemical and fuel storage, including signage/labelling, proper packing and tie downs ▪ Maintain a register of spills and/or leaks and implement corrective actions based on analysis of spill events ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness	**Minor**	**Unlikely**	**Medium** Risk reduced to As Low As Reasonably Practical (ALARP) by management measures
Spill associated	▪ Contamination of groundwater, surface water,	▪ All flowlines are designed, constructed and	**Major**	**Unlikely**	**Medium**

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
with flowline failure in a creek bed	soil and other riparian systems ▪ Danger to health and safety of employees, contractors and possibly the public	operated in accordance with relevant standards ▪ Safety, testing, maintenance and inspection procedures are implemented ▪ High pressure flowlines associated with jet pumps not installed across creek beds ▪ Establishment of appropriate emergency/spill response procedures for spills or leaks to soil and water ▪ Immediate clean up and remediation to minimise contamination to soil/water ▪ Fencing of contaminated areas if threat is posed to stock or wildlife ▪ Regularly educate staff of product, review and monitor chemical and fuel storage, including signage/labelling, proper packing and tie downs ▪ Maintain a register of spills and/or leaks and implement corrective actions based on analysis of spill events ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness			

5.5 Road Construction and Maintenance

Major hazards associated with road construction are earthworks, vegetation clearance, chemical and fuel storage and waste disposal. Earthworks and vegetation clearance can potentially result in soil erosion, interruption of natural drainage patterns, disturbance to cultural heritage sites, introduction and spread of weeds and loss of vegetation. Waste disposal and chemical and fuel storage can lead to localised soil or water contamination.

Hazards associated with road maintenance and operation include earthworks (i.e. grading) and introduction of construction material (e.g. fill). Earthworks can potentially disturb natural drainage patterns and lead to soil erosion. Similarly introduction of fill material can result in alteration of drainage patterns and possibly introduction and/or spread of weeds.

Public roads will be maintained, as appropriate, to minimise impacts on other public road users.

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

Table 19: Road Networks Risk Assessment

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Earthworks (e.g. clearing of construction easement, grading, trenching and backfilling)	▪ Injury or death of fauna/stock in construction zone ▪ Introduction and/or spread of weeds ▪ Long term disturbance to natural drainage patterns ▪ Significant damage to third party infrastructure ▪ Soil erosion and siltation of watercourses ▪ Inversion of soil profile ▪ Disturbance to cultural heritage sites	▪ Minimise impact on the environment by appropriate route selection to minimise or avoid sensitive land systems, vegetation and cultural heritage sites ▪ Design and construct road with drainage features (e.g. culverts and offtakes) that minimise erosion and sedimentation ▪ Liaise with landowners regarding notification and management of works and site issues including livestock management ▪ Minimise vegetation disturbance, and plan construction to avoid vegetated areas ▪ Avoid significant or priority[6] vegetation and ensure proposed routes have been scouted for significant vegetation and wildlife habitats by appropriately trained and experienced personnel ▪ Where possible trim vegetation rather than clearing ▪ Observe procedures and guidelines for the identification, management and protection of cultural heritage sites including heritage clearances by Native Title groups ▪ Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations ▪ Remove waste to minimise visual impact	**Negligible / Minor** (Depending on the nature of the consequences – e.g. introduction aggressive noxious weed compared to spread of existing common weed)	**Rare / Unlikely** (Strict implementation of these Management strategies reduce the likelihood of occurrence)	**Low / Medium**
	▪ Dust generation ▪ Soil compaction of the easement ▪ Temporary disruption to land use (e.g. grazing and recreation) ▪ Impeded fauna movement through construction zone ▪ Damage to native vegetation ▪ Temporary loss of visual amenity ▪ Disruption to land use (e.g. grazing and recreation)		**Negligible**	**Virtually Certain**	**Low**

[6] Wiltshire and Schmidt (1997). Summarised in PIRSA's *Field guide for the environmental assessment of newly abandoned seismic lines in the Cooper and Eromanga Basins, South Australia.*

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Movement of heavy machinery and vehicles along road and access tracks	▪ Dust generation ▪ Soil compaction ▪ Soil erosion ▪ Damage to native vegetation ▪ Injury or death of native fauna ▪ Disturbance to cultural heritage sites ▪ Introduction and/or spread of weeds ▪ Damage to third party infrastructure ▪ Disruption to land use (e.g. grazing and recreation) ▪ Increased public access to remote areas	▪ Use existing cleared areas for laydowns and turn-arounds ▪ Liaise with landowners regarding notification and management of works and site issues including livestock management ▪ Undertake vehicle and equipment washdown before entering Cooper Basin or after operating in areas of known weed infestations ▪ Drive only on access tracks and road formation ▪ Rip areas of compacted soil (not on gibber plains and tablelands)	**Negligible**	**Virtually Certain**	**Low**
Ignition of fire	▪ Disturbance to cultural heritage sites ▪ Loss of vegetation and fauna habitat ▪ Release of particulate emissions to the atmosphere ▪ Disruption to land use (e.g. grazing and recreation)	▪ Operation under bushfire permit requirements ▪ Safe smoking areas away from equipment or activity ▪ Personnel are trained to supervise and instruct individuals entering area to conduct work ▪ Safe work permits must be obtained to ensure only individuals with proper clearance can conduct works ▪ Petrol vehicles to be excluded from construction sites ▪ Emergency response procedures should contain a bushfire scenario ▪ Safety, testing, maintenance and inspection procedures are implemented ▪ Immediate clean up and remediation to minimise contamination to soil/water	**Negligible**	**Unlikely**	**Low**
Spills or leaks associated with chemical and fuel storage and handling	▪ Contamination of soil, and/or watercourse ▪ Access to contaminants by stock and wildlife	▪ Implementation of appropriate chemical and fuel storage and handling procedures (e.g. bunding and signage) in accordance with relevant standards, including AS1940 and the Australian Dangerous Goods Code (ADG) ▪ Regularly educate staff of product, review and monitor chemical and fuel storage, including	**Negligible**	**Unlikely**	**Low**

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
		signage/labelling, proper packing and tie downs ▪ Establishment of appropriate emergency/spill response procedures ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness ▪ Immediate clean up and remediation to minimise contamination to soil/water ▪ Fencing of contaminated areas if threat is posed to stock or wildlife ▪ Maintain a register of spills and/or leaks and implement corrective actions based on analysis of spill events			
Presence of borrow pits	▪ Injury or death of stock and wildlife ▪ Dispersal of watering points and redistribution of stock/wildlife movements resulting in inadvertent damage to vegetation and habitats ▪ Soil erosion	▪ Procedures for operation and restoration of borrow pits are followed ▪ Existing unrestored borrow pits are used in preference to establishing new pits, and planning is undertaken to rationalise borrow pit establishment ▪ Reworking of pits, or construction of new pits occurs a minimum of 75m from existing facilities, including stock yards ▪ Pits are not to be established in locations which pose an unacceptable hazard to stock or wildlife ▪ Borrow pits are restored as soon as practicable after material extraction is complete, to a standard consistent with the surrounding land use, to achieve a +2, +1 or 0 Goal Attainment Scaling score (refer to SEO Appendix B) ▪ Restored pits have topsoil / overburden replaced and pit reprofiled where necessary to prevent erosion ▪ Borrow pits are restored to prevent water holding, or adequate fencing is installed to prevent access to water by stock and fauna, unless otherwise agreed with landholder and any necessary approvals obtained (e.g. Pastoral Program)	**Negligible**	**Likely**	**Low**

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Movement of road construction material	▪ Introduction and/or spread of weeds	▪ Inspect / monitor for weeds during standard inspections of facilities and infrastructure ▪ Undertake control measures for weed outbreaks ▪ Do not import material from areas of weed/disease infestation	**Negligible**	**Unlikely**	**Low**
Use of roads	▪ Dust generation ▪ Introduction and/or spread of weeds ▪ Injury or death of stock and wildlife ▪ Increased public access to remote areas	▪ Training, speed restrictions and appropriate signage to reduce speed and increase awareness of hazards ▪ Inspect / monitor for weeds during standard inspections ▪ Signage to prevent unauthorised access	**Negligible**	**Virtually Certain**	**Low**

5.6 Transport

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

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

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

Table 20: Transport Risk Assessment

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Spill associated with transport of oil/condensate (via truck) to land	▪ Contamination of groundwater, surface water and soil ▪ Damage to vegetation and habitats ▪ Access to contaminants by stock and wildlife	▪ Transportation chemicals, fuels and oils in accordance with ADG Code ▪ Regularly educate staff of product, review and monitor chemical and fuel transportation, including signage/labelling, proper packing and tie downs ▪ Training and speed restrictions to reduce speed and increase awareness of hazards ▪ Vehicles are maintained and serviced in accordance with manufacturer's specifications ▪ No transportation movements in wet conditions ▪ Transport movements at night typically avoided (refer to POM) ▪ Appropriate communication between trucks and facilities to plan safe transport movements ▪ Appropriate signage installed (e.g. at access to public roads) ▪ Establishment of appropriate emergency/spill response procedures for spills or leaks to soil and water ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness ▪ Immediate clean-up and remediation to minimise contamination to soil/water ▪ Fencing of contaminated areas if threat is posed to stock or wildlife ▪ Maintain a register of spills and/or leaks and implement corrective actions based on analysis of spill events	**Negligible**	**Unlikely**	**Low**
Spill associated with transport of oil/condensate (via truck) to creek bed	▪ Contamination of groundwater, surface water and soil ▪ Damage to vegetation and habitats ▪ Access to contaminants by stock and wildlife	▪ Transportation chemicals, fuels and oils in accordance with ADG Code ▪ Ensure roads and causeways are designed to minimise risk of vehicle accident ▪ Install signage at creek crossings where appropriate ▪ Vehicles are maintained and serviced in accordance with manufacturer's specifications	**Major**	**Unlikely**	**Medium**

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
		▪ Regularly educate staff of product, review and monitor chemical and fuel transportation, including signage/labelling, proper packing and tie downs ▪ Training and speed restrictions to reduce speed and increase awareness of hazards ▪ No fording of flowing streams, transportation movements in wet conditions ▪ Transport movements at night typically avoided (refer to POM) ▪ Appropriate communication between trucks and facilities to plan safe transport movements ▪ Establishment of appropriate emergency/spill response procedures for spills or leaks to soil and water ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness ▪ Immediate clean-up and remediation to minimise contamination to soil/water ▪ Fencing of contaminated areas if threat is posed to stock or wildlife ▪ Maintain a register of spills and/or leaks and implement corrective actions based on analysis of spill events			

5.7 Waste Management

Domestic waste at Beach production facilities is incinerated on site, and any waste disposed to landfill is currently transported to an appropriately licensed facility (either to Moomba or Beach's south-west Queensland facilities). Sewage and grey water is treated in concrete lined Envirocycle/Biocycle treatment systems on site. There is a potential for localised contamination of soil and groundwater as a result of leaks from the sewage treatment system. Quantities of sewage generated at satellite camps are not currently measured.

Beach does not currently operate landfill sites for disposal of domestic waste in South Australia. If landfill sites were required to be developed in the future, they would be sited in a suitable, stable area, distant from watercourses or floodplain areas and operated in accordance with EPA guidelines, as discussed in Section 3.6.1.

Beach's operations currently produce little oily waste or contaminated soil and Beach does not currently have a land treatment area for treating oily waste or contaminated soil in South Australia. It is possible that Beach will need to establish a land treatment site for soil remediation at some stage, as discussed in Section 3.6.2. A land treatment site would treat oily waste by mixing with existing soil, with the aim of breaking down oil by evaporation, photochemical processes and biological action of naturally occurring soil micro-organisms. Once hydrocarbons are broken down, soil would be analysed and uncontaminated[7] soil transported by truck to appropriate disposal location.

Chemical wastes are not currently generated, but would be removed off-site to an appropriately licensed disposal facility.

Temporary product storage pits may be required to store oil from a flowing well during some production operations, although this practice is avoided if possible. Oil in the pits would either be removed by vacuum truck for disposal to a land treatment area or burnt in the pit. If required, temporary product storage pits would be lined, with an adequate layer of soil to prevent damage to the lining during burning. On completion, contaminated soil would be removed for remediation, and the pit backfilled.

Each of these facilities poses an environmental hazard and potential consequences include contamination of soil or groundwater and the introduction and/or spread of weeds. In the case of a landfill site consequences also include outbreaks of pests and scavenging by wildlife.

[7] Appropriate oil spill end point criteria to be determined in consultation with PIRSA and EPA.

Table 21: Waste Management Risk Assessment

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
Storage of domestic waste at camps, burning and transport to landfill	▪ Scavenging by native and pest species ▪ Pest outbreaks ▪ Localised contamination of soil and/or groundwater ▪ Loss of visual amenity ▪ Air pollution associated with burning ▪ Odorous emissions	▪ Minimise generation of waste where practicable ▪ Provide suitable covered bins for the collection and storage of wastes ▪ All waste are collected in one area at each camp site ▪ Cover all loads of rubbish leaving camps to ensure no spillage ▪ Reduce, reuse and recycle	**Negligible**	**Likely**	**Low**
Spills or leaks associated with disposal and treatment of sewage	▪ Localised contamination of soil and/or groundwater ▪ Access to contaminants by stock and wildlife	▪ Containment of all sewage wastes within concrete lined Envirocycle / septic tank ▪ Fence off contaminated areas ▪ Repair any damaged fences or gates ▪ Backfill of all pits upon completion of production and processing operations	**Negligible**	**Unlikely**	**Low**
Domestic waste disposal facility	▪ Contamination of soil and/or groundwater ▪ Loss of visual amenity ▪ Scavenging by native animals and pest species ▪ Pest outbreaks	▪ Sited in a suitable, stable area, distant from watercourses or floodplain areas ▪ Design and operation in accordance with EPA guidelines ▪ Undertake soil and groundwater monitoring ▪ Cover and fence site with an appropriate material to prevent the spread of rubbish from the site by wind and prevent access by stock and wildlife ▪ Bury rubbish immediately to facilitate degradation and reduce offensive odours and aesthetic impacts ▪ Fill in waste pits if flood inundation is imminent	**Negligible**	**Unlikely**	**Low**
Storage and disposal of contaminated soil	▪ Contamination of soil and/or groundwater ▪ Access to contaminants by stock and wildlife	▪ Appropriate siting of land treatment site in a suitable, stable area, distant from watercourses or floodplain areas ▪ Appropriate disposal of oil sludge to land treatment area ▪ Monitoring of surrounding soil and groundwater for contaminants annually ▪ Fence off contaminated areas	**Minor**	**Unlikely** Through the implementation of operational procedures/guid elines the likelihood of these	**Low**

Hazard	Consequence	Management Strategy	Severity	Likelihood	Risk
		▪ Repair any damaged fences or gates ▪ Development of remediation plans for the sludge pits and land treatment area		consequences are considered unlikely	
Temporary storage of product in pits	▪ Contamination of soil and/or groundwater ▪ Fire or explosion ▪ Danger to health and safety of employees, contractors and possibly the public ▪ Access to contaminants by stock and wildlife	▪ Temporary storage of product in pits avoided unless no feasible alternative ▪ Product stored for shortest time possible ▪ Pit lined to contain product ▪ On completion of use of pit, contaminated soil removed for remediation and pit backfilled ▪ Safe smoking areas away from storage pit ▪ Erection of fencing and signage to delineate restricted/hazardous areas ▪ Fencing of pit to prevent access by stock or wildlife ▪ Establishment of appropriate procedures for temporary storage of product ▪ Consider weather and flood likelihood when planning pit use ▪ Remove oil from pit before flooding occurs ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness ▪ *Refer also to Table 13 for production facility management*	**Minor**	**Unlikely**	**Medium** Risk reduced to As Low As Reasonably Practical (ALARP) by management measures
Flaring of product in temporary storage pits	▪ Fire or explosion at facility ▪ Release of greenhouse gases contributing to climatic warming ▪ Atmospheric emissions	▪ Pit located to minimise risk of fire spreading to facility or surrounds ▪ Erection of fencing and signage to delineate restricted/hazardous areas ▪ Appropriate fire-fighting equipment on-site ▪ Record and report volumes flared ▪ Continual review and improvement of operations ▪ Establishment of appropriate procedures for temporary storage and emergency response ▪ Periodic review and exercise of response equipment and procedures to ensure preparedness ▪ *Refer also to Table 13 for production facility management*	**Minor**	**Unlikely**	**Medium** Risk reduced to As Low As Reasonably Practical (ALARP) by management measures

5.8 Management Strategies

The Beach Petroleum Environmental Management System (EMS) and Production Operations Manual (POM) provide the framework within which environmental responsibilities in South Australia are managed.

Beach environmental management systems will continue to evolve in response to executive management reviews, changing technology, industry practices, regulatory requirements, research, monitoring, and community expectations.

5.8.1 Environmental Management System

The EMS is a key tool in managing Beach's environmental responsibilities, issues and risks. The Beach Petroleum EMS for Production Operations in the Cooper Basin is currently being reviewed and updated using ISO14001 (Environmental Management Systems) as a guideline.

The key EMS elements outlined in ISO14001 are:

- Environmental Policy
- Planning
  - Environmental aspects
  - Legal and other requirements
  - Objectives and targets
  - Environmental management programme(s)
- Implementation & Operation
  - Structure & responsibility
  - Training, awareness & competence
  - Communication
  - EMS documentation
  - Document control
  - Operational control
  - Emergency preparedness and response
- Checking and corrective action
  - Monitoring and measurement
  - Non-conformance and corrective and preventive action
  - Records
  - EMS audit
- Management review

5.8.2 Environmental Procedures

The current EMS for production operations includes procedures / guidelines for:

- Erosion and sediment control
- Petroleum products storage
- Rubbish pit construction and operation
- Evaporation pond construction and operation
- Borrow pits
- Soil bioremediation area construction and operation, and
- Waste management

These procedures are currently under review. Procedures for the following aspects of operations are also being developed and refined:

- Produced formation water
- Transport

- Flowlines
- Load-out facilities
- Temporary product storage pits
- Heritage, and
- Emergency response.

The Production Operations Manual (refer Section 5.8.3) also provides environmental guidelines.

5.8.3 Production Operations Manual

The POM is the reference manual for Beach production Supervisors and Production Operators controlling well production operations of onshore wells in South Australia. Production Operations in South Australia will generally entail basic 'fit for purpose' oil production facilities including the following:

- Inlet manifold
- Hydrocarbon storage tanks
- Water separation tanks
- Skimmer tank
- Drains and sum
- Loadout pump and ancillaries
- Instrument system inkling emergency shutdown
- Produced water handling including interceptor, holding and evaporation ponds
- Artificial lift systems
- Site office

Beach has developed Operations Procedures that cover a range of activities, these are included in Table 22. The procedures detail safety, environmental, inspecting, monitoring, auditing and reporting proforma and guidelines.

Table 22: Operations Procedures

Operations Procedure	Reference Number
General	
Temperature recording	POP.003
Shut in / start up	POP.010
Field inspection and report – Jet pump	POP.014
Recording weekly pond dips	POP.023
Storage tank / Test tank dipping	POP.024
Purchase and payment of goods	POP.030
Cleaning concrete load out pads	POP.045
Recording unplanned shut downs	POP.046
Vehicle entry into a restricted area	POP.057
Equipment	
Bean pump – Start up / Shut down	POP.001
Lister engine – Start / Stop	POP.002
Field report and inspection – Beam pumps	POP.008
Beam pump – Check pump tapping / reposition	POP.011
Inspection, cleaning and testing of composite hoses	POP.012
Start up / shut down of unidraulic / jet pump unit	POP.013

Sonolog operation	POP.021
Pressure recording using a gauge	POP.022
Sump pump operation	POP.025
Beam pump bridle replacement	POP.026
Conduction a dynamometer survey	POP.031
Clutch replacement	POP.033
Isolation of a gunbarrel separator	POP.054
Hazards	
Lock out – Danger tag	POP.018
Response to transport emergency	POP.019
Permanent facilities tanker load out	POP.038
Handling of synthetic mineral fibres	POP.040
Chemical transfer	POP.041
Hot ambient temperatures / Sun exposure	POP.042

Each procedure outlines specific environmental management techniques and practices to be followed whilst undertaking various operational activities.

5.8.4 Oil Spill Management and Restoration

A review of oil spill management was conducted by Santos Ltd to determine appropriate criteria for the assessment of oil spill remediation in their operations area and to define when management and monitoring activities of a particular spill site can justifiably cease.

The Santos review recommended the following spill response:

- contain the spill
- report the spill
- recover as much spilt material as possible
- fence stock out of the area affected by the spill
- rake the spill area to facilitate the natural biological remediation of the site
- monitor the remediation progress as per monitoring program, and
- ongoing Spill Site Monitoring and Sampling.

Soil samples should be collected from the spill site to determine residual contamination levels and sampling is likely to focus on TPH, BTEX and heavy metals.

Santos are currently developing a Soil Health Index for remediation of oil spills, in consultation with EPA and PIRSA (Santos 2003). It is expected that this will become the industry standard form managing oil spill remediation.

5.8.5 Abandonment

Beach will progressively rehabilitate facilities that are no longer required (e.g. disused roads, pipeline routes and borrow pits). The rehabilitation of these sites will include:

- removal of all infrastructure and rubbish
- testing for contamination of soil and groundwater and remediation to the relevant regulatory standard
- re-contouring of the land surface to reinstate natural contours and drainage lines, and
- ripping of compacted areas (except in gibber systems) to alleviate compaction and encourage revegetation.

Site specific procedures apply to some facilities. For example, oil flowlines are pigged to remove residual hydrocarbons or sludge and, for buried flowlines, above ground points are cut off and blinded below the surface. Rehabilitation requirements will be determined by the relevant regulatory agency or agencies at the time of abandonment.

Major facilities such as evaporation ponds will also be rehabilitated when they are no longer required. The above process generally applies to abandonment of all facilities, but specific procedures will apply for some facilities.

6 Consultation

The Cooper Basin is a sparsely populated and remote arid region. The local community broadly includes Innamincka township members, pastoral leaseholders, the National Parks and Wildlife Service (NPWS), tourists, and petroleum producers and associated contractors.

It is a requirement under the *Petroleum Regulations 2000* that information on consultation with relevant landowners, Aboriginal groups or representatives, government departments or agencies, or any other interested person or parties be outlined in an EIR.

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

Extensive consultation with stakeholders has been undertaken by Santos and PIRSA during production and review of the SACBJV Production and Processing Operations EIR and SEO (Santos 2003). Consequently, key stakeholders are aware of and understand the relevant issues associated with production operations in the Cooper Basin.

An overview of each stakeholder group and issues raised through consultation in the past is provided in Table 23.

Table 23: Key Stakeholder Issues Identified in Previous Consultation by Santos Ltd

Stakeholder	Key Issues
Government Agencies	
Environment Australia	▪ EPBC Act 1999 requirements
Environment Protection Authority	▪ Licensing and reporting requirements ▪ Monitoring and reporting of particulate emissions ▪ Water quality monitoring in evaporation ponds ▪ Environmental incident reporting (significant environmental incidents) ▪ Waste licensing
Greenhouse Challenge Office	▪ National Pollution Inventory (NPI) reporting (Appendix E)
NPWS	▪ Production activities in designated conservation reserves/areas (e.g. Innamincka Regional Reserve, Strzelecki Regional Reserve)
Pastoral Management Board (within DEH)	▪ Stocking rates ▪ Access to water ▪ Access roads and fences maintenance
PIRSA	▪ Licensing and reporting requirements ▪ Action plans and KPI targets ▪ Oil spill remediation ▪ Produced formation water monitoring and management ▪ Environmental incident reporting (significant environmental incidents)
Tourism SA	▪ Third party use of lease areas ▪ Maintenance of roads ▪ Third party safety
Transport SA	▪ Construction and maintenance of road infrastructure in the Cooper

Stakeholder	Key Issues
	Basin region
Industry Groups	
APPEA	▪ Yearly greenhouse gas emissions inventory report ▪ Greenhouse gas challenge program
Business Chamber of Australia	▪ Petroleum production and development
Petroleum contractors	▪ Petroleum production and development
Petroleum developers	▪ Petroleum production and development
Pipeline operators	▪ Petroleum production and development
Community/Environmental Groups	
Representatives of Aboriginal groups	▪ Native Title agreements ▪ Heritage clearance of well sites and access tracks ▪ Identification and preservation of Aboriginal cultural heritage sites
Arid Areas Catchment Water Management Board	▪ Cooper Creek Catchment management
Australian Conservation Foundation	▪ Issue by issue (e.g. operational activities in designated RAMSAR areas)
Conservation Council of South Australia	▪ Issue by issue (e.g. operational activities in designated RAMSAR areas)
Cooper Creek Catchment Committee	▪ Cooper Creek catchment management
Farmers Federation	▪ NASAA organic beef certification requirements ▪ Water access ▪ Pest control
Great Artesian Basin Consultative Council	▪ GAB water extraction
Lake Eyre Basin Coordinating Group	▪ Cooper Creek catchment management ▪ Multiple landuse strategies for the Cooper Basin
Marree Soil Conservation Board	▪ Issue by issue (e.g. pest control, provision of information)
Nature Conservation Society	▪ Issue by issue (e.g. operational activities in designated RAMSAR areas)
Pastoral leaseholders (Table 5-3)	▪ Land access ▪ Lease arrangements ▪ NASAA organic beef certification requirements ▪ Cattle Care Quality Assurance System

As Beach Petroleum's operations are very similar in nature to production activities outlined in the Santos EIR (although at a much smaller scale) it was not considered necessary to undertake another round of extensive consultation with all stakeholders. It was agreed in consultation with PIRSA that key stakeholders should be consulted, including:

- Landholders directly affected by Beach's activities
- Department for Environment and Heritage / National Parks and Wildlife
- EPA
- Department for Water, Land and Biodiversity Conservation

Issues raised during this targeted consultation are summarised in Table 24.

Table 24: Additional Issues Identified During Beach Petroleum Targeted Consultation

Stakeholder	Key Issues
Mungeranie Station	▪ Minimise disturbance to flood flows and loss of pasture/ stock holding areas
Environment Protection Authority	▪ EPA licence required for disposal of waste to landfill ▪ EPA approval for discharge to aquifers ▪ PFW ponds need to demonstrate no significant environmental harm ▪ Telemetry / frequent inspection for pipelines
DEH	▪ Borrow pits and tracks - strategic planning required. Borrow pit restoration criteria should be specified, including not holding water ▪ Fencing for areas holding water ▪ Excavation in gibber generally not suitable ▪ Biocides / emulsion breakers ▪ Transport restrictions in wet weather
DWLBC	▪ Shallow aquifers below PFW ponds – potential for contamination ▪ Groundwater monitoring for PFW ponds ▪ Permits for water extraction
PIRSA	▪ Management measures from EIR included in SEO

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Abbreviations

ADG Code	Australian Dangerous Goods Code
ALARP	As Low as Reasonably Practical
APPEA	Australian Petroleum Production & Exploration Association
bbls	Barrels (1 barrel = 159 litres)
Beach	Beach Petroleum Ltd
BTEX	Benzene, Toluene, Ethyl Benzene, Xylene
CAMBA	China-Australia Migratory Bird Agreement
CO	Carbon monoxide
CO_2	Carbon dioxide
DEH	Department for Environment and Heritage
DEHAA	Department for Environment, Heritage and Aboriginal Affairs
DWLBC	Department of Water, Land and Biodiversity Conservation
EIR	Environmental Impact Report prepared in accordance with Section 97 of the Petroleum Act 2000 and Regulation 10
EMS	Environmental Management System
EPA	Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
GAB	Great Artesian Basin
GRE	Glass Reinforced Epoxy
ha	Hectare
H_2S	Hydrogen Sulphide
ISO	International Standards Organisation
JAMBA	Japan-Australia Migratory Bird Agreement
kboe	Thousand barrels of oil equivalent
km	Kilometre
km^2	Square kilometres
KPI	Performance indicators

L	Litre
LTU	Land Treatment Unit
m	Metre
m^2	Metre squared
mg/L	Milligrams per litre
mm	Millimetre
NASAA	National Association for Sustainable Agriculture Australia
NPI	National Pollutant Inventory
NPWS	National Parks and Wildlife Service
OBE	Organic Beef Exporters
PAH	Polycyclic Aromatic Hydrocarbon
PEL	Petroleum Exploration Licence
PFW	Produced Formation Water
PIRSA	Primary Industries and Resources, South Australia
PEL	Petroleum Exploration Licence
POM	Production Operations Manual
PPL	Petroleum Production Licence
psi	Pounds per square inch
PSV	Pressure Safety Valve
ROW	Right-of-Way
SA	South Australia
SACBJV	South Australian Cooper Basin Joint Venture
Santos	Santos Ltd
SEO	Statement of Environmental Objectives prepared in accordance with the Petroleum Act 2000
TPH	Total Petroleum Hydrocarbons

Glossary

Appropriately manage	To take into consideration and assess relevant environmental factors (including location of surface water, potential flooding, location of vegetation, etc.) and take measures to reduce the potential impact on these factors through the use of best practice
Ramsar Convention	Convention on Wetlands, signed in Ramsar, Iran, in 1971
Fugitive Emissions	Substances that escape to air from a source not associated with a particular process such as leaks from equipment
Gathering System	Network of hydrocarbon pipelines that relay raw gas, condensate and crude oil to processing plants
Hydrostatic testing	A means to check the pipeline for strength and leaks prior to operation in which the pipeline is filled with water and the pressure increased and monitored under controlled conditions
Pig	A tool which is inserted into the pipeline and carried by the oil flow to clean the pipe wall, separate the oil, or inspect the pipeline
Construction easement	A cleared area required to construction and install the pipeline / road
Satellite	Remote operating plant where raw gas or crude oil are processed prior to relay to the Moomba plant
Skids	Timber blocks similar to railway sleepers used to keep the pipeline off the ground
Stringing	Laying the pipe adjacent the pipeline trench
Trench spoil	Soil from the pipeline trench
Trunkline	Hydrocarbon pipelines that connect satellite facilities to the Moomba plant

Appendix 1: Beach Petroleum Environmental Policy

Environmental Policy

Beach Petroleum N.L. is committed to conducting operations in an environmentally responsible manner.

To fulfil these objectives the Company will:

- Commit to and comply with Statements of Environmental Objectives for each activity as required by the appropriate Regulating Authority

- Avoid disturbance to known sites of archaeological, historical and natural significance

- Inform all employees and contractors of their environmental responsibilities through consultation and distribution of appropriate guidelines and publications

- Protect native flora and fauna in all areas of operation

- Avoid the pollution of land, water and air by conformance with regulatory guidelines and industry standards applicable to all areas of operation.

Application of this policy resides with Beach Petroleum management, with all employees sharing responsibility for its implementation.

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Managing Director (Beach Petroleum Responsible Officer)

Operative from:
Review by: