Leigh Creek Energy

Environmental Impact Report

Exploration Drilling Operations
Petroleum Exploration Licence 650

PGER 00318

Prepared by:

Leigh Creek Energy Limited
ACN: 107 531 822
Level 11
19 Grenfell Street
Adelaide SA 5000
Phone: 08 8132 9100
Fax: 08 8231 7574

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Prepared by	Alex Mutiso and John Centofanti, Leigh Creek Energy Limited

Revision History

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1	23/11/18	Draft released for consultation	SM/BW (JBS&G)	AM	AM
2	24/10/19	Updated with additional feedback, air quality and groundwater water results	DN/AM/SA	JC	AM
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5	28/11/19	Updated with additional feedback	AM	JC	AM
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7	13/02/20	Updated following DEM review	AM	AM	AM

Leigh Creek Energy acknowledge the Adnyamathanha people, the traditional owners of the land on which our operations occur and pay our respects to their Elders past and present.

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Leigh Creek Energy (LCK) plans to produce energy from coal using a process known as in situ gasification (ISG). The ISG process converts coal from its solid state into a gaseous form, resulting in the generation of synthesis gas (syngas) containing methane, hydrogen and other valuable components. The syngas can be either used to produce electricity directly or further refined into a variety of products including synthetic methane and ammonia.

Both locally and internationally ISG is also known as underground coal gasification (UCG), however the terms 'in situ gasification' or 'ISG' are used in South Australia to describe the process. ISG has been used in this document to provide consistency with the terminology outlined in the *Petroleum and Geothermal Energy Act 2000*, which is the legislation governing ISG in South Australia.

To obtain information to inform the design for a potential commercial facility, LCK proposes to design and conduct exploration drilling operations to determine the location of the coal seams, faults and the best location of any future ISG facilities. The exploration drilling operations will be conducted on Petroleum Exploration Licence 650 (PEL 650) as a part of the Leigh Creek Energy Project (the Project), which includes the heavily modified Leigh Creek Coalfield.

The exploration drilling operations will also be used to conduct groundwater monitoring investigations of PEL 650. The exploration drilling operations will involve the planning and construction of access tracks and drill sites, in preparation for the drilling activity and the actual exploration drilling operations. This EIR does not cover the drilling of any gasifier inlet or production wells for future ISG sites, or water production bores, as these will be covered in a separate EIR. The exploration drilling programs are regulated as an exploration activity under the *Petroleum and Geothermal Energy Act 2000*. This Environmental Impact Report has been prepared under the Petroleum and Geothermal Energy Act to cover the proposed exploration drilling operations.

As the northern Flinders Ranges region is culturally significant to, and the traditional lands of, the Adnyamathanha people, a Work Area Clearance Agreement (WACA) was previously signed with the Adnyamathanha Traditional Lands Association (ATLA). To protect and manage cultural heritage, Work Area Clearance surveys must be conducted prior to any proposed land disturbing activities. In addition, a Cultural Heritage Discovery Procedure is in place to ensure that Aboriginal sites, objects and remains, as well as non-Aboriginal Heritage sites and or items are protected if they are discovered during exploration drilling activities.

It is important to acknowledge that due to the presence of the coal (and other naturally occurring hydrocarbon rich rocks) that the soils, rocks and groundwater naturally contain chemicals that might otherwise be referred to as contaminants. In this environment these chemicals are referred to as chemicals of potential concern, as they are intrinsic to the environment and as such are not contamination resulting from an activity.

The Leigh Creek Coalfield has a long history of mining commencing at a commercial scale in the 1940s, initially under the auspices of the South Australian Engineering and Water Supply and then the newly formed Electricity Trust of South Australia. Over a period of 80 years different owners (both public and private) have operated the mine under different regulatory, social and environmental expectations. In addition to the naturally occurring hydrocarbons and other chemicals of potential concern, there has been documented soil and groundwater contamination resulting from mining activities which has been assessed and documented with the South Australian Environment Protection Authority.

An environmental risk assessment has been undertaken as part of this Environmental Impact Report. It indicates that the level of risk is manageable and relatively low for the key areas of

concern (cultural heritage, air quality, groundwater, flora, fauna, and surface water). No unacceptable environmental risks have been identified. One high safety risk in relation to driving light vehicles during exploration drilling activities has been identified. Leigh Creek Energy will implement engineering designs in accordance with relevant standards, risk assessment and management procedures and environmental management systems to ensure that all risks are appropriately managed.

Stakeholder engagement will continue to be an ongoing priority and third-party stakeholders, including pastoral landowners, will be kept informed prior to, during and at the completion of the surveys. A targeted online Community Portal has been established (since 2018) where community members can share their experiences of the Project, leave feedback, and locate or request information. The portal provides enhanced two-way communication where community users can track the progress of any requests made and include reminders to ensure their questions are answered by LCK in a timely manner.

The Community Portal can be accessed through the Leigh Creek Energy's website 'Contact Us' section (www.lcke.com.au/contact) and direct through http://lcke.c3register.com/. Leigh Creek Energy is committed to open and transparent communication with stakeholders and encourages community members to use the Community Portal to ask questions and leave feedback regarding this document.

1 Introduction

Leigh Creek Energy Limited (LCK) holds Petroleum Exploration Licence (PEL) 650 located at Leigh Creek in South Australia (SA), 550 km north of Adelaide. LCK plans to undertake exploration drilling operations within PEL 650 to identify and delineate potential structures and the depth of the coal seams for the Leigh Creek Energy Project (LCEP), as well as conduct groundwater monitoring investigations. This Environmental Impact Report (EIR) has been prepared as a requirement of the *Petroleum and Geothermal Energy Act 2000* (PGE Act) to provide information on the proposed activities, the potential environmental impacts and their management.

The boundary of PEL 650 is approximately 0.7 km from Copley and 5 km from Leigh Creek.

As the northern Flinders Ranges region is culturally significant to, and the traditional lands of, the Adnyamathanha people, a Work Area Clearance Agreement (WACA) was previously signed with the Adnyamathanha Traditional Lands Association (ATLA). To protect and manage cultural heritage, Work Area Clearance surveys must be conducted prior to any proposed land disturbing activities. In addition, a Cultural Heritage Discovery Procedure is in place to ensure that Aboriginal sites, objects and remains, as well as non-Aboriginal Heritage sites and or items are protected if they are discovered during exploration drilling operations.

LCK plans to produce energy from coal using a process known as in situ gasification (ISG). The ISG process converts coal from its solid state into a gaseous form, resulting in the generation of synthesis gas (syngas) containing methane, hydrogen and other valuable components. Pending a final commercial decision to be made at a later date, the syngas can either be used to produce electricity directly or further refined into a variety of products including methane and ammonia.

To obtain information to inform the design for a potential commercial facility, LCK proposes to design and conduct exploration drilling operations to determine the location of the coal seams, faults and conduct groundwater monitoring investigations. This information will allow LCK to determine the best location of any future ISG facilities. The exploration drilling operations will involve the planning and construction of access tracks and drill sites, in preparation for the drilling activity and the actual exploration drilling operations, including groundwater monitoring investigation drilling. This EIR does not cover the drilling of any gasifier inlet or production wells for future ISG sites, as these will be covered in a separate EIR. This EIR does not cover the drilling of production water bores, as these will be covered in a separate EIR.

The location of the PEL 650 is shown in Figure 1-1.

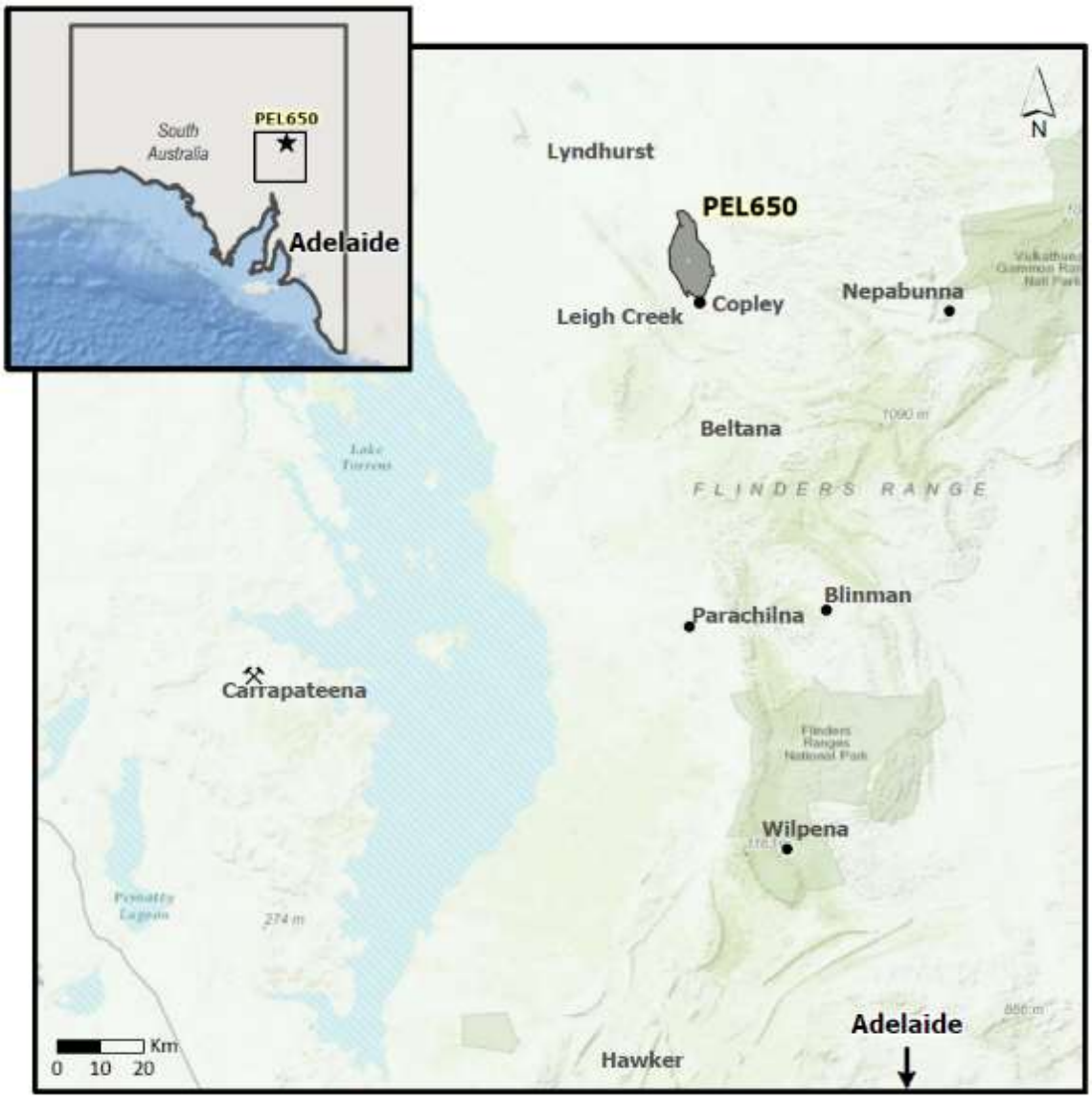


Figure 1-1: Project location

1.1 Project Proponent

LCK is an emerging gas company focussed on developing the Leigh Creek Energy Project in northern South Australia. Leigh Creek Energy is listed on the Australian Securities Exchange (ASX) under the ASX code of LCK and is headquartered in Adelaide, SA.

LCK (through wholly owned subsidiary Leigh Creek (Operations) Pty Ltd) holds PEL 650, which covers an area of 93 km^2 over the Leigh Creek Coalfield, and Gas Storage Exploration Licence (GSEL) 662 which covers the same area. LCK also hold Petroleum Exploration Licence Application (PELA) 647 adjacent to PEL 650.

1.2 About this Document

This document has been prepared to satisfy the requirements of an EIR under the PGE Act for the proposed exploration drilling activities on PEL 650. It has been prepared in accordance with the current legislative requirements, in particular Section 97 of the PGE Act, and Regulation 10 of the *Petroleum and Geothermal Energy Regulations 2013* (PGE Regulations).

A Statement of Environmental Objectives (SEO) for the project will be prepared based on this EIR[1].

This EIR covers:

- construction, maintenance and rehabilitation of access tracks to access the exploration drilling sites within PEL 650
- construction, maintenance and rehabilitation of drill sites, along with their drill sumps within PEL 650
- construction, maintenance and rehabilitation of camp facilities (only if required) during the drilling program within PEL 650
- drilling of exploration drillholes, including chip (percussion) holes, core holes and groundwater investigation holes within PEL 650
- Packer testing to evaluate the permeability of any faults or shear zones
- Geomechanical, geotechnical and stress testing of the ground conditions to determine the best operating pressures of any planned gasifiers.
- completions, workovers and abandonments of all exploration drill holes within PEL 650.

Drilling of the gasifier inlet and outlet wells are not covered by this EIR and will be covered under a separate EIR. Drilling of water production bores are not covered by this EIR and will be covered under a separate EIR. There will be no exploration drilling outside of PEL 650 and is therefore not included within this EIR.

2 Legislative Framework

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

2.1 Petroleum and Geothermal Energy Act

Petroleum[2] exploration and production activities are governed by the South Australian *Petroleum and Geothermal Energy Act 2000* and the *Petroleum and Geothermal Energy Regulations 2013*. This legislation is administered by the Energy and Resources Division of the Department of Energy and Mining (DEM).

2.1.1 Statement of Environmental Objectives

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

The SEO is developed on the basis of information provided in an Environmental Impact Report.

[1] Or the SEO may be required to be prepared on the basis of an environmental impact assessment under the Development Act, depending on the classification of the activities under Section 98 of the *Petroleum and Geothermal Energy Act 2000*, as discussed in Section 2.1.

[2] The definition of petroleum under the Petroleum and Geothermal Energy Act includes coal or shale occurring in circumstances where the use of techniques for in situ gasification would be appropriate and also includes hydrocarbons that are a product of coal gasification (produced below or above ground) for the purposes of the production of synthetic petroleum.

2.1.2 Environmental Impact Report

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 to the health and safety of the public inherent in the regulated activities
- contain sufficient information to make possible an informed assessment of the likely impact of the activities on the environment.

As per Regulation 10 of the *Petroleum and Geothermal Energy Regulations 2013* the following information must be provided for the purposes of an EIR:

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

2.1.3 Assessment and Approval

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

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

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

The level of environmental impact of a particular activity is assessed and classified by DEM on the basis of predictability and manageability criteria required by s.98 of the Act (DMITRE 2013).

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

2.1.4 Referral of Project Applications to the IESC

South Australia is a signatory to the National Partnership Agreement on Coal Seam Gas and Large Coal Mining Development, and as a consequence, coal seam gas and large coal mining projects must be referred by DEM to the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) for advice. Where projects under the Petroleum and Geothermal Energy Act are to be referred under the South Australian referral protocol[3], it would generally be when an EIR and draft SEO are available.

Although exploration drilling operations are not clearly captured by the National Partnership Agreement, DEM may refer this EIR (and the resulting draft SEO) to the IESC for advice. Consequently, this EIR aims to provide the information necessary to support such a referral.

2.1.5 Activity Notification / Approval Process

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

- the Minister's prior written approval is required for activities requiring high level supervision with a notice of activities to be provided 35 days in advance (as per Regulation 19), and
- notice of activities requiring low level supervision is to be given at least 21 days in advance (as per Regulation 18).

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

Consequently, this activity notification process provides an additional opportunity for DEM to ensure that the proposed activities and their impacts can be effectively managed and are consistent with the approvals obtained in the EIR and SEO approval process.

2.2 Other Legislation

A variety of legislation applies to petroleum exploration activities, and those of particular relevance to the proposed exploration drilling are listed below (note that this is not a comprehensive list of all applicable legislation).

Table 2-1: Summary of applicable legislation

Jurisdiction	Legislation
Commonwealth	*Aboriginal and Torrens Strait Islander Heritage Protection Act 1984* *Environment Protection and Biodiversity Conservation Act 1999* *Native Title Act 1993*
South Australia	*Aboriginal Heritage Act 1988* *Crown Land Management Act 2009* *Dangerous Substances Act 1979* *Electricity Act 1996* *Environment Protection Act 1993* *Explosives Act 1936* *Fire and Emergency Services Act 2005* *Heritage Places Act 1993* *National Parks and Wildlife Act 1972* *Native Title (South Australia) Act 1994* *Native Vegetation Act 1991* *Natural Resources Management Act 2004* *Occupational Health, Safety and Welfare Act 1985* *Radiation Protection and Control Act 1982* *Road Traffic Act, 1961* *South Australian Public Health Act 2011* *Work Health and Safety Act 2012*

2.2.1 Commonwealth Environment Protection and Biodiversity Conservation Act

Referral and approval under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required for actions that will have, or are likely to have a significant impact on matters of national environmental significance including World Heritage properties, National Heritage places, Ramsar wetlands of international importance, listed threatened species and ecological communities, listed migratory species and a water resource, in relation to coal seam gas development and large coal mining development.

There are no matters of national environmental significance present or likely to be significantly impacted from the proposed exploration drilling operations. There is no known 'water resource' present in PEL 650 and consequently this matter of national environmental significance is not relevant to the project. Consequently, LCK believes that a requirement for referral and approval under the Act is not likely to be triggered. LCK will continue to review proposed activities against the EPBC Act triggers and will submit a referral under the Act if necessary.

2.2.2 Environment Protection Act

The *Environment Protection Act 1993* imposes a "general environmental duty" of care not to undertake an activity that pollutes or might pollute the environment unless all reasonable and practicable measures have been taken to prevent or minimise any resulting environmental harm. Environmental authorisations are required to undertake activities prescribed under the Act.

The Environment Protection Act does not apply to exploration activity undertaken under the Petroleum and Geothermal Energy Act, or to wastes produced in the course of an activity (not being a prescribed activity of environmental significance) authorised by a licence under the

Petroleum and Geothermal Energy Act, when produced and disposed of to land and contained within the area of the licence.

2.2.3 Native Vegetation Act

The *Native Vegetation Regulations 2017* permit clearance of vegetation incidental to exploratory operations authorised under the Petroleum and Geothermal Energy Act. Under Regulation 15, clearance is permitted if it is undertaken in accordance with approved industry standards that are directed towards minimising impact and encouraging regrowth of any native vegetation that is cleared.

All activities will be undertaken in accordance with a Statement of Environmental Objectives, which is the approved industry standard for activities under the Petroleum and Geothermal Energy Act.

2.2.4 Natural Resources Management Act – Water Management

The *Natural Resources Management Act 2004* applies to a range of aspects of natural resource management. Of particular relevance to this project is its applicability to activities that affect surface water and groundwater resources:

- Drilling of new water wells (or modification to or decommissioning of existing water wells) requires a permit under this Act.
- This Act and the SA Arid Lands Regional Natural Resources Management Plan (SAAL NRM Board 2017) set out a number of other water affecting activities that must not be undertaken without a permit. These are usually avoidable by planning and siting of infrastructure to maintain surface water flows. A requirement for a permit for other water affecting activities will not be triggered by the proposed activities.

PEL 650 lies within the non-prescribed surface water and groundwater resources area of the South Australian Arid Lands Natural Resources Management (SAAL NRM) Region (Penney 2015). It is outside the Far North Prescribed Wells Area and there is no Water Allocation Plan in place over the project area (SAAL NRM Board 2009).

2.2.5 Native Title Act

The Commonwealth *Native Title Act 1993* and the *Native Title (South Australia) Act 1994* provide for the recognition and protection of native title. Native title will exist in those areas of land or water (e.g. on vacant or unallocated crown land) where it has not been extinguished by the conduct of Public Works or the grant of land tenure (such as freehold) or where there is clear intent to extinguish freehold tenure and certain other forms of land title. Native title is discussed further in Section 4.12.3.

3 Description of Activities

The exploration drilling operations will be a series of small-scale and short-term programs for the PEL 650. It involves the construction of the drill sites within the PEL 650, the construction of access tracks for the drill sites, the drilling of the exploration drill holes and any other related activities.

The purpose of the exploration drilling operations is to confirm the location and quality of the coal seams and locations of faults and conduct groundwater monitoring investigations within PEL 650. Information collected will include:

- Location and thickness of the coal seams
- quality of the coal seams
- confirm the location of major faults detected during the geophysical surveys
- interpretation of any structural features in the coal and overburden (e.g. joints, bedding, small scale faults
- groundwater levels, quality and quantity.

This section provides a general overview of the exploration drilling programs and then provides detailed descriptions of the proposed activities associated with the exploration drilling programs. Technical terms used in this section are explained in the Glossary (Section 9).

3.1 Overview of Exploration Drilling Programs

Leigh Creek Energy plan to carry out exploration drilling to determine the geology and groundwater under the ground surface. It is used to confirm the location of coal seams, faults and groundwater tables that are detected from geophysical surveys. This will involve a couple of different types of drilling, using different drill rigs that are suitable for:

- Drilling percussion/chip holes for identifying coal seams, faults and the existence of groundwater.
- Drilling core holes to evaluate the quality of the coal and the geotechnical properties of the coal and overburden.

Due to the lack of gas within the coal seam and surrounding rock types, conventional petroleum drilling rigs will not be used. Instead conventional mineral exploration drilling rigs will be used. Studies (Geoconsult, 2016) conducted by LCK have shown that there is a lack of coal seam gas within the coal and rocks at the Leigh Creek coalfields.

Mineral exploration drill rigs also require a smaller scale for constructed access tracks and much smaller drill site pads, which will result in less disturbance to the environment.

3.1.1 Drill Site Access

The exploration drilling operations will be accessed using existing tracks and public roads as much as possible and usually require the construction of a purpose-built access track to connect the drill site to an existing track or road.

The construction method used for access track construction is dependent upon the terrain in which it is being built and the expected level of use or traffic. In most cases the access track is cleared and graded or rolled, with minimal ground disturbance.

The number of vehicle movements involved in drilling varies greatly depending on the type of drilling being undertaken.

A conventional mineral exploration drill rig typically requires one truck mounted drilling rig (e.g. 8x4 vehicle with mounted rig), one support truck with water tank mounted (e.g. 6x6 truck), one support truck with auxiliary/booster compressors and two 4x4 vehicles for transporting personnel.

During drilling, a water truck may be required to cart water from a water source to the drill site every 1-2 days. Other vehicle movements during drilling typically include daily movements of four-wheel drive vehicles (e.g. contractors or crew changes) and supply runs by a truck (typically 15 t) every 1-2 days).

During coring operations, a drill site and associated access track may be in use for up to 3 weeks. During percussion/chip drilling, a drill site and associated access track may be in use for only a few days to a week.

3.1.2 Drill Site

Drilling operations require the construction of a stable drill pad for the placement of the drilling rig and support vehicles and areas for associated equipment and facilities (e.g. generators, fuel and chemical storage, casing and pipe storage).

A drill site for the exploration drilling activities generally requires the following features:

- a compacted and stable drill pad for stabilisation of the rig
- a series of mud sumps for the disposal of drill cuttings and the recirculation of water into the mud system (in the order of 2-3 m by 3-4 m and 2 m deep, depending on the particular rig)
- if required, a lined 'turkey's nest' for the storage of clean water required for exploration drilling operations (lined with plastic (HDPE) to prevent loss of water through seepage)
- clear entry and exit points for vehicles
- Equipment laydown area.

The size of the drill site depends on the rig being used. Typical mineral exploration rigs for coring or percussion drilling, require a drill site with the maximum dimensions in the order of 60 m x 60 m. A typical layout of an exploration drill site is shown in Figure 1-1 below.

Figure 3-1: Typical layout of an exploration drill site

Mineral exploration rigs used for coring and percussion/chip drilling require a much smaller drill site and require less preparation and compaction of the drill pad than normally used for petroleum drilling.

Drill site construction methods are dependent upon the terrain in which it is being built. In most locations, topsoil and vegetation is cleared and stockpiled separately for use in restoration. Borrow pits may be established to provide hardstand and access road construction material if suitable material is not available from existing sources. Any ground disturbance and clearing will be limited to the minimum necessary.

3.1.3 Borrow Material

Depending upon the nature of the ground in a particular drill site, clay or other borrow material may be required to stabilise the drill pad or to assist in access track construction. Generally, borrow material is sourced from local borrow pits or previously disturbed areas. Borrow pits vary considerably in dimension depending upon the quality and quantity of material contained within them.

3.1.4 Campsite

If accommodation is not available in nearby Leigh Creek or Copley, then a temporary campsite will be required to provide accommodation for drilling operations personnel. Campsites for minerals exploration drilling are usually designed to accommodate approximately 8-12 people. If a temporary campsite is required, it will be constructed, after a work area clearance, on previously disturbed ground on the old Leigh Creek Coal Field, where disturbance of vegetation and surface drainage and the importation of borrow material can be avoided or minimised.

Putrescible domestic wastes (e.g. food waste, paper) created at campsites are stored on site along with other wastes (such as plastics, cans and glass) prior to transportation to a licensed waste disposal facility. Recyclable materials are segregated for recycling where practicable and are also transported to a licensed waste facility. Storage methods including fenced areas, weighted lids on bins consider, issues such as scavenging animals, to avoid litter scattering and impacts on wildlife.

Campsites require the provision of systems for the management of sewage wastes, which must be managed in accordance with the *South Australian Public Health (Wastewater) Regulations 2013* or to the satisfaction of the Department of Health'. Approved environmental treatment units may be utilised where practical and appropriate. Following treatment via an approved system wastewater may be disposed of on-site (onto land, well away from any place from which it is reasonably likely to enter any waters, and well away from any infrastructure) when in remote areas. The method of disposal for wastewater must comply with the Standard for the Construction, Installation and Operation of Septic Tank Systems in SA, or be to the satisfaction of the Department of Health.

3.2 Minerals Exploration Drilling Operations

Exploration drilling operations will be typical of standard minerals exploration drilling and are summarised below. The exploration hole is drilled by rotating a drill bit or core bit while exerting a downward force on the drill bit. During the drilling, water-based and biodegradable mud is pumped down the inside of the drill rods and up the outside of the drill rod, between the drill rods and the hole. The water and/or mud helps to lift the drill cuttings out of the hole and is channelled

into sumps, where the drill cuttings settle out and separate from the water/mud. The water/mud is then returned down the hole in a continuous process.

As the drill hole gets deeper, more drill rods are added to the drill string. The drill muds also help to drill through lost circulation zones (e.g. faults) and unconsolidated formations.

For core drilling, a tubular core sample of the rock being drilled, can be obtained by drilling with a specific core bit, that allows for the core to be drawn up into a core barrel. The core is then retrieved every 1.5 to 6m at a time, by retrieving the core barrel through the drill rods, without the need to trip or pull all the rods out of the drill hole.

The following drilling operations will be carried out:

- Drilling to a projected depth (typically 250 to 800m). Drilling muds used will be water-based, biodegradable and non-hazardous to the environment. The sump will not be lined unless drilling is likely to occur in an area where very shallow aquifers are present and/or the toxicity and concentrations of the drilling mud present a risk to any very shallow aquifers.
- Running and cementing surface casing and any intermediate casing required.
- Packer testing, which may be used to evaluate the permeability of any fault or shear zones.
- Groundwater investigation testing involving airlift testing and/or drawdown testing.
- Geomechanical, geotechnical and stress testing of the ground conditions to determine best operating pressures of any planned gasifiers.
- Well integrity testing to test the integrity of the casing and the cementing of the casing to ensure barrier verification.
- Openhole logging to evaluate the rock characteristics of the coal and overburden.
- Decommissioning of exploration drill holes.

No commercial quantities of hydrocarbons are expected to be discovered based on previous exploration and mining activities and test work completed by LCK (Geoconsult, 2016). Therefore, BOP (Blow Out Prevention) devices will not be required.

3.2.1 Openhole Wireline Logging

Wireline logging is performed during and after the drill hole has been drilled. Wireline logging during the drilling of the drill hole is usually conducted to check on the deviation of the drill hole from its planned path. Wireline logging of the drillhole after hole completion is used to record the properties of the different rock layers and fault zones encountered in the drillhole. This allows a determination of the location of the coal seams and the fault zones.

Wireline operations for LCK are undertaken by a number of different industry recognised specialist service companies[4]. During the course of wireline operations, different energy sources are used in some of the logging tools. Low level radioactive sources are used only in the density and neutron logging tools and are subject to strict licensing, usage and transportation procedures. In the unlikely event that a wireline tool containing a radioactive source becomes stuck in a drillhole, every reasonable effort will be made to manage the fishing operations to recover the tool and radioactive source. In the unlikely event that the radioactive source is not recoverable, then the relevant government approval will be obtained, prior to abandoning the drill hole. One of the

[4] Wireline operators using radiation sources are required to hold a licence issued under the South Australian Radiation Protection and Control Act 1982 when operating in South Australia. The Wireline Operators must have a radiation management program and contingency plans for management and reporting of incidents like stuck logging tools containing radiation sources.

relevant authorities who will be contacted to provide approval for the abandonment of any radioactive tool is the Radiation Protection Branch of the EPA.

Optical Televiewers and acoustic scanners are also used to generate an image of the inside of the drillhole using an optical scanner for the televiewer or an acoustic transmitter and receiver for the acoustic scanner. This information assists with the identification of the bedding, joints in the rock and faults. The optical televiewer and acoustic scanners do not use any radioactive sources in their operation.

A Cement Bond Log (CBL) tool is run down the cased drillhole to measure the quality of the cement bond between the steel casing and the rock formation, while a caliper log and a pressure test checks the integrity of the steel casing.

3.2.2 Downhole Formation Testing

During the drilling of the drillholes and prior to the placement of the steel casing and cement, there may be some packer tests conducted to test the strength and permeability of the rock formation and of any shear zones.

To test the permeability of the geological formation and of any zones of weakness (faults, shears, etc.), packers will be placed at either side of the test zone and the pressure monitored to determine the permeability. In order to determine the rock strength of the formations and determine the potential for shear zones to re-open, DFIT tests may be completed to gather the required data.

3.2.3 Running and Cementing Casing

After the drillhole has been drilled to the required depth and all the wireline logging has been performed, the drillhole is then either cased or cemented up. This will depend on the future requirements of the hole. If the drillhole is no longer required, it will be filled with cement from the bottom of the drillhole to the surface. This ensures that no fluids or gases can flow along the drillhole path and this eliminates crossflow between potential aquifers.

If the drillhole will be used for other purposes (e.g. water level monitoring, water quality monitoring, etc.), then the hole will be cased. This involves running steel casing into the drillhole and cementing it into place. The cement is pumped into the base of the drillhole, so that it flows and fills the space between the steel casing and the drillhole. This ensures that no fluids or gases can flow along the drillhole path and this eliminates crossflow between aquifers.

The type of cement used will be according to the design from the specialist engineering company. This design will depend on the location of the drillhole and the purpose of the drillhole.

The casing is pressure tested after installation and the annulus (the space) between the casing strings is fully contained in the wellhead. A Cement Bond Log (CBL) tool is run down the cased drillhole to measure the quality of the cement bond between the steel casing and the rock formation. This will provide barrier verification to ensure that there are no pathways for fluids and gases to flow along the path of the drillhole. Regular barrier verification checks, using CBLs will be carried out during the lifetime of the cased drillhole to ensure that the cement barriers remain in place. The frequency of CBL checks is dependant of the location and purpose of the drillhole.

The casing designs for the monitoring drillholes are completed by a specialist engineering company. The drillhole casing design and cement material used is developed to ensure long term casing integrity. The design parameters are based on previous experience in nearby basins and recent experience from more recent drilling and casing operation in the Telford Basin by LCK.

After the planned monitoring drillholes have been cased and the casing cemented in, the drillhole will have a wellhead installed. The wellhead includes all equipment on the surface that supports the various pipe strings (if installed), seals off the drill hole and controls the paths and flow of any potential fluids and gases.

The wellhead to be used will be designed for the conditions anticipated and the objective of the drillhole. The wellhead designs are completed by a specialist engineering company, depending on the well type and its objective. Each well may be designed differently and may have different requirements based on its purpose with specialist engineering company's input.

3.2.4 Hole Abandonment and Decommissioning

After the drillhole has been drilled to the required depth and the decision has been made to abandon/decommission the hole, the hole will be cemented up from the base of the hole to the surface. This eliminates any crossflow between potential aquifers. The type of cement used will according to the design from the specialist engineering company.

3.3 Rehabilitation of Access Tracks and Drill sites

After the completion of all drilling activities (including wireline logging, casing and cementing operations), the access tracks and drill sites are rehabilitated, if they are no longer required. If a drillhole is planned to be used as a monitoring hole, then the access track and a small area of the drill site is left appropriately prepared for access.

3.3.1 Initial Rehabilitation

After the completion of drilling activities on a drill site, the site clean-up will involve the following:

- Fencing of the drillhole mud sump following completion of the drilling, casing and/or cementing activities, to prevent stock access and discourage wildlife access.
- Removing all materials and waste from the drill site.
- Removing any water from turkey's nest (if used) and remove the turkey's nest liner.

The drill site mud sump will remain fenced until the contents have dried sufficiently to allow rehabilitation by 2 possible methods. The first method is for the sump to be backfilled without displacing the sump contents to the soil surface. The second alternative is to allow the sump contents to be removed using a backhoe and truck and the contents disposed of at a licenced facility.

The time required for the contents of the sump to dry is dependent on the weather conditions and usually takes 2 to 6 months.

3.3.2 Final Rehabilitation

Once the drill sump has been rehabilitated, and assuming that the completed drill hole will not be used as a monitoring hole, then the drill site and access track rehabilitation will be undertaken, in consultation with the relevant landholder.

Final rehabilitation will involve:

- Ensuring that all mud sumps and pits are backfilled.
- Ripping and/or recontouring of drill site, access tracks and temporary campsite.
- Spreading of any removed topsoil back over the drill site and access tracks.
- Removing any windrows to ensure that surface water flows are not impeded.

3.4 Other Associated Activities

3.4.1 Water Supply / Use

The exploration drilling programs are expected to require small amounts of water (<10 kl per day) to assist with dust suppression during drilling and for the mixing of drilling muds. Some water may be used for dust suppression on the access tracks if required.

Water for exploration drilling is expected to be sourced from the existing mine industrial catchment (i.e. the same water used currently to water roads), or potable quality water supplied by SA Water. Water will be either trucked to the drill sites by the support truck and stored in the drill sumps or potentially in a turkeys nest.

If a temporary camp is set up on the mine site, then potable water for use in the kitchen and ablutions block will be transported by truck from Leigh Creek or from the Flinders Power mine supply and stored in tanks on site.

3.4.2 Power Supply

If a temporary camp is set up on the mine site, power will be supplied by diesel generators at the site. The drill sites will not require any power.

3.4.3 Waste Management

A range of wastes will be generated during the proposed operations.

As each drilling program will only operate for a short timeframe, the quantities of waste generated during the drilling programs will be relatively limited.

Generation of domestic waste (e.g. food waste and packaging, paper, plastics, cans and glass) will be limited as personnel will be accommodated off site (see Section 3.4.6). All domestic waste will be disposed of at the Leigh Creek Township EPA licensed landfill (which is currently operated by The Outback Communities Authority).

Waste streams will be segregated on site and collected and stored in covered bins before being transported to appropriate facilities for reuse / recycling (where possible) or disposal. Waste management practices will be guided by the principles of the waste hierarchy (i.e. avoid, reduce, reuse, recycle, recover, treat, dispose).

3.4.4 Fuel and Chemical Storage and Management

A variety of fuels and chemicals will be required for the proposed operations. These include fuel (diesel), oils, paint, solvents and corrosion inhibitors. Fuel, oils and chemicals are stored in accordance with applicable standards and guidelines (e.g. AS 1940, EPA guideline 080/16 *Bunding and Spill Management*), typically in approved containers in lined bunded areas or on self-bunded pallets.

Approximately 5,000 L of diesel will be stored on site to provide fuel for the drilling rig, support trucks and compressors/boosters. This will be stored in accordance with AS 1940, in bunded tanks or double-skinned tanks. Drip bunds will be used under hose connections during refuelling. Diesel transfer will be performed by appropriately trained personnel from reputable diesel suppliers.

3.4.5 Spills and Emergency Response

Appropriate spill containment and clean-up equipment will be maintained on site, including chemical and hydrocarbon spill kits. If spills occur, they will be contained, reported (internally and to regulatory agencies where required) and cleaned up by treatment in situ or elsewhere on the lease where appropriate, or by removal off-site for treatment or disposal. A spill response and emergency response plan will be in place detailing actions to be taken to minimise the impacts of

accidents and incidents. In relation to the emergency response the LCK Emergency Response Procedure will in place. For services in the region, the following are also available:

- Leigh Creek Country Fire Service (CFS) and State Emergency Services (SES): fully equipped Fire appliance including Breathing Apparatus (BA) with HAZMAT and road crash rescue capabilities and trained volunteers
- Leigh Creek South Australian Ambulance Service SAAS: fully equipped Ambulance and trained volunteers
- Leigh Creek Health Services: medical clinic staffed by two fulltime, remote-area nurses, providing a 24/7 on call service. The Leigh Creek Health service also provides a General Practitioners service once weekly.
- Leigh Creek South Australian Police (SAPOL): fulltime staffed police station
- Royal Flying Doctors Service (RFDS): emergency flights based out of Adelaide and Port Augusta
- Hawker Memorial Hospital: fully operational regional hospital, 156 km south of Leigh Creek, providing both medical and surgical hospital services

In addition, LCK provides an auto defibrillator, remote-area first aid kits, portable burns kit and portable eyewash station. LCK also plans to have at least one staff member on site at all times, who is trained to Occupational First Aid level (as a minimum).

3.4.6 Workforce and Accommodation

A workforce of approximately 8 to 12 personnel will be required during the exploration drilling program.

The workforce will be accommodated in existing accommodation at Leigh Creek and/or Copley. If accommodation is not available in either town, then a temporary mobile camp will be set up for the duration of the drilling program at the old Leigh Creek Coal Mine. The site of the potential temporary mobile camp will be subject to a Work Area Clearance as per the existing Work Area Clearance Agreement between LCK and the Adnyamathanha Traditional Lands Association (ATLA).

3.4.7 Access and Transport

The site will be accessed via the sealed public road network and the sealed main access road into the Leigh Creek Coalfield.

The Exploration drilling vehicles will arrive on site via the road network. All vehicles are registered for operation on public roads and do not require transport to site.

During the exploration drilling programs, traffic will largely be restricted to light vehicles with a limited number of truck movements required, primarily for fuel deliveries and transport of water or waste.

4 Existing Environment

4.1 Historical Activity Overview

The proposed exploration drilling programs are located on PEL 650 within the Leigh Creek Coalfield in northern South Australia. Coal was initially discovered at Leigh Creek in 1888 and intermittent testing and mining took place with limited success over the next 55 years. Open cut mining officially commenced in 1943 under the management of the Engineering and Water Supply Department (EWS) until the Electricity Trust of South Australia (ETSA) took control of the Coalfield in 1948 as part of the process of developing the Port Augusta Power Station.

The Leigh Creek Coalfield was originally defined as comprising three distinct basins; Copley Basin (Lobes A and E), Telford Basin (Lobe B) and Northfield Basin (Lobes C and D). Three of these Lobes (Lobes B, C and D) have been actively mined. The Copley Basin (Lobes A and E) was not included in any mining operations and are excluded from LCK's PEL 650.

Open cut mining commenced in 1943 in Lobe B, which was known as the 'Telford Open Cut'. Mining at Lobe D and Lobe C to the north began in 1948 and 1963, respectively. These deposits were mined until September 1977 using conventional open cut mining methods with overburden broken by blasting, and dragline cuts into coal.

The coalfield was enlarged after the decision in the 1970s to build an additional power station at Port Augusta. This involved new methods to extract deeper coal, increasing production, building a retention dam to divert Leigh Creek and prevent possible flooding of the field and diverting the main highway around the coalfield. The Leigh Creek township was relocated from the coalfield to its current location. Open pit strip mining was employed at the pits on Lobes C and D of the Leigh Creek Coalfield until the early 1990s when the terrace (or haulback) mining method was adopted to extend the life of the Lobe B mine (PIRSA 1997).

Mining ceased in November 2015, following a decision by Alinta Energy to close the mine as it had become uneconomic. Flinders Power Partnership (previously a subsidiary of Alinta Energy) is currently undertaking closure activities at the Leigh Creek Coalfield.

The Leigh Creek Coalfield includes the following components, which are shown in Figure 4-1:

- Lobe B (the Telford Basin) which is the largest and deepest of the basins in the coalfield; it encompasses the large Main Series Pit, the smaller Lower and Upper Series pits, extensive waste rock dumps (which cover an area of over 10 km2), the remnants of the original township of Leigh Creek and mine site offices and other buildings
- Lobes C and D to the north, including pits and waste rock dumps
- numerous access roads, power lines, train loading facilities and the train line to the east
- the Retention Dam to the south of Lobe B, which captures and diverts the flow of Leigh Creek around the site and is also used by the public for recreational activities
- a town landfill to the west of Lobe B.

Other features of note in the area include the townships of Copley and Leigh Creek to the south, and associated infrastructure including the airport and Aroona Dam.

The proposed exploration drilling programs will initially be concentrated within the Telford Basin (Lode B) of the Leigh Creek Coal Field (see Figure 4-1). The Telford has been highly disturbed as a result of previous mining activities, including earthworks across the site, depressurisation and dewatering of aquifers in the Telford Basin (to the south of the Upper Series Pit), diversion of natural surface water flows, and significant disturbance to native vegetation.

At present there are no ongoing coal mining operations and the coalfield has entered into closure planning and implementation. Exploration drilling programs may later extend out to other areas within PEL 650, including the Northfield Basins. The Northfield Basin includes Lobe C & D as presented in Figure 4-1 below. Copley township is located approximately 8.5 km from the initial exploration drilling programs on the Telford Basin and 12 km from the Leigh Creek township, and the presence of the pits and waste rock dumps effectively enclose and buffer the site from the area outside the coalfield. The features within and surrounding PEL 650 are shown below in Figure 4-1 to Figure 4-6.

Figure 4-1: Leigh Creek Coalfield and surrounds

Figure 4-2: Upper Series Pit at the Leigh Creek Coalfield

Figure 4-3: Typical waste rock stockpiles at the Leigh Creek Coalfield

Figure 4-4: Looking west from the waste rock stockpile to the public highway B83 (the Outback Highway)

Figure 4-5: Old railway line looking north to Lobe C

Figure 4-6: Upper series of Leigh Creek coalfield

4.2 Cultural Heritage

4.2.1 Aboriginal Cultural Heritage

PEL 650 is located in the northern Flinders Ranges region which is culturally significant to the Adnyamathanha Aboriginal People. The Adnyamathanha have a long history of occupation in this region which was significantly disrupted when the country was opened up to pastoral settlement and mining following European exploration during the 1840's (Northern Flinders Ranges SCB 2004).

The name "Adnyamathanha" is the Adnyamathanha language form of the name generally applied to the Aboriginal inhabitants of the Flinders Ranges and surrounding areas by their neighbours. The name may be etymologically analysed as "adnya" – "stone" or "rock", "matha" – "mob" or "group", plus "nha" – suffix (proper noun marker): literally, "stone people". The name is generally rendered however, as "ranges people" or "hills mob" (EDO NSW 2019).

The Adnyamathanha maintain a strong connection to the project region including ownership of the Myrtle Springs and Leigh Creek pastoral stations adjoining PEL 650, the community of Neppabunna and Igawarta, management of the Nantawarrina Indigenous Protected Area (IPA) located approximately 50 km south-east and co-management of the Vulkathunha - Gammon Range National Park located 50 km to the east. The IPA and national park are of great cultural significance as traditional tribal territory and places of culturally important sites. Areas of cultural heritage significance to the Adnyamathanha people and evidence of long-term occupation in the region include song lines, stone arrangements, rock art, occupation sites, graves and ochre quarries (DoE 2013; DEH 2006). The Leigh Creek area forms part of the Adnyamathanha Dreaming journey of Yulu the Kingfisher Man to Wilpena Pound (Ikara).

The Federal Court awarded the Adnyamathanha people non-exclusive rights to over 41,000 square kilometres of land in the state's biggest ever native title claim on March 30th, 2009. The vast area of land included the 918 sq. km Flinders Ranges National Park that also includes the Wilpena Pound, a natural amphitheatre of mountains, and the Iga Warta cultural tourism centre.

A search of the Central Archive, which contains the Register of Aboriginal Sites and Objects (DPC-AAR 2016) indicated that there are 22 registered or reported sites within 10 km of PEL 650. One registered site and two reported sites are located within the PEL. Site types on the Register identified in the region include objects, archaeological sites, engravings, quarries, and ceremonial and burial sites. Two of the sites located outside the PEL are identified as restricted sites.

The *Aboriginal Heritage Act 1988* applies to the entirety of the Leigh Creek Coalfield (including PEL 650) and provides for the protection of all Aboriginal sites, object and remains, including recorded, reported, or undiscovered heritage. The protection extends to Aboriginal sites, object and remains which may exist in areas which have been disturbed in the past and / or subject to a cultural heritage survey or work area clearance.

LCK has executed (September 2016) a Work Area Clearance Agreement (WACA) with the Adnyamathanha Traditional Lands Association (ATLA), as the prescribed body corporate for the native title area. LCK will work within the terms of this agreement for the proposed exploratory drilling works within nominated areas of PEL 650 for the purpose of avoiding damage and disturbance to any Aboriginal site object or remains with those areas.

The WACA was successfully implemented for LCK's Pre-Commercial Demonstration (PCD) project and LCK is continuing to seek ATLA's involvement in a work area clearance for the exploratory drilling activities which are the subject of this EIR.

4.2.2 The *Mura* Traditions and the Leigh Creek Coal Field

The Adnyamathanha recognise the *Mura* as the fundamental source of all law. The *Mura* is articulated through ritual, through *Wibma* ("history songs") and through the *Mura* "history" stories themselves; and in the second, through the operation and application of the moiety[5] system which is itself derived from the *Mura* (EDO NSW 2019).

The formation and presence of the Leigh Creek coalfield according to the *Mura* has several levels of explanation. According to the tradition relating to the Leigh Creek Coalfield *Yulu*, the sacred kingfisher, was travelling to Wilpena Pound – *Ikara* in anticipation of a *Malkarra* (man-making ceremony) which was being assembled at that location. *Yulu* was bringing with him new initiation methods he intended to demonstrate at the gathering. He travelled from the north via *Kakarlapunha* (Termination Hill) and Myrtle Springs to the Leigh Creek location where he lit a fire made from dry mallee sticks to signal that he was on his way to the ceremony his approach to those gathered at Ikara (EDO NSW 2019). It is by these means *Yulu* created the coal, which Adnyamathanha people have always called *Yulu's Coal*.

4.2.3 Non-Aboriginal Heritage

Non-Aboriginal heritage in the region dates back to early exploration of the region by Edward Eyre beginning in 1839 and the subsequent opening up of the area through pastoral expansion and small-scale mining. By the end of the 1850's many mines (mostly copper) had been established in the Northern Flinders Ranges. Coal bearing shales were discovered at Leigh Creek in 1888 and later abandoned, and it was not until the 1940's that the deposits were reconsidered for exploration. Many of the historical sites in the region are associated with early mining exploration and production works (Northern Flinders Ranges SCB 2004).

A number of sites relating to the early pastoral and mining history in the broader region are listed on the South Australian Heritage Register (DEWNR 2016b). The closest to PEL 650 is the Copper King Copper and Ochre Mine located 15 km to the south. Other sites include:

- Paull's Consolidated Mine - 27 km east of the PEL
- Sliding Rock Mine - 30 km south-east
- Beltana Stage Heritage Area - 30 km south

[5] Adnyamathanha society is divided into two, named, matrilineal, exogamous, moieties: *Ararru* and *Mathari*. A person's moiety affiliation is consequently inherited from the mother, along with his or her mukunha (personal totem) which is also matrilineally inherited (EDO NSW 2019).

- Beltana Station HS - 32 km south.

There are also sites of palaeontological and geological interest listed on the South Australian Heritage Register situated within the region; the closest being the Ajax Mine Fossil Reef, approximately 21 km south of PEL 650, and the most significant being the Ediacara Fossil Reserve Palaeontological Site located 39 km south-west of PEL 650. The Ediacara Fossil Site – Nilpena, which is entered on the National Heritage List is located a further 20 km to the south of this location (DEWNR 2016b, AHPI 2016).

There are no registered sites of non-Aboriginal heritage significance within PEL 650. There are potentially some heritage values associated with parts of the original Leigh Creek township and mine (e.g. the cemetery), which are within the Telford Basin of PEL 650.

There are no non-Aboriginal heritage sites associated with the exploration drilling program.

4.3 Climate

The site is located in the Northern Flinders Ranges, which has an arid climate with hot, very dry summers, cool to mild winters, and a low annual rainfall. In the hotter part of the year (late November to March), mean maximum temperatures exceed 30°C while mean minimum temperatures in the cooler months can drop below 5°C. Frost days recorded at Leigh Creek are most common from June to August (Northern Flinders Ranges SCB 2004).

The average annual rainfall at Leigh Creek is 224 mm and the median annual rainfall (which is a more appropriate measure where rainfall is erratic) is 200 mm. Rainfall can occur at any time of year, is highly variable and widespread significant rainfall is infrequent. Rainfall in the warmer months is highly erratic, and most often in the form of heavy showers associated with thunderstorms (Northern Flinders Ranges SCB 2004). Average annual evaporation is over 2400 mm (BOM 2016).

A summary of climate records for Leigh Creek Airport (Station #017110) for the period 1982 - 2016 is provided in Table 4-1 (BOM 2016).

Table 4-1: Temperature and rainfall records for Leigh Creek

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean Max Temp (°C)	35.6	34.6	31.2	26.3	21.1	17.0	16.6	19.2	23.5	27.1	30.8	33.2	26.3
Mean Min Temp (°C)	20.8	20.5	17.4	13.0	8.9	5.5	4.7	6.1	9.4	12.6	16.2	18.7	12.8
Mean Rainfall (mm)	22	27.1	20.2	14.7	18.3	16.7	16.4	15.0	17.2	17.1	18.6	23.2	224.2
Median Rainfall (mm)	6.5	17.6	5.3	6.4	9.4	9.2	8.4	8.0	8.7	13.5	11.2	19.2	200.4
Mean Daily Evaporation (mm)*	14.5	13.2	10.5	7.0	4.3	3.0	3.3	4.8	7.2	9.7	11.9	13.4	8.6

* Evaporation data are from Woomera Aerodrome, Station 016001, for the period 1967-2016

Prevailing winds are from the south and east, with northerly winds also relatively common. Figure 4-7 shows the wind rose for Leigh Creek Airport. Each branch of the rose represents wind coming from that direction.

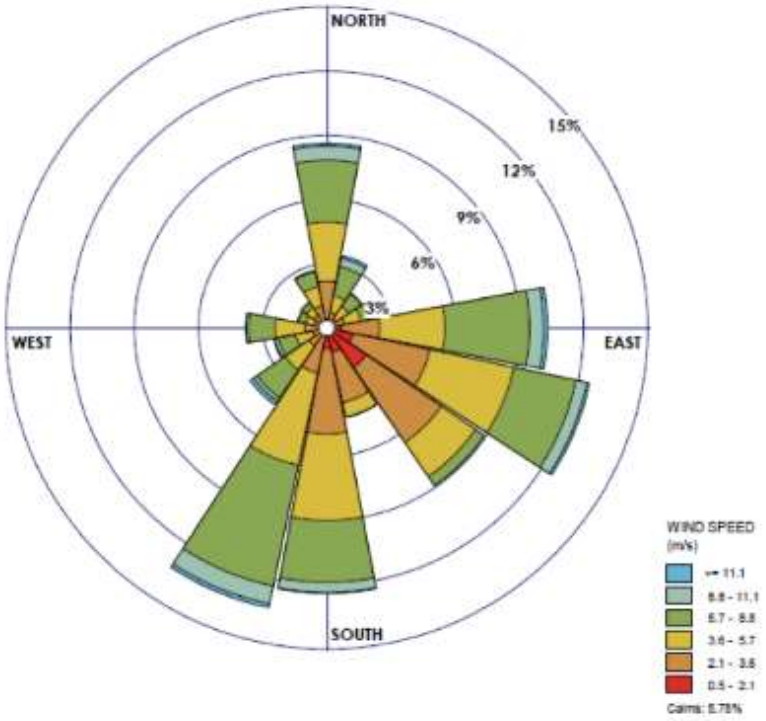


Figure 4-7: Wind rose for Leigh Creek Airport (2010/2011).

4.4 Bioregions, Land Systems and Soils

4.4.1 Bioregional Setting

PEL 650 is located on the boundary of the Stony Plains biogeographical region (or bioregion) and the Flinders Lofty Block bioregion[6].

The western half of PEL 650 lies in the southern-most section of the Stony Plains bioregion, in the Murnpeowie subregion, which is characterised by stony downs and alluvial plains. The eastern half of PEL 650 (and the extreme south-western margin of the PEL) lies in the Flinders Lofty Block bioregion, in the Northern Flinders subregion which is characterised by ranges and hills with rock outcrops, stony pediments and small basin plains, narrow valleys with some gorges, and some remnants of stony downs.

The IBRA subregions can be further divided into land systems[7], which provide a smaller mapping unit. Three land systems have been mapped in PEL 650: Paradise (in the western half of PEL 650), Morris (in the eastern half of the PEL), and Umberatana (on the extreme south-western margin of the PEL), as shown in Figure 4-8.

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

[7] Land systems are an area, or group of areas, throughout which there is a recurring pattern of geology, topography, soils and vegetation (DEH 2005). Land systems used in this document are based on the SA Land Systems data that was developed as part of land system mapping of the pastoral areas of South Australia (DWLBC 2007, Naturemaps 2016b).

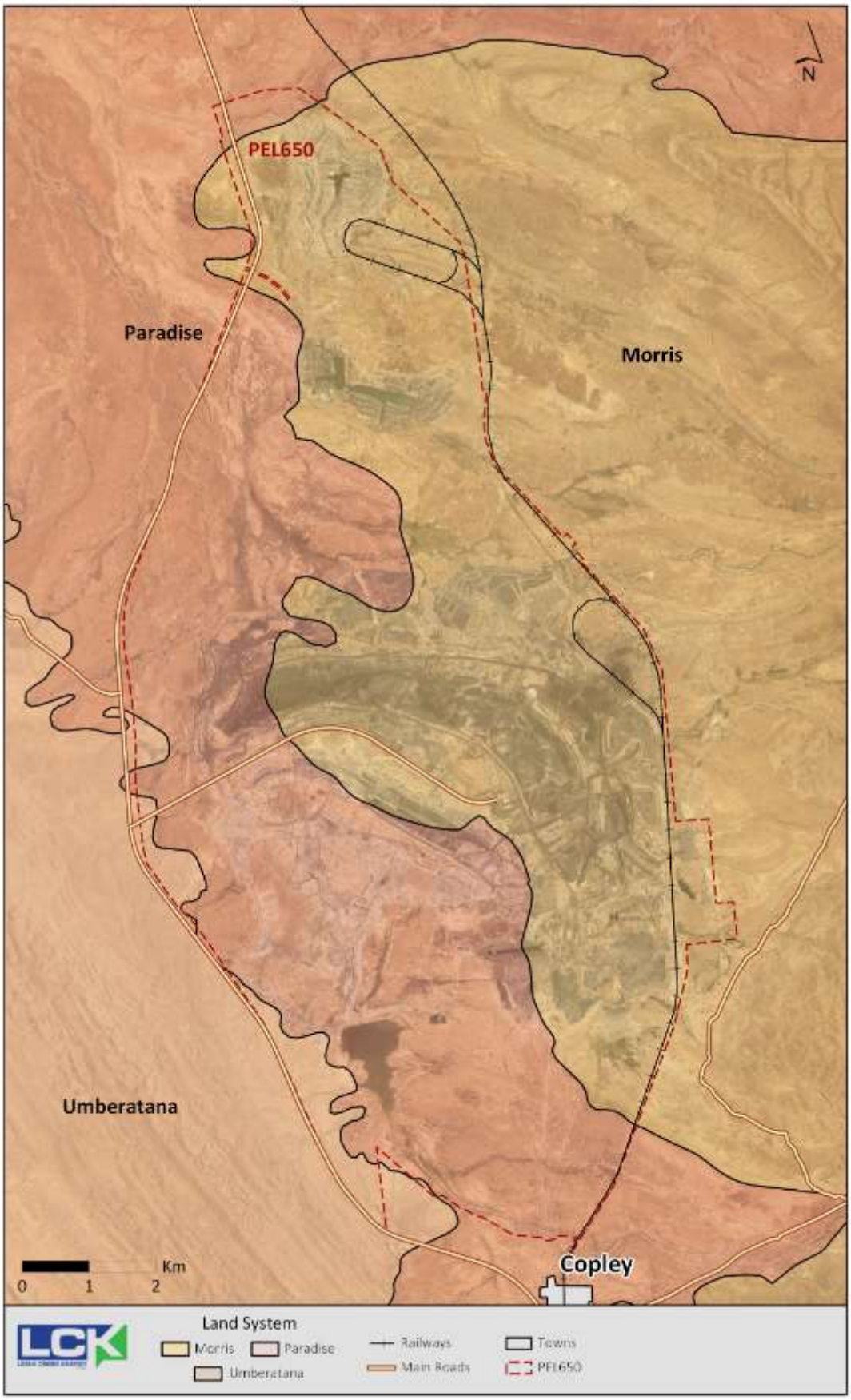


Figure 4-8: Map of land systems within PEL 650

Descriptions of these land systems are provided in Table 4-2. It is noted that across a significant proportion of PEL 650, these land systems have been heavily modified and little of the natural land form or vegetation remains intact.

Table 4-2: Land systems in PEL 650

Bioregion	Land system	Description
Stony Plains	Paradise	Flood outs, stony flats and alluvial plains; clay loam soils. Large creeks - River Red Gum, Coolibah, Broughton Willow, River Cooba, Plumbush and Prickly Wattle Floodouts - Old Man Saltbush, Cottonbush, Samphire, Plategrass, Swamp Canegrass Stony hills and flats - Bladder Saltbush, Blackbush, Mitchell grass and Bindyis.
Flinders Lofty Block	Umberatana	Hills and low hills - shallow, skeletal fine-textured soils; Dead Finish, Prickly Wattle, Rock Fuchsia Bush, Bullock Bush woodland over Copperburrs and grasses Stony calcareous plains - Low Bluebush, Bladder Saltbush and annual grasses Creeks - River Red Gum, Prickly Wattle and White Tea-tree.
	Morris	Low hills and rises with sandy loam soils - Low Bluebush and Bladder Saltbush shrublands; patches of Red Mallee or Blackoak woodland flats with annual, Wards Weed and Bottlewashers.

4.4.2 Landform and Soils in PEL 650

PEL 650 and the Leigh Creek Coalfield are located at an elevation of approximately 200 m. In the immediate area of the PEL, the landform is generally a gently undulating plain comprised of reddish powdery calcareous soils and low rocky outcrops. At the base of the nearby ranges, alluvial fans and closely spaced dunes of crusty red duplex soil and loose aeolian sands extend over the plains (AECOM 2016).

The majority of the landform and ground surface within the coalfield in PEL 650 has been heavily disturbed and modified by over 70 years of open cut coal mining activities. The coalfield is dominated by the main Lobe B with the large Main Series Pit, and the smaller Upper and Lower Series Pits. The smaller Lobe C and D pits are located 5 km and 8 km north of Lobe B.

The pits within the coalfield are surrounded by extensive mine spoil piles and waste rock dumps. Other earthworks have also been undertaken extensively across the coalfield site, including construction of the retention dam and numerous berms around the site to modify water flows, and construction of numerous access tracks. Two quarries (now water-filled) are located south of the Lobe B Upper Series Pit.

The pits and other main features associated with PEL 650 are shown in Figure 4-9.

Figure 4-9: Leigh Creek Coalfield within PEL 650

4.4.3 Exploration Drill Sites

The initial exploration drill sites are located in the Telford Basin, in a relatively flat area between the Upper series pits and the Middle series pits, around the eastern area around where the current Flinders Power offices are located, as shown in Figure 4.9, Plate 4-1 and Plate 4-2.

It is significantly disturbed, and a substantial proportion of the site has been previously graded. Haul roads, old road alignments, excavations, stockpiles and other disturbances are prevalent across the site. Aerial photographs indicate that the site is located west and east of the original path (before mine development) of the Leigh Creek floodplain.

Soils at the site are predominantly a red / brown gravelly clay loam with patchy gibber scatter and are consistent with the Telford Gravels. Some lower lying areas and drainage paths have a thin veneer of grey, silty material that has been washed off adjacent stockpiles. Soils at the site have relatively low permeability due to the high clay content and cementing in the gravels and water readily pools across the site after rain.

There are no erosion issues on the site itself, however some adjacent stockpiles exhibit significant erosion, with deep gullies present.

The site of the initial exploration drilling program will be between the Main Series Pit and Upper Series Pit east of the demonstration plant site. Later exploration drilling programs will extend out into the rest of PEL 650. The ground surface in the rest of PEL 650 is less disturbed than the Telford Basin.

Exploration drilling for water monitoring studies will be conducted both within the disturbed and undisturbed areas of PEL 650.

Plate 4-1: Panorama of initial exploration drilling area site looking south across site from adjacent stockpile

Plate 4-2: Typical landscape of initial exploration areas within PEL 650

4.5 Existing Site Contamination

Historical mining activities and associated infrastructure have involved numerous potentially contaminating activities at a range of locations.

In addition, Flinders Power submitted a Voluntary Site Contamination Assessment Proposal (VSCAP) to the Environment Protection Authority for the Leigh Creek Coalfield. Flinders Power engaged Coffey Environments Pty Ltd to undertake the site contamination assessment to determine the nature and extent of existing site contamination and the actual or potential risk to human health or the environment resulting from such contamination. The Coffey Environments Pty Ltd report *'The Detailed Site Investigation of the Leigh Creek Coal Mine (Lobe B)'* identified 14 areas of environmental concern including but not limited to former crusher refuelling facility, Telford rail siding fuel storage tanks, asbestos landfill, permanent and temporary refuelling tanks, transformer graveyard, mining operations area, town landfill and explosive storage compounds.

Areas and activities across the Leigh Creek Coalfield that may have had potentially contaminating activities are shown in Figure 4-10 below (AECOM 2016).

If in the course of activities LCK identifies a change in the nature and extent of site, LCK will provide a section 83 or section 83A notification to the Environmental Protection Agency (EPA) as soon as reasonably practical in accordance with EPA legislation & guidelines.

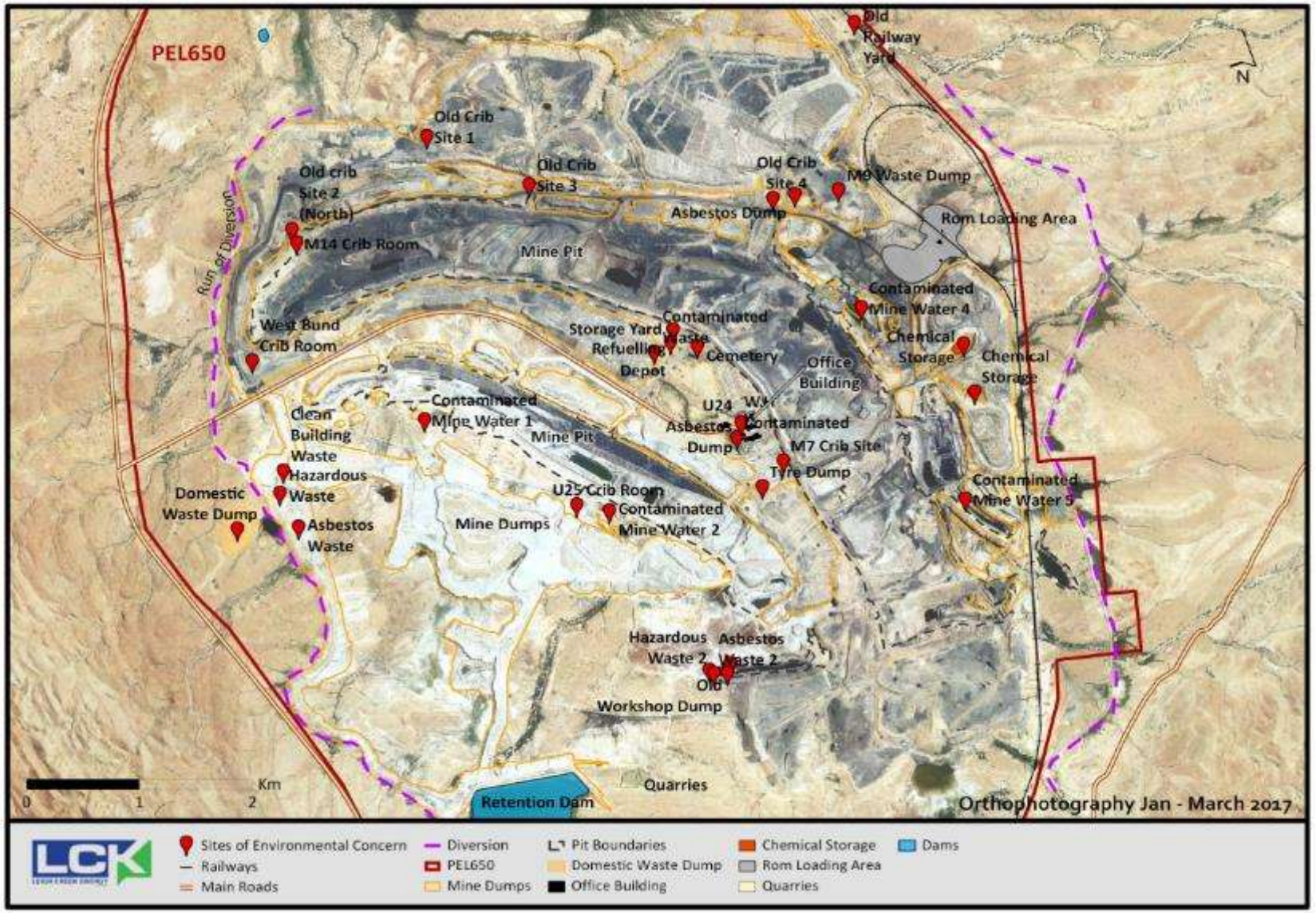


Figure 4-10: Sites of environmental concern within PEL 650

4.6 Geology

4.6.1 Regional Geology

The geology of the Telford and Northfield Basins and surrounds are previously described in Parkin (1953), Johns (1970) and Springbett (1995).

In general, the areas surrounding Leigh Creek are characterised by ranges and low undulating hills of variably weathered and folded rocks of the Adelaide Geosyncline. These Adelaidean aged basement rocks in the region include those of the Heysen Supergroup (the Wilpena Group and the Umberatana Group), and the Warrina Supergroup (the Burra Group). These rocks are generally well indurated (hardened) and are predominantly steeply dipping with the strike extent of the unit often readily identifiable at the surface. Lithologies, which are highly weathered, include laminated siltstone and shale, dolomitic siltstone, quartzitic boulder tillite, quartzite, and sandstone.

The Telford and Northfield Basins are Mesozoic (Late Triassic to Early Jurassic) basins hosted within the complexly folded Neoproterozoic Adelaidean metasediments of the Adelaide Geosyncline. The surrounding hills and ranges are often flanked by alluvium covered plains of Quaternary sands, gravels, silts and clays.

Figure 4-11 shows the surface geology of the Leigh Creek Coalfield and surrounding area.

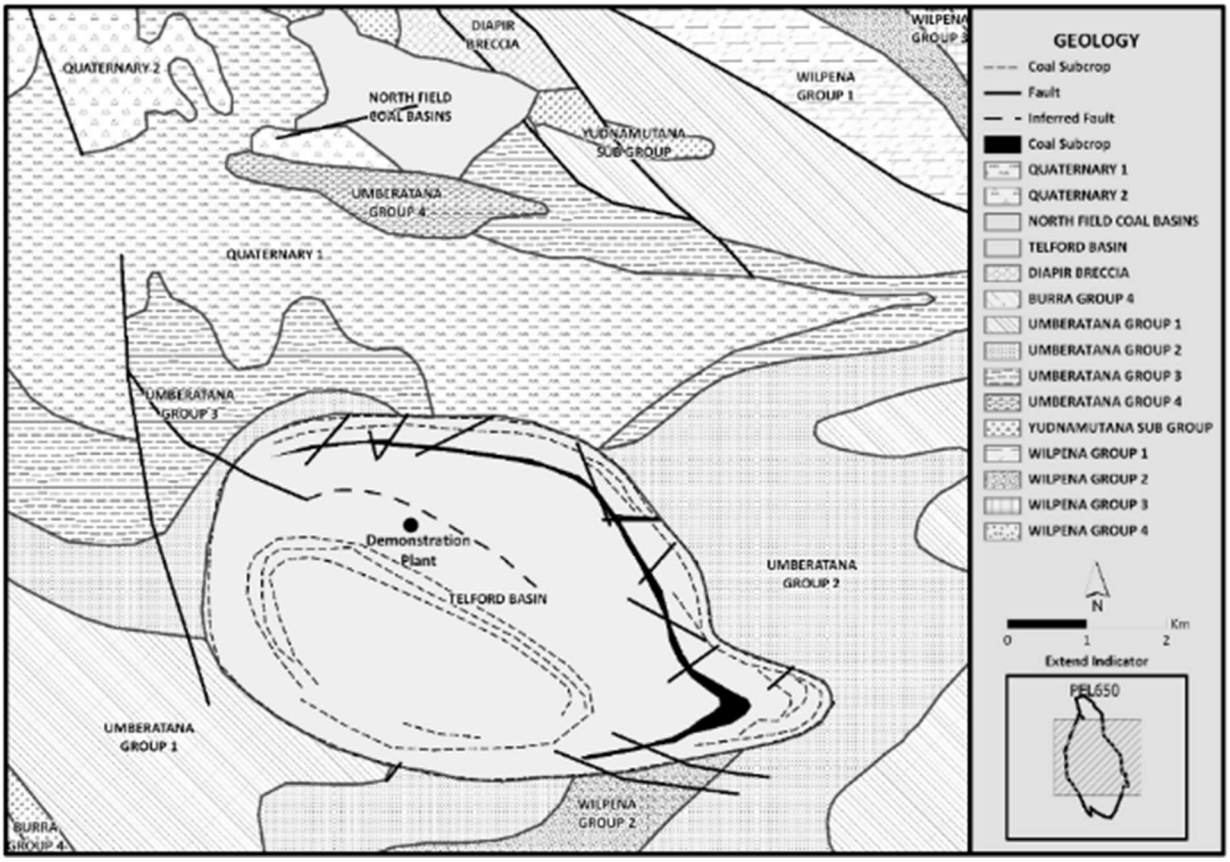


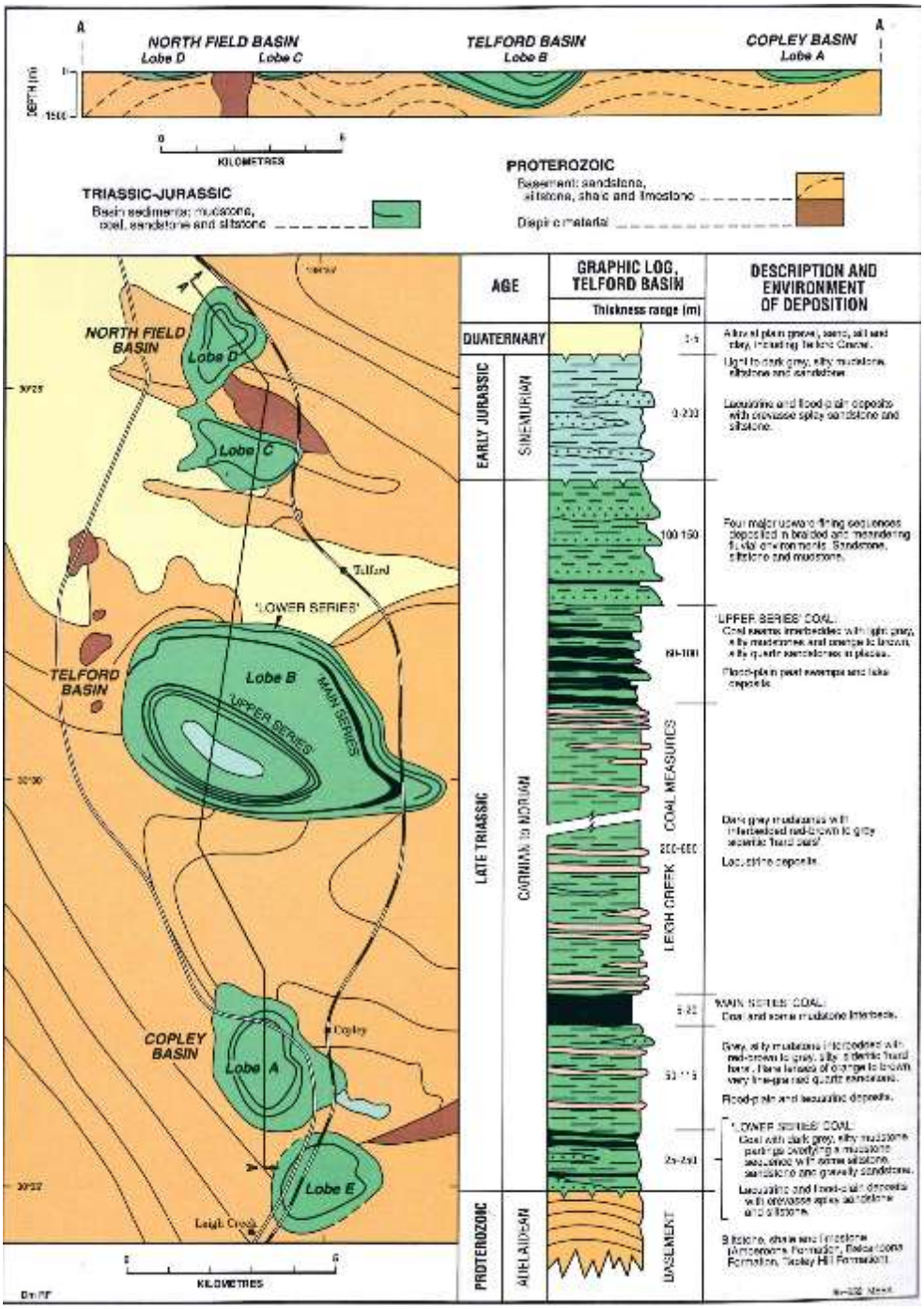
Figure 4-11: Surface geology of the Telford and Northfield Basins and surrounding region

4.6.2 Local Geology of the Telford and Northfields Basins

The Telford Basin (which is Lobe B of the Leigh Creek Coalfield) is the largest of the five basins in the area of Leigh Creek. These basins are structural depressions within the surrounding

Adelaidean aged basement rocks. The larger Telford Basin is an asymmetrical, ellipse shaped basin reaching depths of approximately 1,000 m.

Figure 4-12 shows the Telford, Copley and Northfield Basins in the area of Leigh Creek and provides a graphic log of the stratigraphy within the basin.



Source: The Geology of South Australia: The Phanerozoic. GSSA Bul 54

Figure 4-12: Telford Basin Geologic Sequence

The Leigh Creek Coal Measures within the basins are a result of three depositional phases beginning in the Upper Triassic and concluding in the Middle Jurassic. The basins comprise predominantly fine-grained sediments and the larger Telford Basin spans approximately 34 km^2

in surface area. A thin veneer of alluvium and gravel, collectively called the Quaternary Alluvium, covers most parts of the basins and areas of the surrounding basement rocks.

The Leigh Creek Coal Measures occurs in three main sequences, named informally in descending stratigraphic order as the Upper Series Coal, Main Series Coal and Lower Series Coal. The overall coal sequence typically comprises coal seams interbedded with carbonaceous shales, siltstones and mudstones with numerous sideritic (iron carbonate) hardbars. The Leigh Creek Coal Measures are described stratigraphically as follows:

- Upper Series Coals comprise approximately 100 m of interbedded mudstone, siltstone and numerous coal plies with minor fine-grained sandstone. A predominately sandstone sequence approximately 100 m thick with some siltstone, mudstone and minor thin coal plies overlie the Upper Series Coal.
- Main Series Coal comprises a 20 m thick zone of (predominately) coal separated from the Lower Series by approximately 50 to 100 m of grey carbonaceous mudstone containing thin, hard sideritic siltstone interbeds (hardbars).
- The Lower Series Coal contains two coal plies in a zone approximately 60 m thick underlain by approximately 50 m of mudstone and a thin basal gravelly sand.

After deposition, the Triassic and Jurassic sequence and the underlying Basement sequence has been subject to deformation and erosion, resulting in a bowl-shaped syncline. A thin veneer of alluvium and gravel, collectively called the Quaternary Alluvium, covers most parts of the Telford Basin and areas of the surrounding basement rocks.

The general stratigraphic section through the 3 basins are described in Table 4-3. Indicative cross sections through the Telford Basin in the vicinity of the drilling programs are shown in Figure 4-13, Figure 4-14 and Figure 4-15.

Table 4-3: Generalised stratigraphy of the Telford, Copley and Northfield Basins

Period	Unit	Description
Quaternary	Telford Gravels	GRAVEL: reddish brown to white, rounded to sub-rounded cobbles and pebbles in red-brown silty clay soil. Often cemented by white to pale pink calcareous matrix. Unconformably overlies the Upper Series Overburden.
Lower to Middle Jurassic	Upper Series Overburden 1	CARBONACEOUS MUDSTONE: dark to light grey silty mudstone with abundant carbonaceous fragments and some carbonaceous beds. SANDSTONE: brown fine grained quartz sandstone with abundant silty laminations. Weakly cemented. Up to 5 m thick.
	Upper Series Overburden 2	COAL: dark brown to black, thin (200 mm) friable coal seams containing laminations of highly plastic clay. CARBONACEOUS MUDSTONE: dark grey to brown laminated silty mudstone with carbonaceous fragments. SILTY SANDSTONE: brown, fine grained, quartz sands with abundant sandy silt laminations. Weakly cemented. SANDSTONE: orange brown to white medium to coarse grained quartz sandstone. Cross-bedded in some places, generally moderately well cemented.
	Upper Series Coal	COAL: dark brown to black, friable coal seam. Characterised by seam thickness and seam splitting (0-8 m thick). CARBONACEOUS MUDSTONE: dark grey silty mudstone with abundant carbonaceous fragments and laminations. Medium bedded (100-300 mm). SANDSTONE: orange to brown, fine grained silty quartz sandstone. Moderately to weakly cemented. Beds up to 2 m thick.
Upper Triassic	Main Series Overburden	CARBONACEOUS MUDSTONE: grey to dark grey silty mudstone, containing abundant carbonaceous fragments with some thin carbonaceous beds (30-100 mm). SIDERITIC HARDBANDS: red brown to grey silty siderite band 50 mm to 300 mm thick often containing disseminated pyrite.
	Main Series Coal	COAL: dark brown to black, hard, very low rank sub-bituminous or lignite A coal, with carbonaceous mudstone parting in some places.
	Lower Series Overburden	CARBONACEOUS MUDSTONE: grey to dark grey silty mudstone, containing abundant carbonaceous fragments and some thin carbonaceous beds (30-100 mm). SIDERITIC HARDBANDS: red brown to grey silty siderite band 50 mm to 300 mm thick often containing disseminated pyrite. SANDSTONE: orange to brown, fine grained silty quartz sandstone. Moderately to weakly cemented. Beds up to 2 m thick.
	Lower Series Coal	COAL: dark brown to black, hard, very low rank sub-bituminous or lignite A coal, often separated by carbonaceous mudstone parting. CARBONACEOUS MUDSTONE: grey to dark grey silty carbonaceous mudstone containing abundant carbonaceous fragments. SANDSTONE: brown to light grey medium to coarse grained carbonaceous sandstone or grit. Often weathered at basement contact. CARBONACEOUS MUDSTONE: grey to dark grey silty carbonaceous mudstone, containing abundant carbonaceous fragments with some thin carbonaceous beds (30-100 mm). SIDERITIC HARDBANDS: red brown to grey silty siderite band 50 mm to 300 mm thick often containing disseminated pyrite. SANDSTONE: orange to brown, fine grained silty quartz sandstone. Moderately to weakly cemented. Beds up to 2m thick.
Adelaidean	Weathered basement Fractured basement	CARBONACEOUS SANDSTONE: blue grey to green silty calcareous shales and siltstone. Thinly bedded (30-100 mm). DOLOMITIC LIMESTONE: red and grey dolomitic limestone beds up to 10 m thick containing oolites and stromatolites in some places.

Figure 4-13: Location of cross-sections A-A' and B-B'

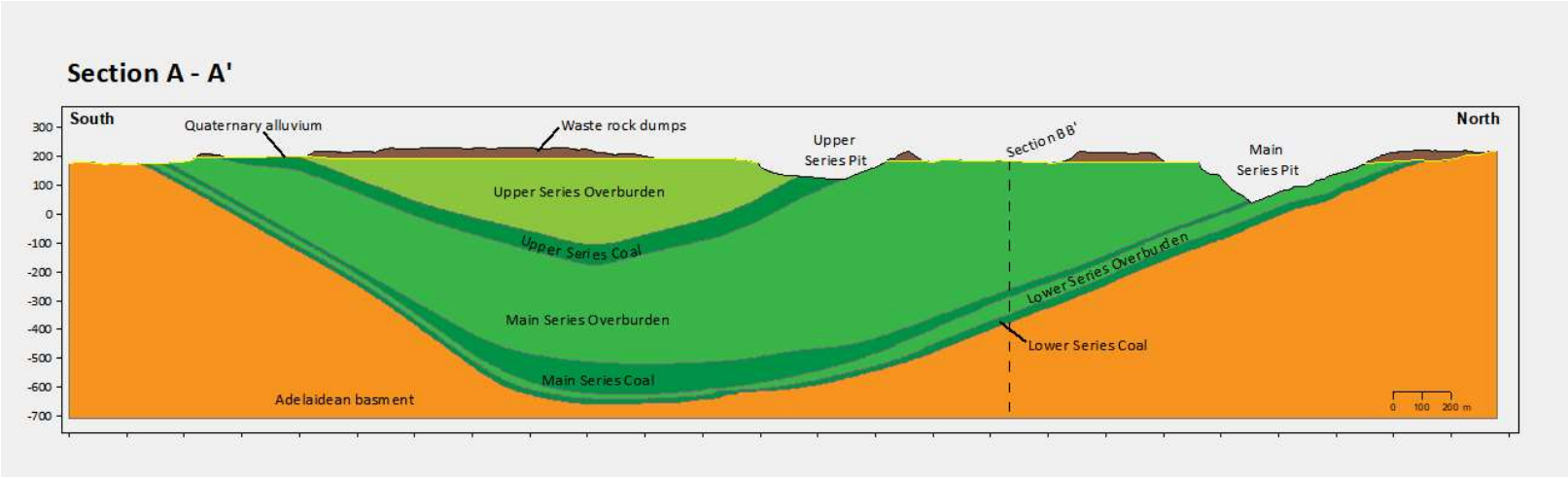


Figure 4-14: Schematic south-north cross section of the Telford Basin

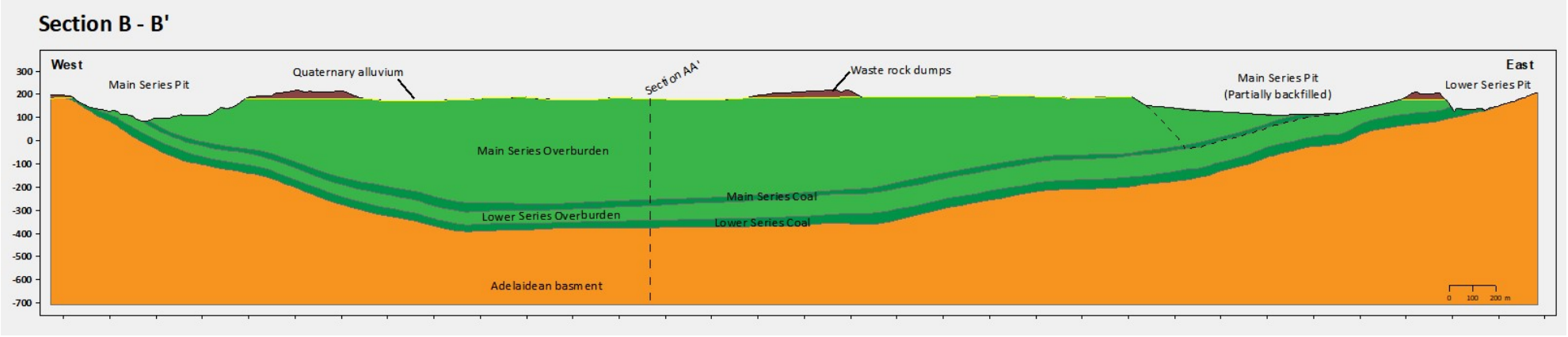


Figure 4-15: Schematic west-east cross section of the Telford Basin

4.7 Hydrogeology

This section presents an overview of the hydrogeology of the Telford Basin and surrounds, based on existing information and hydrogeological data generated for the Leigh Creek Coalfield, and drilling and hydrogeological investigations undertaken by Leigh Creek Energy. Further detail is provided in the hydrogeological conceptual site model report contained in Appendix A of the EIR for the ISG Demonstration Plant (Leigh Creek Energy, 2017).

4.7.1 Groundwater, Aquifers, Aquitards and Water Quality

All water found below the ground surface is considered groundwater. Where the rock becomes saturated, this depth is referred to as the water table.

The ability for groundwater to move through rock media is controlled by the porosity of the rock (volume of void space within the rock media) and the permeability (the connectivity of the voids to allow movement of water).

The void space within the rock media can be the spaces between sedimentary grains (in sedimentary rocks) which is referred to as 'primary', or the space developed when joints or faults open up (fractured rocks) or where the rock media has been dissolved (e.g. in limestone), which is referred to as 'secondary'. The measure of the rate at which a rock can transmit water is termed the "hydraulic conductivity" of the rock, which is sometimes referred to as the "permeability" of the rock.

The depth at which rock becomes saturated (the water table) may be different to the depth (or height) water may rise to in a well (or bore) when the point of measurement of the groundwater pressure is deep. This is the 'artesian' nature of a groundwater system, whereas in the Great Artesian Basin, there is enough groundwater pressure to push water out of the well, when the surrounding rock may be dry to a depth of 50 m or more. In a groundwater system where there is not enough pressure to push water out of the well above ground level, but there is enough pressure to cause water in the well to rise above the depth at which groundwater is intersected by the well, this is referred to as being 'sub-artesian'.

When many points of measurement of groundwater head pressure are used to draw a surface, this is referred to as the 'potentiometric surface' of that groundwater system. The shape of this surface may vary at different rates than the water table surface due to changes that cause different pressures to act on the groundwater system.

4.7.1.1 Aquifers

Aquifers are geologic materials with high hydraulic conductivity that are able to receive, store and transmit groundwater in quantities sufficient for use as a water supply. The aquifer materials are typically sands and gravels, limestones, and fractures in hard rock materials.

4.7.1.2 Aquitards

Aquitards are geologic materials with low hydraulic conductivity that are able to receive and store groundwater but cannot transmit the groundwater in quantities sufficient for use as a water supply. The aquifer materials are typically clays, silts and unfractured hard rock materials.

4.7.1.3 Water Quality

The terms aquifer and aquitard relate to the potential yield (amount of water) that can be pumped from a well for some desired use. A critical factor in what any given water can be used for is its quality, typically measured in terms of the concentration of Total Dissolved Solids (TDS) measured in mg/L or parts per million. In the field this is often assessed in the context of the electrical

conductivity of the water, with higher the TDS giving higher electrical conductivity. In Australia, the environmental values of particular waters as a measure of TDS is presented in the following table.

Table 4-4: Water quality categories

Underground water with a background Total Dissolved Solids level (mg/L)	Typical use
Less than 1,200	Drinking Water for human consumption Primary industries— irrigation and general water uses Primary industries— livestock drinking water Primary industries— aquaculture and human consumption of aquatic foods
1,200 to 3,000	Primary industries— irrigation and general water uses Primary industries— livestock drinking water Primary industries— aquaculture and human consumption of aquatic foods
3,000 to <13,000	Primary industries— livestock drinking water Primary industries— aquaculture and human consumption of aquatic foods

*Source: EPA (2015) https://www.epa.sa.gov.au/files/11255_wqepp_policy2015.pdf

4.7.2 Regional Hydrogeology

The Telford, Copley and Northfield Basins are small sedimentary basins which is contained within rocks of the Adelaidean basement. The Leigh Creek Coalfield occupies the entire footprint of the Telford Basin, with the initial exploration drilling program located in the Coalfield between the Upper Series Pit and Main Series Pit and related waste rock dumps.

The Great Artesian Basin is, at its closest, approximately 50 km to the north and has no connection with groundwater in the Telford Basin (see Figure 4-16).

Natural springs in the region include the Aroona, Top Well and Myrtle Springs. These springs are outside the Telford Basin and are not hydraulically connected to the Telford Basin.

4.7.3 Hydrogeology of the Telford Basin

The Telford Basin is approximately 8 km by 5 km and is up to 1,000 m deep. It is a small sedimentary basin which is contained within the rocks of the Adelaidean basement.

The location of the Telford Basin within the Adelaidean fractured rock basement indicates that the groundwater at this site is sourced from local rainfall runoff and infiltration and not connected to other regional groundwater systems such as the Great Artesian Basin.

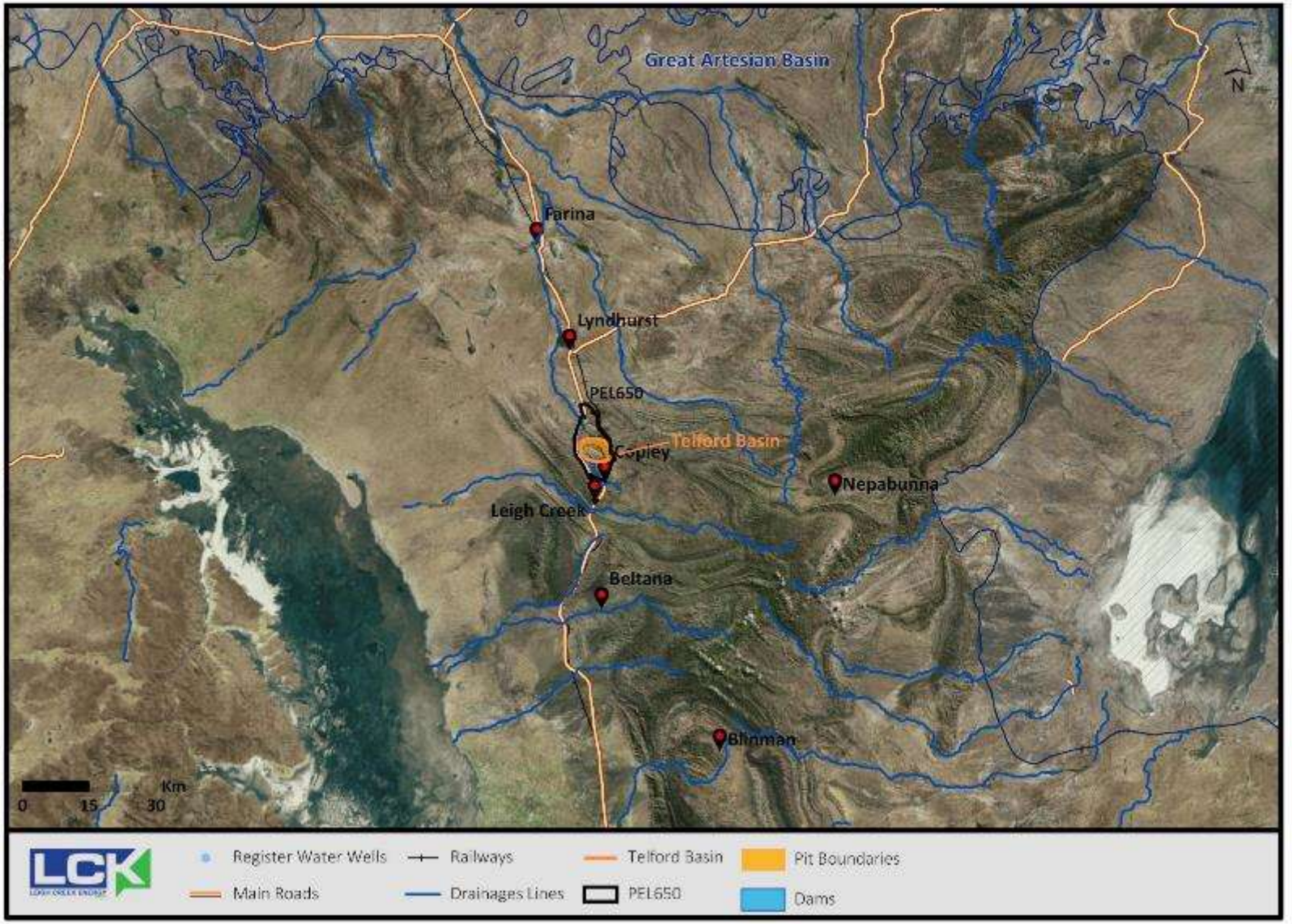


Figure 4-16: Regional hydrogeology

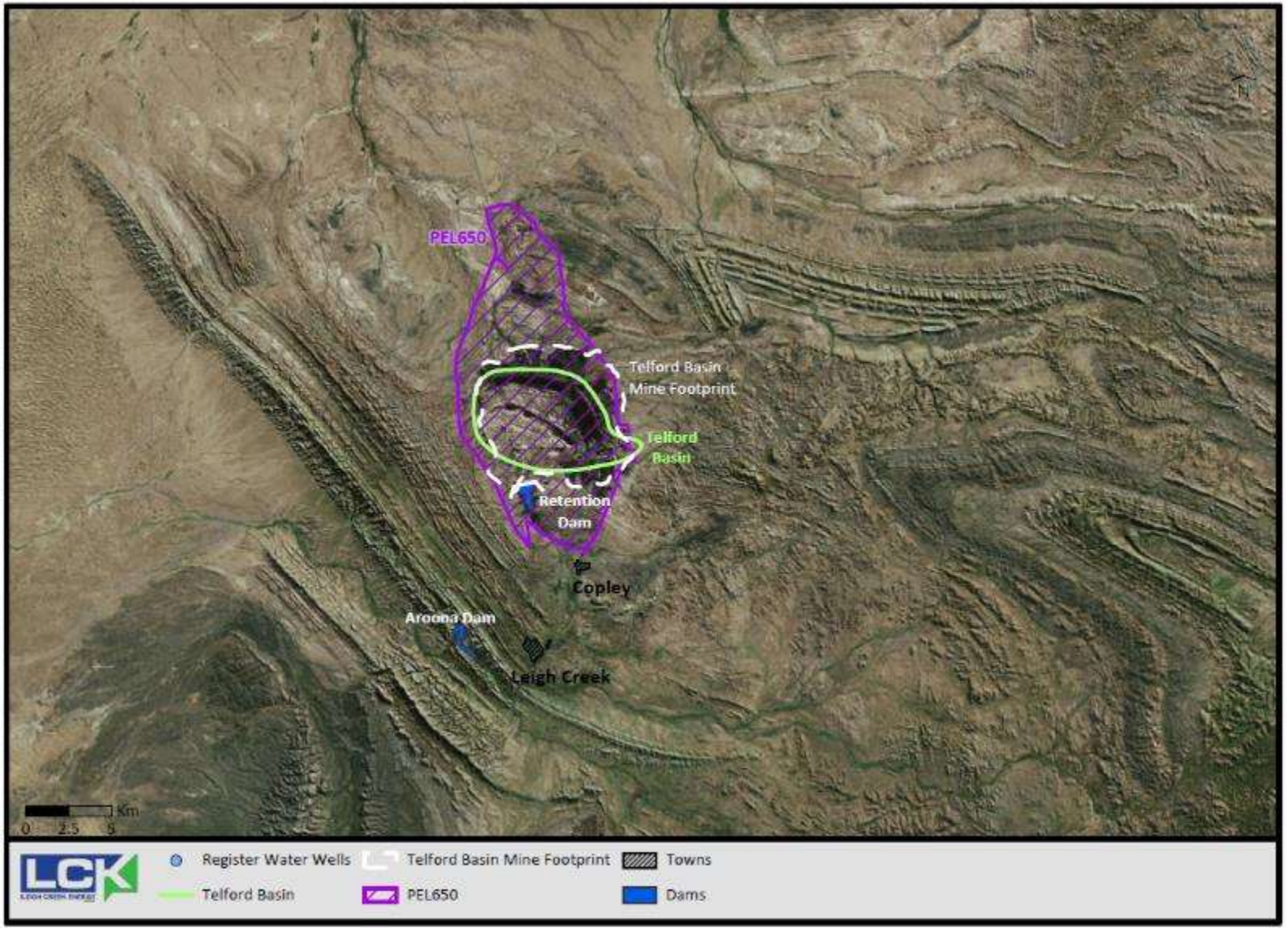


Figure 4-17: PEL 650 and surrounds - hydrogeological features

It is considered unlikely that the Telford Basin sequence plays a significant role in the regional groundwater flow patterns, because the Leigh Creek Coal Measures where they sit on the basement have a very low hydraulic conductivity and form a very thick aquitard. The Telford Basin is a barrier to groundwater flow, and it is anticipated that historically the majority of the regional groundwater would have flowed around and beneath the Leigh Creek Coal Measures, rather than through it. Some relatively small volumes of surface water may recharge into sub cropping Upper Series Overburden strata, the only aquifers in the Leigh Creek Coal Measures. These strata intersect the Upper Series Pit and have been depressurised and significantly dewatered to maintain stability of the pit walls. Any drillholes that are planned to be drilled through the Upper Series Coal Measures, will be cased with the casing cemented in place to ensure that a permanent barrier exists between the drillhole and any potential aquifers in the Upper Series Coal Measures and prevent any potential pathways to/from the Upper Series Coal Measures.

All other formations in the Telford Coal Measures are aquitards with low permeability to virtually impermeable.

The influence of the Leigh Creek Coal Measures on regional groundwater flow patterns may have changed since the creation of the open cut pits. The open cut pits expose rocks to a depth of up to 250 m, facilitating increased rates of evaporation from the groundwater system. This would likely encourage any movement of groundwater, however small, through the Coal Measures toward the open pits. When considered in the context of the modified surface drainage, the Telford Basin could now be considered a terminal basin with almost all groundwater and runoff within the modified landscape now moving to the pits where it will evaporate.

4.7.3.1 Telford Gravels

The Telford Gravels are a variably silicified, sedimentary perched water table groundwater system. The Telford Gravels within the Telford Basin, with the modification of the landscape by operation of the Coalfield, and the Telford Gravels which are external to the Telford Basin within PEL 650 are likely to receive opportunistic infiltration recharge when rainfall events generate surface flow conditions. With high evaporation rates of the Far North region, any remaining groundwater in the Telford Gravels is localised and discontinuous due to the mine pits and limited runoff.

Ten wells have been installed into the Telford Gravel sediments within the Telford Basin as part of the monitoring requirements of the PCD Trial and three existing shallow wells were also included in the PCD Trial monitoring program.

Two of the three existing wells, Ti Tree well (6536-1) and Stone Hut Windmill (6537-2318) located on the southern portion of PEL 650 and along the western boundary respectively, included in the monitoring program are external to the Telford Basin.

Telford Gravels depth to groundwater within the Telford Basin is approximately 5m below the surface, however well MW12 located near the Upper Series Pit and drilled to the base of the formation at 12.0m bgl, has reported dry since installation in June 2018.

Additional shallow monitoring wells were identified in the FPP Mine Closure Plan with drilling depths up to 12.1m bgl. Recorded shallow groundwater levels were generally less than 6m below the surface. Data for the wells presented in the Closure Plan included the Telford Rail Siding and six wells drilled north of the Main Series pit.

4.7.3.2 Groundwater Movement

Groundwater in the Telford Basin Leigh Creek Coal Measures is understood to be moving very slowly to the north toward the Main Series Pit. The rate of natural groundwater movement through the area of the site is expected to be in the range of 1 m per year to 1 m per 100 years, based on observed groundwater gradients and hydraulic conductivities that have been

determined in baseline investigations and groundwater well recovery records. Groundwater level recovery of bores within coal measures has been slow and recorded depths to groundwater are not representable. However, vibrating wire piezometer monitoring within the Telford Basin indicates lower pore pressures within the coal measures since the initiation process of the gasifier, indicating a localised pressure gradient towards the gasifier.

Groundwater within the Telford Gravels beneath the PCD is travelling in a northerly to north easterly direction towards the Main Series Pit. Surface pits constructed during the drilling program near MW11 and MW12 are potentially affecting the water levels near the inlet well pad and where MW11 natural surface elevation is lower. The southern background well MW22, drilled to the base of the Telford Gravels, has reported dry since installation and is potentially due to its proximity to the Upper Series Pit. Telford Gravels water levels have been declining since well installation in 2018 and is attributed to the lack of recent rainfall.

With limited data available for groundwater on PEL 650 external to the Telford Basin it is difficult to determine groundwater movement. The two wells monitored as part of the monitoring program (Stone Hut Windmill and Ti Tree) are separated by approximately 5kms and generally report depth to groundwater <4mbgl. Groundwater levels within the windmill well were potentially affected by the operation of the windmill, however since solar pump installation in January 2019, water levels in the Windmill well have dropped by more than 3m and would be creating a localised groundwater depression. In other locations around PEL 650 the water table is likely to be dominated by the topography and drainage from waste rock piles where present.

4.7.4 Groundwater Quality

Groundwater quality samples have been collected within PEL 650 during the background and trial period to date[8]. The observed chemical characteristics of groundwater samples are summarised below and presented in Table 4-5

4.7.4.1 Main Series Overburden, Main Series Coal and Lower Series Overburden

Samples were collected from groundwater wells installed within the Main Series Overburden (Upper and Lower portions), Main Series Coal and Lower Series Overburden horizons of the Telford Basin. A summary of the groundwater analytical data is presented in Table 4-6 and reviewed below.

- Groundwater from each well is generally saline with maximum electrical conductivity (EC) ranging between 727µS/cm to 40,100µS/cm. Note minimum salinity ranges recorded below 5,000mg/L are suspected to be fresh water present within the groundwater wells as a result of flushing well screens following installation.
- BTEX were reported at higher concentrations in samples collected from the groundwater well targeting the Main Series Overburden horizon (P1M1) compared to all other samples collected. This may be due to the presence of oily inclusions within the Main Series Overburden material reported in historical reports.
- Concentrations above the limit of reporting (LOR) of petroleum hydrocarbons have been reported in each horizon with a maximum concentration of TRH fraction C10-C16 (5,430µg/L) reported in background monitoring well P1M2 completed in the Main Series Coal. .
- The key metals reported in groundwater samples included boron, copper, manganese and zinc. Note some heavy metals were reported in core samples.

[8] At the time of writing, groundwater data received up to and including December 2018 monthly monitoring program

As noted previously, the Main Series Coal and Main Series Overburden are aquitards and groundwater cannot be extracted at a rate that makes these units suitable for use as a water supply. Comparison of the groundwater quality against water quality guidelines (ANZECC 2000) indicated that the groundwater (even if it was able to be extracted) would not be suitable for livestock (cattle) water supply, drinking water supply, long-term irrigation or aquaculture, exceeds the trigger levels for protection of freshwater aquatic ecosystems and exceeds a number of guidelines for recreational purposes.

4.7.4.2 Telford Gravels

Samples were collected from groundwater wells with well screen intervals installed within the Telford Gravels. A summary of the groundwater analytical data is presented in Table 4-6 and reviewed below.

- Groundwater collected from the Telford Gravels located within the Telford Basin during the monitoring program have reported EC ranging from 27,100µS/cm to 69,200µS/cm, indicating saline to hypersaline groundwater conditions.
- The regional shallow wells reported EC ranging from 7,070µS/cm to 66,200µS/cm, indicating saline to hypersaline groundwater conditions. Well data from the Closure Plan wells presented EC ranging from 13,000µS/cm to 30,000µS/cm.
- BTEX concentrations for all Telford Gravel bores were reported below the limits of reporting.
- Minor Petroleum hydrocarbons (C10 to C16 and C16 to C34 fractions) were reported in groundwater samples collected from MW12 and MW13 within a short period after construction and are potentially due to insufficient well development after installation. Concentrations below LOR have been recorded since February 2019.
- Dissolved metals concentrations were reported in all Telford Gravels bores with boron and manganese reporting the highest concentrations.
- No concentrations of mercury were reported from groundwater sampled from the local regional monitoring wells.

Table 4-5: Baseline concentration ranges in groundwater samples (mg/L)

	P1M1		P1M2		P1M3		MW01-MW05		MW06-MW10		Telford Basin Gravels		PEL 650 Shallow Wells	
Analyte	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
pH - Lab	7.28	8.9	11.6	12.3	7.44	11.3	6.54	9.28	6.27	7.8	5.48	7.93	5.97	8.16
Electrical Conductivity (µS/cm)	12,000	14,500	727	15,700	7,160	12,000	3,450	39,600	2,560	40,100	27,100	69,200	7,070	66,200
Nutrients														
Total Nitrogen as N	76.3	123	13.8	196	77.1	132	31.5	158	27.5	116	0.2	21.5	<0.1	4.9
C6 - C10 *	30	90	<20	100	<20	70	<20	40	<20	<20	<20	<20	<20	<20
>C10 - C16 *	<100	240	<100	5430	<100	2380	<100	310	<100	<100	<100	130	<100	<100
>C16 - C34 *	<100	1730	<100	3140	<100	3170	<100	3180	<100	190	<100	320	<100	130
Benzene*	4	24	3	13	2	9	<1	6	<1	2	<1	<1	<1	<1
Ethylbenzene*	<2	10	<2	3	<2	2	<2	3	<2	<2	<2	<2	<2	<2
Toluene*	3	8	<2	6	<2	<2	<2	5	<2	<2	<2	<2	<2	<2
Total Xylenes*	<2	<2	<2	<2	<2	18	<2	6	<2	<2	<2	<2	<2	<2
Metals														
Arsenic	<0.001	0.002	<0.001	0.001	<0.001	0.007	<0.001	0.001	<0.001	0.002	<0.005	0.002	<0.002	0.001
Boron	0.17	0.41	0.06	0.29	0.13	0.45	0.23	0.96	0.27	1.65	2.93	9.61	0.91	4.84
Chromium	<0.001	0.003	<0.001	0.032	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.005	0.124	<0.002	0.001
Copper	<0.001	0.26	<0.001	0.303	<0.001	0.545	<0.001	1.18	<0.001	0.007	<0.002	0.131	<0.002	0.013
Lead	<0.001	<0.001	<0.001	0.049	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.005	0.016	<0.002	0.022
Manganese	0.072	0.171	-0.001	0.019	-0.001	0.151	0.009	2.53	0.204	2.12	0.005	3.44	0.025	18.6
Mercury	<0.0001	<0.0001	<0.0001	0.0009	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	0.0002	<0.0001	0.0033	<0.0001	<0.0001
Nickel	<0.001	0.028	<0.001	0.027	<0.001	0.021	0.001	0.04	<0.001	0.007	0.002	0.173	<0.001	0.424
Thorium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.006	<0.005	0.008	<0.002	0.004
Uranium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	0.034	<0.002	0.027
Zinc	<0.005	0.43	<0.005	5.44	<0.005	0.504	<0.005	2.89	<0.005	0.032	<0.01	0.689	<0.005	1.85

* reported in µg/L

4.7.4.3 *Baseline Chemistry of Rock Strata*

Chemistry of the rock strata present in and around the target coal seam has the potential to influence groundwater chemistry and the transport of COPC from the gasifier chamber.

Drill core samples were collected from rock strata in, above, and below the target coal seam. Samples were analysed for a range of chemicals (Table 4-6) and the following was determined:

- The coal is characterised by higher concentrations of total hydrocarbon (C_{15}-C_{28}) fractions, the presence of PAHs and lower concentrations of metals compared to samples above and below
- Concentrations of nitrogen (mainly TKN) were reported in samples collected from all three horizons
- Key metals reported at higher concentrations (compared to other metals tested) in samples collected from above and below the coal (predominantly mudstone) included barium (Ba), cobalt (Co), chromium (Cr), copper (Cu), lead (Pb), manganese (Mn), and zinc (Zn).

Table 4-6: Baseline concentration ranges in drill core samples (mg/kg)

Analyte	MO drill core	MC drill core	LO drill core
Nutrients			
Total Nitrogen	800 - 2,980	190 - 3,000	580 - 2,240
Hydrocarbons			
C_6-C_{10}	<10 - 21	<10	<10 - 13
>C_{10}-C_{16}	<50	<50 - 90	<50
>C_{16}-C_{34}	<100 - 190	130 - 630	<100 - 180
Benzene	<0.2 - 0.3	0.3 - 1.0	<0.2 - 0.2
Ethylbenzene	<0.5 - 1.2	<0.5	<0.5 - 0.6
Toluene	<0.5	<0.5	<0.5
Xylene	<0.5	<0.5	<0.5
Metals			
Arsenic	<5 - 7	<5	8 - 9
Barium	130 - 1,110	10 - 50	70 - 150
Chromium	15 - 31	3 - 25	8 - 14
Cobalt	9 - 17	<2 - 2	6 - 22
Copper	35 - 52	<5 - 21	35 - 42
Lead	12 - 30	<5 - 19	21 - 26
Manganese	31 - 814	<5 - 32	<5 - 10
Mercury	<0.1 – 0.4	<0.1	<0.1 – 0.1
Nickel	20 - 32	<2 - 8	6 - 32
Thorium	17.4 - 22.8	2.1 - 5.5	15.1 - 16.5
Uranium	2.1 - 4.6	0.1 - 1.4	1.1 - 2.9
Vanadium	24 - 36	<5 - 57	18 - 19
Zinc	78 - 153	<5 - 62	113 - 170
Polycyclic Aromatic Hydrocarbons (PAH)			
PAHs (Sum of total)	<0.5	3.1 - 29	<0.5
Dioxins			
Octa-Dioxin	n/a	17.8 pg/g	n/a

Note: pg/g = parts per billion

4.7.5 Groundwater Beneficial Uses and Sensitive Receptors

The review of potential sensitive groundwater receptors and beneficial uses in the region indicated the following:

- No beneficial uses have been identified within the existing coal mine footprint. The mine has ceased operations and groundwater is not believed to be extracted for any activities associated with the mine closure.
- Groundwater is used from wells outside the mine footprint and outside the Telford Basin for stock water. Groundwater wells to the west (Myrtle Springs Station), east (Leigh Creek Station), and south (Copley area) are at higher elevations than the Coalfield and are likely to be extracting groundwater from shallow water table groundwater systems. Such groundwater will be moving toward the Telford Basin and therefore will not be affected by any exploration drilling activity.

The Telford Basin is now understood to be a terminal groundwater basin, due to the presence of the mine pits and related modifications to the landscape preventing external runoff from entering the mine site.

4.7.6 Groundwater Dependent Ecosystems

As discussed in Section 4.9.3, there are several areas of vegetation in and adjacent to the PEL that are expected to be reliant on groundwater as well as surface water inflows that would be classified as groundwater dependent ecosystems.

4.8 Surface Water

PEL 650 lies in the catchment of Leigh Creek, which is on the southern edge of the Lake Eyre Basin and drains north-west towards Lake Eyre. The major surface water features in the region are Lake Torrens, located approximately 55 km to the west, and Lake Frome which is located approximately 110 km east of PEL 650, on the eastern side of the Gammon Ranges.

Leigh Creek is the main surface water system in PEL 650. It enters the PEL on the southern boundary, north of Copley and exits the PEL near Lobe C of the Leigh Creek Coalfield at the PEL's north-western boundary.

Ridge lines located to the west and east of PEL 650 direct runoff via numerous small drainage lines towards the gently undulating plain where the PEL is located. Under natural (pre-mining) conditions, surface water would have moved generally northwards through PEL 650 from south to north-west, discharging to the Leigh Creek floodplain where it crosses the current Outback Highway. Figure 4-18 shows the regional surface water features.

Modifications to drainage patterns by mining operations have resulted in much of the flow of Leigh Creek and its tributaries being retained on the southern, eastern and western boundaries of Lobe B. The Retention Dam captures the majority of flow in Leigh Creek, and two earthen walls have been constructed on the eastern and western margins of the coalfield to intercept flows towards the pits from the eastern and western ranges. A gap in the western wall allows water overflowing from the Retention Dam to flow closer to the coalfield through a purpose built diversion drain.

Surface water within Lobe B is inferred to remain predominantly within the Telford Basin, given the likelihood of mine pits acting as groundwater depressions and the reduced surface water runoff contributions from the ranges due to interception by the earthen walls. Transport downstream of Lobe B is confined to surface water overflow around the north-eastern and north-western margins of the site (outside the earthen walls) and via limited flow in the shallow water

table aquifer, primarily in the floodplain sediments from recharge north of the Main Series Pit. As discussed in Section 4.7, the Main Series and Upper Series pits act as groundwater sinks and would capture any shallow groundwater from south of the Main Series Pit in Lobe B.

There are artificial water storages across the site, including the Retention Dam, dams formed by the eastern and western earthen walls, the two quarries located east of the Retention Dam, the mine pits and numerous constructed surface depressions where water pools after rain. Water in the Retention Dam, the quarries and the Lobe C, Lobe D and Lower Series pits is permanent.

Aroona Dam and its catchment is outside PEL 650 and outside the Leigh Creek catchment. Aroona Dam and its feeding creeks, Emu and Windy Creeks, are part of the Lake Torrens catchment draining to the west.

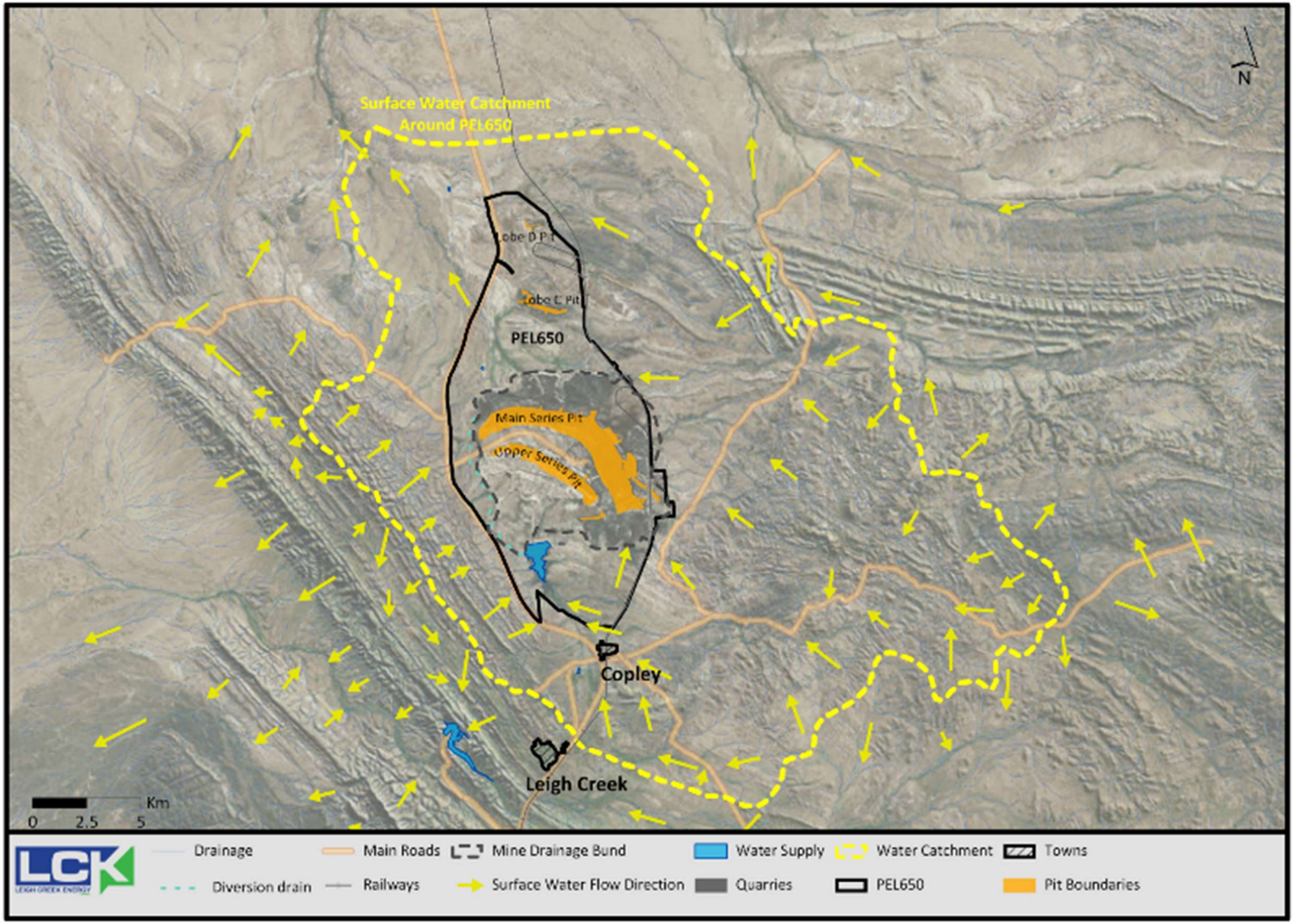


Figure 4-18: Regional surface water feature

4.9 Flora and Fauna

A desktop review was undertaken to determine the flora and fauna species within a 20-kilometre buffer from the PEL 650 boundary (T&M Ecologists, 2018). The desktop review was supported by field observations including aerial photography, standard treadle Elliott traps and Anabat recorders to help identify bat species for example. Most of the vegetation communities and habitats within the PEL 650 are common and widespread throughout the nearby region.

4.9.1 Vegetation

Six native vegetation groupings are classified within the PEL (Appendix A, T&M Ecologists, 2018).

1. Red Gum (*Eucalyptus camaldulensis ssp. arida*) woodland. This vegetation type is principally found along Leigh Creek. The overstorey is comprised of Red Gums (*Eucalyptus camaldulensis ssp. arida*).

2. Red Gum (*Eucalyptus camaldulensis ssp. arida*) low open woodland on rocky outcrops. There is only a small patch of this vegetation type present in the site. It occurs in rocky areas around the edge of the retention dam and is to some extent a community that has been created by the construction of the dam. The overstorey is comprised of relatively open, low (<10m) Red Gums (*Eucalyptus camaldulensis ssp. arida*) and the understorey contains species generally associated with seasonally inundated areas (such as Samphires (*Tecticornia spp*.) and sedges (*Cyperus gymnocaulus*), along with more typical arid zone species, such as Native Myrtle (*Myoporum montanum*), Bindyi's (*Sclerolaena spp*.), and chenopod shrubs, including Saltbush (*Atriplex spp*.) and Bluebush (*Maireana spp*.).

3. *Acacia victoriae* shrubland along drainage lines. This vegetation type occurs in shallow depressions and drainage lines across the site, and in some of the wash-out areas where Red Gum is not present in the overstorey. Elegant Wattle (*Acacia victoriae*) is persistent throughout this habitat type but ranges in density from >40% cover to only scattered individuals. Many other medium to tall shrubs (>1.5 metres) are also represented in this vegetation type, but the density, cover and type of these shrubs vary. Common species include Native Myrtle (*Myoporum montanum*), Native Apricot (*Pittosporum angustifolium*), Sennas (*Senna spp*.), Emubushes (*Eremophila spp*.), Shrubby Riceflower (*Pimelea microcephala*), and Plumbush (*Santalum lanceolatum*). The understorey has many of the chenopod shrubs typical of the adjoining plains vegetation, but grass species, particularly Lemon-grass (*Cymbopogon ambiguus*), are more prevalent than in adjacent shrublands.

4. *Nitraria billardieri* open shrubland with scattered emergent tall shrubs. This vegetation type is found at the southern end of PEL 650, adjacent to Leigh Creek. The dominant overstorey plant is Nitre Bush (*Nitraria billardieri*), growing to up to 2 metres in height, with Nitre Goosefoot (*Chenopodium nitrariaceum*) of a similar size also present, along with scattered emergent shrubs, predominantly Native Myrtle (*Myoporum montanum*). Dominant understorey (<1m) shrubs are chenopodaceous, including Bladder Saltbush (*Atriplex vesicaria*), Baldoo (*Atriplex lindleyi ssp. lindleyi*), Low Bluebush (*Maireana astrotricha*) and Short-leaf Bluebush (*Maireana brevifolia*).

5. *Maireana spp.* This is the most common vegetation type on the PEL. It is characterised by a sparse to moderate (10-40% cover) layer of low to medium chenopod species, with Low Bluebush (*Maireana astrotricha*) and Bladder Saltbush (*Atriplex vesicaria*) generally

dominant. Bindyi (*Sclerolaena spp*.) species are common in the understorey and Ward's Weed (*Carrichtera annua*). There are sparse and patchy emergent taller (>1.5 metre) shrubs, comprising species such as Elegant Wattle (*Acacia victoriae ssp. victoriae*), Emubush (*Eremophila spp*.), Native Myrtle (*Myoporum montanum*), Native Apricot (*Pittosporum angustifolium*) and Sennas (including Silver Senna (*Senna artemisioides ssp. artemisioides*) and Broad-leaf Desert Senna (*Senna artemisioides ssp. coriacea*)). These taller shrubs are taking advantage of small depressions or drainage lines where water may accumulate. There are scattered rocky outcrops, generally aligned east to west in the central sections of the PEL, where Bluebush (*Maireana sedifolia*) and Brilliant Hop Bush (*Dodonaea microzyga var. microzyga*) occur in addition to the dominant chenopod species. Surface rock strew, generally less than 5cm diameter, is generally present, although absent in some of the lower lying areas. To the west of the retention dam there has been some revegetation activity in this vegetation type, with various Eucalypts (most of which are not indigenous to the site) being the key revegetation species.

6. *Tecticornia spp*. ± *Cyperus sp. samphire low shrubland*. This vegetation type is found in areas which are infrequently to regularly inundated, generally around the edge of the retention dam. Samphires (*Tecticornia spp*.) are the dominant shrub, but are generally less than 70cm in height, and typically cover between 20 and 40%. In areas where inundation is more frequent Spiny Flat Sedge (*Cyperus gymnocaulos*) can become dominant. This habitat generally intergrades into the *Maireana spp*. shrubland on higher ground.

Further details of the flora and fauna assessment can be found in Appendix A (T&M Ecologists, 2018) of this report.

4.9.2 Fauna

Both the Euro (*Macropus robustus*) and Red Kangaroo (*Osphranter rufus*) were observed to be very common in the PEL. Small mammals, including the Bolam's Mouse (*Pseudomys bolami*), Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Stripe-faced Dunnart (*Sminthopsis macroura*) are found in PEL 650.

Eighteen (18) species of reptiles have previously been observed in PEL 650. A further sixteen (16) species are considered to be possible or likely to be present based an assessment of known records and habitat preferences. Further details can be found in the flora and fauna assessment (Appendix A, T&M Ecologists, 2018).

The total number of birds that have now been recorded in PEL 650 is 137 (based upon Atlas of Living Australia records). More species were observed in the Red Gum woodland area along Leigh Creek than in other vegetation types. The retention dam also forms significant habitat, with eighteen species observed in this rea that are considered to be waterbirds.

The Thick-billed Grasswren is listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). During the operation of the PCD (EIR 2017) Leigh Creek Energy made a presentation to the Federal Department of the Environment and Energy regarding a submission on the impact of the Thick-billed Grasswren. The feedback from the Federal Regulator was that the Department would not take any further action under the EPBC Act.

Two species of amphibians, the Desert Tree Frog (*Litoria rubella*) and Sudell's Frog (*Neobatrachus sudelli*) have been observed in PEL 650. The presence of permanent water in the retention dam, along with good fringing habitats, provide suitable habitat for frog species that require semi-permanent to permanent water (Northern Flinders Ranges Froglet (*Crinia flindersensis*), Spotted Grass Frog (*Limnodynastes tasmaniensis*) and Desert Tree Frog (*Litoria rubella*), and so these species are likely to be present.

Further details including a comprehensive list of fauna species can be found in the flora and fauna assessment (Appendix A, T&M Ecologists, 2018).

4.9.3 Groundwater Dependent Ecosystems

There are several areas of vegetation in and adjacent to the PEL that are expected to be reliant on groundwater as well as surface water inflows and would be classified as groundwater dependent ecosystems. These are associated with the channels of Leigh Creek and its tributaries and are generally outside the earthen walls bounding Lobe B, including several areas where hydrological modifications (such as blocking of creek lines that would have entered the mine site) have increased surface water ponding and water table recharge. The two excavated quarries that are approximately 4 km south of the demonstration plant site are understood to be expressions of the water table aquifer (AECOM 2016), and support a derived groundwater dependent ecosystem, with fauna present including fish and waterbirds.

4.9.4 Listed Threatened Species and Ecological Communities

A search of the EPBC Act and DEWNR flora and fauna databases has identified a number of rare or threatened flora and fauna species as being present or likely to occur in the general area of the PEL 650 (DEE 2016a; DEWNR 2016a).

Species of conservation significance are considered unlikely to occur within Lobe B, given the habitats present and the highly disturbed nature of the site[9].

There are no nationally listed threatened ecological communities known to be present in the area.

A number of State-listed threatened ecological communities have been identified as conservation priorities within the Stony Plains and Flinders Lofty Block bioregions, including Coolibah and River Red Gum woodland on drainage lines and floodplains, Old-man Saltbush on floodplains, Queensland Bluebush shrubland on cracking clay depressions and Bullock Bush tall shrubland (DEH 2009).

4.9.5 Weeds and Pest Animals

All sites from the flora and fauna assessment (Appendix A, T&M Ecologists, 2018) contained two or more introduced (weed) species – the least number of weed species was found in samphire habitats, and the highest number of weeds was found in the Red Gum community along Leigh Creek. Two weeds of National Significance (WoNS) have been previously recorded in the PEL 650[10] – Jerusalem Thorn (*Parkinsonia aculeata*) and Athel Pine (*Tamarix aphylla*).

Athel Pine (*Tamarix aphylla*) is present in the site and has been recorded in three habitat types. Athel pines have a number of impacts on native ecosystems, including:

- The species forms a dense canopy that provides inferior habitat for wildlife and inhibits regeneration of native plants;
- It has deep roots that taps soil water, and can lower the water table;
- In saline groundwater situations, Athel Pine extracts the salt and excretes it through gland on the leaves. This process can increase the salinity of the surface soil and eliminates less salt-tolerant plants from the site;

[9] The site inspection was carried out in late autumn following generally dry conditions, although there had been some significant rainfall approximately two months prior and one week prior to the inspection. Due to the timing and preceding conditions, there may be annual or ephemeral species present at the site, or migratory species that use the site, that were not evident at the time of the inspection. However, given the highly disturbed nature of both the site and the vegetation community present, it is considered unlikely that any species of conservation significance would occur.

[10] www.naturemaps.sa.gov.au accessed 10/1/2018.

- Along watercourses Athel Pine can trap sediments, which can reduce channel capacity and modify riparian landforms[11].

Whilst not being a WoNS, the Declared Plant Buffel Grass (*Cenchrus ciliaris*), a perennial tussock grass from Africa and Asia, has the capacity to spread widely and dominate arid zone habitats. This species was introduced for rangeland improvement and is now widespread across northern Australia.

Pest animals in the region that could potentially occur on site include cats, goats, foxes, rabbits and wild dogs. The area is inside (south of) the Dog Fence where wild dogs / dingoes are a declared pest under the Natural Resources Management Act, and numbers are generally low. Goats are widespread in the Flinders Ranges but are typically more common in hills and rockier areas. European Carp (*Cyprinus carpio*) was known to be present in the Leigh Creek Retention Dam following its illegal introduction (Ehmann 2009) however surveys in 2012 did not locate any carp following eradication work undertaken in previous decades (FPP 2017).

4.10 Air Quality

Air quality in the broader region is expected to be typical of a remote rural environment and influenced by a range of activities such as:

- dust from stock and vehicle movements or high winds
- vehicle and equipment exhaust fumes.

Air quality in the vicinity of the Leigh Creek Coalfield is also likely to be influenced by:

- dust generation from spoil dumps and mining / rehabilitation activities
- particulates, vapour and combustion emissions from spontaneous combustion of mine spoil dumps. The pits are surrounded by mine spoil dumps which are known to spontaneously combust releasing particulates and sulphurous and phenolic odours.

The closest residences are at Copley which is located approximately 8.5 km south of the initial exploration drilling programs and approximately 1 km south of the southern boundary of PEL 650.

The occurrence of odours at Copley (e.g. the smell of rotten eggs) has been informally raised by several stakeholders in mid to late 2016 (before any activities with the potential to release odour had been undertaken by Leigh Creek Energy).

A preliminary background odour assessment was carried out in June 2017 (Pacific Environment 2017a). This detected odour from the coalfield (a smoky character consistent with fugitive emissions from spontaneous combustion) at a distance of approximately 5 km. Odour was also recorded in Copley from the caravan park wastewater irrigation area. Winds were not blowing towards Copley at the time of the site visit for field odour observations, which meant that there was no opportunity to observe odour from the coalfield at Copley. However, it is understood that odour from the coalfield is occasionally present in Copley and that coalfield odour has been observed as far south as Leigh Creek.

Further baseline air quality monitoring was undertaken between July 2018-May 2019 under an approved Air Quality Monitoring Plan (2017) during different phases of the PCD operation using air diffuse samplers. The samplers were installed in Leigh Creek, Copley, Flinders Power site office, Leigh Creek Energy site office, Retention dam, Leigh Creek Waste Water Treatment Plant and the

[11] Government of South Australia (2014). Declared Plant Policy under the *Natural Resources Management Act 2004*; athel pine (*Tamarix aphylla*).

10m weather station. The air diffuse samplers measured background volatile organic carbons (measured as BTEX[12]), hydrogen sulphide (H_2S), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2).

The Department of Energy and Mining concluded that LCK had met the requirements of the Air Quality Monitoring Plan and demonstrated compliance with the SEO, in particular the assessment criteria that 'regular air quality measurements indicate levels are below relevant health-based air quality criteria (as listed in the *Environment Protection (Air Quality) Policy*) at sensitive receptors (i.e. towns or residences).' The *Environment Protection (Air Quality) Policy 2016* ('EPP') establishes maximum ground level concentrations (GLCs) for air pollutants.

The results from the air quality monitoring demonstrated that all the parameters (volatile organic carbons, H_2S, NO_2 and SO_2) were all below the EPP maximum GLC concentration limits.

4.11 Noise

The existing noise environment in the region is typical of sparsely populated regional and pastoral areas, with generally low levels of background noise dominated by natural sources (e.g. wind, animals and insects) and intermittent background noise from traffic on the nearby Outback Highway. Mining activities, including blasting, would have influenced the noise environment in proximity to the mine prior to closure. Ongoing mine closure activities by Flinders Power are expected to generate intermittent noise (e.g. from heavy machinery operation), with locations and noise levels dependent on the activities being undertaken. Flinders Power is expected to complete all activities by early quarter one 2019.

The region is extremely sparsely populated and there are no residences or other sensitive receptors within the PEL. The closest residences are at Copley which is located approximately 8.5 km south of the initial exploration drill sites and approximately 1 km south of the southern boundary of PEL 650.

4.12 Land Use

4.12.1 Land Owners

The Exploration Drilling programs for PEL 650 are located in the Leigh Creek Coalfield, which is constituted by a number of different titles.

A list of all land owners for the PEL 650 (as defined by the Petroleum and Geothermal Energy Act) is provided in Table 4-7. The Exploration Drilling programs are located on Crown Lease 1545/20 (Section 324).

[12] BTEX is an acronym for the group of chemicals Benzene, Toluene, Ethylbenzene and Xylene

Table 4-7: Land Owners for the PEL 650

Name	Land Owner
Leigh Creek Coalfield	Perpetual Crown Lease CL 1067/36 Section S320 Transferred to Flinders Power Pty Ltd 23/04/1999 Perpetual Crown Lease CL 1234/37 Section S319 Transferred to Flinders Power Pty Ltd 23/04/1999 Perpetual Crown Lease CL 1545/20 Sections S321, S324, S418, S485, S486 and S489 Transferred to Flinders Power Pty Ltd 23/04/1999 CL 6163/703 Section Q3003 Transferred to Generation Lessor Corporation (State Government) 19/06/2003 The following perpetual leases were transferred to the Minister for Energy and Mining in 2019: Perpetual Lease No. 18578 (Crown Lease Volume 1067 Folio 36) Perpetual Lease No. 19393 (Crown Lease Volume 1234 Folio 37) Perpetual Lease No. 20239 (Crown Lease Volume 6209 Folio 921) Perpetual Lease No. 20311 (Crown Lease Volume 6186 Folio 900)
PEL 650	Leigh Creek Operations Pty Ltd

4.12.2 Land Use

The major land uses in the region are mining, pastoralism, conservation and tourism.

The closest population centres to PEL 650 are Copley (1 km south of the PEL and 8.5 km south of the Telford Basin), Leigh Creek (5 km south of the PEL and 12 km south of Telford Basin) and Lyndhurst (12 km north of the PEL and 21 km north of Telford Basin). Beltana is located 30 km to the south of the PEL and Neppabunna is located 51 km to the east (see Figure 4-19).

4.12.2.1 Mining

Mining has been undertaken in the project region since the 1850's. There are a number of Mining Leases (MLs) in the region surrounding PEL 650, the closest of which (the Mountain of Light Copper Mine) is located approximately 3 km south of PEL 650. Commodities produced in the region include copper, marble, gold and magnesite. Several Mining Exploration Licences (ELs) are also in place in the region primarily west, south and east of PEL 650, covering exploration for magnesite, gold, silver, copper, lead, zinc, base metals and marble. There are numerous abandoned mines in the broader region from which minerals such a copper, radium and uranium were extracted (Northern Flinders Ranges SCB 2004).

The primary land use in PEL 650 was open cut coal mining which commenced in Leigh Creek in the 1940s. The Leigh Creek open cut mine was originally established under a Crown Agreement issued by the South Australian Government to the Electricity Trust of South Australia (ETSA) in an effort to secure the State's electricity supply. After the *Mining Act 1971* came into effect to regulate

mining in the state, the Leigh Creek area continued to be reserved from its provisions rather than operating under a conventional Mining Lease issued under the Mining Act (AECOM 2016).

The Leigh Creek Coalfield was most recently operated by Alinta Energy. Mining ceased in November 2015 after it became increasingly uneconomic. Mine closure activities are currently being undertaken within PEL 650 by Flinders Power.

4.12.2.2 Pastoralism

Pastoralism, in the form of livestock grazing (cattle and sheep) on native pastures, has a long history in the region, beginning in the 1850s and continues to be the most extensive regional land use. Pastoral leases in the region around PEL 650 are listed in Table 4-8 and shown in Figure 4-19.

Table 4-8: Pastoral leases in the region of PEL 650

Pastoral lease	Distance from PEL 650 (station boundary)
Myrtle Springs (Vinya Aboriginal Corporation)	Adjacent (west)
Leigh Creek (Adnyamathanha Land Council Inc.)	Adjacent (east)
Farina	6 km north
North Mooloolooo	6 km south-east
Burr Well	7 km east
Beltana	15 km west
Puttapa	10 km south
Mount Lyndhurst	12 km north

4.12.2.3 Conservation

The Vulkathunha - Gammon Range National Park (50 km east of PEL 650) and Ikara-Flinders Ranges National Park (81 km south of PEL 650) are the largest protected areas in the region. The parks are co-managed by the Department of Environment, Water and Natural Resources and the Adnyamathanha traditional owners. The Adnyamathanha people also manage the 58,000 ha Nantawarrina Indigenous Protected Area, which adjoins the southern boundary of the Vulkathuna – Gammon Ranges National Park.

Lake Torrens National Park is located 48 km west of PEL 650 and protects Lake Torrens, a large ephemeral salt lake. Lake Torrens is listed in the Directory of Important Wetlands as 'Inland Saline Lake' together with Lake Frome and Lake Callabonna (DEE 2016b). This series of inland lakes together form a complex of relatively pristine playa and ephemeral wetlands providing habitat for large wader (bird) populations when in flood.

Ediacara Conservation Reserve is located 35 km south-west of PEL 650 and was established to protect an internationally significant fossil assemblage and places of Aboriginal and non-Aboriginal cultural heritage.

Aroona Sanctuary, which encompasses Aroona Dam and areas around the Leigh Creek township and was gazetted as a sanctuary under the National Parks and Wildlife Act in 1995, is approximately 3 km south of the PEL and 10 km south of the demonstration plant location.

Warraweena, a former pastoral station which is operated as a private conservation reserve, is located approximately 25 km south-east of PEL 650.

There are no protected areas within PEL 650. Conservation reserves in the area are shown in shown in Figure 4-19.

4.12.2.4 Tourism

Tourism in the region is mainly focussed on 'outback' and 'wilderness' experiences, particularly associated with the national parks located in the Flinders Ranges. Tours of the region are offered by tour operators and provide a range of activities including coach tours, personalised 4WD tours, camel trekking, horse riding, bushwalking, town tours and scenic flights. Many pastoral stations in the region also offer accommodation and activities such as self-drive 4WD tours for tourists (Northern Flinders Ranges SCB 2004).

The community at Nepabunna offers visitors to the region accommodation and tours to locations such as painting and carving sites, ochre pits, and local gorges which would otherwise be inaccessible without a local Adnyamathanha guide (Nepabunna Community Inc 2016). Iga Warta, located approximately 5 km west of Nepabunna, is an Aboriginal cultural tourism centre which offers a unique opportunity for visitors to experience Adnyamathanha, Aboriginal culture, living, sharing and learning in an Aboriginal community setting (Iga Warta 2016).

The most regular visitation to the Leigh Creek area is by self-drive, independent and RV (recreational vehicle) travellers, with caravan and camping enjoyed by 35% of domestic and 55% of international tourists to the area (DSD 2016). Leigh Creek Township is utilised as a base for day trips to destinations such as Beltana, Copley, Lyndhurst and Farina.

The Outback Highway (the Hawker-Lyndhurst Road) which passes the township of Leigh Creek and the Leigh Creek Coalfield, is utilised by tourists travelling to and from outback South Australia, Queensland and the Northern Territory via the Oodnadatta, Birdsville and Strzelecki Tracks.

The South Australian Government is focusing on developing further tourism opportunities for the area following the closure of the Leigh Creek Coalfield and the transition of Leigh Creek Township from a 'closed' community solely dedicated to the operation of the coalfield, to an open independent regional service centre (DSD 2016).

4.12.3 Native Title

PEL 650 lies within the boundaries of the Adnyamathanha No 1 Native Title determination. The State of South Australia granted PEL 650 on the basis that native title within the land has been extinguished. Irrespective of the incidence of tenure history, LCK recognise and respect the Adnyamathanha as the traditional owners of the region and therefore as key stakeholders. LCK has entered into a heritage protection agreement (WACA) with the Adnyamathanha Traditional Lands Association (ATLA) and is consulting with ATLA relative to proposed activities within PEL 650.

There are a number of Indigenous Land Use Agreements currently agreed between the South Australian Government and the Adnyamathanha Native Title claimants in the broader region covering issues including mineral exploration and co-management of national parks.

4.13 Socio-economic

The region is located in the Unincorporated area (i.e. out of Councils area) of South Australia. Jurisdiction for the area falls under the responsibility of the Outback Communities Authority (OCA) which has legislative responsibility to provide administration and management support for outback communities.

The main population centre in the region is Leigh Creek Township, built in 1982 by the State Government to support the State-owned electricity company. The township was leased to Alinta Energy and operated as a 'closed' town until the closure of the Leigh Creek Coalfield in 2016. As

of 1 January 2017, the OCA had taken over municipal responsibility for the township, with the transition involving a range of government agencies led by the Department of Planning, Transport and Infrastructure (OCA 2017).

Flinders Power has handed the management of Leigh Creek Township to the OCA (OCA 2016). At its peak the population of the Leigh Creek Township was in excess of 1000 people (OCA 2016), but by 2011 the resident population had fallen to 505 (ABS 2016). Following announcement of the coalfield closure, the population has continued to decrease incrementally with data indicating 220 residents in the town in April 2016, comprised of residual families, contractors, government employees and business employees (DSD 2016).

The town of Copley, located 6 km north of Leigh Creek township, had a population of 103 in 2011, 45% of whom were Aboriginal and Torres Strait Islanders (ABS 2016). The population of Copley has also reduced to 72 people in 2016 (ABS 2016).

The township of Leigh Creek is an important regional service centre providing essential services including water supply, an airport, a school, a hospital, emergency services, a supermarket, a post office and shops. Almost all government employees in the region are accommodated in Leigh Creek. Leisure services are also provided with the town having a tavern, swimming complex, a caravan park, community buildings and parks. Leigh Creek is expected to continue to provide essential services for about 700 people in the township and surrounding region (DSD 2016).

The Outback Highway (the Hawker-Lyndhurst Road) which passes the township of Leigh Creek and the Leigh Creek Coalfield is the main transport and tourism access road in the region.

The Stirling North-Telford Railway was constructed to transport coal from the Leigh Creek Coalfield to the Port Augusta power stations. Following closure of the coalfield, the railway remains operational despite no further coal trains being operated. The railway has been transferred from Flinders Power to the government (Flinders Power 2016).

ElectraNet's Davenport to Leigh Creek 132 kV high-voltage transmission line and sub-station which supply power to Leigh Creek Township and the coalfield are located south-west and west of PEL 650.

In December 2016 SA Water took over the management of water services in Leigh Creek from Flinders Power. Since the announcement of the mine closure at Leigh Creek a cabinet submission recommended that the SA State Government support services in Leigh Creek for five years, appointing SA Water to manage the towns water supply. Leigh Creek draws drinking water from a number of local bores (Windy Creek, Emu Creek and Emu Creek South). Due to the relatively high salinity of the ground water supply, a small desalination plant is used to treat the water. The plant is capable of producing up to 1.25ML of drinking water per day (SA Water, 2018).

5 Environmental Impact Assessment

This section discusses potential and perceived environmental impacts related to the proposed exploration drilling programs.

Sections 5.1 to 5.10 provide a detailed discussion of the components of the environment that are potentially impacted by the proposed activities. A key focus of the discussion is the potential for impact to groundwater, which is discussed in Section 5.2.

The discussion is supported by an environmental risk assessment. The risk assessment is summarised in Table 5-1 (in Section 5.11), which outlines the potential hazards, the potential consequences and their likelihood, the management measures that will be applied and the resulting level of risk.

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

5.1 Cultural Heritage

Due to the minimal disturbance required, potential impacts to cultural heritage arise mainly from:

- earthworks associated with construction and rehabilitation of access tracks and drill sites
- activity outside designated / approved areas.

The main area of the drilling is in existing disturbed areas within the Telford Basin of the Leigh Creek Coalfield. The site and its surrounds have been subject to extensive, heavy disturbance from previous coal mining activities however it cannot be assumed that cultural heritage values do not exist, and sensitivity have been significantly reduced. The potential impact of the proposed drilling works on Aboriginal sites, objects and remains will be determined in consultation with ATLA and managed as appropriate. Later drilling may extend out to the rest of PEL 650, which has less ground disturbance from past mining activities.

Work Area Clearances with ATLA have been carried out on nominated areas within PEL 650 previously and will be carried out for all ongoing activities as per the formal Work Area Clearance Agreement (WACA) entered into with ATLA, subject to their ongoing compliance therewith. As an additional control measure signage and fencing (where required) will be installed to delineate approved areas and any restricted areas. If sites of cultural heritage significance are present in the vicinity they will be flagged and/or fenced off where necessary to prevent any disturbance. In addition, LCK has in place a Cultural Heritage Policy in place to deal with the incidental discovery of cultural heritage material. The Cultural Heritage Policy recognises the importance of maintaining an effective and robust Cultural Heritage Risk Management Plan.

The level of risk to cultural heritage in relation to earthworks associated with construction activities has been assessed as moderate but LCK appreciates that there is still the risk of encountering surface or sub-surface cultural heritage. However, as per the WACA as entered with ATLA, cultural heritage clearances will be undertaken to reduce this risk still further. Any Aboriginal heritage sites, objects and remains discovered during operations will be appropriately reported and responded to, consistent with the *Aboriginal Heritage Act 1988*.

5.2 Groundwater

Potential (and perceived) impacts to groundwater from drilling activities arise mainly from the following hazards:

- Loss of aquifer containment due to loss of well integrity

- Spills or leaks of fuel, chemicals or produced fluids

This is discussed further in the following sections.

5.2.1 Telford Basin

In general, the risk to groundwater posed by drilling is relatively low as the sites are surrounded by very low permeability aquitards. Groundwater in these aquitards is saline and there are no groundwater receptors present in the Telford Basin with no credible pathways to external groundwater receptors, furthermore all drilling will be undertaken according to industry codes of practise. The drilling and construction of the drillholes will be dependent on their location, purpose and requirements and the design of each drillhole will be completed by a specialist engineering company.

Any drillholes that are planned to be drilled through the Upper Series Coal Measures, will be cased with the casing cemented in place to ensure that a permanent barrier exists between the drillhole and any potential aquifers in the Upper Series Coal Measures and prevent any potential pathways to/from the Upper Series Coal Measures.

5.2.2 Potential Aquifers External to Telford Basin

It is difficult to determine the presence, characteristics and interactions of aquifers of PEL 650 external to the Telford Basin due to the limited groundwater drillhole data. Outcrops of basement rock are evident and quaternary sediments are identified in drainage channels; however, no information is available on their interactions.

Groundwater Dependant Ecosystems (GDEs) identified within PEL 650 are related to shallow groundwater (water table) locations. Drilling activities targeting the Telford Basin coal seams would not impact the drainage systems associated with these GDEs. Where investigation drilling may be undertaken in areas with identified GDEs this would be for the provision of monitoring infrastructure to enable assessment of potential subsurface interactions.

Installation of investigation monitoring wells would be constructed to the Minimum Construction Requirements for Water Bores in Australia where drill hole casings are sealed between aquifers to eliminate potential crossflow.

5.2.3 Spills or leaks of fuel or chemicals

Spills or leaks of fuel or chemicals have the potential to result in localised contamination of any unconfined water table aquifer, where present.

At the planned sites of the initial exploration drilling, the shallow water table aquifer in the Telford Gravels has been dewatered by historic mining activities. Although the Telford Gravels may contain discontinuous perched water seasonally, the presence of the adjacent Main Series and Upper Series pits is expected to effectively keep this potential aquifer dewatered. Measures discussed in Sections 5.3.2 and 5.4.2 will be implemented to prevent spills, leaks, or mitigate their impact if they do occur.

If spills did infiltrate into the Telford Gravels within the Telford Basin, the presence of the pits would prevent spilt material being transported to areas where shallow groundwater is present.

Note that any activity which has the potential to cause site contamination to underlying groundwater will be assessed in accordance with the guidance provided in the National Environment Protection (*Assessment of Site Contamination*) Measure (1999) and the current South Australian Guidelines for the Assessment & Remediation of Site Contamination (2018).

In areas of PEL 650 external to the Telford basin any investigation drilling is likely to be small scale with limited opportunity and of low volumes of chemicals for spills and would be able to be effectively managed on-site. Consequently, the level of risk has been assessed as low (see Table 5-1).

5.2.4 Groundwater drawdown from exploration drilling

The potential for drawdown of aquifers because of drilling activities in the Telford Basin and the rest of PEL 650 is expected to be low.

This does not present a credible risk for this project because there are no known aquifers present within the coal measures of the Telford Basin, or within PEL 650 that could potentially be impacted. The Main Series Coal and all adjacent strata are aquitards with very low permeability, so widespread drawdown would not occur. Any impacts to groundwater pressure in these aquitards would be localised to the immediate vicinity of the exploration drill hole. During drilling, no groundwater is expected to be brought to the surface, unless airlift testing and/or drawdown testing is conducted on a drillhole during the water investigation drilling part of the drilling programs. The drill mud system will be designed to ensure no groundwater enters the drillhole during drilling operations.

If any significant groundwater is encountered during water investigation drilling, then airlift testing and/or drawdown testing may be used to determine if there is a potential aquifer. This type of testing involves bringing the groundwater to the surface, using the drilling rig's air pressure, to determine the potential water yield and size of the aquifer. All measures will be put in place during this testing to contain the water within the mud sumps or similar bunded enclosure.

5.2.5 Copley Basin and North Field Basin Interaction

The Copley Basin and PEL 650 have a small common portion of intersecting land. The small portion of common land has a surface area of approximately 0.07 km^2 where the landform has been modified and remains somewhat disturbed. The area represents ~1% and <0.1% area of the Copley Basin and PEL 650 respectively. The interaction of the Copley Basin with any PEL 650 and Telford Basin activities is considered negligible due to the area being topographically higher and being separated by a broad low ridge of Adelaidean Basement rocks about 4km wide (AWE, Dec 2017) respectively.

The North Field Basin is contained within PEL 650 where no groundwater drillhole data is available to determine interactions. With shallow groundwater within PEL 650 being associated with drainage channels it is likely that infiltration to the regional Telford Gravels is controlled by topography. Any North Field Basin interaction is likely to be negligible given any adjacent drilling is likely to be for shallow groundwater monitoring infrastructure only.

5.3 Soils

Potential impacts to soils arise mainly from:

- earthworks associated with construction and rehabilitation of well sites and access tracks
- spills or leaks associated with storage and handling of fuel and chemicals
- storage, handling and disposal of waste.

5.3.1 Earthworks

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

The proposed areas for the initial drilling are relatively flat and have been subject to heavy disturbance related to previous coal mining activities. Later drilling in areas outside of the Telford Basin have less disturbance from past mining activities.

Disturbance to soils will be localised and restricted to defined areas. Topsoil will be stockpiled prior to construction activities, for use in rehabilitation. Following the completion of drilling activities at the site, it will be rehabilitated in accordance with industry standard criteria (e.g. SAPEX 2013, PIRSA 2009) to ensure that visual impact is minimised, revegetation of indigenous species occurs and that sites are left in a clean, tidy and safe condition.

Given the disturbed nature of the site, the impacts resulting from the initial drilling in the Telford Basin, will not be significant. Adherence to company policies and procedure (including permitting) will ensure that the impact to the rest of PEL 650 will not be significant.

5.3.2 Spills or leaks of fuel or chemicals

Improper storage and handling of fuel or chemicals have the potential to result in localised contamination of soil. In order to minimise this risk, all fuel, oil and chemicals on site are stored and handled in accordance with relevant standards and guidelines including AS 1940 and EPA guideline 050/07 Bunding and Spill Management. Note that any activity which has the potential to cause site contamination to soil will be assessed in accordance with the guidance provided in the National Environment Protection (*Assessment of Site Contamination*) Measure (1999) and the current South Australian Guidelines for the Assessment & Remediation of Site Contamination (2018).

Fuel and chemicals will be stored in designated areas with appropriate secondary containment as required (e.g. lined, bunded areas or on self-bunded pallets). Any spills will be immediately cleaned up and any contaminated material removed off-site for appropriate treatment or disposal. If larger scale spills that cannot be immediately contained and cleaned up occurred, they would be assessed consistent with the requirements of the NEPM[13] and, where required, remediated in accordance with relevant guidelines (e.g. EPA guidelines). Hazardous materials will be transported and disposed in accordance with appropriate standards and legislative requirements, including the Australian Dangerous Goods Code. Appropriate spill response equipment and MSDS will be available on site for all fuels and chemicals used on site.

5.3.3 Waste management

Inappropriately managed waste has the potential to result in localised disturbance or contamination of soil. Storage of waste and transport to licensed disposal or recycling facilities will be undertaken in accordance with relevant legislation and guidelines. Waste generation will be minimised where practicable, waste will be stored securely, and appropriately licensed waste contractors will be used for waste transport. Consequently, the level of risk has been assessed as low (see Table 5-1).

5.4 Surface Water

Potential impacts to surface water arise mainly from:

- earthworks associated with construction and rehabilitation of tracks and drill pads (e.g. disturbance to natural drainage patterns, increased erosion / sedimentation)
- spills or leaks associated with storage and handling of fuel and chemicals
- storage, handling and disposal of waste

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

- water use for drilling activities.

As discussed in the subsections below, the potential for impact to surface water is generally low, due to the highly modified nature of the Telford Basin.

5.4.1 Earthworks

Earthworks have the potential to alter natural drainage patterns or result in increased sedimentation of surface water features.

Due to the highly modified nature of the majority of the site, its location within the Leigh Creek Coalfield and the internal nature of drainage within the mine, the potential for impact is very low. Minor and localised impacts will occur as a result of site earthworks; however, these will only affect areas in in the vicinity of the site where drainage is already heavily modified and isolated from natural drainage features.

A marginal increase in sedimentation may occur, however this is not significant given the existing high sediment loads from adjacent stockpiles, highly disturbed nature of the site and absence of flow off the mine site or to natural surface water features.

5.4.2 Spills or leaks of fuel or chemicals

The principal risk to surface water typically results from the potential transport off-site of material from spills or leaks.

Due to the modified nature of most of the site and the isolation from drainage lines or significant surface water features, any impacts from spills or leaks would be relatively minor and localised even if material was transported off the immediate spill site. Any material transported off the site would be confined to disturbed areas in the immediate vicinity and impacts outside the mine site are not plausible.

The measures discussed above in Section 5.3 will be implemented to ensure safe storage and handling of fuel and chemicals. Spill containment and clean-up equipment would be present on site and any spills immediately cleaned up.

5.4.3 Waste management

Measures to ensure secure storage and handling of waste will be implemented as outlined in Section 5.3 above.

5.4.4 Water use for drilling activities

The main risks related to surface water from the use of water for project activities include the potential depletion of surface water supplies, potential adverse impact on surface water users, and potential impact on surface water dependent ecosystems.

The water supply will be obtained from SA Water or artificial water storages constructed for mine-site use which have minimal environmental value. Water supply sources will be reviewed to ensure that their use does not impact adversely on environmental values or existing users.

Water extraction volumes will be monitored to ensure there are minimal impacts to surface water supplies. The level of risk has been assessed as low for these potential hazards (see Table 5-1).

5.5 Flora and Fauna

Potential impacts to flora and fauna arise mainly from:

- earthworks associated with construction and rehabilitation of well sites and access tracks
- spills or leaks associated with storage and handling of fuel and chemicals

- activity outside designated / approved areas
- presence of personnel, lighting, general site activity and road use
- storage, handling and disposal of waste.

5.5.1 Earthworks

Earthworks from access track and drill site construction activities have the potential for localised impacts to native vegetation and wildlife habitats and to disturb or injure fauna.

The general site has been highly disturbed, and no vegetation of conservation significance is present. Any disturbed sites will ultimately be rehabilitated in accordance with standard regulatory criteria, as discussed in Section 5.3.1 and 5.3.1. Impacts to vegetation and wildlife habitats will not be significant or long term.

Any direct impacts to fauna will be short term and localised. As the activities will impact degraded habitat, which forms an extremely small proportion of available habitat in the region, the activities are not likely to have any significant impact on fauna populations.

Earthworks and movement of vehicles and machinery can also result in the introduction or spread of weeds. Standard measures will be implemented to minimise this risk (e.g. vehicles and equipment will be cleaned (and washed down where necessary) before commencing work at site or after operating in an area of known weed infestation). If project activities result in the introduction or increased densities of pest plants, a weed control plan will be developed and implemented in consultation with the land manager and the relevant NRM officer where appropriate.

5.5.2 Spills or leaks of fuel or chemicals

Spills of fuel or chemicals have the potential to damage native vegetation. As discussed in Section 5.3, this risk will be minimised by appropriate storage, handling and spill response in accordance with relevant standards and guidelines. As noted above, vegetation and habitats present in the vicinity of the drill sites have been highly disturbed and no vegetation of conservation significance is present, which limits the potential for impact. For areas outside of approved work areas, there is little likelihood that a spill or leak could impact vegetation that is undisturbed, has high environmental value or is of conservation significance within the PEL 650.

Access to fuel and chemicals presents a potential hazard for wildlife. Access to chemicals and fuel will be prevented by storing and handling them appropriately in designated areas and implementing immediate containment and clean-up if any spills occur. Emus and kangaroos are occasionally present on site and stock-proof fencing will be erected around storage areas.

5.5.3 Activity outside designated / approved areas

Activities outside designated / approved areas have the potential to impact vegetation and fauna. All activities will be confined to designated areas, with signage and fencing (where required) installed to delineate approved areas and any restricted areas. The disturbed nature of vegetation and habitats within the Telford Basin, means that any impact from activities outside designated / approved areas would be of very limited consequence.

Impact to natural vegetation and habitats from drilling activities outside of the Telford Basin will be minimised to areas where permits have been approved after conducting Flora and Fauna surveys.

5.5.4 Presence of personnel, lighting and general site activity and road use

The presence of personnel, lighting and general activity on site have the potential to impact vegetation and fauna. Use of roads and tracks could also result in injury or death of small numbers

of fauna. Impacts will be relatively localised and are not expected to have any significant impact on fauna populations, particularly given the disturbed nature of vegetation and habitats present within the Telford Basin.

Drilling operations outside of the Telford Basin will have minimal impacts on flora and fauna, due to small scale of the drilling operation and controlled speed limits. Work area clearances, permitting and flora and fauna surveys will help to reduce the impact of drilling activities to flora and fauna.

5.5.5 Waste management

Measures to ensure secure storage and handling of waste will be implemented as outlined in Section 3.4.3. Covered bins will be used to prevent native fauna and pest animals accessing or spreading waste. The level of risk has been assessed as low for these potential hazards (see Table 5-1).

5.6 Air Quality

Potential impacts to air quality arise mainly from:

- dust generation from earthworks and site activities
- combustion emissions (e.g. diesel generators and compressors)

5.6.1 Dust generation

Earthworks and the use of unsealed roads have the potential to generate dust.

Earthworks for construction and rehabilitation will be limited in scale and short term. Dust emissions are likely to be less than those from previous mining operations and ongoing rehabilitation operations and there are no sensitive receptors within the proposed area of operations. Dust control measures (e.g. water spraying) will be implemented if required.

Vehicle access will be predominantly via sealed public roads and the main mine access road. Vehicle speeds will be restricted at the site across all PEL 650 and dust control measures (e.g. water spraying) will be implemented if required.

5.6.2 Combustion emissions

Combustion emissions from the operations of fuel burning equipment such as compressors and generators have the potential to reduce local air quality and result in the generation of greenhouse gases.

Baseline air quality measurements will be undertaken throughout the project phase to confirm the level of impact and collect data used to inform the future commercial scale development

5.6.3 Risk Assessment

The level of risk has been assessed low in relation to dust and combustion emissions.

5.7 Noise

Potential impacts associate with noise emissions include:

- disturbance to local community
- disturbance to wildlife.

Noise emissions generated at the site during the proposed drilling operations will be localised and short term and are not likely to have a significant impact on any sensitive receptors. There are no residences nearby, with the closest house approximately 8.5 km from the initial drill sites and at

least 1 km from future drilling sites. Noise levels from site activities would not be significant at such separation distances, as a result of noise attenuation with distance, and potential noise levels are further reduced by the screening provided by the stockpiles and trees surrounding the project site.

Noise levels are unlikely to be higher than those associated with previous mining operations or ongoing rehabilitation activities at the site.

Equipment will be operated and maintained in accordance with specifications in order to minimise noise emissions.

Limited numbers of wildlife are present and site noise will not have a significant impact. The level of risk associated with noise emissions has been assessed as low.

5.8 Land Use

The proposed activities are not likely to have any significant impact on land uses (e.g. mining / mine rehabilitation, pastoralism, conservation or tourism) or landholders within the region. The site is located within an area where there are no mining or rehabilitation works planned, and operations are being undertaken in consultation with Flinders Power to ensure there is minimal impact from drilling activities.

The site is not visible from the adjacent Outback Highway. It is distant from public roads or pastoral stations (see Figure 4-19) and separated from them by the mine stockpiles and mine boundary. Consequently, it will have little to no impact on pastoral activities or visual amenity. There are no conservation reserves in close proximity. The site will ultimately be rehabilitated, as discussed in Section 5.3.1.

5.8.1 Risk Assessment

There were no credible potential environmental impacts to land use identified by the risk assessment (see Table 5-1).

5.9 Public Safety and Risk

The key areas where potential or perceived impacts to public safety and risk could arise are:

- unauthorised access resulting in exposure to site hazards during operations
- use of roads and movement of vehicles and machinery

5.9.1 Unauthorised access

The drilling activities are located within the Leigh Creek Coalfield, where public access is prohibited. The closest drill site is at least 1 km inside the mine site boundary and 2 km from the adjacent Outback Highway. In addition to security at the mine site entrance, measures such as signage and fencing will be in place to warn of the hazards at the site and restrict access into the site. Access to the drill sites by other third parties (e.g. Flinders Power personnel) is also strictly controlled. Potentially hazardous areas will be securely fenced with warning signs in place.

5.9.2 Use of roads

The existing road network is already heavily used by the transport, mining, oil and gas and pastoral industries and the incremental change as a result of the demonstration plant is not likely to be significant. Measures to mitigate the risks to the public will be in place including signage near the site entrance, speed restrictions and education programs.

As noted in Section 5.3.3, transport of waste to licensed disposal or recycling facilities will be undertaken in accordance with relevant legislation and guidelines.

5.9.3 Risk Assessment

The level of risk has been assessed as medium for these potential hazards due to the higher consequence ratings assigned when considering the safety of the public (see Table 5-1).

5.10 Economic Impact

The drilling activities are unlikely to result in adverse economic impacts on stakeholders. The activities will be relatively short term within an area where there are no mining or rehabilitation works planned. Operations are being undertaken in consultation with Flinders Power to ensure there is minimal impact from drilling operations. As discussed in Section 5.8, there will be no impact to other land uses within the area.

The exploration drilling project has a number of potential benefits. These include:

- increased understanding of the cultural heritage aspects of the region (in collaboration with the traditional owners)
- direct economic benefits to the Leigh Creek and Copley townships resulting from supply of fuel, food, accommodation and other services during the drilling campaign
- direct economic benefit via payments to local earthworks construction companies
- employment opportunities for local personnel during various phases of the project
- increased understanding of the geology, soils, water, air, flora and fauna of the region.

If the project leads to further ISG development at the Leigh Creek Coalfield, including the construction of a commercial operation, the potential benefits include:

Cultural:

- increased understanding of the cultural heritage aspects of the region (in collaboration with the traditional owners)
- development of cultural awareness training

Economic:

- direct benefits to the traditional owners in production payments
- direct benefits Leigh Creek and Copley townships resulting from supply of fuel, food, accommodation and other services
- development of new business opportunities
- payment of royalties to the State of South Australia

Social:

- creation of employment opportunities, training and education for new staff
- supply of power to state electricity grid
- potential supply of syngas derivatives including methane, ammonia and fertiliser
- ongoing need for town amenities including school, police and health services
- investment in social infrastructure and services

Environmental:

- benefits in the provision of significant environmental benefit (SEB) payments
- ongoing rehabilitation and monitoring of previous coal mining activities
- increased understanding of the water, air, flora and fauna of the region.

5.11 Environmental Risk Assessment Summary

As discussed above, Leigh Creek Energy has undertaken an environmental risk assessment of the proposed exploration drilling activities in PEL 650. This section summarises the process and results of the assessment.

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

The risk assessment process involves:

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

The level of risk for the proposed exploration drilling programs has been assessed based on the assumption that management measures that are discussed in this EIR will be in place. The risk assessment was prepared by JBS&G and Leigh Creek Energy, based on knowledge of the existing environment, understanding of proposed operations and previous experience of Leigh Creek Energy personnel with similar operations.

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

5.11.1 Environmental Risk Assessment Definitions and Risk Matrix

The risk assessment uses the risk matrix and definitions for consequences and likelihood that are outlined below in Figure 5-1.

LCK Risk Matrix

	Corporate[1]	Operational
LOW	Activity may proceed with care and observance of local environment. Risks are to be reduced to ALARP.	Activity may proceed with care and observance of local environment. Risks are to be reduced to ALARP.
MODERATE	Activities may proceed only with authorisation of a LCK Executive Manager. Risks are to be reduced to ALARP.	Activities may proceed only with authorisation of a LCK Site Manager. Risks are to be reduced to ALARP.
HIGH	**Health, Safety and Environment**: Activity must not proceed until further risk reduction implemented. Authorisation to accept People or Environment risk as ALARP and proceed required from MD or delegate.	**Health, Safety and Environment**: Activity must not proceed until risks are reduced to ALARP. Authorisation to accept People or Environment risk as ALARP and proceed required from MD or delegate.
	Financial and Reputation: Authorisation to accept Financial and Reputation Risk required from MD or delegate.	**Financial and Reputation:** Authorisation to accept Financial and Reputation Risk required from MD or delegate.
EXTREME	Activity must not proceed. LCK Board notification required.	

[1] Corporate includes project design and long-term planning.

	LIKELIHOOD				
Description	May happen in extreme circumstances	May happen sometime	May happen	May easily happen	Expected to occur
Probability	Consequence occurs once in ten years	Consequence occurs once in five years	Consequence occurs once a year	Consequence occurs monthly	Consequence occurs weekly
Historical	Unusual across industry	Has occurred once or twice in industry	Has occurred several times in industry, but not in the company	Has occurred multiple times in industry, or once or twice in company	Has occurred frequently in industry, or multiple times in company

CONSEQUENCE					RARE	UNLIKELY	POSSIBLE	LIKELY	ALMOST CERTAIN
Health & Safety	Environment	Financial	Reputation						
No injury, report only	Minor consequences, local response. Minimal impacts to environment.	Less than $20K. Minimal schedule impact	Local mention only, quickly forgotten, freedom to operate unaffected.	MINOR	LOW	LOW	LOW	MODERATE	MODERATE
First aid injury	Minor local environmental impact and/or regulatory notification is required.	$20K-$150K. Slight schedule impact	Short term local concern. Some impact on asset level non-production activities.	MODERATE	LOW	LOW	MODERATE	MODERATE	HIGH
Medically treated injury	Significant local environmental impact and/or regulatory intervention	$150K-$1M. Serious schedule impact	Attention from government, media or persistent community concern.	SERIOUS	LOW	MODERATE	MODERATE	HIGH	HIGH
Lost time injury permanent disability	Significant ecological or cultural impact and/or regulatory intervention.	$1M-$5M. Significant business reorganisation. Schedule disrupted up to two months.	Persistent national concern. Major venture/asset operations restricted.	MAJOR	MODERATE	MODERATE	HIGH	HIGH	EXTREME
Any potential fatality or fatality	Critical ecological or cultural impact and/or regulatory intervention.	Greater than $5M. Extreme business reorganisation. Schedule disrupted for more than two months.	Serious national concern. Serious public or media outcry. Legal action. Long term brand impact.	CRITICAL	MODERATE	HIGH	HIGH	EXTREME	EXTREME

Figure 5-1: LCK risk matrix (version 2.0 November 2018)

5.11.2 Environmental Risk Assessment Summary Table

A summary of the level of environmental risk for the proposed exploration drilling activities is provided in Table 5-1 below. As noted previously, the level of risk has been assessed based on the assumption that the management measures outlined in this EIR will be in place.

Table 5-1: Environmental risk assessment for exploration geological drilling in PEL 650

Impact Identification				Control Strategy	Risk Assessment		
Activity	**Event**	**Type of Impact**	**Potential Consequences**	**Key Management Measures**	**Consequence**	**Likelihood**	**Residual Risk**
Preparation of access tracks and drill site pads and vehicle movement	Earthworks	Cultural Heritage	Disturbance to Cultural Heritage	• Where possible, existing tracks, roads or disturbed areas are used for access and drill pads. • To avoid any impacts to Aboriginal sites, objects and remains, areas of proposed land disturbance will be subject to a cultural heritage Work Area Clearance as per the WACA executed in September 2016 and the land disturbance will then be undertaken in accordance with conditions of the completed Work Area Clearance. • Areas of sensitivity (e.g. cultural heritage exclusion areas, if present) will be flagged and/or fenced off where necessary to prevent disturbance. • Training for all personnel on Aboriginal cultural heritage as well as their obligations under the *Aboriginal Heritage Act 1988* (legislative awareness training) and the importance of remaining within designated / approved areas. • If suspected cultural heritage material is discovered during operations, immediately stop any further work in the area, secure the site and ensure no further ground disturbing activity takes place in the immediate area. Contact the Adnyamathanha Traditional Lands Association (ATLA) to identify an appropriate course of action. Options may include risk managing the area with ATLA's assistance or seeking authorisation under section 23 of the *Aboriginal Heritage Act 1988* where damage to Aboriginal heritage cannot be avoided. • If Aboriginal sites, objects and remains are discovered, the discovery is reported to the Department of the Premier and Cabinet - Aboriginal Affairs and Reconciliation (DPC-AAR) division.	Major	Unlikely	Moderate (14)
Preparation of access tracks and drill site pads and vehicle movement	Earthworks	Soil impacts	Localised impacts to soil through inversion, compaction or increased erosion	• Where possible, existing tracks, roads or disturbed areas are used. • Areas where there is potential for (or signs of) soil erosion or sedimentation occurring will be stabilised and control measures implemented. • Training and induction for all personnel to educate them on the importance of remaining within designated / approved areas. • Any topsoil removed will be stockpiled for later rehabilitation of the site.	Minor	Unlikely	Low (2)
Preparation of access tracks and drill site pads and vehicle movement	Earthworks	Surface water	Disturbance to natural drainage patterns, increased erosion / sedimentation	• Tracks constructed at or near natural surface level • Disturbed areas reinstated once they are no longer required e.g. by restoring natural contours, ripping areas of compacted soil and respreading topsoil and stockpiled vegetation. Existing drainage patterns will be restored.	Minor	Rare	Low (1)
Preparation of access tracks and drill site pads and vehicle movement	Earthworks	Fauna	Native animals become trapped in drill sumps on the drill pads	• Drill mud sumps will be fenced off to prevent animals from entering the sumps. • Drill mud sumps designed and constructed to allow trapped animals to escape up one side of the sump (escape ramp). • Drill mud sumps monitored regularly to ensure no animals become trapped.	Minor	Possible	Low (4)
Preparation of access tracks and drill site pads and vehicle movement	Earthworks	Flora/ Fauna	Damage to native vegetation and fauna habitats	• Activities confined to clearly defined designated approved work areas to minimise areas of new disturbance. • Where possible, existing tracks, roads or disturbed areas are used. • Areas of sensitivity (e.g. significant vegetation if present) flagged and / or fenced off where necessary to prevent disturbance.	Minor	Possible	Low (4)

Impact Identification				Control Strategy	Risk Assessment		
Activity	**Event**	**Type of Impact**	**Potential Consequences**	**Key Management Measures**	**Consequence**	**Likelihood**	**Residual Risk**
				• Water supply sources (e.g. artificial water storages constructed for mine-site use) reviewed to ensure that their use does not impact adversely on environmental values. • Water supply wells (if used) reviewed to ensure that their use does not impact adversely on existing groundwater dependent ecosystems. • Pre-disturbance site inspection undertaken to document existing conditions.			
Preparation of access tracks and drill site pads and vehicle movement	Earthworks	Flora/ Fauna	Introduction and spread of weeds or pathogens	• Earth moving equipment and drilling rigs are cleaned and inspected before commencing work at site or after operating in areas of known weed infestations. • Imported material (e.g. gravel or road base) sourced from areas considered to be weed /disease free. • If project activities result in the introduction or increased densities of weeds, a weed control plan will be developed and implemented.	Minor	Unlikely	Low (1)
Preparation of access tracks and drill site pads and vehicle movement	Dust from earthworks	Public nuisance	Dust nuisance to the public	• Vehicle speeds will be restricted at the site and dust control measures (e.g. water spraying) will be implemented if required.	Minor	Rare	Low (1)
Preparation of access tracks and drill site pads and vehicle movement	Earthworks	Community Health and Safety	Exposure to site hazards during operations from unauthorised site access	• Earthworks for access tracks and drill pads constructed and maintained in accordance with relevant industry standards and/or best practice. • Safety, testing, maintenance and inspection procedures are implemented. • Recognised risk management processes implemented in design through to demobilisation to identify threats and controls to mitigate risks. • Site Management Plan implemented as agreed with the third-party documenting health and safety management systems. • Emergency response plan (scenario based) in place and drills conducted. • Signage and site access control measures in place to warn of hazards and restrict access to the site of the earthworks. • Safe work permits be obtained to ensure only individuals with proper clearance can conduct works. • Appropriate fire-fighting equipment on site. • Smoking only permitted in designated areas. • Fire and Emergency Services Act 2005 requirements complied with (e.g. permits for ‘hot work’ on total fire ban days). • Appropriate firebreaks are maintained.	Serious	Rare	Low (6)
Storage and handling of fuel and chemicals	Spills or leaks of fuel, chemicals and drilling muds	Groundwater	Localised contamination of any unconfined water table aquifer, if present	• No major refuelling outside of designated refuelling/servicing areas. • Drip trays used when refuelling vehicles on the drill pads. • Any activity which has the potential to cause site contamination to soil will be assessed in accordance with the guidance provided in the National Environment Protection (Assessment of Site Contamination) Measure (1999) and the current South Australian Guidelines for the Assessment & Remediation of Site Contamination (2018). • All hydrocarbons and chemicals are to be stored/contained within bunds in accordance with the appropriate Australian Standards, including AS1940, Safety Data Sheets and EPA guidelines. Spills and leaks are reported immediately and clean up actions initiated. • Drilling muds contained in sumps	Moderate	Unlikely	Low (5)

Impact Identification				Control Strategy	Risk Assessment		
Activity	**Event**	**Type of Impact**	**Potential Consequences**	**Key Management Measures**	**Consequence**	**Likelihood**	**Residual Risk**
				• A record of all spill/leak events and their corrective actions are maintained. • Personnel have received training in the use of spill response equipment.			
Storage and handling of fuel and chemicals	Spills or leaks of fuel, chemicals and drilling muds	Soil contamination	Localised contamination of soil	*See section on Groundwater above* • Any activity which has the potential to cause site contamination to soil will be assessed in accordance with the guidance provided in the National Environment Protection (Assessment of Site Contamination) Measure (1999) and the current South Australian Guidelines for the Assessment & Remediation of Site Contamination (2018).	Moderate	Unlikely	Low (5)
Storage, handling and disposal of waste	Inappropriately managed waste	Soil contamination	Localised contamination of soil	• Waste generation minimised (e.g. by compliance with EPA's Waste Hierarchy model (avoid, reduce, reuse, recycle, recover, treat, dispose)). • Secure systems used for storage and transport of waste (e.g. covered bins in designated area for waste collection and storage prior to transport). • High standards of 'housekeeping' implemented. • Waste removed off-site and disposed of at an EPA licensed waste handling facility. • Hazardous wastes handled in accordance with relevant legislation and standards. • Licensed contractors used for waste transport. • Drilling muds contained in sumps • Liquid waste (e.g. waste oil stored in appropriate tanks and transported off site to an EPA licensed facility. • All wastewater (sewage) disposed in accordance with the South Australian Public Health (Wastewater) Regulations 2013 or to the satisfaction of the Department of Health.	Minor	Unlikely	Low (2)
Storage and handling of fuel and chemicals	Spills or leaks of fuel, chemicals and drilling muds	Surface water	Localised contamination of surface water, if present	*See section on Groundwater above*	Moderate	Unlikely	Low (5)
Storage and handling of fuel and chemicals	Spills or leaks of fuel, chemicals and drilling muds	Flora/ fauna	Damage native vegetation and potential hazard for wildlife	*See section on Groundwater above*	Minor	Rare	Low (1)
Storage, handling and disposal of waste	Inappropriately managed waste	Surface water	Localised contamination of surface water, if present	• Waste generation minimised (e.g. by compliance with EPA's Waste Hierarchy model (avoid, reduce, reuse, recycle, recover, treat, dispose)). • Secure systems used for storage and transport of waste (e.g. covered bins in designated area for waste collection and storage prior to transport). • High standards of 'housekeeping' implemented. • Waste removed off-site and disposed of at an EPA licensed waste handling facility. • Hazardous wastes handled in accordance with relevant legislation and standards. • Licensed contractors used for waste transport. • Liquid waste (e.g. waste oil stored in appropriate tanks and transported off site to an EPA licensed facility).	Moderate	Rare	Low (3)

Impact Identification				Control Strategy	Risk Assessment		
Activity	**Event**	**Type of Impact**	**Potential Consequences**	**Key Management Measures**	**Consequence**	**Likelihood**	**Residual Risk**
				• All wastewater (sewage) disposed in accordance with the South Australian Public Health (Wastewater) Regulations 2013 or to the satisfaction of the Department of Health.			
Storage, handling and disposal of waste	Inappropriately managed waste	Flora/ fauna	Harm to native fauna or increase in feral animals	*See section on Surface water above*	Moderate	Rare	Low (3)
Exploration drilling	Rig move	Cultural heritage	Disturbance to cultural heritage sites	• To avoid any impacts to Aboriginal sites, objects and remains, areas of proposed land disturbance will be subject to a cultural heritage Work Area Clearance as per the WACA executed in September 2016 and the land disturbance will then be undertaken in accordance with conditions of the completed Work Area Clearance. • Where possible, existing tracks, roads or disturbed areas are used for access and drill pads.	Moderate	Unlikely	Low (5)
Exploration drilling	Loss of well integrity	Groundwater	Localised contamination of any unconfined water table aquifer, if present	• Drillhole is either cased or cemented up to isolate potential aquifers • Wellhead, casing, and cementing designs are completed by a specialist engineering company • Well integrity testing to test the integrity of the casing and the cementing of the casing to ensure it has been completed correctly. •	Minor	Rare	Low (1)
Exploration drilling	Spills or leaks of fuel, chemicals and drilling muds	Groundwater	Localised contamination of any unconfined water table aquifer, if present	• Drip bunds will be used under hose connections during refuelling. • The drill sump will not be lined unless drilling is likely to occur in an area where very shallow aquifers are present and/or the toxicity and concentrations of the drilling mud, present a risk to any very shallow aquifers	Minor	Unlikely	Low (2)
Exploration drilling	Dust from drilling operations	Public nuisance	Dust nuisance to the public.	• Vehicle speeds will be restricted at the site (PEL 650) and dust control measures (e.g. water spraying) will be implemented if required. • Water sprayed on access tracks to control dust levels.	Minor	Rare	Low (1)
Exploration drilling	Dust from drilling operations	Health and Safety	Dust may impact those without suitable personal protective equipment	• Vehicle speeds will be restricted at the site (PEL 650) and dust control measures (e.g. water spraying) will be implemented if required. • Signage displayed at entrance to drill pad to advise use of dust masks.	Minor	Unlikely	Low (2)
Exploration drilling	Noise disturbance	Public nuisance	Noise nuisance to the public	• Equipment will be operated and maintained in accordance with specifications in order to minimise noise emissions. • No drilling will be conducted in public areas.	Minor	Rare	Low (1)
Exploration drilling	Noise disturbance	Health and Safety	Noise may impact those without suitable personal protective equipment	• Signage displayed at entrance to drill pad to advise mandatory use of hearing protection. • Hearing protection available for any authorised visitors to the drill rig.	Moderate	Unlikely	Low (5)
Exploration drilling	Interaction with other land users	Impact on other land uses	Interactions with other land users could result in health and safety interactions and interference with planned activities	• Water supply sources reviewed to ensure that their use does not impact adversely on existing users or supplied by SA Water. • Water supply wells (if used) reviewed to ensure that their use does not impact adversely on existing users of groundwater. • Existing water wells (if used) accessed in consultation with well owners (if not owned by LCK).	Moderate	Unlikely	Low (5)

Impact Identification				Control Strategy	Risk Assessment		
Activity	**Event**	**Type of Impact**	**Potential Consequences**	**Key Management Measures**	**Consequence**	**Likelihood**	**Residual Risk**
				• Relevant stakeholders notified prior to undertaking operations, pursuant to PGE Regulations. • All exploration geological drilling activities will be undertaken in consultation with landowners to ensure there is minimal impact from the exploration drilling activities. • Liaison with land owners regarding notification / management of works, traffic and site issues. • Liaison with local community regarding operations. • System in place for logging complaints to ensure that issues are recorded, addressed as appropriate and resolved in a timely manner. • High standard of 'housekeeping' maintained. • Induction for all employees and contractors covers stakeholder matters. • Emergency services and potentially affected landholders / local community will be informed of significant activities (e.g. movement of large items of equipment) on public roads.			
Use of roads and movement of vehicles and machinery	Traffic incident	Safety of the public and other third parties	Traffic incident causing injury	• Measures to mitigate the risks to the public will be in place including signage near the site entrance, speed restrictions and education programs. • All required authorisations (e.g. DPTI, police) obtained where required for significant activities (e.g. movement of large items of equipment) on public roads. • Driver behaviour and vehicle speed limits included in compulsory induction. • Traffic and journey management procedures followed.	Major	Possible	High (18)
Activity outside designated/ approved areas	Earthworks	Cultural Heritage	Disturbance to Cultural Heritage	• Areas of sensitivity (e.g. cultural heritage exclusion areas, if present) will be flagged and / or fenced off where necessary to prevent disturbance. • Training and induction for all personnel on cultural heritage issues and the importance of remaining within designated / approved areas.	Major	Rare	Moderate (10)
Activity outside designated/ approved areas	Earthworks	Flora/ fauna	Damage to native vegetation and fauna habitat	• All activities will be confined to designated areas, with signage and fencing (where required) installed to delineate approved areas and any restricted areas.	Moderate	Rare	Low (3)
Presence of personnel, general site activity and road use	Traffic incident	Flora/ fauna	Fauna collision	• Driver behaviour and vehicle speed limits included in compulsory induction. • Traffic and journey management procedures followed	Minor	Likely	Moderate (7)
Campsite and associated activities	Campsite preparation and site activities	Soil impacts	Soil erosion and compaction	• Mobile camp will be set up on previously disturbed areas used as a former mobile camp site. • Any sumps and excavations shall be backfilled with subsoil being placed below topsoil.	Moderate	Unlikely	Low (5)
Campsite and associated activities	Campsite preparation and site activities	Flora/ fauna	Damage to native vegetation and fauna habitat	• Camps will be located wherever possible on previously disturbed areas and / or areas with minimal vegetation cover.	Moderate	Unlikely	Low (5)
Campsite and associated activities	Campsite preparation and site activities	Cultural Heritage	Disturbance or damage to sites of cultural or heritage significance.	• Camps will be located away from sites of known cultural or heritage significance and located on previously disturbed areas used as a former mobile camp site.	Serious	Rare	Low (6)

Impact Identification				Control Strategy	Risk Assessment		
Activity	**Event**	**Type of Impact**	**Potential Consequences**	**Key Management Measures**	**Consequence**	**Likelihood**	**Residual Risk**
Campsite and associated activities	Disposal of camp wastewater and waste	Soil impacts	Localised contamination of soil	• Wastewater (sewage and grey water) disposal where possible in accordance with the South Australian Public Health (Wastewater) Regulations 2013 and/or in consultation with the Department for Health and Wellbeing and/or in accordance with licenses/permits, if any. Department of Health and Wellbeing approved transportable wastewater treatment plants used for camps, or septic tank systems used with collection of wastewaters for disposal at a licensed facility • Appropriate controls for management of sewage effluent (developed in consultation with Department for Health and Wellbeing) implemented for situations where excursions outside effluent quality guidelines may occur (e.g. during start-up or system upset). • Secondary treated sewage wastewater is disposed of onto land well away from any place from which it is reasonably likely to enter any waters, and to minimise spray drift and ponding.	Minor	Unlikely	Low (2)
Campsite and associated activities	Disposal of camp wastewater and waste	Flora and fauna	Damage to native vegetation and fauna habitat Injury or loss of native fauna	• Wastewater disposal locations sited to minimise the impact to vegetation, fauna and sensitive ecological areas. • Fencing installed where required around irrigation areas.	Minor	Unlikely	Low (2)
Fire (resulting from activities)	Fire (resulting from activities)	Flora and fauna	Damage to native vegetation and fauna habitat Injury or loss of native fauna	• Appropriate fire-fighting equipment on site. • Smoking only permitted in designated areas. • Fire and Emergency Services Act 2005 requirements complied with (e.g. permits for 'hot work' on total fire ban days). • Appropriate firebreaks are maintained.	Minor	Unlikely	Low (2)

6 Environmental Management Framework

6.1 Environmental Management System

LCK has designed an Environmental Management System based on the principles of *ISO 14001: Environmental Management Systems*. LCK's Environmental Management System therefore comprises the following components, as described by ISO 14001:

- Environmental Policy
- Planning
- Implementation and Operation
- Checking and corrective action
- Management Review.

Environmental Policy

LCK acknowledges that excellence in environmental management is essential to the success of the LCK. Therefore, LCK's Environmental Policy is a statement of the company's intent to achieve environmental compliance and ensures all environmental activities are consistent with LCK's objectives. The policy is a statement of commitment from management and reflects the values of the LCK Board. The policy is reviewed every year by the Board for its appropriateness and to ensure it is up to date with current legislation. The policy is signed and dated by the Managing Director after every review.

The policy is communicated to people working for or on behalf of LCK through environmental health and safety inductions and is displayed by the entrance to the LCK offices. The policy is made available to the public on the LCK website www.lcke.com.au.

Environmental Objectives

Environmental objectives for the proposed activities have been developed in the accompanying SEO (LCK 2018). These objectives have been designed to provide a clear guide for the management of environmental issues.

Responsibilities

Environmental management and compliance will be the responsibility of all personnel with overall responsibility for environmental compliance lying with Leigh Creek Energy. The indicative organisation roles and responsibilities for personnel overseeing environmental management are detailed in Table 6-1. All contractors and individuals will also be responsible and accountable through their conditions of employment or contract. The training of all personnel will ensure that everyone is aware of their environmental responsibility.

Table 6-1: Indicative roles and responsibilities

Role	Accountabilities
Managing Director	• Accountable for facilitating the achievement of the project objectives, including the environmental objectives and the operation of the project. • Responsible for relationships with regulatory authorities. • Endorsing the environmental policy • Ensure that resources are made available so that all accountabilities below are actioned by the relevant people
Environmental Approvals and Compliance Manager	• Implement the environmental policy • Implement programs for achieving set objectives and targets • Monitoring and measurement of environmental performance • Overall responsibility for system implementation
General Manager - Operations	• Support the implementation of the EMS through approval of adequate resources and budgets. • Ensure management systems are implemented and maintained to ensure compliance with legislative requirements as required by the EMS. • Facilitate exploration drilling operations in accordance with the EMS, in particular, with the operational and environmental plans and procedures. • Monitor adherence to legal and corporate requirements and the effectiveness of all relevant procedures and standards. • Ensure any potential or actual issue (environmental incident) is reported in accordance with legal requirements and the corporate standard. • Liaising with and keeping the DEM informed on issues relating to environmental compliance affecting the project and environmental requirements through the commissioning, operational and decommissioning contract phases. • Communicate EMS responsibilities to site employees
Health & Safety Manager	Ensure that all employees, contractors and visitors have been inducted in health and safety and appropriate training and awareness programs are delivered to all project team members, contractors and visitors.
Senior Environmental Scientist	• Overall responsibility for EMS implementation • Implement programs for achieving set objectives and targets • Day to day implementation of EIR/SEO • Monitoring and measurement of environmental performance • Environmental internal reporting • Investigate environmental incidents and implement emergency responses and corrective actions. • Implement a system of corrective actions and continuous improvements
Employees, contractors and visitors	Adhere to policies and procedures at all times.

Environmental Management Plan

All Leigh Creek Energy employees and contractors are responsible for ensuring compliance with the Leigh Creek Energy Environmental Management Plan (EMP) and associated environmental legislation. Leigh Creek Energy conducts periodic environmental reviews to assess the appropriateness of the EMP to meeting Leigh Creek Energy's policy, legislative requirements and environmental objective commitments and whether the EMP has been properly implemented and maintained.

Job Safety Analysis (Permit to Work)

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

Induction and Training

Prior to the start of field operations all field personnel are required to undertake an environmental and cultural heritage induction to ensure they understand their role in protecting the environment and identified cultural heritage values of the area. This induction is part of a general induction process which also includes safety procedures. Site specific environmental requirements will be documented in the work program or work instruction. A record of induction and attendees will be maintained.

6.2 Emergency Response and Contingency Planning

Emergency response plans (ERPs) will be developed to guide actions to be taken to minimise the impacts of accidents and incidents. ERPs will be reviewed and updated on a regular basis to incorporate new information arising from any incidents, near misses and hazards and emergency response simulation training sessions. These plans will also include the facilitation of fire danger season restrictions and requirements.

Emergency response drills will also be undertaken at regular intervals to ensure that personnel are familiar with the plans and the types of emergencies to which it applies, and that there will be a rapid and effective response in the event of a real emergency occurring.

6.3 Environmental Monitoring and Audits

Ongoing monitoring and auditing of the exploration drilling activities will be undertaken to determine whether significant environmental risks are being managed, minimised and where reasonably possible, eliminated.

Monitoring programs will be designed to assess:

- compliance with regulatory requirements (particularly the SEO)
- integrity of bunding and containment systems
- site contamination
- site revegetation following completion and any restoration

6.4 Incident Management, Recording and Corrective Actions

LCK and its contractors have a system in place to record environmental incidents, near misses and hazards, track the implementation and close out of corrective actions, and allow analysis of such incidents to identify areas requiring improvement. The system also provides a mechanism for recording 'reportable' incidents, as defined under the *Petroleum and Geothermal Energy Act 2000* and associated regulations.

6.5 Reporting

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

If site contamination has occurred (as described under section 5B of the SA EP Act 1993) as a result of an incident at the site (regardless of its significance), it is potentially notifiable under Section 83 or S83A of the *Environmental Protection Act 1993*.

External reporting (e.g. incidents, annual reports) will be carried out in accordance with *Petroleum and Geothermal Energy Act 2000* requirements and the SEO. Annual reports are available for public viewing on the DEM website.

7 Consultation

LCK is committed to the principles of stakeholder engagement as outlined by the International Association of Public Participation (IAP2). LCK recognises its stakeholders as any individual, group of individuals, organisation or entity with an interest in its activities.

LCK is committed to respectful and transparent communications, and aims to:

- have informed discussions and proactively work with stakeholders
- engage openly and honestly with stakeholders
- identify and address issues or opportunities raised by stakeholders
- build long term relationships of trust with stakeholders.

LCK aims to continue to engage stakeholders for the lifecycle of the project to ensure that all potential concerns are identified and appropriately addressed. Stakeholder correspondence is registered and documented to ensure that issues are appropriately addressed.

LCK will be undertaking a program of consultation with directly affected parties and other stakeholders.

7.1 Stakeholder Consultation

Stakeholders in the Leigh Creek region include the Adnyamathanha Traditional Lands Association, the local communities of Copley, Leigh Creek, Nepabunna, Iga Warta and Hawker, Flinders Power, regulatory agencies, industry groups and environmental organisations.

LCK has been undertaking stakeholder engagement from the inception of the Leigh Creek Energy Project (project) and is committed to informing stakeholder throughout the project lifecycle. Early engagement centred around the PCD plant and has evolved into future explorations programs (geophysical and drilling) for a commercial ISG facility.

The consultation undertaken by LCK for this EIR and supporting SEO (LCK 2018) involved circulation of the draft documents for comment along with face-to-face sessions in the townships of Copley and Leigh Creek. Comments and questions received from stakeholders from the project's inception and during the November / December 2018 consultation sessions in Copley and Leigh Creek can be found below in Section 7.2.

LCK initially disseminated this EIR and supporting SEO (LCK 2018) as drafts to key stakeholders on Friday 23 November 2018 and gave them a 20-business day window to make comments on the documents. A further round of consultation was conducted in the period 29 October to 8 November 2019. Review of any comments were then be fed into the final documents prior to formal submission to the Department of Mining and Energy (DEM). Key stakeholders who were sent the draft documents included:

- ATLA
- Outback Communities Authority
- Leigh Creek Community Progress Association
- Copley and Districts Progress Association
- Surrounding pastoral properties
- Regional Development Australia far north
- Natural Resources SA Arid Lands
- North Flinders NRM Group
- DEM
- Environment Protection Authority

- Department for Environment and Water
- Department of the Premier and Cabinet - Aboriginal Affairs and Reconciliation
- Department of Planning, Transport and Infrastructure
- Safework SA
- SA Health

ATLA requested further time to provide feedback and comments on this draft document. Out of respect and in good faith, LCK supported additional time for ATLA to submit their comments and feedback.

In addition to the targeted consultation on the proposed exploratory drilling activities in relation to this document and supporting SEO, Table 7-1 identifies the key stakeholders engaged with since the commencement of the project and highlights the activities undertaken with each stakeholder.

Table 7-1: Summary of stakeholder consultation

Stakeholder Category	Stakeholder	Activities undertaken
Traditional Owners	Adnyamathanha Traditional Lands Association (ATLA)	Email communications, project updates, presentations and workshops. Execution of a Work Area Clearance Agreement (WACA) occurred in September 2016 as part of LCK consultations with ATLA.
Community	Aroona Council	Email communications and project updates
	Blinman	Project updates
	Copley	Email communications, information sessions and project updates
	Farina	Project updates
	Hawker	Information sessions and project updates
	Iga Warta	Project updates
	Leigh Creek	Email communications, information sessions and project updates
	Lyndhurst	Project updates
	Nepabunna	Project updates
	Parachilna	Project updates
Progress Associations	Blinman Progress Association	Project updates
	Copley and Districts Progress Association	Email communications and project updates
	Leigh Creek Community Progress Association	Email communications and project updates
	Lyndhurst Progress Association	Project updates
Landholders	Flinders Power	Project updates, meetings, FP morning meetings
Pastoralists	Angepena Station	Email communications and project updates
	Beltana Station	Email communications and project updates

Stakeholder Category	Stakeholder	Activities undertaken
	Depot Springs Station	Email communications and project updates
	Farina Station	Email communications and project updates
	Leigh Creek Station	Email communications and project updates
	Maynards Well Station	Email communications and project updates
	Mount Lyndhurst Station	Email communications and project updates
	Mt Serle Station	Email communications and project updates
	Myrtle Springs Station	Email communications and project updates
	North Moolooloo Station	Email communications and project updates
	Nilpena Station	Email communications and project updates
	Puttapa Station	Email communications and project updates
	Wilpoorinna Station	Email communications and project updates
Regional Councils	Flinders Ranges Council	Project updates
	Nepabunna Council	Project updates
	Outback Communities Authority	Email communications and project updates
	Port Augusta Council	Email communications and project updates
	Whyalla Council	Project updates
Government Departments and Bodies	Aboriginal Affairs and Reconciliation	Email communications (letter and fact sheets)
	Department of Energy and Mining – Energy Resources Division	Meetings, project updates and email communications
	Department of Energy and Mining – Minerals Division	Project updates and email communications
	Department of Environment and Water	Email communications
	Department of Planning Transport and Infrastructure	Email communications
	Environment Protection Authority	Email communications
	Leigh Creek Taskforce	Meetings and email communications
	Natural Resources Management (NRM) Board	Board briefings, meetings and email communications
	NRM – Far North Flinders Group	Project updates and email communications
	Pastoral Board	Meetings and project updates

Stakeholder Category	Stakeholder	Activities undertaken
	Regional Development Australia Far North	Meetings, project updates and email communications
	Regional Development Australia Mid North	Meetings and project updates
	Regional Development Australia Whyalla and Eyre Peninsula	Meetings and project updates
	Safework SA	Project updates and email communications
	SA Health	Email communications
	Upper Spencer Gulf and Outback Taskforce	Meetings, project updates, email communications
Non-Government Organizations	Conservation Council SA	Project briefings
	Global Maintenance Upper Spencer Gulf	Project updates
	Friends of the Vulkathunha - Gammon Ranges	Project updates
	Nature Foundation SA	Project briefings
	Wilderness Society	Project briefings

7.2 Stakeholder Feedback

LCK submitted draft copies of the EIR and SEO to the ATLA and had targeted consultations with the local communities of Copley and Leigh Creek in November/December 2018.

Table 7-2 identifies the key stakeholder issues raised over the life of the project and indicates the sections of the EIR which relate to these issues. It has been amended to include further comments that arose from the November 2018 to January 2019 consultation sessions in Copley and Leigh Creek, as well as questions received from other stakeholders via email and the online portal during the 29 October to 8 November 2019 consultation period.

Table 7-2: Responses to stakeholder questions

Comment	Where covered in EIR	Summary of Response
What land disturbance will be required for the exploration drilling activities?	Section 3.1.1, 3.1.2	The access tracks and drill sites will be on currently disturbed land within the Telford Basin of the Leigh Creek coal field. Outside of the disturbed areas of the Telford Basin, any new access tracks or drill pads, will be planned and constructed to minimize impact to the ground, native vegetation, potential animal habitats and surface drainage patterns. Work Area Clearances will be conducted prior to any earthworks. There is still a risk that works will encounter Aboriginal heritage. As such, all personnel involved in the drilling activities will be inducted on environmental management and will be instructed to keep disturbance within the designated work areas.
What will happen if an aboriginal site or objects are located during the exploration drilling?	Section 1 Section 5.1 Table 5-1	Although the site of the exploratory drilling is within and around an old coal mine and the area is heavily disturbed, all personnel conducting the exploration drilling will be inducted on cultural heritage and will be instructed to report any suspected sites or objects. If any sites or objects are discovered, the Adnyamathanha Traditional Lands Association (ATLA) will be contacted to identify an appropriate course of action. Discoveries will be flagged for their protection and detoured around. Options then will include risk managing the area with ATLA's assistance or seeking authorization under section 23 of the *Aboriginal Heritage Act 1988* where damage to Aboriginal heritage cannot be avoided. If Aboriginal sites, objects and remains are discovered, the discovery is reported to the Department of the Premier and Cabinet - Aboriginal Affairs and Reconciliation (DPC-AAR). In addition, LCK has sought the participation of ATLA to undertake a WAC over the area, however we are yet to receive feedback from ATLA to this initial December 2018 (and subsequent) request. LCK entered into a Work Area Clearance Agreement (WACA) in September 2016 and on this basis LCK continues to seek ATLA's participation in the requested WAC to provide a further level of confidence that sites or objects, should they exist in the area, are protected.
Will the exploration drilling affect surface water?	Section 5.4	For the drilling activities, all drill cuttings, drilling water and biodegradable drill muds will be contained within the drill sumps. Once all drilling activities are completed, the sumps will be covered over and rehabilitated. Surface water drainage patterns will not be affected by the access track construction works.

Comment	Where covered in EIR	Summary of Response
What type of drilling will you be doing?	Section 3	The types of drilling being conducted under this EIR are for chip drilling and core drilling using mineral exploration drill rigs. Any drilling of future inlet or outlet wells will be covered by a separate EIR and SEO.
Why are you doing exploration drilling?	Summary, Introduction Section 3	The exploration drilling will be used to determine the location and quality of the coal seams and location of any faults and provide information on any ground waters.
How deep are exploration drill holes?	Section 3.2	The initial drill holes will be 250m to 800m deep depending on the area. Later drill holes will target the deeper parts of the coal seams down to 1,000 meters.
Where will the people doing the exploration drilling be living?	Section 3.1.4, 3.4.6	The people involved in the exploration drilling will be accommodated in Copley and/or Leigh Creek if there is accommodation available. If not, then they will setup a mobile camp in the old Leigh Creek coalmine. Due to the 24-hour operation of the drilling during the exploration drilling, the personnel may need to be accommodated in a mobile camp on the old Leigh Creek coalmine
How long will the exploration drilling take?		The initial exploration drilling is expected to take 2 to 3 months to complete. Additional exploration drilling programs can take longer depending on the size of the area being explored and the number and type of holes being drilled.
Isn't there enough drilling from the previous mining company?		No. The coal that the previous operators of the Leigh Creek coalmine were targeting was for open cut mining. The coal and surrounding geology that LCK are targeting is much deeper, therefore exploration drilling is required to determine the location of these deeper coal seams and faults.
Does the exploration drilling affect the groundwater quality?	Section 5.2	Due to the lack of permeability and porosity, there is very little groundwater in PEL 650. All drill cuttings, drilling water and biodegradable drill muds are stored in the drill sumps. At the end of the drilling program, all exploration drill holes will be cased and/or cemented up (as required) to prevent any potential for contamination of groundwater.
Why do you need to do exploration drilling if the seismic tells you what is under the ground?	Section 3 Section 3.1	Seismic will give a good approximation of where the coal seams and faults are, but this needs to be followed up with drilling to confirm their exact location.

Comment	Where covered in EIR	Summary of Response
Does this exploration drilling cover the drilling of the next lot of inlet and outlet wells?	Summary, Introduction Section 1.2	No. All drilling associated with the next series of inlet and production wells will be covered by a separate SEO and EIR. This exploration drilling is designed to locate the position of the coal seams, faults and groundwater.
What happens if an animal falls into one of the drill sumps?	Section 3.3.1 Table 5-1	The drill sumps are fenced off with cattle gates to prevent animals entering the drill sumps. The sumps will also be monitored from when they are constructed until when they are rehabilitated. If an animal does find a way in past the cattle gates and falls into the drill sump, then the animal can escape from a ramp designed on one side of the drill sump.
What if animals drink the water in the drill sump?	Section 3.3.1	The fluid contents in the drill sump is non-toxic to humans and animals. It will consist of groundwater, drinking water from SA Water, rock chips and biodegradable drill muds. It will be muddy due to the drill chips (similar to stirring up the bottom of a creek), but it is not toxic.
What other types of drilling activities are planned?	Summary, Introduction Section 1.2	Later drilling of the gasifiers will be covered by a separate SEO and EIR.
What are the employment opportunities?	N/A	Short term contracts for the exploration drilling will be managed by the drilling companies
Are there any waste products?	Section 3.4.3	The exploration drilling activities will only generate some domestic waste (e.g. food waste, paper, etc.).
Where does any waste go?	Section 3.4.3. Section 5.3.3 Section 5.5.5	All domestic waste will be taken to the Leigh Creek landfill. Any non-domestic waste will be taken offsite to EPA licensed landfill
ATLA is further concerned about whether or not the exploration drill holes will be de-commissioned, and if so, how this will occur. In the Drilling EIR there appears to be no proposal to backfill the exploration holes. ATLA has received expert advice that if these holes are to remain as open boreholes, then they could potentially create future pathways for migration of gases and fluids during subsequent underground gasification. The risk of leaving the boreholes open in the long term needs to be properly assessed.	Section 3.2.2	After the drillhole has been drilled to the required depth and all the Wireline logging has been performed, the drillhole is then either cased or cemented up. This will depend on the future requirements of the hole. If the drillhole is no longer require, it will be completely filled with cement from the bottom of the drillhole to the surface. This ensures that no fluids or gases can flow along the drillhole path and this eliminates crossflow between aquifers. If the drillhole will be used for other purposes (e.g. water level monitoring, water quality monitoring, etc.), then the hole will be cased. This involves running steel

Comment	Where covered in EIR	Summary of Response
		casing into the drillhole and cementing it into place. The cement is pumped into the base of the drillhole, so that it flows and fills the space between the steel casing and the drillhole. This ensures that no fluids or gases can flow along the drillhole path and this eliminates crossflow between aquifers.
ATLA is also concerned about the unassessed impacts of the proposed temporary workers' accommodation. For examples, the Drilling EIR states: "If a temporary campsite is required, it will be constructed on previously disturbed ground on the old Leigh Creek Coal Field, where disturbance of vegetation and surface drainage and the importation of borrow material can be avoided or minimized." ATLA submits that such temporary workers' accommodation is inadequately assessed in the Draft Environmental Documents and requests a proper assessment be conducted.	Section 3.1.4, 3.3.2, 3.4.1, 3.4.2, 3.4.6,	The temporary workers' accommodation will only be constructed in the unlikely event that accommodation is unavailable in the nearby townships of Copley and/or Leigh Creek. Due to the low manning levels required on the drill rigs, this is not expected to occur. If a temporary workers' accommodation is constructed for the Exploration Drilling Operations, then it will be constructed within the disturbed area of the Leigh Creek Coal Field in an area that has already been used in the past for temporary workers accommodation. Note that the location of the site temporary workers' accommodation will be subject to a Work Area Clearance as per the Work Area Clearance Agreement that ATLA signed with LCK in 2016. Waste streams will be segregated on site and collected and stored in covered bins before being transported to appropriate facilities for reuse / recycling (where possible) or disposal. Waste management practices will be guided by the principles of the waste hierarchy (i.e. avoid, reduce, reuse, recycle, recover, treat, dispose).
The Exploration Drilling EIR states (p. 69, 5.5.2. Spill or leaks of fuel or chemicals) "There is no likelihood that a spill or leak could impact vegetation that is undisturbed, has high environmental value or is of conservation significance within the PEL 650."	Section 5.5.2	This statement will need to be read in relation to the previous paragraph in the EIR to provide context. In summary, in the unlikely event of a spill or leak, it will occur within the disturbed drill site and not in the undisturbed area outside of the drill site. Appropriate storage, bunding, handling and spill response will contain any potential spills to the disturbed drill site and prevent the spill entering the undisturbed areas.
Exploration drillholes will be either decommissioned or converted to groundwater monitoring wells. SEO and EIR should explicitly state the guidelines that will be complied with based on the end objective for each drillhole, e.g. Minimum Construction Requirements for Water Bores in Australia. https://www.water.wa.gov.au/__data/assets/pdf_file/0005/1796/Minimum-construction-guidelines-for-water-bores-in-Australia-V3.pdf	Sections 3.2.3 and 5.2.2	In section 3.2.3 Hole Abandonment and Decommissioning, we have stated "After the drill hole has been drilled to the required depth and the decision has been made to abandon/decommission the hole, the hole will be cemented up from the base of the hole to the surface. This eliminates any crossflow between aquifers".

Comment	Where covered in EIR	Summary of Response
		In section 5.2.2 Potential Aquifers External to Telford Basin, we state that "Installation of investigation monitoring wells would be constructed to the Minimum Construction Requirements for Water Bores in Australia…."
		Once we know where the drill holes will be and the depth to which they will be drilled we will be in a better position to decide on their final use and work with the Department for Environment and Water, if need be, to ensure regulatory compliances and standards are met.
The Department of the Premier and Cabinet - Aboriginal Affairs and Reconciliation (DPC-AAR) submitted comments in response to the EIR and SEO.		
Environment Impact Report (EIR) – DPC-AAR Comments		
Amend – 'DSD-AAR' Change to – 'DPC-AAR'	Section 4.2.1	This has been corrected
Note – DPC-AAR updates the Central Archive regularly. As such, it is recommended that proponents submit periodic search requests to DPC-AAR.HeritageSites1@sa.gov.au. Requesting a search of the Central Archive is prudent prior to commencing any ground disturbance activities.	Section 4.2.1	This is noted
Section 5.1 Cultural Heritage, paragraph two Suggest change – 'It is fair to assess that the proposed drilling works are of a significantly lesser impact and that they will pose little risk'. Suggest replacing with – 'The potential impact of the proposed drilling works on Aboriginal sites, objects and remains will be determined in consultation with ATLA and managed as appropriate'. Comment –	Section 5.1	This has been done and the comment noted

Comment	Where covered in EIR	Summary of Response
The proposed drilling works may impact Aboriginal sites, objects and remains within the works area. All Aboriginal sites, objects and remains are protected under the Aboriginal Heritage Act 1988.		
Comment – As discussed in DPC-AAR's covering letter, it may be prudent for LCE to develop an overarching Cultural Heritage Management Plan (CHMP) for the project (if this is not already included in LCE's Work Area Clearance agreement with ATLA). A CHMP would augment LCE's existing heritage management frameworks by laying out measures to be undertaken before, during and after project activities to adequately manage the protection of Aboriginal heritage.	Section 5.1	This is noted. LCE have a Cultural Heritage Policy and in it a commitment to develop a Cultural Heritage Risk Management Plan if needed, that will be developed with ATLA following the work area clearance.
Section 5.1 Cultural Heritage, paragraph four Suggest adding – '…and as there is still the risk of encountering surface or sub-surface cultural heritage.' Comment – 'Despite previous ground disturbance works there is still potential for surface or sub-surface cultural heritage to exist'.	Section 5.1	This has been done and the comment noted
Table 5-1 Suggest change – 'By way of risk mitigation…' Suggest replacing with – 'To avoid any impacts to Aboriginal sites, object and remains….' Comment- A section 23 authorisation should be sought prior to works where damage is possible or unavoidable.	Section 5.1	This has been done and the comment noted
Table 5-1 Suggest change – 'Training and induction for all personnel on cultural heritage issues…' Suggest replacing with –	Section 5.1	This has been done

Comment	Where covered in EIR	Summary of Response
'Training for all personnel on Aboriginal cultural heritage as well as their obligations under the Aboriginal Heritage Act 1988 (legislative awareness training)'		
Table 5-1 Suggest change – 'Options include risk managing the area with ATLA's assistance or other available legislative processes'. Suggest replacing with – 'Contact the Adnyamathanha Traditional Lands Association (ATLA) to identify an appropriate course of action. Options may include risk managing the area with ATLA's assistance or seeking authorisation under section 23 of the Aboriginal Heritage Act 1988 where damage to Aboriginal heritage cannot be avoided'.	Table 5-1	This has been done
Table 5-1 Amend – 'Department of Premier and Cabinet, Aboriginal Affairs and Reconciliation (AAR) division'. Change to – Department of the Premier and Cabinet - Aboriginal Affairs and Reconciliation (DPC-AAR).	Table 5-1	This has been amended
Table 5-1 Disturbance to Cultural Heritage Add – 'If suspected cultural heritage material is discovered during operations, immediately stop any further work in the area, secure the site and ensure no further ground disturbing activity takes place in the immediate area. Contact the Adnyamathanha Traditional Lands Association (ATLA) to identify an appropriate course of action. Options include risk managing the area with ATLA's assistance or seeking authorisation under section 23 of the Aboriginal Heritage Act 1988 where damage to Aboriginal heritage cannot be avoided.	Table 5-1	This has been added
Also add –		This has been done and the comment noted

Comment	Where covered in EIR	Summary of Response
If Aboriginal sites, objects and remains are discovered, the discovery is reported to the Department of the Premier and Cabinet - Aboriginal Affairs and Reconciliation (DPC-AAR)'. Comment – DPC-AAR administers the Aboriginal Heritage Act 1988 on behalf of the Premier. Section 20 of the Aboriginal Heritage Act 1988 provides that if Aboriginal sites, objects or remains are discovered, LCE is required to report the discovery to the Premier, through DPC-AAR, as soon as practicable.		
Section 7.1 Stakeholder Consultation Comment – See DPC-AAR letter for the details of stakeholders who assert Aboriginal heritage interests for the area. It is suggested that both groups be independently consulted.	Section 7.1	This has been noted
Table 7-2 Responses to Stakeholder questions (end of first sentence) Add – '…there is still a risk that works will encounter Aboriginal heritage. As such, all personnel…' Comment – Despite the fact that an area has been heavily disturbed through previous ground disturbing works, LCE should be aware that ground disturbing activities may still pose a risk to Aboriginal sites, objects and remains which exist below the ground.	Table 7-2	This has been done and the comment noted
Table 7-2: Responses to stakeholder questions Suggest change – 'If any sites or objects are discovered, the site will be flagged for inspection and detoured around.' Suggest replacing with – 'If any sites or objects are discovered, the Adnyamathanha Traditional Lands Association (ATLA) will be contacted to identify an appropriate course of action. Discoveries will be flagged for their protection and detoured around. Options then will include risk managing the area with ATLA's assistance or	Table 7-2	This has been changed

Comment	Where covered in EIR	Summary of Response
seeking authorisation under section 23 of the Aboriginal Heritage Act 1988 where damage to Aboriginal heritage cannot be avoided. If Aboriginal sites, objects and remains are discovered, the discovery is reported to the Department of the Premier and Cabinet - Aboriginal Affairs and Reconciliation (DPC-AAR)'.		
Statement of Environmental Objectives (SEO) – DPC-AAR Comments		
Page 8 – Section 2.1 Objectives Suggest change – 'Avoid damage, disturbance or interference to Aboriginal heritage sites, objects and remains through undertaking risk mitigation strategies and where required, procuring authorisation under relevant legislation'. Suggest replacing with – '1) Minimise risk of damage, disturbance or interference to Aboriginal heritage sites, objects and remains by undertaking risk mitigation strategies. Where damage, disturbance or interference cannot be avoided, or may occur inadvertently, seek authorisation under section 23 of the Aboriginal Heritage Act 1988.'	Section 2.1	This has been done
Page 10 – Table 1: Environmental Objectives and Assessment Criteria Suggest change – '1) Avoid damage, disturbance or interference to Aboriginal heritage sites, objects and remains by undertaking risk mitigation strategies and, where required, procuring authorisation under the relevant legislation.' Suggest replacing with – '1) Minimise risk of damage, disturbance or interference to Aboriginal heritage sites, objects and remains by undertaking risk management strategies. Where required, seek authorisation under the Aboriginal Heritage Act 1988.'	Table 1	This has been done
Page 10 – Table 1: Environmental Objectives and Assessment Criteria Amend – 'Department of Premier and Cabinet, Aboriginal Affairs and Reconciliation (AAR) division'. Change to –	Table 1	This has been amended

Comment	Where covered in EIR	Summary of Response
'Department of the Premier and Cabinet – Aboriginal Affairs and Reconciliation (DPC-AAR).		

7.3 Online Community Portal

LCK has introduced a targeted online community portal via the LCK website for interested stakeholders. Community members can easily login and share their experiences of the project, leave feedback, and locate or request information. The portal offers enhanced two-way communication where community users can track the progress of any requests they make and add reminders so that their questions are answered in a timely manner.

The site has been designed for ease of use and will be monitored by a dedicated Stakeholder Relations Coordinator. The Community Portal can be accessed through the LCK website's 'Contact us' section (www.lcke.com.au/contact) and directly through http://lcke.c3register.com/.

In addition, a suite of educational materials about the company and the project are being developed for use in community engagement activities and more will be developed as questions are asked through the Community Portal and ongoing community meetings.

7.4 Formal Consultation

As part of the formal consultation process, copies of the EIR and SEO were provided by DEM to the following South Australian government agencies:

- Department for Environment and Water (DEW)
- Environment Protection Authority (EPA)
- Department of the Premier and Cabinet - Aboriginal Affairs and Reconciliation (AAR)
- Department of Planning, Transport and Infrastructure (DPTI)
- SA Health: Department for Health and Wellbeing
- Primary Industries and Regions South Australia (PIRSA)

DEM received four submissions from EPA, SA Health, AAR and DEM. The feedback and comments raised by these agencies, and the responses provided by LCK, have been incorporated into Appendix B of this EIR.

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9 Abbreviations and Glossary

Adelaide Geosyncline	A major central South Australian geological province that extends from the northern parts of the Flinders Ranges to Kangaroo Island and includes the Mount Lofty Ranges. The sedimentary rocks were primarily deposited in the Neoproterozoic era. Lithology includes siltstone, shale and limestone.
Aquifer	Geologic materials with high hydraulic conductivity that are able to receive, store and transmit groundwater in quantities sufficient for use as a water supply.
Aquitard	Geologic materials with low hydraulic conductivity that are able to receive and store groundwater but cannot transmit the groundwater in quantities sufficient for use as a water supply.
ASX	Australian Securities Exchange. Prior to December 2006 it was known as the Australian Stock Exchange.
ATLA	Adnyamathanha Traditional Lands Association.
bgl	Below ground level
BOM	Bureau of Meteorology.
Contamination	Contamination means the condition of land or water where any chemical substance or waste has been added as a direct or indirect result of human activity at above background level and represents, or potentially represents, an adverse health or environmental impact.
DEE	Department of Environment and Energy.
DEH	Department of Environment and Heritage (SA) (now DEWNR).
DEM	Department of Energy and Mining.
DEW	Department of Environment and Water.
DSD	Department of State Development.
EIR	Environmental Impact Report.
EMP	Environmental Management Plan.
EPA	Environment Protection Authority (SA).
EPBC	*Environment Protection and Biodiversity Conservation Act 1999* (Cth).
EPP	*Environment Protection (Air Quality) Policy 2016* ground level concentrations (GLCs).
Ephemeral	Existing for only a short time, often dependent upon climatic influences.
ETSA	Electricity Trust of South Australia.
FAOA	Field Ambient Odour Assessment.
Gasification	Process that converts coal into gas, principally carbon dioxide, hydrogen and carbon monoxide.
GLC	Ground level concentrations.
GSEL	Gas storage exploration licence.
HDPE	High Density polyethylene.
IBRA	Interim Biogeographic Regionalisation for Australia.
In situ	In position.
ISG	In situ gasification. In situ (underground) conversion of coal into an energy-rich product gas.
Independent Scientific Panel	Independent Scientific Panel for Underground Coal Gasification established in Queensland in 2013 to review and report on outcomes of UCG trial activities in Queensland.
Jurassic	Relating to the period of geological time approximately 205 to 141 million years ago.
LCEP	Leigh Creek Energy Project.

LCK	Leigh Creek Energy Ltd.
Mesozoic	Relating to the era of geological time including Triassic, Jurassic and Cretaceous ages, approximately 250-65 million years ago.
Neoproterozoic	Relating to the era of geological time 1000-545 million years ago, which precedes the Palaeozoic era.
NEPM	*National Environment Protection (Assessment of Site Contamination) Measure (1999)* amended in 2013.
OCA	Outback Communities Authority.
Overburden	Rock or soil overlying a mineral deposit which would need to be removed for the deposit to be mined.
PEL	Petroleum Exploration Licence.
PELA	Petroleum Exploration Licence Application.
Quaternary	Relating to the period of time approximately 1.8 million years ago to the present.
Receptor	A person, animal, plant, ecosystem, property or water with the potential to be adversely affected or impacted by an activity.
SAAL NRM Board	South Australian Arid Lands Natural Resources Management Board.
SEO	Statement of Environmental Objectives.
Syngas	Synthesis gas. The product of gasification composed mainly of carbon dioxide, hydrogen, carbon monoxide, methane, nitrogen, steam and gaseous hydrocarbons.
Triassic	Relating to the period of geological time approximately 251 to 205 million years ago.
UCG	Underground coal gasification. UCG is equivalent to ISG.
WACA	Work Area Clearance Agreement.

Appendix A: Flora and Fauna Information

Table A-1: Plant species recorded on site, as well as previously recorded from the PEL 650 (T&M Ecologists, 2018)

Name	Common Name	*Conservation Status			Vegetation Community						
		EPBC	NPWSA	OU	1. Red Gum woodland creekline	2. Red Gum open woodland on rocky outcrops	3. Acacia victoriae shrubland	4. Nitraria billardieri open shrubland	5a. Maireana spp. low shrubland	5b. Maireana spp. low shrubland	6. Samphire low shrubland
Abutilon leucopetalum	Desert Lantern-bush					1	T			N	
Abutilon malvaefolium	Scrambling Lantern-bush			NT			X				
Acacia aneura var. aneura	Mulga										
Acacia beckleri ssp. beckleri	Beckler's Rock Wattle										
Acacia beckleri ssp. megasphérica	Beckler's Rock Wattle										
Acacia brachystachya	Turpentine Mulga										
Acacia georginae	Georgina Gidgee		RA	RA							
Acacia oswaldii	Umbrella Wattle										
Acacia rigens	Nealie			RA							
Acacia salicina	Willow Wattle										
Acacia tetragonophylla	Dead Finish					N				E	
Acacia victoriae ssp. victoriae	Elegant Wattle				1	N	O/2	E	E	E	
Alectryon oleifolius ssp. canescens	Bullock Bush									X	
Amyema miraculosa ssp. boormanii	Fleshy Mistletoe			NT							
Amyema preissii	Wire-leaf Mistletoe									X	

Name	Common Name	*Conservation Status			Vegetation Community						
		EPBC	NPWSA	OU	1. Red Gum woodland creekline	2. Red Gum open woodland on rocky outcrops	3. Acacia victoriae shrubland	4. Nitraria billardieri open shrubland	5a. Maireana spp. low shrubland	5b. Maireana spp. low shrubland	6. Samphire low shrubland
Arabidella trisecta	Shrubby Cress										
Aristida nitidula	Brush Three-awn			NT	N	T				N	
Atriplex angulata	Fan Saltbush										
Atriplex eardleyae	Eardley's Saltbush										
Atriplex fissivalvis	Gibber Saltbush										
Atriplex holocarpa	Pop Saltbush					T					
Atriplex lindleyi ssp. conduplicata	Baldoo										
Atriplex lindleyi ssp. lindleyi	Baldoo					1		1/U			
Atriplex lindleyi ssp. quadripartita	Baldoo			NT							
Atriplex nummularia ssp. nummularia	Old-man Saltbush					N					
Atriplex obconica				NT							
Atriplex suberecta	Lagoon Saltbush			NT							
Atriplex vesicaria	Bladder Saltbush				N		N	2/U	1/O	1/O	
Austrostipa nitida	Balcarra Spear-grass				X					X	
Austrostipa sp.						T	N		T	N	
Boerhavia dominii	Tar-vine				N	T	T			T	
Brachyscome ciliaris var. ciliaris	Variable Daisy				T	1	T	N	T	T	

Name	Common Name	*Conservation Status			Vegetation Community						
		EPBC	NPWSA	OU	1. Red Gum woodland creekline	2. Red Gum open woodland on rocky outcrops	3. Acacia victoriae shrubland	4. Nitraria billardieri open shrubland	5a. Maireana spp. low shrubland	5b. Maireana spp. low shrubland	6. Samphire low shrubland
Brachyscome ciliaris var. lanuginosa	Woolly Variable Daisy									X	
Brachyscome dichromosomatica var. dichromosomatica	Large Hard-head Daisy			RA							
Brachyscome lineariloba	Hard-head Daisy										
Carpobrotus rossii	Native Pigface								N		
Casuarina pauper	Black Oak								X		
Chenopodium curvispicatum	Cottony Goosefoot			NT	N					T	
Chenopodium desertorum ssp. microphyllum	Small-leaf Goosefoot			NT							
Chenopodium nitrariaceum	Nitre Goosefoot						N	1		1	
Convolvulus eyreanus	Silver Bindweed										
Convolvulus recurvatus ssp. nullarborensis				RA							
Convolvulus remotus	Grassy Bindweed				N				N	X	
Cullen australasicum	Tall Scurf-pea										
Cymbopogon ambiguus	Lemon-grass			NT	1	1	1			N	
Cynanchum viminale ssp. australe	Caustic Bush			?							
Cyperus gymnocaulos	Spiny Flat-sedge					1/U					2/O

Name	Common Name	*Conservation Status			Vegetation Community						
		EPBC	NPWSA	OU	1. Red Gum woodland creekline	2. Red Gum open woodland on rocky outcrops	3. Acacia victoriae shrubland	4. Nitraria billardieri open shrubland	5a. Maireana spp. low shrubland	5b. Maireana spp. low shrubland	6. Samphire low shrubland
Digitaria brownii	Cotton Panic-grass								X		
Dissocarpus biflorus var. biflorus	Two-horn Saltbush										
Dissocarpus paradoxus	Ball Bindyi									N	
Dodonaea microzyga var. microzyga	Brilliant Hop-bush			NT					T		
Dodonaea viscosa ssp. angustissima	Narrow-leaf Hop-bush										
Duma florulenta	Lignum										
Dysphania melanocarpa	Black-fruit Goosefoot						X				
Einadia nutans ssp. nutans	Climbing Saltbush			NT		N	N				
Enchylaena tomentosa var. tomentosa	Ruby Saltbush				1	1	N	T			
Enneapogon avenaceus	Common Bottle-washers					1		N	T	T	
Enneapogon cylindricus	Jointed Bottle-washers				N					N	
Enneapogon polyphyllus	Leafy Bottle-washers										
Enteropogon acicularis	Umbrella Grass			NT					N		
Eragrostis infecunda	Barren Cane-grass		RA	VU	1						
Eremophila alternifolia	Narrow-leaf Emubush			NT	N						
Eremophila duttonii	Harlequin Emubush			NT							

Name	Common Name	*Conservation Status			Vegetation Community						
		EPBC	NPWSA	OU	1. Red Gum woodland creekline	2. Red Gum open woodland on rocky outcrops	3. Acacia victoriae shrubland	4. Nitraria billardieri open shrubland	5a. Maireana spp. low shrubland	5b. Maireana spp. low shrubland	6. Samphire low shrubland
Eremophila freelingii	Rock Emubush						X		E		
Eremophila longifolia	Weeping Emubush				N						
Eremophila maculata ssp. maculata	Spotted Emubush			NT	N						
Eremophila oppositifolia ssp. oppositifolia	Opposite-leaved Emubush			NT							
Eriachne mucronata	Mountain Wanderrie			NT							
Eriochiton sclerolaenoides	Woolly-fruit Bluebush									N	
Erodium carolinianum	Clammy Heron's-bill										
Eucalyptus camaldulensis ssp. arida	Northern River Red Gum			NT	2/O	1/O					
Eucalyptus camaldulensis ssp. minima	River Red Gum			NT							
Eucalyptus intertexta	Gum-barked Coolibah			RA							
Eucalyptus socialis ssp. socialis	Beaked Red Mallee										
Euphorbia drummondii s.str.					N					N	
Euphorbia multifaria											
Euphorbia tannensis ssp. eremophila	Desert Spurge								T		
Frankenia serpyllifolia	Thyme Sea-heath										
Frankenia subteres			RA	NT	T	T					

Name	Common Name	*Conservation Status			Vegetation Community						
		EPBC	NPWSA	OU	1. Red Gum woodland creekline	2. Red Gum open woodland on rocky outcrops	3. Acacia victoriae shrubland	4. Nitraria billardieri open shrubland	5a. Maireana spp. low shrubland	5b. Maireana spp. low shrubland	6. Samphire low shrubland
Glinus lotoides	Hairy Carpet-weed										
Gnephosis arachnoidea	Spidery Button-flower										
Goodenia fascicularis	Silky Goodenia									N	
Grevillea nematophylla ssp. nematophylla	Water Bush										
Gunniopsis kochii	Koch's Pigface			NT							
Gunniopsis papillata	Twin-leaf Pigface										
Gunniopsis tenuifolia	Narrow-leaf Pigface			RA							
Hakea leucoptera ssp. leucoptera	Silver Needlewood										
Ixiochlamys cuneifolia	Silverton Daisy			NT			X				
Juncus kraussii	Sea Rush			NT							
Lawrencia glomerata	Clustered Lawrencia										
Leiocarpa websteri	Narrow Plover-daisy						X				
Lepidium phlebopetalum	Veined Peppercress										
Lotus cruentus	Red-flower Lotus										
Lysiana exocarpi ssp. exocarpi	Harlequin Mistletoe					N	N		N		
Maireana aphylla	Cotton-bush						N	N			

Name	Common Name	*Conservation Status			Vegetation Community						
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Maireana appressa	Pale-fruit Bluebush										
Maireana astrotricha	Low Bluebush					1	N	1	2/O3	2/O	
Maireana brevifolia	Short-leaf Bluebush			NT	T	T	T	1/U	N		
Maireana campanulata	Bell-fruit Bluebush			NT						1	
Maireana eriantha	Woolly Bluebush										
Maireana pentatropis	Erect Mallee Bluebush			NT		T			1		
Maireana pyramidata	Black Bluebush							T		X	
Maireana radiata	Radiate Bluebush			NT							
Maireana sedifolia	Bluebush			NT					T		
Maireana spongiocarpa	Spongy-fruit Bluebush										
Maireana trichoptera	Hairy-fruit Bluebush			NT						X	
Malvastrum americanum var. americanum	Malvastrum				1	1	T		T	T	
Marsdenia australis	Native Pear			NT						N	
Melaleuca glomerata	Inland Paper-bark			RA	N	T					
Menkea crassa	Fat Spectacles			NT							
Minuria annua	Annual Minuria			NT							

Name	Common Name	*Conservation Status			Vegetation Community						
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Minuria cunninghamii	Bush Minuria					N		N	N	T	
Myoporum montanum	Native Myrtle			NT	1/U	1/U	3/U	E	E	E	E
Myoporum platycarpum ssp. platycarpum	False Sandalwood			NT							
Nitraria billardierei	Nitre-bush				N			2/O	N		
Orobanche cernua var. australiana	Australian Broomrape		RA	NT							
Osteocarpum acropterum var. acropterum	Tuberculate Bonefruit										
Osteocarpum dipterocarpum	Two-wing Bonefruit										
Osteocarpum salsuginosum	Inland Bonefruit			RA				N			T
Oxalis perennans	Native Sorrel			NT			X				
Petalostylis labicheoides	Butterfly Bush			NT	N						
Pimelea microcephala ssp. microcephala	Shrubby Riceflower			NT	N		N		N		
Pittosporum angustifolium	Native Apricot				N		2/O		E		
Plantago drummondii	Dark Plantain										
Pluchea dentex	Bowl Daisy			NT							
Polycalymma stuartii	Poached-egg Daisy										

Name	Common Name	*Conservation Status			Vegetation Community						
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Pseudognaphalium luteoalbum	Jersey Cudweed										T
Pterocaulon sphacelatum	Apple-bush				T	1	T			N	
Ptilotus disparilis	Small-leaf Mulla Mulla			VU							
Ptilotus obovatus					T	T			1	T	
Pycnosorus pleiocephalus	Soft Billy-buttons										
Rhagodia spinescens	Spiny Saltbush					T1	1/U		N		
Rhodanthe corymbiflora	Paper Everlasting			NT							
Rhodanthe microglossa	Clustered Everlasting										
Rytidosperma sp.									T		
Salsola australis	Buckbush									N	
Santalum lanceolatum	Plumbush				N		3/O			N	
Santalum spicatum	Sandalwood		VU	NT							
Sarcozona praecox	Sarcozona			NT							
Scaevola spinescens	Spiny Fanflower								X		
Sclerolaena bicornis var. bicornis	Goat-head Bindyi										
Sclerolaena brachyptera	Short-wing Bindyi								1	1/U	
Sclerolaena constricta											

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Sclerolaena cuneata	Tangled Bindyi					1					
Sclerolaena decurrens	Green Bindyi									X	
Sclerolaena diacantha	Grey Bindyi									X	
Sclerolaena divaricata	Tangled Bindyi								1		
Sclerolaena limbata	Pearl Bindyi										
Sclerolaena longicuspis	Long-spine Bindyi						T	1		1/U	
Sclerolaena obliquicuspis	Oblique-spined Bindyi					1	1		1/U	T	
Sclerolaena parallelicuspis	Western Bindyi										
Sclerolaena patenticuspis	Spear-fruit Bindyi					N					
Sclerolaena tatei	Tate's Bindyi			NT							
Sclerolaena tricuspis	Three-spine Bindyi			NT						T/U	
Sclerolaena ventricosa	Salt Bindyi										
Senecio cunninghamii var. cunninghamii	Shrubby Groundsel				T		N	N	N	N	
Senecio lanibracteus	Inland Shrubby Groundsel										
Senecio magnificus	Showy Groundsel									N	
Senecio runcinifolius	Thistle-leaf Groundsel			RA							

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Senna artemisioides ssp. artemisioides	Silver Senna				T		T		E		
Senna artemisioides ssp. coriacea	Broad-leaf Desert Senna								E	X	
Senna artemisioides ssp. petiolaris							N		E		
Senna cardiosperma ssp. gawlerensis	Gawler Ranges Senna			NT						E	
Senna phyllodinea											
Sida fibulifera	Pin Sida				T	T			T	1/U	
Sida intricata	Twiggy Sida					T	T				
Sida petrophila	Rock Sida			NT		1					
Sida trichopoda	High Sida										
Sigesbeckia australiensis ssp. australiensis	Australian Sigesbeckia										
Solanum ellipticum	Velvet Potato-bush					T		N		N	
Solanum sturtianum	Sturt's Nightshade			NT						X	
Spergularia marina	Salt Sand-spurrey			NT							
Stemodia florulenta	Bluerod										1
Stenopetalum lineare	Narrow Thread-petal										

Name	Common Name	*Conservation Status			Vegetation Community						
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Swainsona fissimontana	Broken Hill Pea			RA						N	
Swainsona stipularis	Orange Swainson-pea			NT							
Tecticornia disarticulata				NT							
Tecticornia indica ssp. leiostachya	Brown-head Samphire			NT		2					3/O
Tecticornia pergranulata ssp. divaricata	Black-seed Samphire			NT							3/O
Tecticornia sp.								T	N		1
Teucrium racemosum	Grey Germander										
Thyridia repens	Creeping Monkey-flower										2
Trichanthodium skirrophorum	Woolly Yellow-heads										
Tripogon loliiformis	Five-minute Grass										
Vittadinia cuneata var. cuneata	Fuzzy New Holland Daisy				N	1			N	T	
Vittadinia sulcata	Furrowed New Holland Daisy									X	
Wahlenbergia communis	Tufted Bluebell									N	
Zygophyllum apiculatum	Pointed Twinleaf			NT						N	
Zygophyllum aurantiacum ssp. aurantiacum	Shrubby Twinleaf							T	N		

Name	Common Name	*Conservation Status			Vegetation Community						
		EPBC	NPWSA	OU	1. Red Gum woodland creekline	2. Red Gum open woodland on rocky outcrops	3. Acacia victoriae shrubland	4. Nitraria billardieri open shrubland	5a. Maireana spp. low shrubland	5b. Maireana spp. low shrubland	6. Samphire low shrubland
Zygophyllum aurantiacum ssp. verticillatum	Shrubby Twinleaf			NT							
Zygophyllum confluens	Forked Twinleaf			NT							
Zygophyllum iodocarpum	Violet Twinleaf			NT							
Zygophyllum prismatothecum	Square-fruit Twinleaf										

***Conservation Status**

EPBC = Environment Protection and Biodiversity Conservation Act 1999

NPWSA = Schedules of the National Parks and Wildlife Act 1972 accessed May 2016

OU = Gillam, S. and Urban, R. (2013) Species Risk Assessment Pilot Project Phase 1 Report: Regional Species Conservation Assessments, Outback Region. Department for Environment and Heritage, South Australia.

CR = Critically Endangered, EN = Endangered, VU = Vulnerable, RA = Rare, NT = Near Threatened

Vegetation Community Cover Abundance Codes (adapted from the Biological Survey of SA):

N = Not many (1-10 plants and <5%)

T = sparsely present; cover small (<5%)

1 = plentiful, but of small cover (<5%)

2 = any number of individuals covering 5-25% of area

3 = any number of individuals covering 25-50% of area

4 = any number of individuals covering 50-75% of area

5 = covering more than 75% of area

Dominant/Co-dominant species:

O = Overstorey

U = Understorey

E = Emergent

Table A-2: Rare or Threatened species potentially occurring within the PEL 650 (T&M Ecologists, 2018)

Species	Status		Location / comment
	SA[1]	Cth[2]	
Flora			
Australian Broomrape (*Orobanche cernua* var. *australiana*)	R		Record 4 km S of PEL (Mountain of Light mine), Record 15 km W of PEL (Mt Parry). Herb 15-45 cm, found in dry sandy creek beds.
Bentham's Goodenia (*Goodenia anfracta*)	R		Record 15 km N of PEL (N of Lyndhurst). Perennial herb, occurs in saline or sub-saline conditions.
Blackfruit Blue-bush (*Maireana melanocarpa*)	R		Record 8 km N of PEL (Punch's Rest), 18.5 km NE of PEL (Strzelecki Track). Perennial shrub, found on sandy rises around salt lakes.
Bushy Peppercress (*Lepidium pseudoruderale*)	R		Record (1883) 15 km W of PEL (Mt Parry). Rare annual or ephemeral herb species in semi-arid regions.
Eichler's Saltbush (*Atriplex eichleri*)	R		Record (1917) 12 km N of PEL (Lyndhurst). Small annual to 30 cm tall, usually on heavier soils and associated with drainage lines or floodplains.
Five-wing Bonefruit (*Osteocarpum pentapterum*)	E		Records 15 km W of PEL (Mt Parry). Small perennial shrub. Occurs in heavy soils subject to flooding.
Flinders Ranges Goodenia (*Goodenia saccata*)	R		Record 6.5 km SW of PEL (Aroona Dam). Shrub to 1 m. Found on stony slopes and creek beds in the Flinders Ranges.
Frankenia cupularis	R		Record 15 km N of PEL (N of Lyndhurst). Small sea-heath. Occurs in floodout areas in Lake Eyre region. Prefers saline to semi-saline soils subject to flooding.
Frankenia plicata	V	E	Predicted by EPBC database. Grows in a range of habitats, including on small hillside channels, which take the first run-off after rain (Leigh et al., 1985). Species is found in a wide range of vegetation communities that have good drainage (Neagle, 2002).
Frankenia subteres	R		Records in PEL 650 and north. Small shrub. Grows in rocky drainage lines in Lake Eyre, Flinders Ranges region.
Georgina Gidgee (*Acacia georginae*)	R		Record in PEL 650. Stocky, gnarled or spreading tree 2-7 m high with a dense crown. Most records in far north of SA (low open woodland) and Georgina Basin in Queensland.
Atriplex morrisii	V		Record 12 km N of PEL (Lyndhurst rail line). Branching annual forb. In good seasons may be found in small localised patches in various habitats including rocky hillsides.
Lee's Swainson-pea (*Swainsona leeana*)	R		Record 6.5 km SW of the PEL (Aroona Dam). A small prostrate annual or perennial to 10 cm. Found in the northern Flinders Ranges in South Australia in dry stony soil or clay-loam in tussock grassland, saltbush and mulga woodland.

Species	Status		Location / comment
	SA[1]	Cth[2]	
Murray Swainson-pea *Swainsona murrayana*	V	V	Predicted by EPBC database. Prostrate, ascending to erect perennial herb. Often grows in heavy soils, especially depressions. Grey and brown heavy clay and clay loam soils in bladder saltbush, blackbox and grassland communities.
Sandalwood (*Santalum spicatum*)	V		Record in PEL 650, 8 km W of PEL; Leigh Creek township 6 km S of PEL. Shrub or small tree in woodland or shrubland. Found throughout the arid to semi-arid zone In E of range in SA occurs in clayey soils on stony hillsides and flats in gullies, and along watercourses.
Short-stem Daisy (*Brachyscome eriogona*)	R		Record 4 km S of PEL (Mountain of Light mine). Small ephemeral herb to 25 cm occurring on sandy clay soils to cracking clays in chenopod shrublands on gibber plains or herblands in run-off or floodplain areas
Slender Bell-fruit (*Codonocarpus pyramidalis*)	E	V	Predicted by EPBC database. Record (1938) 12 km N of PEL (Lyndhurst); 24 km NW of PEL (1958). Small tree with scruffy drooping appearance and smooth grey-green bark. Occurs on sandy soils and stony rises and creek banks in the Flinders Ranges.
Wilga (*Geijera parviflora*)	R		Record at Leigh Creek township 6 km S of PEL. Shrub or small tree to 8 m. Usually occurs on areas with calcareous red clay loams, less common on alluvial soils and hillslopes with shallow soils.
Yellow Burr-daisy (*Calotis lappulacea*)	R		Record (1883) 15 km W of PEL (Mt Parry). Perennial herb or undershrub 20-50 cm. Occurs on loamy sand to clay loam red earths. Found in all mainland States.
Birds			
Australasian Darter *(Anhinga novaehollandiae)*	R		Found across most of mainland Australia. Inhabits lakes, rivers, swamps and estuaries.
Australian Painted Snipe *(Rostratula australis)*	V	E, Ma	Predicted by EPBC database. EPBC Act database predicts presence. Inhabits wetlands. No suitable habitat present at the site.
Australasian Shoveler (*Anas rhynchotis*)	R		Records in PEL 650 (retention dam). Nomadic and dispersive across SE and SW Australia. Occurs in wetlands in good years.
Banded Stilt (*Cladorhynchus leucocephalus*)	V		Record in PEL 650 (retention dam). Nomadic and often in dense flocks. Occurs in fresh and saltwater marshes and large ephemeral lakes.
Bluebonnet (*Northiella haematogaster*)	R (ssp.)		Record 14 km W of PEL (Myrtle Springs homestead) Inhabits semi-arid woodlands. Naretha Bluebonnet *N. h. narethae* (which occurs in the Nullarbor region) is listed as Rare; this subspecies would not occur here.
Blue-billed Duck (*Oxyura australis*)	R		Records in PEL 650 (retention dam) and Aroona Dam. Occupies a range of wetlands, relatively sedentary.
Blue-winged Parrot (*Neophema chrysostoma*)	V		Record 11 km E of PEL. Usually seen in grasses in a wide variety of habitats, nests in hollows in eucalypt or stump.

Species	Status		Location / comment
	SA[1]	Cth[2]	
Cattle Egret (*Ardea ibis*)	R	Ma, Mg	Predicted by EPBC database. Inhabits tropical and temperate grasslands, wooded lands and terrestrial wetland and uses shallow, open and fresh wetlands. Records in arid and semi-arid regions are rare.
Chestnut-backed Quailthrush (*Cinclosoma castanotum*)	R (ssp.)		Record 3 km SE of PEL (1900) at Woolly Bore and 19 km E (1925) at Depot Springs. Inhabits casuarina-cypress woodland, mallee woodland, sand-plain hummock grassfields. *C. c. castanotum* (which occurs in the Murray Mallee and Flinders Ranges) is listed as Rare.
Chestnut-breasted Whiteface (*Aphelocephala pectoralis*)	R		Records 12 km N of PEL (Lyndhurst), 13 km W of PEL (Myrtle Springs homestead) Inhabits stony plains.
Common Greenshank (*Tringa nebularia*)		Ma, Mg	Predicted by EPBC database. Sewveral records in the Flinders Ranges. Migratory wader. Found in a wide variety of inland wetlands and lakes and sheltered coastal habitats.
Common Sandpiper (*Actitis hypoleucos*)	R	Ma, Mg	Records in PEL 650 (retention dam). Migratory wader. Widespread in small numbers and found along all coastlines of Australia and in many areas inland.
Elegant Parrot (*Neophema elegans*)	R		Multiple records in PEL 650 (retention dam) and region surrounding the PEL. Occurs in open country and semi-arid scrublands.
Fork-tailed Swift *(Apus pacificus)*		Ma, Mg	Predicted by EPBC database. Known to use many habitat types, including coastal, arid and urban areas, migrating across broad regions of Australia.
Freckled Duck (*Stictonetta naevosa*)	V		Records in PEL 650 (retention dam) Prefers heavily vegetated permanent freshwater swamps, moving to permanent open lakes during drought. Breeds in large swamps created by floods in Bulloo and Lake Eyre Basins.
Glossy Ibis (*Plegadis falcinellus*)	R		Record in PEL 650 (retention dam). Frequents swamps and lakes throughout much of the Australian mainland.
Great Crested Grebe (*Podiceps cristatus*)	R		Records in PEL 650 (retention dam). Found on fresh or saline waters such as lakes and lagoons.
Great Egret (*Ardea alba*)		Ma, Mg	Predicted by EPBC database. Occurs in all states/territories of mainland Australia and in Tasmania. Breeding colonies in Channel Country (NE SA and SW Qld).
Grey Wagtail (*Motacilla cinerea*)		Ma, Mg	Predicted by EPBC database. Included in international agreements but extremely uncommon migrant. Strong association with water, particularly rocky substrates along water courses but also lakes and marshes.
Hooded Robin (*Melanodryas cucullata*)	R (ssp.)		Record 3 km SW Leigh Creek. Found in Eucalypt woodland and mallee and Acacia shrubland. *M. c. cucullata* (which occurs in south-east SA to Port Augusta) is listed as Rare.

Species	Status		Location / comment
	SA[1]	Cth[2]	
Musk Duck (*Biziura lobata*)	R		Records in PEL 650 (retention dam). Found in permanent swamps with dense vegetation from north-west Australia through the south and east to southern Queensland.
Night Parrot (*Pezoporus occidentalis*)	E	E	Predicted by EPBC database. Thought to inhabit *Triodia* grasslands and samphire and chenopod shrublands in arid and semi-arid Australia. Current distribution is possibly limited to western Queensland and the Pilbara but is poorly understood due to difficulty in detection and very limited numbers of sightings.
Painted Finch (*Emblema pictum*)	R		Record S of the PEL (1940). Occurs on spinifex covered stony hills and rocky landscapes across Northern and Central Australia.
Peregrine Falcon (*Falco peregrinus*)	R		Record in PEL 650 (retention dam). Inland and coastal areas, with a preference for heavily timbered and rugged mountainous country. Most of Australia, except central Australia, western SA and Tasmania.
Plains-wanderer (*Pedionomus torquatus*)	E	CE	Predicted by EPBC database. Inhabits sparse, treeless, lowland native grasslands with around 50% bare ground and occasionally in chenopod shrublands (Harrington et al. 1988).
Oriental Plover (*Charadrius veredus*)		Ma, Mg	Predicted by EPBC database. Known to occupy dry plains and semi-arid regions, highly mobile, migrating annually between Mongolia, China, and Australia. Prefers to forage among short grass or on hard stony bare ground (McCrie 1984, Close 1982).
Rainbow Bee-eater *(Merops ornatus)*		Ma, Mg	Predicted by EPBC database. Common migrant from September to April in woodland and timbered plains throughout Australia. Nests in sand banks or sloping sandy soil.
Restless Flycatcher (*Myiagra inquieta*)	R		Record W of the PEL (4 Mile Bore). Inhabits open forests and woodlands. Migrant or nomadic in much of its range.
Slender-billed Thornbill (*Acanthiza iredalei*)	R		Records in PEL 650 (1900, 1910). Inhabits chenopod and samphire shrublands and saline flats around salt lakes.
Thick-billed Grasswren (*Amytornis modestus*)		V	Predicted by EPBC database. Distributed in Northern Territory and catchments of Lake Frome and western Lake Eyre Basin in South Australia. Preferred habitat is chenopod shrublands dominated by Atriplex spp. and Maireana spp., generally on gibber or other hard soils.
Yellow Wagtail *(Motacilla flava)*		Ma, Mg	Predicted by EPBC database. Included in international agreements but extremely uncommon migrant. Mostly well-watered open grasslands and the fringes of wetlands.
Mammals			
Plains Rat (*Pseudomys australis*)	V	V	Predicted by EPBC database. Generally associated with low lying patches of deep cracking clay soils characteristic of drainage depressions and gilgais in stony plains and gentle slopes supporting sparse chenopod shrublands and other ephemeral vegetation after rain.

Species	Status		Location / comment
	SA[1]	Cth[2]	
Yellow-footed Rock-wallaby (*Petrogale xanthopus xanthopus*)	V	V	Predicted by EPBC database. Inhabits rocky outcrops in semi-arid country, ranging from sandstones, limestones and conglomerates in the Flinders Ranges, to granites in the Gawler Ranges and Olary Hills (Copley & Alexander 1997)

1. *South Australian National Parks and Wildlife Act 1972* status: Endangered (E); Vulnerable (V); Rare (R). Subspecies (ssp) indicates that a subspecies is listed under the NPW Act but database records do not identify which subspecies was recorded
2. *Environment Protection and Biodiversity Conservation Act 1999* status: Critically Endangered (CE), Endangered (E); Vulnerable (V); Rare (R), Listed Marine (M), Listed Migratory (Mg)

Database records within approximately 25 km of the PEL have been included in this table.

Appendix B: Summary of Government Agency Submissions and Responses

#	Agency	EIR/SEO Reference	Topic/ Issue	Issue/Comment Raised in Submission	Response
	EPA				
1	EPA	EIR Section 3.2	Drilling muds	The EIR states "Drilling muds used will be water-based and biodegradable and the sump will not be lined unless the well site is in an area where very shallow aquifers are present". Drilling muds contain a variety of additives each having a different purpose (e.g. biocidal, pH adjustment, viscosity control, corrosion inhibition). The drilling mud is to be non-hazardous to the environment and therefore the toxicity and concentrations must be considered to determine if the lining of the sump is required.	This is noted and the sentence has been revised to reflect the same. The section now reads: Drilling muds used will be water-based, biodegradable and non-hazardous to the environment. The sump will not be lined unless drilling is likely to occur in an area where very shallow aquifers are present and/or the toxicity and concentrations of the drilling mud present a risk to any very shallow aquifers.
2	EPA	EIR Section 5.23, 5.32 & Table 5.1	Site contamination to soil or underlying groundwater	It is the EPA's expectation that if LCK undertakes an activity which has the potential to cause site contamination to soil or underlying groundwater (as described in sections 5.23, 5.32 & Table 5.1) it should be assessed in accordance with the guidance provided in the National Environment Protection (Assessment of Site Contamination) Measure (1999) and the current South Australian Guidelines for the Assessment & Remediation of Site Contamination (2018).	The sections in the EIR should be 5.2.3, 5.3.2 and note 5.23, 5.32. The comments have been noted and included in sections 5.2.3, 5.3.2 and Table 5.1.
3	EPA	EIR Section 6.5 Reporting	Reporting	If site contamination has occurred (as described under section 5B of the SA EP Act 1993) as a result of an incident at the site (regardless of its significance), it is potentially notifiable under Section 83 or S83A of the EP Act 1993. This is in addition to the reporting requirements identified in section 6.5 of the EIR.	This is noted and has been included in section 6.5 of the EIR.
4	EPA	EIR Section 4.5	Existing site contamination	If in the course of activities LCK identifies a change in the nature and extent of site, LCK will provide a section 83 or section 83A notification to the Environmental Protection Agency (EPA) as soon as reasonably practical in accordance with EPA legislation & guidelines.	This is noted and has been included in section 4.5 of the EIR.
5	EPA	EIR Section 4.7.1.3	Water Quality	In "Table 4-4: Water quality categories" LCK refer to the EPA website fact page on salinity. The EPA does not see the value in this table and considers a more appropriate approach would be for LCK to refer to the Environment Protection (Water Quality) Policy 2015, Schedule 1 Section 3 'Environmental values of particular waters' as the values within the policy would be used for EPA regulation.	This is noted and the table has been updated to reflect Schedule 1 Section 3 'Environmental values of particular waters' as the values within the policy used for EPA regulation.
6	EPA	EIR Section 3.2.1	Open hole wire logging	The EPA reminds LCK that wireline operators using radiation sources are required to hold a licence issued under the South Australian Radiation Protection and Control Act 1982 when operating in South Australia. The operators must have a radiation management program and contingency plans for management and reporting of incidents like stuck logging tools containing radiation sources. It is noted that the EIR and SEO list the (unlikely) risk that a radioactive tool may fall downhole and cannot be retrieved. Please note that in the case where it may need to be abandoned down hole, the EPA (Radiation Protection Branch – contact (08) 8463 7826) is one of the relevant authorities who will need to provide approval for the abandonment of any radioactive tool.	This is noted. A footnote has been added to indicate that 'Wireline operators using radiation sources are required to hold a licence issued under the South Australian Radiation Protection and Control Act 1982 when operating in South Australia. The Wireline Operators must have a radiation management program and contingency plans for management and reporting of incidents like stuck logging tools containing radiation sources.'. The last sentence in the second paragraph reads 'One of the relevant authorities who will be contacted to provide approval for the abandonment of any radioactive tool is the Radiation Protection Branch of the EPA'.
7	EPA	SEO	Soil disturbance and contamination	The EPA has considered the environmental objectives detailed in this document and supports the actions/comments on how the objectives can be achieved. In assessing the risk of environmental harm, the EPA has focused on three (3) key objectives being:	These have been noted.

#	Agency	EIR/SEO Reference	Topic/ Issue	Issue/Comment Raised in Submission	Response
			Drainage patterns and surface water Loss of aquifer pressure and avoid aquifer contamination EPA Waste Hierarchy model	Objective 2 - Minimise soil disturbance and avoid contamination to soil. Objective 3 - Minimise disturbance including contamination to drainage patterns and surface waters; Objective 4 – Minimise loss of aquifer pressure and avoid aquifer contamination. Fuel, oil and chemical storage and handling referred to in Objectives 2 and 3 have been adequately addressed through the description of appropriate containment measures, refuelling measures and spill response. The reference to the EPA Waste Hierarchy model (avoid, reduce, reuse recycle, recover, treat, dispose) has been noted in Objective 9.	
	SA Health				
8	SA Health	EIR	Acts and Regulations	Table 2, can remove Public Health Act 1987 as this does not exist - has been superseded by the Public Health Act 2011 (this is listed in Table 2-1 also) Good reference to our legislation in section 3.1.4 and in Table 5.1.	This is noted. Reference to the Public Health Act 1987 has been deleted. Reference to the legislation in section 3.1.4 and Table 5.1 has been noted.
9	SA Health	SEO	Acts and Regulations	Good reference to our legislation in Objective 9. Good mention that any wastewater (sewage) spills are a reportable incident to SA Health (Table 2).	These have been noted.
	AAR				
10	AAR	EIR and SEO	Comments from draft EIR	AAR acknowledges that all the comments offered in relation to the EIR (November 2019) have been addressed and incorporated into LCE's revised EIR document.	This is noted.
	DEM				
11	DEM	EIR Section 1.2	Fracture simulation	1.2, pg 11 – mentions fracture stimulation is covered in the EIR. There is insufficient information provided for these activities in the EIR document, and largely fracture stimulation is not understood to be part of the proposed activities. Hence, recommend removal of this statement. Clarification to include formation strength and permeability testing may be more appropriate here as opposed to fracture stimulation.	This is noted. This statement has been removed and clarification on formation strength and permeability testing is made in a new section 3.2.2.
12	DEM	EIR Section 3.2	Drilling activities	3.2, pg 18 – activities are listed on pg 19, whereas not much information is included around all the activities in the list e.g. packer testing, airlift testing/ drawdown testing, well integrity testing, etc. Worth elaborating on these activities in additional detail in subsequent sections.	This is noted. More information has been provided in subsequent sections.
13	DEM	EIR Section 3.2.1	Radioactive sources	3.2.1, second paragraph, pg 19 – "every effort will be made to manage the fishing operations to recover the tool and radioactive source". DEM expects every reasonable effort will be made to retrieve the radioactive source/s – may be worth clarifying wording here.	This is noted and the wording has been amended
14	DEM	EIR Section 3.2.2	Cementing design and assurance process	3.2.2, pg 20 – recommend including some information on the cementing design and assurance process. Some commentary on barrier verifications (or similar) would be beneficial here, given cement is a critical barrier.	This is noted. More information has been provided on cementing design and barrier verification.
15	DEM	EIR Section 3.2.2	Wellhead design	3.2.2, last paragraph, pg 20 – consider rewording to clarify: "wellhead to be designed for the conditions anticipated and the objective of the drillhole" or similar. Also consider rewording "The wellhead designs are completed by a specialist engineering company, depending on the well type and its objective" or similar. Need to clarify that	This is noted and the sentence has been amended.

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				each well may be designed differently and may have different requirements based on its purpose with specialist engineering company input.	
16	DEM	EIR Section 3.2.3	Validation of cement as a permanent barrier	3.2.3, pg 20 – consider discussing validation of the cement as a permanent barrier through design, testing and on site verification. Consider mentioning that relevant standards will be adhered to.	This is noted. More information has been added.
17	DEM	EIR Section 4.7.3	Impact to upper series over burden	4.7.3 (pg 50) discusses the upper series overburden as the only aquifers in the Leigh Creek coal measures however impacts to this aquifer has not been considered as part of section 5.2 (pg 62) in the Environmental Impact Assessment.	This is noted. More information has been added on what barriers will be implemented to protect any potential aquifers in the Upper Series Coal Measures.
18	DEM	EIR Section 5.2.1	Drilling construction standards	5.2.1, pg 68 – "all drilling will be undertaken according to minimum construction standards". Would be good to clarify which ones as there are a variety of well types/ objectives proposed to be drilled under this EIR/SEO.	This is noted. Section has been updated.
19	DEM	EIR Section 5.2.4	Groundwater recirculation during drilling	5.2.4, pg 69 – "During drilling, all groundwater will be recirculated back into the ground". Not clear what this statement means – wells are generally drilled overbalanced with drilling fluid and hence intention is for no well products to be produced during drilling operations. Could relate to "well testing" or "well development", but good to clarify.	This is noted. This section has been updated.
20	DEM	EIR Table 4-7	Updating land owners following transfer of crown lease	Table 4-7, pg 63 - Land Owners for PEL 650 should be updated following the transfer of the perpetual crown leases to the Minister for Energy and Mining.	This is noted.
21	DEM	EIR Table 5-1	Risk assessment to subsurface impacts	Table 5-1, pg 82 – no risk assessment of any subsurface impacts e.g. cultural, well integrity, aquifers, etc. Risk assessment should inform SEO objectives, but unclear how this has occurred.	This is noted.
22	DEM	EIR	Errata	1) 3.1, last paragraph, pg 16 – "which is will result in less disturbance…." 2) 3.1.2, second paragraph, pg 18 – should be "road construction material *if* suitable material is not available from existing sources 3) 3.2.1, second paragraph, pg 19 – "…density and neutron logging tools and they *are*(?) subject to strict licensing, usage,…." 4) 3.2.1, second paragraph, pg 19 – "In the unlikely event that the radioactive source is not *recoverable*, then the relevant……" 5) 5.2.5, first paragraph, pg 69 – "PE L650" should be *PEL 650*	These have been noted and all revisions have been made.
23	DEM	SEO Table 1 Objective 2	Minimizing soil disturbance and contamination of soil	Objective 2 – Assessment criteria states 'Any spill of chemicals or fuel to land is either immediately contained and removed or assessed in accordance with NEPM guidelines and remediated (where required) in a timely manner. This should read as follows: Any spill of chemicals or fuel to land is either immediately contained and removed or assessed in accordance with NEPM guidelines and remediated (where required) **in accordance with relevant guidelines** in a timely manner.	This is noted and the sentence has been amended.

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24	DEM	SEO Table 1 Objective 2	Minimizing soil disturbance and contamination of soil	Objective 2 – Suggest addition of the following assessment criteria: a. No overflow, spill or seepage of completions fluids from temporary holding ponds b. Solid wastes and foreign material to remain contained onsite within the well lease/operational area boundaries until disposed of at an EPA licensed facility, with the exception of drilling and completions benign solids to be disposed of in drilling sump.	This is noted and the additions have been made.
25	DEM	SEO Objective 4	Minimise loss of aquifer pressure and avoid aquifer contamination	Objective 4 – a. should use words such as “barrier verification” for Guide To. b. should also clarify only “overbalanced” mud drilling will be undertaken due to no plan for well control equipment. c. sufficient contingency mud weighting stocks should be kept on site. d. relevant EPA and DEM approval to be sought if radioactive source becomes irretrievably stuck required.	This is noted The relevant section has been updated.
26	DEM	SEO	Reportable incidents	Table 2, pg 19 – superscript 12 not applicable to these operations: “12 An area assigned during a Hazard and Operability Process (HAZOP) study as a hazardous area for the purpose of gas venting, and designed as such, is considered to be an area specifically designed to contain a gas escape.”	This is noted and the reference has been removed.