

ENVIRONMENTAL IMPACT REPORT



HOT ROCKS LOGISTICS SUPPORT HUB, COOPER
BASIN SA

MARCH 2022

Revision History

Revision	Date	Prepared By	Reviewed By	Description
00	09/07/2021	Natalie Jongebloed	Steve Fermio	Draft
01	09/09/2021	Natalie Jongebloed	Steve Fermio	Amended to reflect comments by DEM
02	25/11/2021	Steve Fermio	Steve Fermio	Amended to include consultation details
03	18/03/2022	Steve Fermio	Derek Low	Amended to include and respond to agency consultation feedback

Authorisation

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Date	18/03/2022	Date	18/03/2022

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1. INTRODUCTION

ReNu Energy Limited (formerly Geodynamics Limited) has on behalf of the Geothermal Retention Licence 3 (GRL3) licensees, been maintaining infrastructure associated with the now abandoned 1MW Geothermal Power Plant (Power Plant) within the boundaries of GRL3 near Innamincka in the South Australian Cooper Basin, whilst finalising the abandonment of the two remaining geothermal wells. This abandonment was completed in April 2021 and the licensees are intending to surrender the GRL3 permit during the 2021/22 financial year.

ReNu Energy Limited is the Operator of GRL3. As a result of the GRL3 licensees no longer requiring the infrastructure, the Hot Rock Joint Venture (including Precise Outcomes) is proposing to take control of a portion of GRL3 known as “Area A” to develop and operate its Hot Rock Logistics Support Hub (HRLSH). The HRLSH will cater specifically to the needs of the Petroleum and Geothermal Energy industry by providing camp and accommodation services, holding/storage/laydown yard facilities, fuel supply and vehicle maintenance services.

The operational activities will be appropriately covered by a Special Facilities Licence, as provided for under the South Australian *Petroleum and Geothermal Energy Act 2000* (PGE Act). Precise Outcomes (Precise) applied for and was granted the Special Facilities Licence 13 (SFL 13) on the 10th April 2017.

In accordance with Section 97 of the PGE Act, Licensees are required to prepare an Environmental Impact Report (EIR) for proposed regulated activities. The purpose of this EIR is to evaluate the potential environmental impacts of the proposed HRLSH.

Under Regulation 10 of the *Petroleum and Geothermal Energy Regulations 2013* the EIR is required to provide the following information:

- a description of the activities to be carried out;
- a description of the specific features of the natural, social/cultural and economic aspects of the environment which may be affected by the activities;
- a description of the actual and potential events associated with the activities that could pose a threat to the various aspects of the environment (as per definition of environment provided in Section 4 of the *Petroleum and Geothermal Energy Act 2000*) including the likelihood of the events and the level of certainty in their prediction;
- an assessment of the potential consequences of the above defined events on the various aspects of the environment;
- detailed information on the extent to which the above potential consequences can be managed including information on their duration, size and scope; and
- information on any consultation undertaken with the relevant landowner or occupier, relevant government agencies or other interested groups or individuals.

2. PETROLEUM AND GEOTHERMAL ENERGY ACT APPROVALS PROCESS

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

The Department for Energy and Mining - Energy Resources (DEM) is the government body responsible for the regulation of production and processing operations.

This EIR has been compiled in accordance with the Petroleum and Geothermal Energy Act 2000 and the Petroleum and Geothermal Energy Regulations 2013 (the Act and Regulations), and in consultation with DEM.

2.1 Stage 1 – Licensing

Stage 1 requires a licence authorising the licensee to carry out the specific activity to which the licence relates.

The Act and Regulations form the primary legislation governing onshore petroleum exploration and production in South Australia. This legislation is administered by DEM.

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

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

A reference in the Act to petroleum or another regulated substance extends to a mixture of substances of which petroleum or other relevant substance is a constituent part.

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

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

Regulated activities, as defined in Section 10 of the Act, are:

- exploration for petroleum or another regulated resource
- operations to establish the nature and extent of a discovery of petroleum or another regulated resource, and to establish the commercial feasibility of production and the appropriate production techniques
- production of petroleum or another regulated substance utilisation of a natural reservoir to store petroleum or another regulated substance (including in a case where a trace element naturally occurs with the petroleum or other regulated substance)
- production of geothermal energy

- construction of a transmission pipeline for carrying petroleum or another regulated substance
- operation of a transmission pipeline for carrying petroleum or another regulated substance.

A licence to operate and maintain a support base in respect of the SFL area has been granted to Precise (SFL13).

2.2 Stage 2 - Environmental assessment and approval of Environmental Objectives

2.2.1 Environmental Impact Report

In accordance with Section 97 of the Petroleum and Geothermal Energy Act 2000, Licensees are required to prepare an EIR for proposed regulated activities. This document addresses the potential threats and risks on the environment, and outlines the extent to which these threats are likely and manageable.

Under Regulation 10 of the Petroleum and Geothermal Energy Regulations 2013 the EIR is required to provide the following information:

- a description of the activities to be carried out;
- a description of the specific features of the natural, social/cultural and economic aspects of the environment which may be affected by the activities;
- a description of the actual and potential events associated with the activities that could pose a threat to the various aspects of the environment (as per definition of environment provided in Section 4 of the Petroleum and Geothermal Energy Act 2000) including the likelihood of the events and the level of certainty in their prediction;
- an assessment of the potential consequences of the above defined events on the various aspects of the environment;
- detailed information on the extent to which the above potential consequences can be managed including information on their duration, size and scope; and
- information on any consultation undertaken with the relevant landowner or occupier, relevant government agencies or other interested groups or individuals.

The information and material provided by the EIR must:

- be balanced, objective and concise;
- state any limitations that apply, or should apply, to the use of the information and material;
- identify any area or issue in relation to which there is a significant lack of relevant information or a significant degree of uncertainty;
- identify the sensitivity to change of any assumption that has been made and any significant risks that may arise if an assumption is later found to be incorrect; and
- be presented in a way that allows a person assessing the information or material to understand how conclusions have been reached and allows the information or material to be used to make an informed decision on the level of environmental impact of a particular activity without the need to obtain additional technical advice.

2.2.2 Statement of Environmental Objectives

A Statement of Environmental Objectives (SEO) is developed through an open, consultative process, based on information provided in the EIR. A SEO may relate to either a specific activity carried out at a specific location; or a particular activity type (e.g., drilling, seismic activities, the construction and operations of facilities and pipelines) carried out within a specific region or land system.

For the purposes of the Petroleum and Geothermal Energy Act 2000 the definition of environment includes the natural, social, cultural and economic aspects of the area, locality or region.

A SEO for a regulated activity must state the environmental objectives to be achieved in carrying out the specified activities, as well as the assessment criteria used to assess whether the objectives have been achieved by the licensee.

A SEO must include objectives that relate to:

- construction activities;
- operational activities;
- emergency response and management;
- rehabilitation in cases involving a serious or reportable incident under Section 85 of the Petroleum and Geothermal Energy Act 2000;
- decommissioning, abandonment and rehabilitation; and
- dealing with the consequences of events associated with the relevant activities on the various aspects of the environment.

A SEO must also include conditions and requirements for achieving the stated objectives, such as incident reporting requirements. For some objectives, which cannot readily be measured through quantitative assessment, particularly in relation to land and vegetation disturbances such as the restoration of well sites and seismic lines, techniques such as Goal Attainment Scaling have been adopted to provide such measurement.

These features of a SEO provide transparency to stakeholders on what is required of the licensee in terms of its environmental performance.

It is a requirement, under Regulation 14 of The *Petroleum and Geothermal Energy Act 2000*, that a SEO will be reviewed at least once in every 5 years. If this review identifies that a revision of the document is required, the document will be revised by the Minister (or cause the revision to be undertaken by the licensee) and then the statement is submitted for consideration under the *Petroleum and Geothermal Energy Act 2000*.

The performance of the licensee against the SEO will be publicly disclosed annually on the Environment Register, in addition to the provision of EIRs, SEO and details of the Minister's determination of the level of impact of all proposals.

2.2.3 Impact classification

On the basis of the information provided in the EIR and in accordance with Section 98 of the Petroleum and Geothermal Energy Act 2000, the Minister, using a set of publicly developed and disclosed criteria, must classify the level of impact of any proposed activity.

The Criteria for Classifying the Level of Environmental Impact of Regulated Activities outlines the criteria upon which the level of impact of a regulated activity will be assessed and subsequently classified. Guidelines for the application of these criteria are also included.

The classification will either be low, medium or high and will be made in consultation with other relevant Government departments.

These consultation protocols have been established under various administrative agreements between the Energy Resources Division and these departments. Copies of administrative arrangements currently in place are available.

The requirement for a period of public consultation is determined by the classified level of impact of the proposed activity on the basis of a set of publicly developed and disclosed criteria for making such a determination.

Low Impact Activity Assessment Process

The Department undertakes consultation internally with Government agencies including the Department of Environment and Water, the Environment Protection Authority and, if relevant, the Department of Planning, Transport and Infrastructure, and SafeWork SA. Government consultation protocols and time frames are determined through administrative arrangements between the Energy Resources Division and the specific agency.

Medium Impact Activity Assessment Process

Where an activity is classified as medium impact it will follow the public assessment process described under section 101 in the Petroleum and Geothermal Energy Act 2000. The Energy Resources Division seeks community comment through a public consultation period, which is required to run for at least 30 business days. Additionally, the Energy Resources Division may invite submissions from organisations and/or persons who have particular interest in the area or region which is likely to be affected by the proposed activity.

All submissions on the EIR and draft SEO made to the Energy Resources Division are kept available for public inspection on the Environment Register. The proponent is then required to address the issues raised by public submission/s and revise the EIR and draft SEO accordingly, where required.

The Department reviews the revised versions of the EIR and SEO and if the EIR and SEO have been amended substantially, as a result of the public submissions, the Energy Resources Division will require the consultation process to be repeated.

High Impact Activity Assessment Process

If a project is assessed as having a high environmental impact, the proposal is referred to the Minister responsible for the Planning, Development and Infrastructure Act 2016 for an Environment Impact Assessment under Part 12 of that Planning, Development and Infrastructure Act 2016.

2.2.4 Consultation

A proponent must consult with all relevant stakeholders during the project planning stage. The extent of consultation undertaken during this phase is a critical factor considered by the Energy Resources Division in determining the environmental impact classification.

The Energy Resources Division encourages the use of the Ministerial Council on Mineral and Petroleum Resources (MCMPR) endorsed guide. This document sets out the key principles for effective liaison between the resource sector, the community and various stakeholders.

The level of consultation undertaken by the Department during the assessment and approval process for a proposed activity is determined by the impact classification. In the instance where an activity involves a Coal Seam Gas project, the project will be referred to the Independent Expert Scientific Committee to be part of the consultation process to align with the National Partnership Agreement (NPA) and SA protocol for IESC referral process.

2.3 Stage 3 - Activity notification and approval

In accordance with Regulations 18 and 19, licensees are required to notify, and where relevant, seek approval from the Minister through the Energy Resources Division prior to commencing any regulated activity within a licence area. The activity notification requirements for activities classified as requiring low level official surveillance and those classified as requiring high level official surveillance differ by the amount of information provided and the time frame it is provided in.

As part of its assessment, the Energy Resources Division will also advise licensees whether additional approvals from co-regulatory agencies are required in relation to specific activities. Notably, the Department of Environment and Water has provided a checklist in relation to its regulatory matters for licensee's to use when planning activities.

Low level official surveillance activities (Regulation 18)

An activity notification for an activity classified as requiring low level official surveillance must, pursuant to the requirements of Regulation 18, be submitted to the Energy Resources Division at least 21 days before the proposed commencement date of the activity. As long as no landowner objections are received by the Minister, and the application is compliant, activities can commence at the end of the 21-day period.

This notification must be accompanied by information to satisfy Regulation 20.

High level official surveillance activities (Regulation 19)

An activity notification including application for the Minister's approval, pursuant to the requirements stipulated under Regulation 19 for all activities classified as requiring high level official surveillance, must be provided to the Energy Resources Division for assessment and approval at least 35 days before the proposed commencement date of the activity in question.

This notification must be accompanied by information to satisfy Regulation 20.

Sub regulation 19(2)(a) specifies that activity notifications for high level official surveillance activities must also include detailed information on the licensee's proposals in respect of the operator assessment factors, outlined in Regulation 16. ERD have prepared operator assessment factor reporting guidelines for high-level official surveillance activity notifications to aid licensees in satisfying these requirements.

High level official surveillance activities require Ministerial approval prior to commencement.

2.3.1 Detailed activity information (Regulation 20)

Activity notifications for all activities whether classified as requiring high or low level official surveillance, are required to include or be accompanied by information and material specific to the proposed activity pursuant to various sections of the *Petroleum and Geothermal Energy Act*

2000 and associated regulations. The Energy Resources Division have provided guidance on the requirements for activity notifications in the Activity Notification Checklist.

Of particular note, with respect to environmental reporting obligations under sub regulation 20(1)(g), an assessment is required to be provided by the licensee determining whether the proposed activity is covered by an existing and approved SEO, in addition to detailing how the licensee will ensure that the proposed activity will satisfy the respective SEO requirements.

2.3.2 Notice of entry

In addition to the stakeholder consultation requirements in the preparation and approval of the SEO, licensees are obliged under Part 10 of the *Petroleum and Geothermal Energy Act 2000* to give notices of entry to all landowners 21 days prior to entering and commencing any activity on any land.

In accordance with the requirements of Regulation 22 of the *Petroleum and Geothermal Energy Regulations 2013* the notice of entry must contain:

- a detailed description of what will be undertaken
- sufficient information to enable the landowner to reach an informed decision about the impacts and potential impacts the activities will or may have on the land
- sufficient information on the use and/or consequential loss of use of the land by the landowner resulting from the activities.

Furthermore, Part 10 of the *Petroleum and Geothermal Energy Act 2000* provides landowners with the right to object to entry within 14 days and to seek any compensation for loss of use or damage or potential loss of use or damage to the land.

3. PREVIOUS APPROVALS RELEVANT TO THE SITE

Geodynamics Limited originally operated under a SEO for *1 MW Geothermal Power Plant at Innamincka* which was originally prepared in August 2008 by Parsons Brinkerhoff. A SEO is developed through an open, consultative process, based on information provided in the EIR.

The activities covered by the 2008 EIR/SEO included the design, construction and use of a:

- multiple use building incorporating a:
 - 1MW pilot power generation plant using the Habanero 1 and 3 wells (including a high pressure/temperature pipeline connecting the Habanero 3 well to the plant)
 - visitor centre; and
 - workshop
- warehouse, proposed to be located between the Habanero 1 and 3 wells
- wastewater treatment system
- site access located on the existing site footprint; and
- power transmission line from the 1MW Plant to the Innamincka township.

The 2008 EIR/SEO was superseded by a revised EIR and SEO (*EIR/SEO for Operation of 1 MW Geothermal Power Plant at Innamincka*) prepared in June 2014 by WolfPeak. The 2014 revised SEO covered the ongoing operation, maintenance and decommissioning of the Geothermal Power Plant and all associated infrastructure.

4. SCOPE

This EIR covers Precise Outcomes proposed development and operation of a HRLSH catering specifically and strictly to the needs of the petroleum and geothermal industry over the next 5 years. This will involve construction of camp facilities and provision of accommodation services, holding/storage/laydown yard facilities, fuel supply and vehicle maintenance services. These activities are appropriately covered by a Special Facilities Licence, as provided for under the PGE Act. The activities will be undertaken within the SFL 13 boundary and predominantly confined to operational and pre-disturbed areas associated with previous activities described in section 2.

This EIR has drawn on information presented in previous documents as described in section 3 and has been amended where relevant to reflect the proposed activities.

5. LOCATION AND SITE LAYOUT

Precise Outcomes intend to construct a 20-person camp, as shown in Figure 3 and 4. The HRLSH activities will be undertaken within the existing Visitors Centre / Workshop building of the SFL 13 boundary.

The Hot Rocks Logistics Support Hub (HRLSH) will cater specifically to the needs of the Petroleum and Geothermal Energy industry, the activities it will undertake on the site will include logistics services, storage of materials, plant and equipment in laydown areas, as well as vehicle repairs, accommodation for industry staff and maintenance in workshop areas. An outline of other key activities undertaken to operate the site are included in Table 1.

It is not anticipated that during the operation of the HRLSH that more than 20 employees will access the site at any one time. If more employees are required, a new EIR and SEO will be prepared, to assess the environmental impacts of the change in operations.

Key details of the HRLSH are provided in Table 1 below.

Table 1 Key characteristics of the project

Item	Description
Project location	12 km south-west of Innamincka by Dillons Highway, 7km in a straight line, South Australia
Licences	SFL 13
Operating hours	Up to 24 hours per day, 7 days per week
Power sources	Diesel generators & solar (when available)
Potable water source	Darby's Bore
Accommodation	On site camp
Employees	Up to 20 including the site manager plus camp/ trade support staff

<p>Key ancillary activities and facilities</p>	<ul style="list-style-type: none"> • Logistics hub operation including camp construction • commissioning • laydown yards and workshop facilities • fuel and chemical deliveries and storage • fuel supply • potable water treatment and supply • solid waste storage and management • wastewater effluent treatment and disposal • workforce and accommodation; • decommissioning; and • ongoing site rehabilitation activities.
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The regional location of the proposed camp and SFL 13 boundaries in the Cooper Basin are shown in Figure 2 below. The area west of Dillons Highway is also proposed for use as a laydown area, no new buildings are proposed. Darby’s Bore 2 will be accessed using the existing tracks, the existing tracks to Darby’s Bore 2 will be used by others including Beach Energy, SA Roads, Department for Infrastructure and Transport South Australia (DIT) and ReNu. A new EIR will be developed for any other areas required for use. The additional use of land within the SFL is dependent on the needs of industry.

The HRLSH is situated within the Innamincka Regional Reserve in northern South Australia, 12.3km by road and about 7km directly south of the town of Innamincka. The southern boundary of the Coongie Lakes Ramsar Wetland area is located 2.5km northwest of the site, the approximate location is shown in Figure 1.

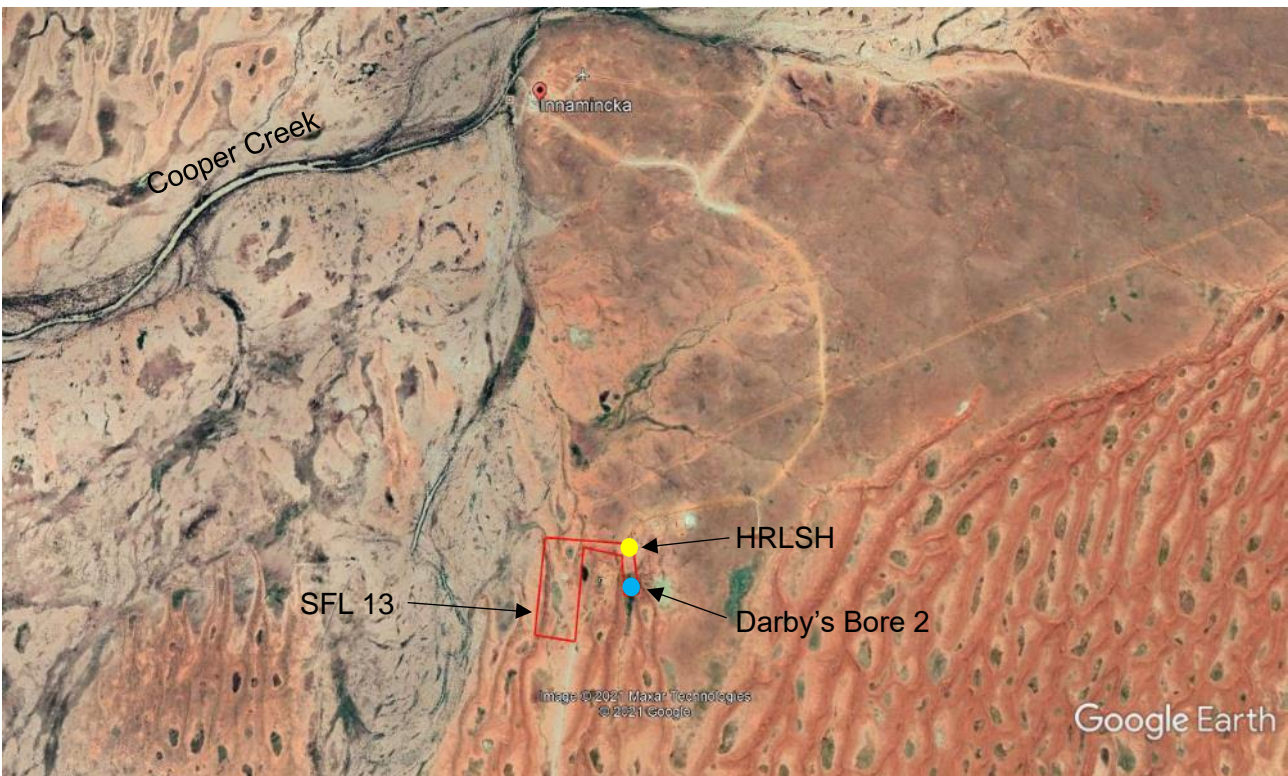


Figure 1 Location of the proposed HRLSH (Google, 2021)



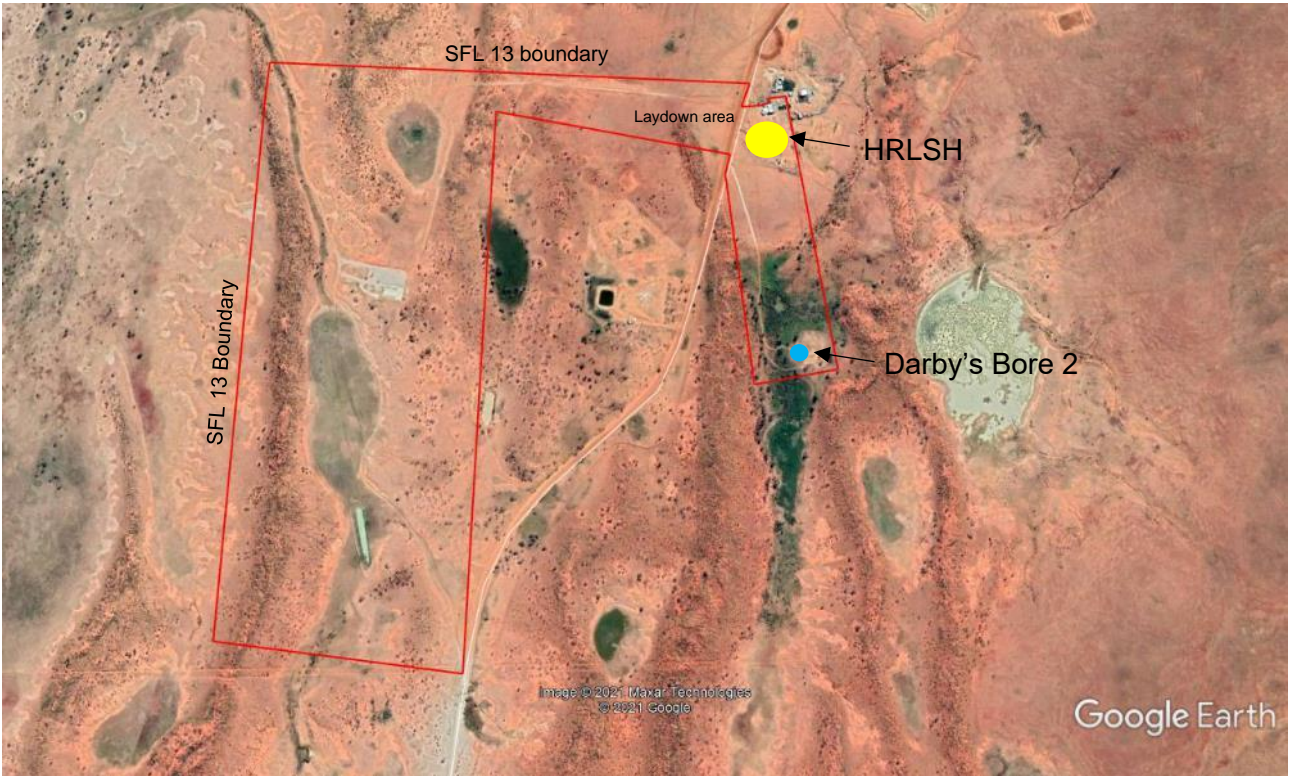


Figure 2 SFL 13 boundary (Google Earth, 2021)

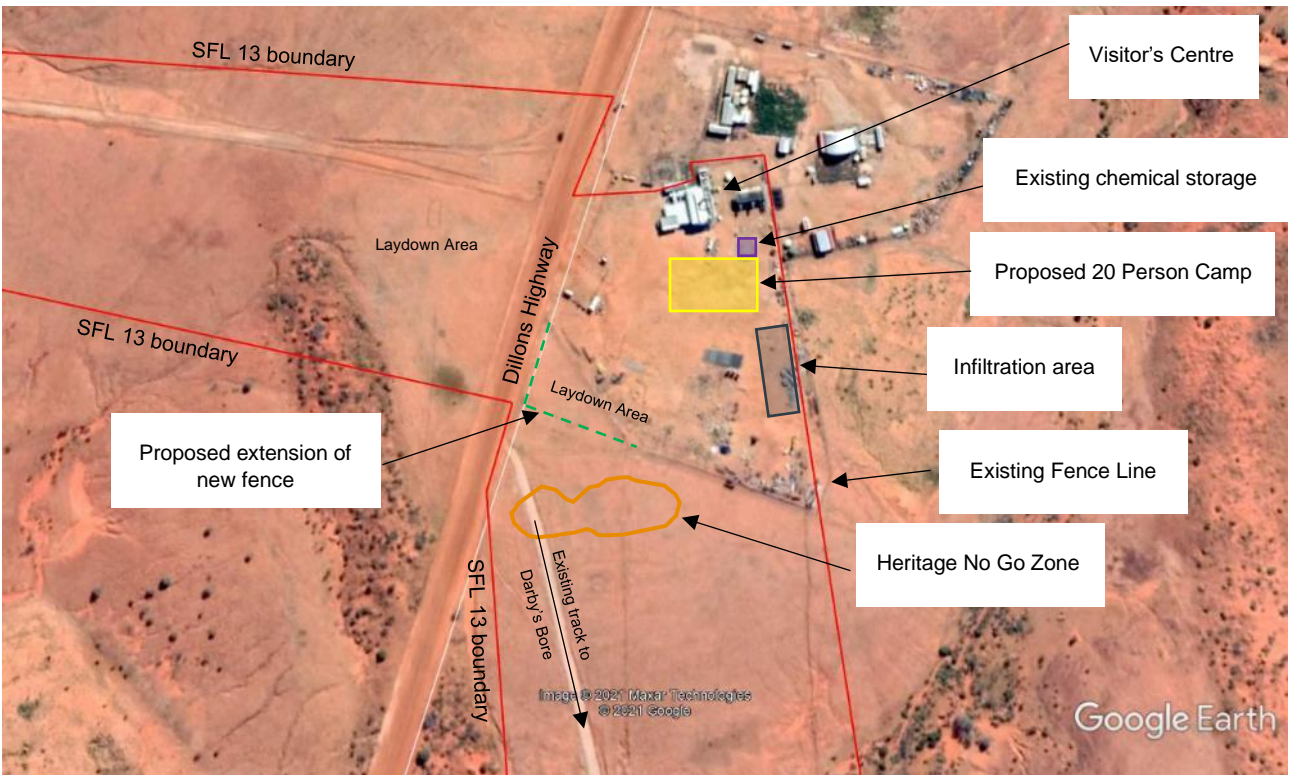


Figure 3 Indicative HRLSH 20 Person Camp, SFL 13 boundary and Heritage No Go Zone (Google Earth, 2020)

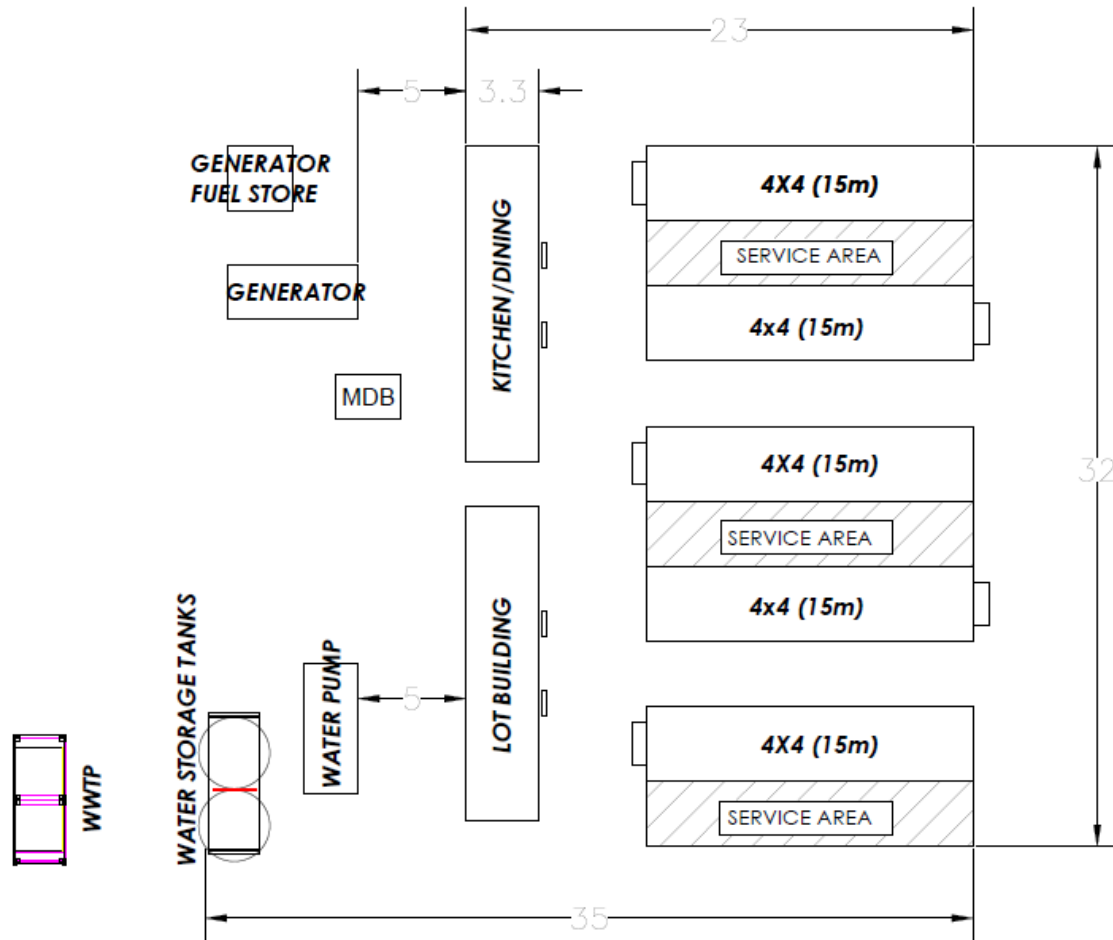


Figure 4 HRLSH indicative site layout - 20-person camp

6. DESCRIPTION OF ACTIVITIES

6.1 Existing Buildings

Precise propose to utilise the existing visitor's centre which includes offices, workshop, and a chemical storage area. The visitor's centre will be used as it was previously, an office, workshop for repairs and chemical storage area. The location of the visitor's centre is shown in Figure 3.

6.2 Installation, construction and operation of the new proposed camp

Initially, the HRLSH will generally involve up to 20 people, who will reside in the camp area shown in Figure 3 and 4. The proposed camp will include service areas, kitchen/dining, water storage tanks, generator fuel store, and laydown area.

The amount of people involved in the operation of the camp will cater specifically to the needs of industry but will not be more than 20 people.

6.3 Wastewater Management

Wastewater effluent from existing site amenities and office facilities will be treated on-site using the existing septic system which has been designed, operated and maintained in accordance with SA Health's On-site Wastewater Systems Code (April 2013). Once the camp is constructed the wastewater from the existing offices will be redirected to the new camp system as it will have its own wastewater system.

Sludge from the septic system will be collected as required for appropriate disposal to an EPA licensed disposal facility. Treated overflow from the septic system is discharged into a subsurface, vegetated infiltration area sized and designed to ensure no ponding or runoff occurs on the surface. The edge of the new infiltration area located at least 50m from the nearest drainage line and the area will be fenced off from members of the public, this area is shown in Figure 3. This will be subject to approval from SA Health.

6.4 Power Generation and Energy Supply

Diesel generators will be used for a power supply. Some communications and other equipment used on site are solar powered, investigations are being made into the expansion of solar and wind power generation to reduce diesel usage.

6.5 Fuel and Chemical Storage

Diesel fuel will continue to be delivered to site on an as need basis and stored in bulk storage tank that is located within an existing chemical storage area. Chemical storage and oil will be contained in the existing chemical storage area.

All areas containing hazardous material will be clearly designated and signed with Safety Data Sheets readily available at the storage area.

All bunds are designed and constructed in accordance with SA EPA requirements.

6.6 Water Supply

The site requires water for potable and domestic use. The potable water requirement for amenities is 300L/day per person. The total amount of water required on a daily basis is therefore expected to be no more than 6,000L/day when the site is operating with 20 people.

This water will be supplied from Darby's Bore 2 (located approximately 50m from Darby's Bore) accessing an unconfined perched shallow aquifer approximately 30 metres below the surface. Based on previous history and use of the site by ReNu, Darby's Bore 2 is able to produce sufficient water for the daily needs of approximately 50 people. If the demand for water exceeds the sustainable supply capacity of Darby's Bore, additional water will be sourced from Moomba by tanker.

Water used for domestic purposes is to be treated on site using a filtration and UV disinfection system and Precise Outcomes will register as a drinking water provider as required under the *Safe Drinking Water Act 2012*. Precise Outcomes has developed a drinking water monitoring and testing plan to ensure the quality and safety of its drinking water supplies and will submit this plan to SA Health as required under the Act.

6.7 Solid Waste Management

Solid waste material generated from operation of the HRLSH would comprise the following:

- general solid waste including that from the camp and amenities
- packaging from parts and components
- waste oils, grease and other fluids from machinery and workshops; and
- minor quantities of contaminated soil and absorbents from clean-up of spills.

Wastes would be segregated, stored and recycled, where feasible. All waste would be transported to the EPA licensed landfill at Moomba (or other EPA licensed facility), having been covered in skips or lidded drums and removed as required.

No industrial waste will be disposed of on-site by burning or burial or disposed of at the Innamincka landfill.

Solid or liquid waste removed from opened equipment items shall be treated as hazardous and shall be contained in suitable containers and removed off-site for processing at an appropriately EPA licensed facility.

6.8 Decommissioning and Rehabilitation

Rehabilitation activities will be aimed at optimising vegetation regrowth within the site and achieving the required Goal Attainment Scaling (GAS) Criteria in accordance with the criteria set out in the *Field Guide for the Environmental Assessment of Abandoned Petroleum Well sites in the Cooper Basin, South Australia, PIRSA* (Appendix A). This is an ongoing process and will occur as areas not required for operations surrounding the HRLSH are cordoned off as No Go Zones.

In relation to any future full decommissioning of the HRLSH (as distinct from it being maintained in a non-operating state), the following activities and criteria would apply:

- A decommissioning and rehabilitation plan will be developed in consultation with DEM and stakeholders at that time
- all equipment (including ancillary equipment) decommissioned and removed from site
- any stockpiled topsoil material respread over the site; and
- ground surface re-contoured to approximate pre-existing contours

7. STAKEHOLDER CONSULTATION

Prior to submission to the Department for Energy and Mining, Energy Resources Division (DEM-ERD), Precise Outcomes provided a draft copy of this EIR and accompanying SEO to all relevant stakeholders on 20 September 2021 to understand any potential concerns associated with its proposed HRLSH. Stakeholders were requested to provide comments by 19 October 2021 however all comments received up to the date of this report have been considered.

In accordance with Regulation 10(1)(f), of the *Petroleum and Geothermal Energy Regulations 2013* (PGE Regulations) Precise Outcomes has included details of the comments raised and how they have been addressed within this EIR and accompanying SEO in Appendix F (Table 7).

Comments raised through DEM's consultation with relevant government agencies as part of the approval process have also been addressed by Precise Outcomes, details of which are included in Appendix F (Table 8).

8. DESCRIPTION OF ENVIRONMENT

8.1 Surrounding Land Use

The dominant land uses surrounding Precise Outcome's proposed operations in the Cooper Basin are associated with the conservation of wildlife, landscape and historic features of the area, geothermal exploration, petroleum and natural gas production, tourism and pastoral production.

The site is approximately 8km southeast of Cooper Creek and is located within the Innamincka Regional Reserve and Innamincka Pastoral Lease area. In South Australia, Regional Reserves provide for the conservation of wildlife or the natural or historic features of that land while, at the same time, permitting the utilisation of the natural resources of that land.

Under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Commonwealth)* a referral of a proposed activity to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities is required for actions that may have a significant impact on matters of national environmental significance. These are:

- World Heritage properties
- National Heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities
- migratory species protected under international agreements
- Commonwealth marine areas
- the Great Barrier Reef Marine Park; and
- nuclear actions (including uranium mining).

The conservation status of the general area has not changed since the same area was assessed in the 2014 EIR. The surrounding land uses are still primarily concerned with the conservation of wildlife, landscape and historic features of the area, petroleum and natural gas production, tourism and pastoral production.

The closest town in Innamincka, is 7km north of the HRLSH.

The operation of the HRLSH is confined within a limited footprint and fenced off site area that is not inconsistent with the maintenance of the conservation status of the Innamincka Regional Reserve and the Coongie Lakes RAMSAR wetland, noting that the HRLSH and surrounding infrastructure sits outside the Coongie Lakes RAMSAR boundary itself (Figure 4).

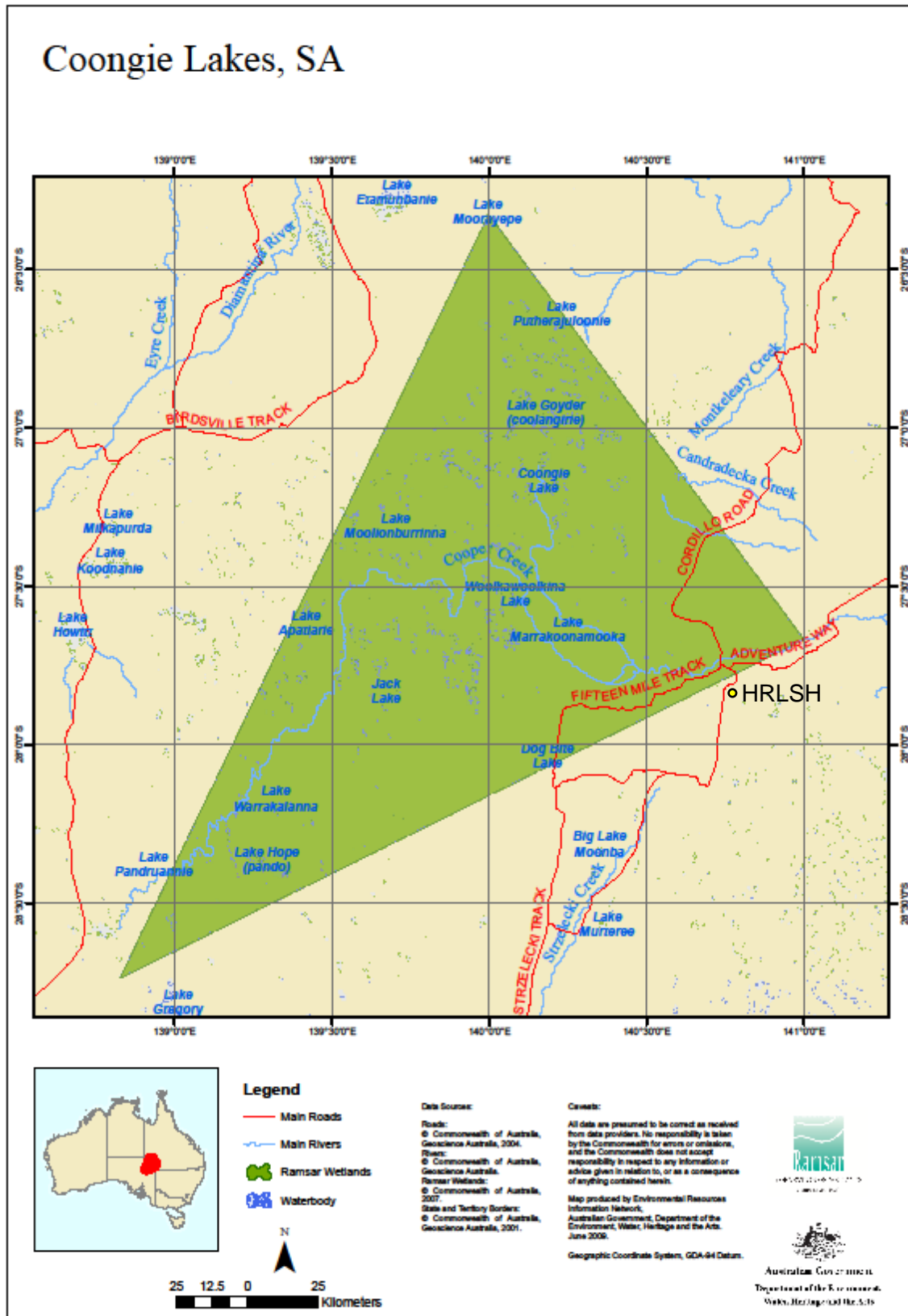


Figure 5 Coongie Lakes boundary



8.2 Climate

Innamincka Regional Reserve is located in one of the most arid areas in Australia. The long-term average annual rainfall (110 years of records) is 172.5 mm, but the area is renowned for its unpredictable and highly variable rainfall (80.7% variation). Over the last 110 years average or above average rainfall has been received 39% of years and droughts (less than 75 mm in summer and 50 mm in winter) 29% of years. On average 42% of rain is received in the summer months of January to March.

8.3 Land Systems

The Lower Cooper flood out and Coongie Lakes are a unique near natural wetland within the Channel Country biogeographic region and play a substantial role in the hydrological and ecological functioning of the Cooper Creek basin. The flows and flooding of the lake system are dependent on the late summer and early autumn rains in the catchment some 800 km upstream.

Although flows reach Cullyamurra waterhole on Cooper Creek upstream of Innamincka nearly every year, not all flows reach Coongie Lakes. However, most years the lake system has an inflow of water, which stimulates breeding in the fish populations and fish-eating birds.

The surrounding landscape consists of a combination of extensive flood plains, channels and lakes (Cooper Land System), dune fields, swamps and lakes (Kertietoonga land system), dune fields (Marqualpie and Della land systems) and the stony tablelands and plains (Merninie, Koonchera and Bloodwood land systems).

To provide an indication of potential clearance or disturbance of land system habitats in the GRL areas the Flora and Fauna Impact Assessment (Appendix E), estimated a worst-case clearance footprint of 250Ha based on estimates of the possible total project footprint of all potential ReNu infrastructure activities (excluding transmission lines). If all of this clearance was distributed evenly within the Cooper, Merninie and Tingana land systems this would represent less than 0.05%, 0.5% and 0.6% of each system respectively.

As activities associated with the footprint of operations at the HRLSH (13Ha) represent a small component of the total ReNu activities assessed within the Flora and Fauna Impact Assessment (Appendix E), the impacts of this particular activity on the land systems will be negligible. It is likely that the existing footprint of operations will be decreased as areas are progressively rehabilitated.

8.4 Surface Water

The major wetlands, swamps and lakes in the area – including the Coongie Lakes RAMSAR wetlands - derive water from flow events in Cooper Creek. The majority of these flows result from summer monsoonal rainfall in central Queensland. Local runoff from the stony tablelands also supplies water to waterholes and swamps but on a less frequent and more erratic basis.

During periods of low flow, most water flows through the North West Branch of Cooper Creek into the Coongie Lakes and Lake Goyder. If flows are large enough to fill these lakes additional water flows down the main branch of the Cooper toward Lake Hope and eventually into Lake Eyre.

The main channel of Cooper Creek is well defined and connects a series of ephemeral swamps and permanent and semi-permanent waterholes. During floods, the main channels overflow and floodwaters spill into the vast floodplain via numerous distributor channels.

HRLSH is located approximately 7km from Cooper Creek and 11km from Strzelecki Creek, surface water runoff from HRLSH will not impact these creeks due to the distance between them. Runoff from the HRLSH does not drain towards Cooper or Strzelecki Creeks but rather to the east and southeast into clay pans, low-lying interdune and dune areas.

8.5 Groundwater and Soils

The project area is underlain by Eromanga Basin sediments which are part of the GAB.

The alluvium along Cooper Creek is a source of sub-artesian water and in particular sandy sequences underlying the Creek provide a baseflow to semi-permanent waterholes during extended dry periods.

Shallow groundwater quality in the project area is variable and some of these bores are suitable for drinking or stock water supply.

At the time of writing this EIR the Hot Rock Joint Venture is in discussions with ReNu on behalf of the GRL3 licencees to have possession of Derbys Bore 2 transferred in “as is condition”.

Precise Outcomes proposed operations will extract potable water from Darby’s Bore 2 (Table 2), located approximately 500m to the south of the HRLSH.

Table 2 Water quality data for Darby’s Bore 2 (from NATA accredited tests carried out for Geodynamics in September 2012 by LBW Environment)

TDS (ppm)	Conductivity (µS)	Salinity (ppm)	pH	Temperature (°C)
1188	1194	594	8.1	22

In the SA Arid Lands region, the only prescribed water resource is the Far North Prescribed Wells Area (FNPWA) which was prescribed on the 27 March 2003 and covers all wells drilled into the aquifers of the Far North, including the South Australian Portion of the Great Artesian Basin and any other ground water aquifers that are accessed.

Permits and licences are required for the FNPWA because it is covered by a Water Allocation Plan (WAP). A WAP is a legal document that sets out the rules for managing the take and use of prescribed water resources areas to ensure resource sustainability.



A water license is required for the proposed HRLSH due to water being extracted from Darby's Bore 2 for industrial use. Precise Outcomes will ensure a license is approved from the Department for Environment and Water (DEW) prior to any water being extracted from Darby's Bore 2.

8.6 Native Vegetation

The HRLSH area is typical of the habitat types of the Channel Country Bioregion i.e., small stream channels and flood courses of the Coongie Lakes wetland system, extensive gibber plains, low hills and mesas and vast dunefields and sand plains supporting low shrubs, grasses and herbs.

The HRLSH is located at the boundary of three land systems, the gibber slopes of the Merninie Land System, the dunes of the Strzelecki Land System, and flood outs and floodplains associated with the Cooper Land System (PB, 2008). All activities associated with the project will be undertaken within the Merninie Land System.

Environmental and Biodiversity Services (EBS) was commissioned by Geodynamics to undertake a flora and fauna survey within its GRLs near Innamincka (completed in March 2009), including GRL3. Subsequent to this survey EBS was commissioned by Geodynamics to consider additional impacts on threatened species and communities associated with activities in the GRLs, in particular habitat clearance and other effects associated with the construction of power lines, power plants and associated buildings and facilities (*Flora and Fauna Impact Assessment for Geodynamics Geothermal Licence Area September 2009, Report prepared by Environmental and Biodiversity Services for Geodynamics Ltd*) (Appendix E). The HRLSH occupies a very small portion within these GRLs so for the purposes of this EIR the same flora and fauna survey has been used to assess native vegetation.

The EBS surveys indicate that no nationally significant threatened ecological communities were recorded or identified in the SFL 13 area. The EBS surveys identified 12 flora species of state conservation significance and 3 ecological communities considered to be of state significance.

The HRLSH is located in the same area as the EBS survey area. It is anticipated that the impacts on native vegetation will be negligible because activities of the HRLSH will be confined to areas where disturbance has already taken place due to previous geothermal activities.

The South Australian *Native Vegetation Act 1991* and the *Native Vegetation Regulations 2017* apply to vegetation clearance for petroleum operations. Under Regulation 14 of the *Native Vegetation Regulations 2017*:

1. Clearance of native vegetation incidental to operations authorised under the Petroleum and Geothermal Energy Act is permitted if it is undertaken in accordance with—
 - a. a management plan, approved by the Native Vegetation Council for implementation, that results in a significant environmental benefit; and

- b. in the case of operations authorised under a Mining Act—a management plan under that Act; and
 - c. in the case of operations authorised under the Petroleum and Geothermal Energy Act 2000—a statement of environmental objectives under that Act.
2. Sub regulation (1)(a) does not apply if the person undertaking the activities or operations (or a person acting on the person's behalf) has made a payment into the Native Vegetation Fund of an amount considered by the Council to be sufficient to achieve a significant environmental benefit in the manner contemplated by section 21(6) or (6a) of the Act.

Guidelines have been developed to provide a framework for determining the significant environmental benefit (SEB) requirement or the amount for payment into the Native Vegetation Fund. These guidelines are administered by DEM, who have delegated authority to approve SEBs.

A requirement to achieve a SEB for any vegetation clearance where required will be included in the accompanying SEO.

8.7 Fauna

The Coongie sub bioregions (of the Channel Country Bioregion) are known to support up to 18 Raptor species, 73 water bird species and another 13 wetland dependent species. The Channel Country Bioregion contains the Coongie Lakes Ramsar Wetland which supports many of these species (PB, 2008).

The proposed HRLSH is located within the Sturt's Stony Desert Sub Bioregion. The following species are known to occur within habitats of this region:

- Kowari (*Dasycercus byrnei*) – nationally Vulnerable – has its South Australian stronghold in the gibber plains on the eastern flanks of Goyder Lagoon; and
- Knife-footed Frog (*Cyclorana cultripes*) – Rare (South Australia) – lives in the gibber and gilgai areas.

The stony gibber plains are characterised by a high proportion of ephemeral species. These species have short lifecycles, enabling them to exploit the irregular and infrequent rains. Most of the perennial vegetation is in the highly productive areas of the gilgais and minor drainage depressions, and even modest rainfall events trigger extensive ephemeral growth. It is this localised and short-lived ephemeral vegetation that provides the unique habitats that are able to be exploited only by certain animals with specific adaptations. This means that more species are restricted or endemic to this landscape type than any other in the bioregion (PB, 2008).

The EBS surveys (Appendix E) were commissioned by Geodynamics to identify species potentially impacted by its activities within its GRLs, i.e., the surveys covered a broader area than the project area, SFL 13 is located within these GRL's. In those surveys EBS identified 37 threatened fauna species under South Australian and Commonwealth legislation (2 mammals, 33 birds, 2 reptiles) as potentially impacted by Geodynamics

activities within its GRLs. EBS also identified the potential for occurrence of threatened species within the GRLs considering habitat preference.

Table 3 Potential for occurrence of threatened species on-site considering habitat preferences (Appendix E)

Species name	Common name	Status		Primary habitat	Identified land system habitat	Likelihood of occurrence on site
		AUS	SA			
<i>Notomys fuscus</i>	Dusky Hopping-mouse	VU	V	Dusky Hopping Mice inhabit soft sandy habitats, preferring dunes with Sandhill Canegrass, Sandhill Wattle, Nitrebush, Sticky Hopbush and other ephemeral plants (Moseby <i>et al.</i> 1999).	Tingana (sand dunes)	High - This species was detected during survey and has been recorded 12 times on the BDBSA. HRLSH operations do not impact sand dunes.
<i>Pseudomys australis</i>	Plains Mouse (Plains Rat)	VU	V	Cracking clay habitats in northern South Australia. Plains Rats are found on stony (gibber) plains and mild slopes that have gilgais, predominantly within chenopod shrubs as well as ephemeral plants that require good rains to flourish. In very good years they can occur on adjoining sandy plains and may also occur on gypsum clay soils with deep cracks and sparse perennial vegetation (Ehmann, 2005; Menkhorst & Knight 2004; Moseby, 2006; Bandle & Moseby, 1999).	Merninie (gibber tableland)	Very Unlikely, but possible – One record of the species has been recorded within the BDBSA previously in 1957. Most of the project area does not support 'preferred habitat'; however, the gibber tableland in the northern section of the project area could potentially provide suitable habitat.
<i>Aspidites ramsayi</i>	Woma	n/a	R	Woma Pythons are found in desert dunefields and on sandy plains, usually with hummock grasses but also other natural vegetation. They often inhabit rabbit burrows but may also shelters under hummock grasses or dense bushes.	Tingana (sand dunes), Merninie (gibber tableland)	High – This species has been recorded 4 times on the BDBSA and the project area is within their known distribution.
<i>Emydura macquarii</i>	Macquarie Tortoise	n/a	V	Murray / Darling River System. Restricted to larger rivers and associated large waterholes on floodplains (Cogger 2000).	Cooper (floodplain)	Very Unlikely, but possible - This species has been recorded 6 times on the BDBSA and the project area is within their known distribution; however, the species inhabits major channels and waterholes, which are not located on the proposed site.

KEY Regions: AUS: Australia (*Environment Protection and Biodiversity Conservation Act, 1999*) SA: South Australia (*National Parks and Wildlife Act, 1972*)

Conservation Codes: V: Vulnerable R: Rare E: Endangered



The nationally rated vulnerable Dusky Hopping Mouse is unlikely to utilise habitat within the direct area of the HRLSH site, although it could possibly utilise the nearby sand dune habitat. However, as the HRLSH will not be expanding onto this dune habitat it is considered unlikely that there will be any significant impact upon this species.

The EBS report (2009) considers that given the huge extent of available and preferred habitat for the Plains Mouse (gibber tableland of the Merninie land system), the overall habitat loss that was associated with all of the likely activities being undertaken by ReNu in its GRLs (of which the Power Plant is a small component) would still be 'very unlikely' to have a significant impact on this species. Therefore, it is not anticipated that the HRLSH will have a significant impact on this species.

Surveys undertaken for the 2008 EIR identified several bird species of national conservation significance as possibly occurring within the project area. Further, several migratory and/or marine species are also known to occur in the area. These species generally rely on areas containing water and area likely to be concentrated around the Cooper Creek and Coongie Lake Systems. It is possible that individuals may be found within the *Muehlenbeckia florulenta* (lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland when surface water is present. However, it is unlikely that the project will have a significant impact on any of these species due to the distance (approximately 8 km) between the HRLSH site and nearest areas containing this habitat around Cooper Creek.

The EBS report identified five bird species of national conservation significance (*Vulnerable* and/or *Migratory* or *Marine*), using the EPBC protected matters search and during a survey the nationally *Vulnerable* Plains Wanderer (*Pedionomus torquatus*) was also identified on site (EBS, 2009). An additional twenty-seven bird species with a state conservation rating under the NPW Act were identified by the BDBSA and have previously been detected or identified as likely to occur within the project area.

In addition to the species identified by the EBS report, a recent search of the Commonwealth EPBC 'Protected Matters Search tool' indicated that the Australasian Bittern (*Botaurus poiciloptilus*) may have habitat available in the project area. The Australasian Bittern species has a national rating of Endangered and a state rating of Vulnerable (*National Parks and Wildlife Act 1972*). However, the Australasian Bittern is unlikely to utilise habitat within the HRLSH site as it is largely recorded in freshwater wetlands, requiring low density reeds, grasses or shrubs. This habitat is not present at the HRLSH site and nor will the site be expanding into habitat of this nature. It is therefore considered that there will not be any significant impact upon this species.

The EBS report stated that the potential impacts most likely to affect these bird species included; habitat clearance associated with the installation of all infrastructure; bird collisions with transmission lines (low and high); and the potential for the creation of artificial waterbodies attracting birds from Coongie Lakes and Cooper Creek. Of these three potential impacts, none are potentially relevant to this EIR, as operation of the HRLSH.

The HRLSH is located within the EBS survey area and it is anticipated the impacts will be less because most of the disturbance has already taken place due to previous geothermal activities undertaken by ReNu.



Accordingly, it is unlikely that the operation of the HRLSH will have any significant impacts on nationally threatened fauna species, migratory species or marine listed species. It is considered that a referral under the *EPBC Act* is not required in relation to threatened or migratory species.

8.8 Heritage

The Cooper Creek area has many sites and stories of particular significance to Aboriginal people. Prior to European colonisation the fresh and often abundant water in a desert environment sustained relatively high populations of Aboriginal people from the Yandruwandha, Yarrawarka and Dieri Aboriginal groups.

The level of occupation is indicated by the many large midden, burial and other sites to be found on the periphery of water bodies. The area also provided materials for tools; particularly grinding stones which were valuable trading items.

In addition to previous surveys, a thorough inspection (by foot traverse) of the area surrounding the power plant was conducted by Heritage Consulting Australia (HCA) in September 2010 (Appendix B), to identify cultural remains and delineated areas of high archaeological sensitivity. This survey was commissioned by Geodynamics as part of its operations to ensure that activities did not result in impact to Indigenous and non-Indigenous cultural heritage items. Accordingly, the recommendations of this study are applicable to the activities contained within this EIR.

The HCA survey found a background scatter of stone artefacts across the survey area ranging in density from 1/500m² to 1/100m². A single large workshop site covering an area of 50 x 130m and raw material source was found to the south of the existing visitor's centre with artefact densities up to 25/m².

The area contains a sand dune to the east containing small numbers of stone artefacts; however, due to very poor ground surface visibility it was thought likely that further artefacts may be present. The dune was therefore designated a Potential Archaeological Deposit (PAD), with strong likelihood that further archaeological traces will be present.

The HCA 2010 report recommended that the sand dune to the east of the proposed camp (formerly Habanero 1) and the previous workshop and raw material site to the south be avoided. These sites will not be impacted by activities of HRLSH, as works will not be occurring on sand dunes. An area has been located as a no-go zone and will be delineated with flagging to ensure there is no disturbance to the area from any potential HRLSH activities please refer to Figure 3. Further Indigenous heritage surveys will be undertaken prior to the disturbance of any new ground that has not been previously disturbed.

The non-aboriginal cultural heritage of the general area is also of significance. The first graves of the ill-fated explorers Burke, Wills and Gray occur on the reserve. The Australian Inland Mission nursing home building, a ruin since the 1950s is now restored as the Regional Reserve office. However, all of these sites are located some distance from the HRLSH, outside the existing fence boundary and will not be affected by its operation.

8.9 Noise and Air Quality

The air quality in the vicinity of the activity is expected to be typical of a remote rural environment and influenced primarily by dust from high winds. Oodnadatta, 575km east of the site, experiences on average 5 dust storms annually, while Birdsville, approximately 425km north-west of the site, experiences on average 6.5 (PB, 2008).

Although there may be some dust generated from logistics operations and heavy vehicle movement it is not anticipated that there will be a significant change to air quality in the area as there will only be a small number of vehicles at the site at any one time. Dillons Highway is currently being upgraded with bitumen which will reduce the amount of dust and air quality impacts from vehicles travelling along this road.

Attended noise level readings undertaken in the vicinity of the previous Power Plant on 2 July 2013 were as follows:

- 150 m north of Plant at 8.30pm (in direction of Innamincka): 53dBA (Plant audible)
- 250 m north of Plant at 8.40pm: 47dBA (Plant audible)
- 500 m north of Plant at 8.50pm: 40 dBA (Plant not audible, background noise, mainly wind)

At 500 m north of the Plant, noise emissions were not audible over the existing background noise.

Innamincka is located over 7 km from the HRLSH (straight line), with intervening higher topography providing a barrier to direct line of sight, noise emissions from the hub would not be perceptible above existing background levels at any time of the day or night. It is not anticipated that there will be a significant change in the operation of the HRLSH compared to the previous Power Plant's trial operations in the same area that could lead to higher noise emissions.

8.10 Pest Plants and Feral Animals

A weed assessment undertaken for Geodynamics by EBS Ecology (Appendix C (EBS, 2012) found that overall, weed densities were low and control efforts carried out by Geodynamics had been moderately successful.

No alien species found on site were listed as weeds of national significance or declared under the *Natural Resources Management Act 2004* (EBS, 2012). The HRLSH area is considered to have the highest potential for weed invasion due to its proximity to Dillons Highway with a high number of vehicles arriving and departing each day. The EBS 2012 report included a number of management controls that are detailed in Section 9.2.2.

Since 2008 occasional infestations of the house mouse have occurred within the site area which have been controlled using commercially available rodent bait stations distributed in strategic locations around the site.

8.11 Socio-economic Issues

Innamincka has a small population of 44 people obtained from the Australian Bureau of Statistics 2016 Census data. The most common industries of employment are farming and the oil and gas industry.

It is not anticipated that the socio-economic environment will be impacted, personnel will be housed at the HRLSH and there will be little, if any, interaction with the facilities at Innamincka. Infrastructure and transport will not change significantly due to the operation of the HRLSH.

9. ENVIRONMENTAL RISK ASSESSMENT AND MITIGATION MEASURES

This section outlines the methodology used to assess the environmental risks associated with the proposed operation of the HRLSH and details the mitigation measures proposed to treat and manage these risks.

7.1 Risk Assessment Process

An assessment of the likelihood and consequences of environmental harm occurring from activities associated with the operation of the HRLSH provides an objective basis for the management of risks.

The risk assessment in this EIR uses a risk matrix and definitions for consequences and likelihood derived from Precise Outcomes corporate risk management system and procedures. These are based on the Australian Standard *AS/NZ 4360: 2004 Risk Management*.

Precise Outcomes risk assessment process involves:

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

The results of the risk assessment undertaken for the project are summarised in Appendix D and the proposed management measures are discussed in this section. The mitigation measures in Appendix D are reflected in the SEO for the HRLSH as providing guidance to how the environmental objectives can be achieved.

The level of risk identified in Appendix D assumes that the proposed management measures will be fully implemented by Precise Outcomes.

The definitions for consequences and likelihood, and the risk matrix used in the assessment are outlined below.

9.1.1 Definition of Consequences

To describe the severity, scale and duration of potential impacts associated with the activity, five categories of consequence have been used (Table 8) based on the risk consequence definitions in Precise Outcomes risk management process.

Table 4 Risk Consequences

Description	Environment	Reputation
Catastrophic	Permanent impact long term (decades) regional impact.	Adverse global media coverage. Major stakeholders terminate. Company at stake.
Major	Long term (decades) local area impact. Medium term (years) regional impact.	Adverse national media coverage. Company on notice.
Moderate	Medium Term (years) local area impact. Short term (months) regional impact.	Long term (weeks), local media and local interest.
Minor	Short term (months) local area impact.	Short term (days), local media and local interest.
Insignificant	Temporary impact (days/weeks) to immediate area.	Local interest only, quickly forgotten.

9.1.2 Definition of Likelihood

The likelihood of environmental consequences occurring was defined using the five categories shown in Table 4 consistent with Precise Outcomes corporate risk process. The likelihood refers to the probability of the particular consequences eventuating, rather than the probability of the hazard or event itself occurring.

Table 5 Risk Likelihood

Description	Probability	Frequency	Historical
Almost Certain	> 1 in 10	Several times per year	Has occurred frequently in the company
Likely	Between 1 in 10 and 1 in 100	About once per year	Has occurred once or twice in the company
Possible	Between 1 in 100 and 1 in 1,000	Once in a 1 - 10 years	Has occurred many times in the industry



Unlikely	Between 1 in 1,000 and 1 in 10,000	Once in 10 - 100 years	Has occurred once or twice in the industry
Rare	< 1 in 10,000	< Once in a 100 years	Unheard of in the industry

9.1.3 Risk Ranking

The risk associated with each hazard is characterised using the matrix in Figure 5 below. Risk reduction measures are applied to reduce risks to tolerable levels and risks are considered acceptable if they can be managed and maintained via mitigation measures into the low category.

Risk Assessment Matrix	RARE	UNLIKELY	POSSIBLE	LIKELY	ALMOST CERTAIN
CATASTROPHIC					EXTREME
MAJOR				HIGH	
MODERATE			MEDIUM		
MINOR		LOW			
INSIGNIFICANT					

Figure 5 Risk Assessment Matrix

An assessment of the level of environmental risk identified for activities and environmental aspects associated with the operation of the HRLSH is provided in Appendix D assuming the implementation of the mitigation measures and controls identified below for each aspect.

9.2 Environmental Aspects & Mitigation Measures

The key environmental aspects identified below are those that have been identified for the proposed HRLSH.

9.2.1 Erosion

The measures proposed below will minimise the potential environmental impacts associated with disturbance of soils at the site of the HRLSH during its operation:

- All staff inducted into Precise Outcomes environmental requirements
- Signage and fencing used to restrict access to undisturbed areas and those undergoing revegetation and rehabilitation
- Sediment controls installed in eroding areas within the site
- Areas not required for operations cordoned off to optimise vegetation cover
- Erosion and sediment control measures regularly inspected and maintained
- Disturbed areas of the site progressively stabilised and rehabilitated
- Stormwater flows onto, through and from the site controlled; and



- Controlled vehicle access to the site through dedicated entry/ exit points, roadways and parking areas.

9.2.2 Vegetation, weeds and pests

The measures proposed below will prevent new infestation of weeds and populations of pest species on site so that native flora and fauna are protected:

- All staff inducted into Precise Outcomes environmental requirements for weed and pest management
- Regular site inspections to check for weed infestations and control / eradication of any weeds identified
- Access outside existing site areas restricted through the use of signage and fencing
- All interstate or high-risk vehicles or equipment checked and cleaned prior to entering the Cooper Basin area
- All vehicles required to remain on formed roads and tracks within the project area
- Any new area to be cleared/modified of vegetation will be assessed and important vegetation will be avoided where possible
- Any new vegetation clearance will also need to be subject to significant environmental benefit (SEB) provisions
- Disturbance and clearance of native groundcover minimised as far as possible; and
- Domestic waste stored in covered skips to minimise scavenging.

9.2.3 Stakeholders, land use and/or associated infrastructure disturbance

This objective is to ensure that dust, noise and pastoral impacts do not adversely affect the environmental values of the health and amenity of people. The management controls adopted during operations will be:

- Areas of native vegetation on site that are not required for plant operations to be cordoned off and retained
- Cover truck loads to minimise tracking of dust
- The use of water cart may be used on an as needs basis (e.g., during construction activities) to prevent the accumulation of dust
- An 10km/hour speed limit enforced on all roads used within the site by staff and contractors; and
- Construction activities with the potential to generate dust during unfavourable weather conditions within site will be monitored and modified as required.

9.2.4 Indigenous Heritage

The Indigenous heritage objective is to avoid disturbance to sites of Indigenous heritage significance. A thorough inspection (by foot traverse) was conducted by Heritage Consulting Australia (see report in Appendix B), to identify cultural remains and areas of high archaeological sensitivity. The control measures below incorporate advice provided within that report:

- All site-based staff and contractors to be inducted into Precise Outcomes environmental requirements and provided with guidance on Indigenous heritage control measures
- An *Environmental Control Plan* which details Indigenous sensitive areas and no-go zones to be posted in prominent areas on site this will be submitted to the Department as part of each Activity Notification prepared for any activity undertaken under this SEO.
- Sensitive area signage to be used to provide further protection of Indigenous sensitive areas in proximity of operating areas
- Further Indigenous heritage surveys will be undertaken prior to the disturbance of any new ground that has not been previously disturbed.
- Signage to indicate public versus private roads and access tracks to discourage third party access to infrastructure, hence impacts to sites of cultural heritage significance.
- Sites of potential cultural and heritage significance are managed in liaison with relevant stakeholders
- Consultation with stakeholders in relation to the possible existence and management of heritage sites
- Surface water run off flows onto, through and from the site controlled,
- Site fencing to be maintained to prevent access to the areas identified in the Heritage Report (Appendix B); and
- If Aboriginal heritage (sites, objects or remains) are discovered, work to be stopped and the Department of the Premier and Cabinet, Aboriginal Affairs and Reconciliation notified. A heritage specialist to be commissioned to record and assess the item(s) and provide advice on the most appropriate impact avoidance measures, and any consultation required with Traditional Owners.

9.2.5 Fuels and Chemicals

The objective is to minimise the potential for impact on soil, groundwater and surface water from inappropriate storage and spillage of fuel and chemicals. The controls that will be adopted during operations are:

- All staff inducted into Precise Outcomes environmental requirements
- Fuels, oils and chemicals stored in accordance with the requirements of the South Australian EPA's bunding guideline 080/16 Bunding & Spill Management (May 2016)
- Spills cleaned up immediately and any contaminated soil treated and disposed of in accordance with the waste management procedure



- Spill kits located in close proximity to fuel and chemical storage and refuelling areas
- Sites regularly inspected to ensure chemicals and fuels stored in bunded and/or double skinned storage tanks and areas in accordance with EPA requirements.
- Incident Response and reporting procedures implemented in accordance with Precise Outcomes corporate management system requirements; and
- Material Safety Data Sheets available on site for all fuels and chemicals stored on site
- Where possible refuelling areas should be located on a hardstand and bunded area. Where this is not possible any soil contaminated during refuelling operations will be collected for appropriate treatment and disposal in accordance with the waste management procedure

9.2.6 Waste storage, handling and disposal

The waste management objective is to minimise the impact of waste storage, handling and disposal on the environment. The following controls will be adopted during operations:

- All wastes to be disposed of at Moomba or other EPA licensed facility. No wastes are to be disposed of at the Innamincka landfill
- Wastewater must be treated and disposed of in accordance with the SA Public Health (Wastewater) Regulations 2013 and the SA Health On Site Wastewater Systems Code, April 2013
- All staff inducted into Precise Outcomes environmental requirements
- Production of waste minimised and waste products reused and recycled wherever practically possible
- Domestic and potentially wind-borne waste (e.g., paper, plastic etc.) stored in covered skips
- Waste segregated for recycling
- No burial or burning of waste on-site
- Contaminated soil and other material requiring disposal to special facilities stored separately
- Wastes covered when transported offsite
- Listed Wastes managed in accordance with the EPA requirements including no such wastes to be removed from site without the necessary authorisation and paperwork completed
- Solid or liquid waste removed from opened equipment items shall be treated as hazardous and contained in suitable containers for off-site processing or disposal in accordance with EPA requirements.
- Wastewater treatment plants regularly inspected and maintained by manufacturer's service representatives; and

- Effluent disposal/transpiration areas regularly inspected to ensure the edge of the infiltration area is located at least 50m from the nearest drainage line and is fenced off to restrict access

9.2.7 Public Safety

The public safety management objective is to not cause harm or risk to members of the public. The following controls will be adopted during operations:

- Necessary measures (e.g., signage/fencing) to prevent the public accessing operational areas
- Driving on designated areas only (i.e., Access tracks and designated operational areas) – unauthorised off-road driving is prohibited
- Use of existing routes/disturbed areas where practicable
- Setting of appropriate vehicle speed limits for Precise personnel and contractors
- Induction of employees and contractor personnel with respect to road use and driver behaviour; and
- Storage of equipment and materials within operational site boundary

9.2.8 Decommissioning and Site rehabilitation

Rehabilitation activities will be aimed at optimising vegetation regrowth within the site and that the required GAS Criteria of at least ≥ 0 (minimise visual impacts and revegetation) is achieved for the rehabilitation of any areas on site, in accordance with the criteria set out in the *Field Guide for the Environmental Assessment of Abandoned Petroleum Well sites in the Cooper Basin, South Australia, PIRSA* (Appendix A) (in the event the hub is no longer operational).

The principle of rehabilitation will be to progressively rehabilitate disturbed areas of the HRLSH (including associated facilities) no longer required for operational activities or to maintain firebreaks.

The rehabilitation measures implemented during operations would be:

- Site areas no longer required for operations cordoned off to encourage regrowth of vegetation
- Stock proof fencing of any remaining vegetation or regrowth within site areas maintained until vegetation is sufficiently established
- Implementation of erosion and sediment controls as required
- Ripping of compacted surfaces (other than gibber surfaces) to encourage regrowth

And in the event of decommissioning:

- All equipment (including ancillary equipment) decommissioned and removed from site
- Any stockpiled topsoil material respread over the site
- Ground surface re-contoured to approximate pre-existing contours.

- On final abandonment the surface will be revegetated to ensure compliance with the required GAS criteria of at least ≥ 0 for facilities and tracks; and
- Development of a Decommissioning and Rehabilitation Management Plan at conclusion of the project, this will be developed in consultation with DEM and relevant stakeholders.

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APPENDIX A – GOAL ATTAINMENT SCALING CRITERIA

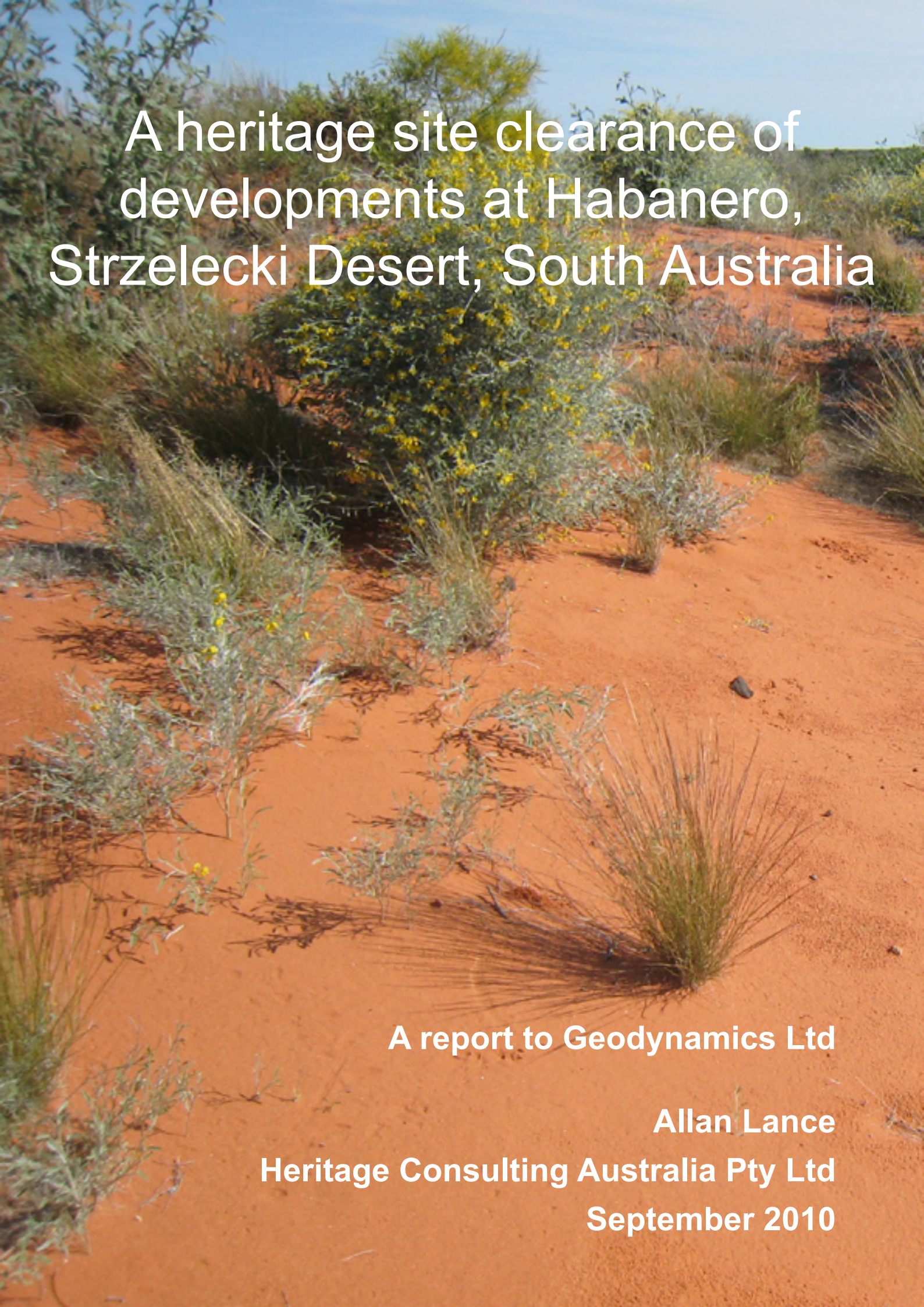
Summary of criteria for assessing the restoration of abandoned wellsites in the Cooper Basin, South Australia.

Score	OBJECTIVE 1 To minimise the visual impact				OBJECTIVE 2 The revegetation of indigenous species(a)		
	Access tracks	Interdune and floodplain wellsites	Dune wellsites	Gibber wellsites	Predictive rehabilitation on abandonment	Less than five years since wellsite abandonment	At least five years since abandonment
-2	The track is prominent because of a scraped surface, windrows along its edges or gully erosion.	The site remains as a prominent consolidated surface with a distinct edge.	Extensive gully erosion down the face of the dune and/ or a steep site edge are prominent.	Site is poorly formed and predominantly bare due to incomplete spreading or loss of the gibber.	No attempt has been made to restore the wellsite.	No revegetation is occurring.	There is no revegetation.
-1	The track surface has been contoured into the surrounding landscape; but the colour of foreign material contrasts with the surroundings.	The site surface and edge have been contoured into the surrounding landscape; but the colour of foreign material contrasts with the surroundings	The site has been restored into the natural contour of the dune; but the colour of foreign material contrasts with the surroundings.	Site matches adjacent colours, but is visible due to inconsistent spreading of the gibber and some bare areas.	The restored surface is inconsistent with the surroundings.	Revegetation with inappropriate species.	The revegetation mostly consists of annuals and biennials; in contrast to the surroundings there are few perennials.
0	The track contours and colour blend with the surroundings; but the earthwork disturbance is still prominent (e.g. ripping, rolling or respreading of original material).	The site contours and colour blend with the surroundings; but the earthwork disturbance is still prominent (e.g. ripping, rolling or respreading of original material).	The edge and colour of the site blend with the surroundings. The site contours are visible only when viewed from the top of the dune; they cannot be seen from the base. Erosion gullies are present down the face of the dune, but they are not extensive or prominent.	Site matches adjacent contours with some imported material still evident within gibber spread.	There has been appropriate preparation of the ground surface to promote revegetation.	Colonisation of the original species is starting to occur.	The revegetation consists of annuals, biennials and perennials; but there are some bare patches which are inconsistent with the surroundings.
+1	The track contours and colour blend with the surroundings and the earthwork disturbance is beginning to blend also.	The site contours and colour blend with the surroundings and the earthwork disturbance is beginning to blend also.	The edge and colour of the site blend with the surroundings. The site contours are visible only when viewed from the top of the dune; they cannot be seen from the base. There are no erosion gullies down the face of the dune.	Site matches adjacent contours and the gibber is uniformly spread with no imported material evident.	N/A	The revegetation is extensive and consists of annuals and biennials; in contrast to the surroundings there are no perennials.	The revegetation, mostly perennials, is consistent with the surroundings; but there is a contrast in maturity between them.
+2	The track contours and colour blend with the surroundings and the earthwork disturbance is indistinguishable.	The site contours and colour blend with the surroundings and the earthwork disturbance is indistinguishable.	The edge and colour of the site blend with the surroundings. The site contours are indistinguishable whether viewed from the top or base of the dune.	Site is indistinguishable from the surrounds.	N/A	The revegetation is extensive and mostly consists of annuals and biennials; perennials are beginning to establish which is consistent with the surroundings.	The revegetation type, density and maturity is indistinguishable from the surroundings.

(a) See Wiltshire and Schmidt (2003) for identification of vegetation.

APPENDIX B – HABANERO SITE HERITAGE REPORT





A heritage site clearance of
developments at Habanero,
Strzelecki Desert, South Australia

A report to Geodynamics Ltd

Allan Lance

Heritage Consulting Australia Pty Ltd

September 2010

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Executive summary

Introduction

Geodynamics Ltd proposes to drill a further geothermal well adjacent to the existing Habanero 3 well situated beside the Strzelecki Track (Dillons Highway) south of Innamincka in north eastern South Australia. Construction of the well lease will entail ground disturbance in the area to the east of the existing well.

To ensure that construction activities in the Habanero area do not result in impacts to Indigenous and non-Indigenous cultural heritage items, a site clearance has been conducted, making recommendations for the management of cultural heritage items found there.

The inspection of the Habanero area was conducted by archaeologist Allan Lance on 8 and 9 September 2010.

Study methodology

A thorough inspection of the ground surface was carried out to identify cultural remains and delineate areas of high archaeological sensitivity to guide the placement of future construction activities. The survey area was examined closely by foot traverse.

Results

A background scatter of stone artefacts was found across the survey area ranging in density from 1/500m². to 1/100m². Stone artefacts found in the gibber are made from silcrete or quartzite. A single large workshop site and raw material source was found to the south of the Habanero facility. This covers an area of 50x130m and here artefact densities are up to 25/m².

A single sand dune is found in the investigated area. Small numbers of stone artefacts are found on this dune, although very poor ground surface visibility suggests that further artefacts may be present. For this reason, the dune has been designated a Potential Archaeological Deposit (PAD) and there is a strong likelihood that further archaeological traces will be present.

Recommendations

To ensure that the cultural heritage values of the project area are not compromised it will be necessary for the avoidance of the two archaeologically sensitive areas identified in this site clearance. These are:

- Sand dune to the east of Haberno 1 (PAD1)

- Workshop and raw material source south of Haberno 1 (Habano Site 1).

Construction of the Habano 4 well will occur in an area that has either been previously disturbed by quarrying for road base, machinery accessing the quarry, or is located in an area with very low background artefact densities. Consequently, there will be no impacts to Indigenous heritage items.

It should be noted that all Aboriginal archaeological sites in South Australia are protected by provisions of the *Aboriginal Heritage Act, 1988*, which makes deliberate destruction of registered sites, without the written authorisation of the minister, an offence. **If the archaeologically sensitive locations are excluded from development plans, there can be no objection on archaeological or Aboriginal heritage grounds to ground disturbance in the project area.**

Archaeological items dating from the post-contact era are protected in South Australia under Section 27 of the *Heritage Places Act, 1993*, which makes their deliberate removal, damage or destruction an offence. No historical artefacts were located during the field reconnaissance. Should any be uncovered, it will be necessary for a heritage specialist to record and assess the item(s) and provide management advice on the most appropriate impact mitigation measures. **There can be no objection on non-Indigenous cultural heritage grounds to construction in the project area.**

1. Introduction

Geodynamics Ltd proposes to drill a further geothermal well adjacent to the existing Habanero 3 well situated beside the Strzelecki Track (Dillons Highway) south of Innamincka in north eastern South Australia. Construction of the well lease will entail ground disturbance in the area to the east of the existing well. Additionally, it will be necessary for associated infrastructure to be built in the surrounding area (Figures 1 and 2).

To ensure that construction activities in the Habanero area do not result in impacts to Indigenous cultural heritage items, representatives of the Yandrawantha/ Yawarrawarrka Native Title groups have previously conducted detailed heritage site clearances (certification that areas for development are clear of cultural heritage sites). These have included areas for existing wells, roads and other infrastructure (for example Lance 1996), although several small areas, including the area for the newly proposed well, had not been cleared. The present report documents the investigation of these previously uncleared areas, making recommendations for the management of cultural heritage items found there.

The inspection of the Habanero area was conducted by archaeologist Allan Lance on 8 and 9 September 2010.

2. Environmental setting

The Habanero wells are located in an area of undulating gibber downs, approximately 7km south of Cooper Creek. Ordinarily, the gibber downs have a sparse cover of grasses and forbs although following heavy rainfall in the weeks preceding the site clearance, herbaceous vegetation had flourished. This reduced the ground surface visibility considerably across the survey area. Ground surface visibility averaged 30% in gibber areas, and less on the low dune found to the east of the Habanero 1 well.

The ground cover in the gibber comprised various varieties of chenopod: saltbush, bluebush and galvanised burr. On the sandy soil were a wide variety of grasses and forbs, including sandhill canegrass (*Zygochloa paradoxa*). A stand of sandhill wattle (*Acacia ligulata*) was also found on the dune crest.

A claypan that fills from local rainfall drained from the gibber is located to the south of the project area. At the time the survey was undertaken this claypan was full of water.

Several areas have been subject to intensive ground disturbance around the existing leases. These include a quarry to the south of Habanero 3. This covers an area of 80x100m and abuts the area disturbed during the preparation of the Habanero 3 lease,

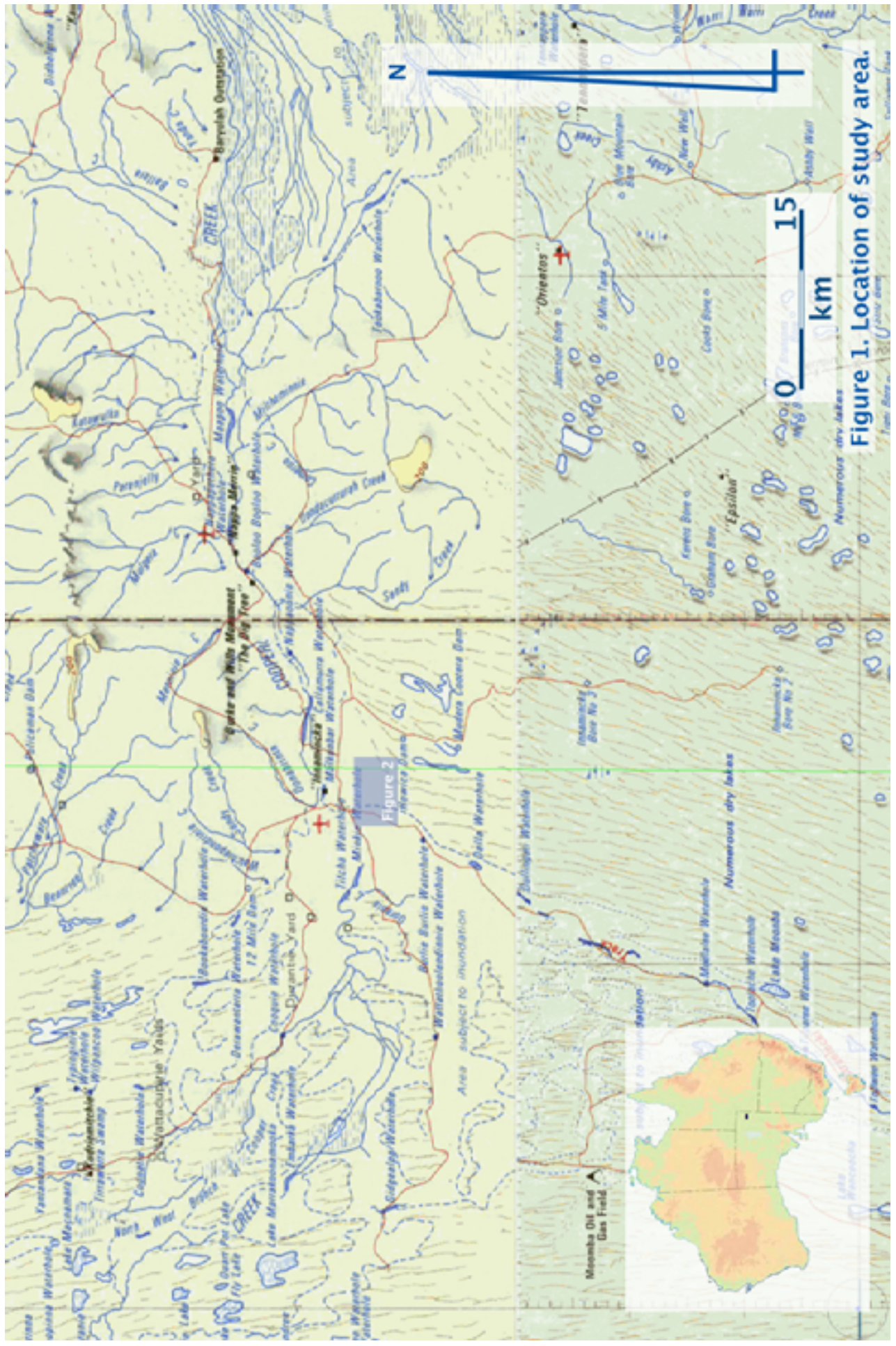
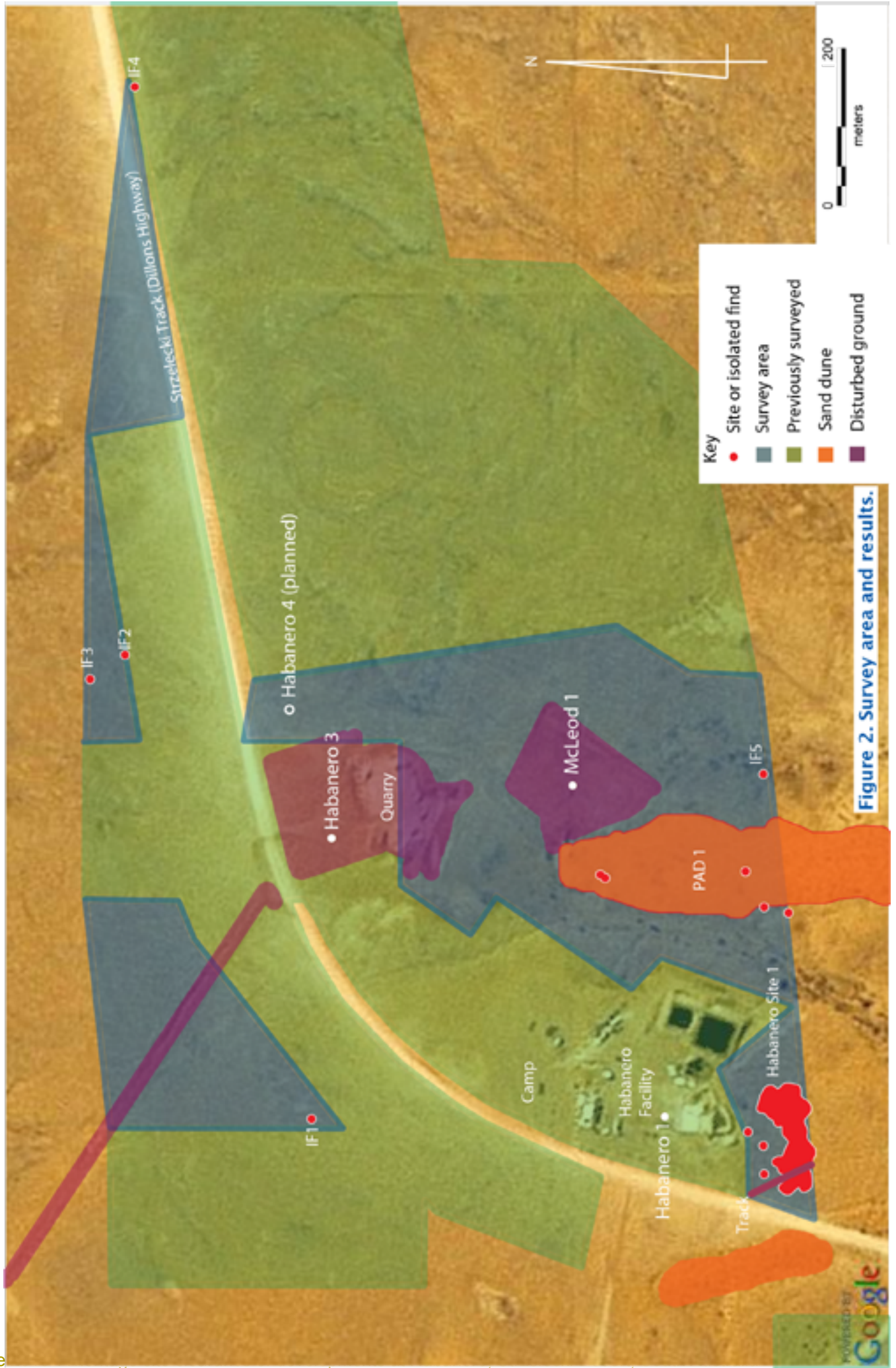


Figure 1. Location of study area.



which extends almost 300m south from the Strzelecki Track. Further disturbance is found around the McLeod 1 well lease. This lease was prepared for Santos and was drilled in 1983. The area of disturbance covers an area of approximately 100x100m and is located to the south of the quarry. This area of disturbance is situated to the east of the only sand dune in the area under investigation.

2.1 Undulating gibber downs

The proposed development area is predominantly undulating gibber downs. The size and density of silcrete pebbles vary, and in some places the gibber is associated with small outcrops of unweathered rock. Red duplex soils underlie the stony gibber, comprising a loamy surface crust and an underlying clay sub-soil. These soils are subject to severe erosion when the protective gibber mantle is removed.



Plate 1. View across gibber downs north of the Strzelecki Track showing the extent of ground cover vegetation.

The vegetation includes grassland dominated by dense grasses and low chenopod shrubs. Barley Mitchell grass (*Astrebla pectinata*) is the dominant ground cover, with bluebush (*Chenopodium auricomum*) and saltbush (*Atriplex* spp.) (Division of Land Utilisation 1974). Whitewood (*Atalaya hemiglauca*) shrubs and trees occur in places (Boyland 1974, Laut *et al.* 1977).

From an Aboriginal perspective, the undulating gibber downs were a Land System with few food resources. Animals including macropods, reptiles and birds (especially emus) are found in this land system, however, these would have only been available in small numbers. A small range of economic plants was, however, available. These include the native plum (*Santalum lanceolatum*) and the ruby saltbush (*Enchylaena tomentosa*),

which bore edible fruit (Lance 1982).

While the undulating gibber downs may not have been rich in plant or animal resources, they did provide an abundance of raw materials suitable for the manufacture of stone tools. The gibber cobbles themselves were suitable for making “instant” tools (cf. Gould 1980:72, 131), which were discarded following use. Silcrete outcrops were quarried for stone suitable for making a range of chipped tools. These included long blades fashioned for trading purposes, rather than domestic use (Lance 1992).

2.2 Sand dunes

A single sand dune is found to the east of the Habanero 1 well and campsite compound. Distinctive vegetation associations are found on this dune. The vegetation on the dune crest includes a range of species, the most common of which are: sandhill canegrass (*Zygochloa paradoxa*), spinifex, needlebush, hopbush, emubush, whitewood and chenopods, native fuchsias (e.g. *Eremophila sturtii*, *E. duttonii*, *E. mitchellii*), cassia, bladder saltbush (*Atriplex vesicaria*), and native grasses such as *Aristida* spp.

The preference shown by Aboriginal people for sandy substrates on which to camp (cf Sullivan 1976, personal observation) concentrated occupation debris in dunes such as this.



Plate 2. View of exposure on sand dune to the east of the Habanero complex showing surrounding dense vegetation.

The foodstuffs available in the dunes were diverse and include seeds from various species of wattle, which were ground on sandstone grinding stones, baked and eaten or simply eaten raw. Sandhill goannas and marsupials including the bilby, mice and rats would have been dug from the dune sands.

In addition to the plants used for tools, grinding stones made from sandstone were obtained from outcrops in the dune corridors to the south of the project area. Two such quarries were discovered during a survey of the present alignment of the Strzelecki Track (Dillon's Highway) (Lance 1996).

3. Previous archaeological studies

Previous archaeological studies in Central Australia have revealed an Aboriginal presence in the interior of the continent at the height of the last glaciation, at least 24,000 years ago (Wright 1971, Smith 1989).

Hughes and Lampert (1980:60), observed scatters of stone artefacts on Pleistocene clay dune cores near Nappa Merrie. They excavated one site but found artefacts only in the upper, recent mobile sand layer, not in the Pleistocene aged dune core. The artefacts could also be assigned to microblade industries, generally accepted as being more recent than 4-5,000 years. Hughes and Lampert (1985:60) therefore concluded that none of the stone artefacts found at this site had been deposited during the Pleistocene.

Most investigated sites also date from the late Holocene period, more recent than 4-5,000 years ago (Williams 1988, Lampert and Hughes 1988). One Pleistocene site south of Moomba was investigated, where radiocarbon dating revealed occupation dating to at least 13,500 years (Wasson 1983:102). Hughes and Lampert (1980:63) claim to have located further *in situ* deposits in clay cores of a sand dune near Strzelecki Creek.

The limited numbers of Pleistocene sites and the predominance of small Holocene sites found in this region has been interpreted as the effect of fleeting visits into the desert during the Pleistocene, made by Aboriginal people who were based in areas with reliable water supplies such as the Flinders Ranges. The large numbers of late Holocene sites suggest that there was a significant increase in Aboriginal populations in the region during the recent past. It has been suggested (Lampert 1985:57-9) that the arid region was only colonised in the mid to late Holocene.

This interpretation is based on an analogy with Aboriginal land use patterns observed by early explorers in the period immediately following European settlement. These Aboriginal people maximised the use of resources by visiting normally dry areas after localised desert

rainfall (McKinlay 1862:48, Allen 1974, Peterson and Long 1986). Claypans throughout the eastern Strzelecki Desert are filled by rainfall or by overflow of the Cooper's Creek - Strzelecki Creek system, and these provided a water supply allowing visitation of this otherwise dry dunefield. We can therefore expect that campsites found throughout this area result from episodic, short term occupation.

3.1 Site types

Previous studies in the region have led to the discovery of a wide range of sites including stone artefact scatters, raw material sources, scarred trees, ceremonial sites and dwellings. Site densities are high, due to the important focus provided by the permanent or semi-permanent water from the creeks and the abundant raw materials for stone tool manufacture. Dense stone artefact scatters are found in the sand dunes near Cooper's Creek and high background artefact scatter densities are also encountered in this area. Historical records from this region indicate that at the time of European contact, Aboriginal people in this region were reliant upon the resources provided by Cooper's Creek, and that they would have moved from the permanent waterholes only after ephemeral water sources were replenished by local rainfall or flooding.

Stone artefact scatters

The abundance of silcrete suitable for tool manufacture, results in the widespread distribution of flaked stone artefacts across the landscape. These scatters of stone artefacts are commonly found near water sources and generally mark the locations of prehistoric campsites. Other concentrations of stone artefacts are found at raw material sources (and quarries) and would have been formed as part of the process of working blocks of stone to produce cores and flakes for use as woodworking and cutting tools.

A general background scatter of stone artefacts is found on the undulating gibber downs. This variable density scatter represents the occasional discard of small numbers of tools by Aborigines over the period that the region was occupied. A long period of occupation and the ready availability of raw materials for stone artefact manufacture, combined to give the high background scatter densities found in this region. These background scatters range in density from 1 artefact/1,500m² to 1 artefact/5m².

Raw material sources

Stone used for the manufacture of stone tools was readily available from scattered outcrops in the gibber. While silcrete is widespread, unweathered material was preferred for toolmaking, as it fractures more predictably. Silcrete cobbles were periodically used for the manufacture of impromptu tools. These would have been quickly discarded following use. Tools made from better raw materials were more likely to have been kept for later use (cf Gould 1977:164). Dense concentrations of stone artefacts in workshops near the

silcrete outcrops reveal the location of these stone sources.

In addition to providing stone for the production of tools used for domestic purposes, stone sources have been found which were used to make grinding stones for trade. Grinding stones are found in campsites throughout the Strzelecki Desert. Grinding stone quarries have been found in the dunes several kilometres south of the Habanero wells.

Scarred trees

Trees from which pieces of bark were removed for utensils or shelter are found along major watercourses in this region. The origin of these scars is often difficult to distinguish, as scars were also caused by Europeans and by natural causes, including insect attack and fire. These scars provide evidence for an Aboriginal presence, however, they provide little information on Aboriginal domestic life, beyond that previously shown from historical accounts.

Ceremonial sites

Ceremonial grounds marked by stone arrangements are known from this district. These comprise large circles of stones, sometimes associated with cleared pathways. A number of these sites are known from the Cooper's Creek area (Lance and Hughes 1983, Hiscock 1984, McFarlane nd, Malcolm Ebsworth personal communication). These arrangements may have been associated with ceremonies or secular activities. Most recorded stone arrangements occur on tablelands where stone blocks and gibber cobbles occur, or on the gibber downs. A number of stone circles are known from dune country in the Strzelecki Creek area. In addition to the stone circles, other sites associated with ritual activities are known from the historical accounts of early settlers and amateur anthropologists (e.g. Horne and Aiston 1924). While these sites would have been of considerable importance to Aboriginal people in the past, knowledge of these sites has been lost with the break-down of traditional Aboriginal life and resultant loss of knowledge about sites and ceremony.

Dwellings

A number of wooden structures, all that remains of Aboriginal dwellings, have been found to the north of the Habanero wells, on the hills overlooking Innamincka township. These structures would originally have formed the framework on which grass and reeds was placed to provide a water and wind proof covering. These structures were found during a program of field reconnaissance, when a number of such Aboriginal dwellings were recorded (Robins 1981, Lance 1996). The timber used for the construction of these structures bears cut marks which reveals that it was felled with a metal axe. This indicates that the structures were constructed since the arrival of Europeans in the district and may have been built by Aboriginal shepherds working in the area in the years from 1880 to 1910 (Robins 1981:89).

Because these structures are fragile and are destroyed by fire, white ant and flood, they are very rare and hence are of considerable archaeological value.

4. Study methodology

A thorough inspection of the ground surface was carried out to identify cultural remains and delineate areas of high archaeological sensitivity to guide the placement of future construction activities (Figure 3). The survey area was examined closely by foot traverse. Areas with good ground surface visibility were targeted, when these were observed during the transects. A number of traverses across and along the sand dune, provided the best opportunity to detect Aboriginal habitation material, given the widespread occurrence of occupation materials found in dunes throughout the region. Traces of Indigenous habitation were recorded. There was no evidence of historical non-Indigenous activity.

Previous investigations in this region have revealed the presence of Aboriginal occupation material on the gibber downs. This primarily comprises a low-density background scatter of stone artefacts, with localised dense patches in areas with suitable tool-making stone. In these areas are found raw material sources with associated workshops. Criteria have been developed to distinguish the generalised background scatter found across the landscape from the denser clusters of artefacts that mark raw material sources and quarries.

These include:

1. Contain more than 5 artefacts.
2. Cover 5m² or more in area.
3. The average artefact density is greater than 5x the average density of the background scatter.
4. Average density of at least 5/m².
5. Contains a stone artefact assemblage rich in implements or conjoinable pieces (indicating a workshop), or contains cultural items other than stone artefacts, such as hearthstones, bone or shell.

As there were few clusters of artefacts, the distinction between the background scatters and sites was easily recognised. Site boundaries were defined on the basis of artefact density rather than boundaries of exposure.

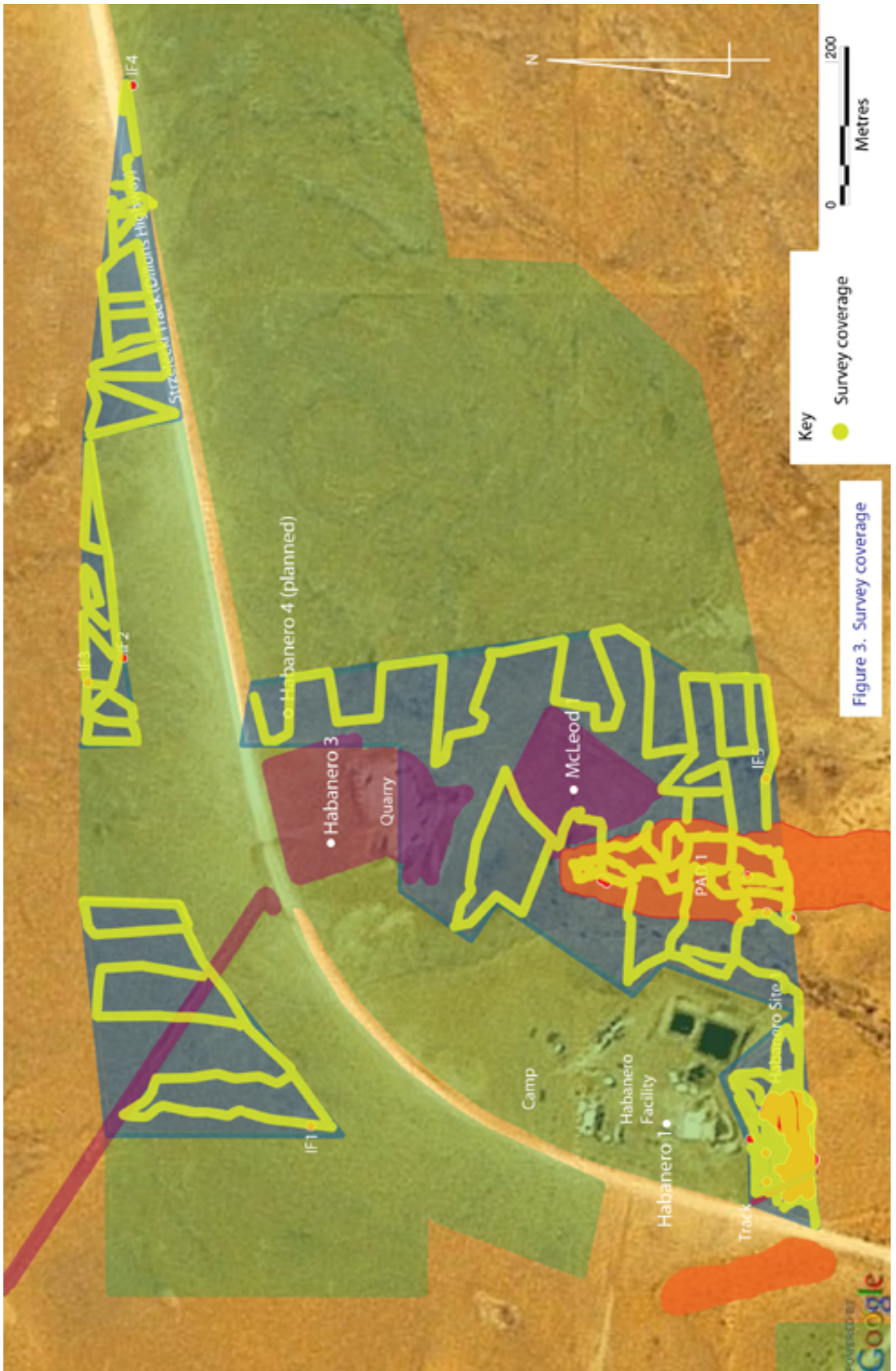


Figure 3. Survey coverage

5. Results

The background scatter of stone artefacts was found across the survey area. This varied according to location, with the lowest densities found on the gibber downs to the north of the Strzelecki Track. When the low ground surface visibility is factored into the survey coverage, the artefact density in this area was approximately 1/500m². Artefact densities on the gibber downs in the southern part of the project area are also low, averaging 1/300m². Stone artefacts found in the gibber are made from silcrete or quartzite. This ranges in quality from medium to very fine-grained. No formal tool types were discovered, although flake tools with edge damage were present, indicating woodworking tasks were being carried out.

Isolated Find 1 (GDA Zone 54J 475809 6923623)

This small quartzite flake was found in an area with reduced vegetation cover, on the gibber downs to the north of the Strzelecki Track and the Habanero 2 well lease. It bears some edge damage on one margin, but no cortex.

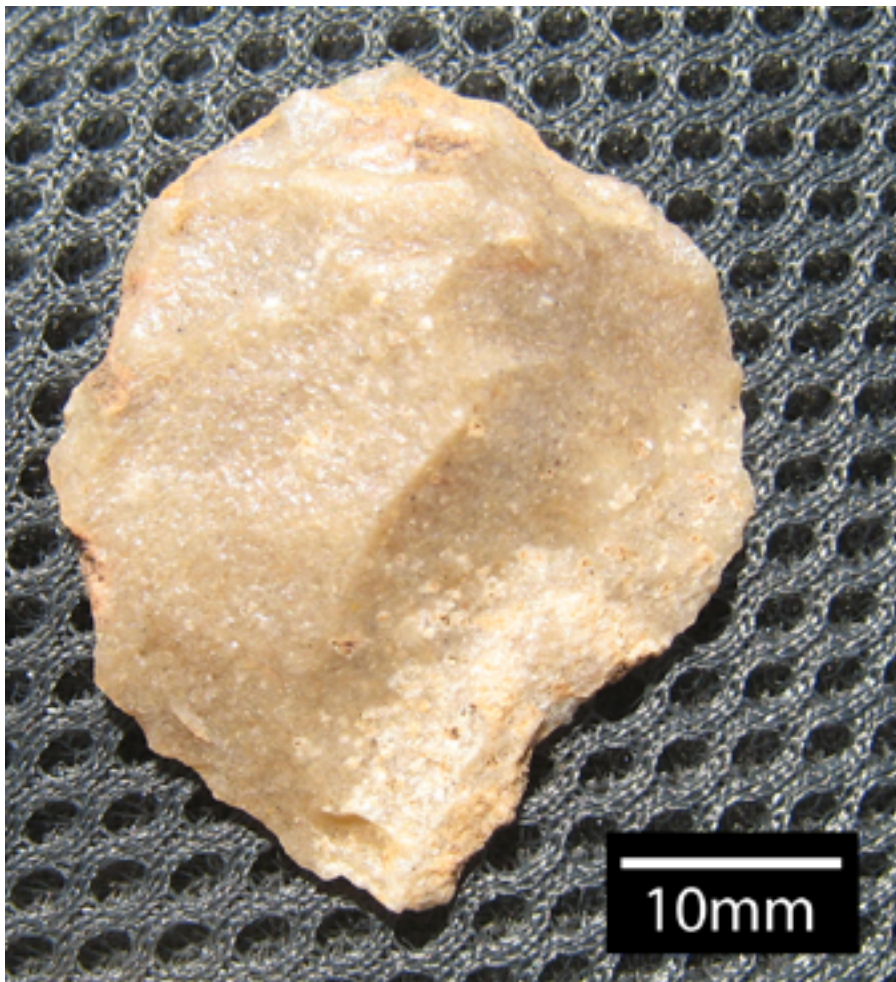


Plate 3. Quartzite flake (IF1) showing dorsal flake surface.

Isolated Find 2 (GDA Zone 54J 476398 6923860)

This silcrete flake was located to the north of the proposed Habanero 4 well lease, in an area of moderate density gibber cover and with thick vegetation cover. The artefact is made from a moderately coarse raw material and retains cortex on the platform surface. It is an outrepassé (overshot) flake, with the flake including a portion of the lower core margin. The raw material type, the cortical platform and shallow core, indicate the core from which this flake was struck was obtained locally.



Plate 4. IF2 showing dorsal flake surface with cortex at bottom of flake.

Isolated Find 3 (GDA Zone 54J 476366 6923904)

This large silcrete flake (60.3x41.9mm) was found 60m to the northwest of IF2. It has been made from a very fine-grained (cryptocrystalline) raw material although there are small inclusions of a coarser material in the matrix. There is no cortex on this artefact, suggesting that this prepared flake was brought from a more distant raw material source. Fine edge damage is found along one flake margin. This comprises scalloped bifacial flake scars ranging from 0.5-1.5mm in width. This edge damage is consistent with timber cutting activities.



Plate 5. IF3 showing dorsal flake surface. Note fine-grained raw material.



Plate 6. Usewear along left-hand margin of IF3 shown in Plate 5.

Isolated Find 4 (GDA Zone 54J 477116 6923850)

This silcrete flake was found just to the south of the Strzelecki Track. It is a coarse-grained artefact with a dorsal face completely covered with cortex. This suggests the flake was produced from a core derived from a local outcrop. The flake is thick and measures 60x78mm.



Plate 7. IF4 showing dorsal flake surface.

Isolated Find 5 (GDA Zone 54J 476247 6923053)

A quartzite flaked piece was found on a gibber pavement at the southern edge of the survey area. This bore cortex on the platform and dorsal flake surface. It bore edge damage and retouch on one margin and measured 33x47mm.



Plate 8. Quartzite flaked piece (IF5) showing flake scars on lower margin.

Habanero Site 1 (GDA Zone 54J 475788 6923013 at centre of site)

To the south of the Habanero facility is a very dense scatter of silcrete artefacts. This is located on a gentle gibber-covered slope, immediately to the east of the Strzelecki Track. The site has been bisected by a vehicle track, and fines washed from upslope, have been deposited on the central part of the site. Artefacts are clustered in an area of 50x130m at densities of up to 25/m². The raw material from which these artefacts have been made is a coffee-coloured, uniform textured stone. The majority of artefacts are flakes and flaked pieces, with small numbers of cores. Artefacts in this tool-making workshop are predominantly large, with elongate flakes measuring up to 15cm. The presence of mainly large, elongate flakes (blade-like) and prepared, single platform blade cores reveals the use of this workshop as the source of trigonal blades manufactured for trade. The silcrete blocks that provided the raw material for production of these blades have been completely exhausted in the tool-making process, leaving nothing more than flaking debris.



Plate 9. View south across Habanero Site 1 showing flaked blocks and scattered artefacts.



Plate 10. Habanero Site 1 showing dense scatter of flaked stone artefacts.

PAD 1 (GDA Zone 54J 476117 6923252 at northern end)

This Potential Archaeological Deposit (PAD) comprises the sand dune located to the east of the Habanero 1 well and camp. Despite the very poor ground surface visibility, nine silcrete artefacts were found on the crest, slopes and around the base of the dune. These included four silcrete cores, four silcrete flakes and a silcrete flaked piece. Average artefact density here was approximately 1/100m², although locally, this was as high as 1/20m². Artefacts are all made from coarse or medium grained silcrete. Artefacts are clustered in two locations on and around the dune. The first location is on the western dune slope, where a core, flake and flaked piece were found within 5m. The second cluster is found 200m to the south and at the base of the dune, where two coarse-grained silcrete cores and a medium-grained silcrete flake were found within 10m. An isolated artefact was found on the dune crest, 50m to the east. This is a silcrete decortication flake with thick cortex. The presence of artefacts with a high proportion of cortex suggests collection of stone from the adjacent gibber downs, followed by preparation of cores and reduction at the dune. There is a high potential for further occupation material to be contained in the sand dune, although from the small number of artefacts found on the surface, it is unlikely to be very abundant.



Plate 11. PAD1 showing stone artefact on scalded surface on the dune crest near the northern end of the dune.

6. Archaeological sensitivity

Localised raw material sources with associated workshops are found through the gibber downs, although the location of these cannot be predicted. The presence of campsite debris, such as occurs on and around the sand dune is more readily predicted. Campsites are normally found on dunes, particularly those near water sources. The presence of a minor spring on the western side of the dune, and a claypan to the south, would have provided a focus for Aboriginal habitation in the past. Low artefact densities on the dune may either reflect infrequent use of the location, or indicate that the absence of erosion of the dune has led to artefacts remaining beneath the dune sand, rather than exposed on the surface. No artefacts were found in the shallow blow-outs in the dune crest. Despite the paucity of evidence of habitation sites in the dune, there remains the very real potential for there to be significant *in situ* deposits in this dune. If activities that disturbed this dune were to occur, further investigation of the occupation deposits should be undertaken first.

7. Summary and recommendations

Small numbers of flaked stone artefacts are found throughout the gibber downs as part of the widespread background scatter. At suitable outcrops, more extensive working has taken place, sometimes for the manufacture of locally used tools, in the present survey area, the discovered raw material source has supplied long blades for the manufacture of trade goods.

In addition to the sporadic occurrence of flaked stone artefacts in the gibber, a higher density scatter of artefacts is found on and around the edges of the low sand dune to the east of Habanero 1.

To ensure that the cultural heritage values of the project area are not compromised it will be necessary for the avoidance of the two archaeologically sensitive areas identified in this site clearance. These are:

- Sand dune to the east of Habanero 1 (PAD1)
- Workshop and raw material source south of Habanero 1 (Habanero Site 1).

To ensure that there are no further impacts to the workshop site, it may be prudent to block access to the minor vehicle track that traverses the site. Alternative access routes are available to the pumping station south of the project area (Figure 2).

Construction of the Habanero 4 well will occur in an area that has either been previously disturbed by quarrying for road base, machinery accessing the quarry, or is located in an area with very low background artefact densities. Consequently, there will be no impacts to Indigenous heritage items.

It should be noted that all Aboriginal archaeological sites in South Australia are protected by provisions of the *Aboriginal Heritage Act, 1988*, which makes deliberate destruction of registered sites, without the written authorisation of the minister, an offence. **If the archaeologically sensitive locations are excluded from development plans, there can be no objection on archaeological or Aboriginal heritage grounds to ground disturbance in the project area.**

Archaeological items dating from the post-contact era are protected in South Australia under Section 27 of the *Heritage Places Act, 1993*, which makes their deliberate removal, damage or destruction an offence. No historical artefacts were located during the field reconnaissance. Should any be uncovered, it will be necessary for a heritage specialist to record and assess the item(s) and provide management advice on the most appropriate impact mitigation measures. **There can be no objection on non-Indigenous cultural heritage grounds to construction in the project area.**

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9. Glossary

- Archaeology** Techniques used to study the human past by looking at their material remains
- Artefact** An object made by humans, more commonly referred to stone artefacts in the Australian context
- Bifacial flaking** Flakes removed from two opposite faces, sometimes with a deliberate rotation of the core using the flake scars from one sequence of flake removals as a platform for the removal of the next sequence of flakes
- Bulb of percussion** Protrusion on the ventral [inner] surface of a flake or blade, caused by the force used in the manufacture of the flake. This feature is characteristic of a culturally rather than naturally derived stone fractures
- Core** A lump or nodule of stone from which one or more flakes have been removed
- Conjoin analysis** Investigation of stone tool technology through the refitting of flakes to cores to reveal the techniques of core preparation and flake removal, and to identify the end-products of reduction.
- Cortex** Outer weathered surface of a block of stone, which can fracture unpredictably and does not hold an edge and is therefore usually removed

prior to controlled flaking of a core

- Decortication** Removal of the outer weathered surface from cores or nodules of rock to permit the controlled working of stone to produce flakes
- Exposure** Extent to which ground surface has been revealed by erosion or disturbance. Archaeological sites which are covered by sediments cannot be detected without subsurface investigation ie excavation
- Flake** A piece of stone detached from a core, which has a bulb of force and a platform
- Flaked piece** A piece of stone which has negative flake scars, indicating that it is an artefact, but which does not bear the two essential characteristics of a flake, namely a striking platform or bulb of percussion
- Gibber** Rounded pebbles and cobbles of weathered silcrete, generally bearing a weathering skin (cortex). The gravel covered gibber downs are the dominant land system in the Innamincka area.
- Ground surface visibility** Degree to which the ground surface can be seen. This is a function of vegetation cover and in the present study was uniformly poor (averaging around 30%).
- Knapping** The removal of flakes from a core using percussion or pressure
- Microblade** A tool-making tradition that employed small cores, with abundant platform preparation to ensure the removal of small regular blades (elongate flakes).
- Outrepassé (overshot) flake** A flake which does not terminate with a thinning of the raw material, in the standard feather termination, but includes the lower part of the core. This results from short cores, or use of excessive force for flake removal.
- Potential Archaeological Deposit (PAD)** This is a landscape unit shown from previous investigation to have a high potential to contain evidence of prior Aboriginal habitation. PADs include sand dunes, particularly those near water sources, creek banks, rocky outcrops.

Platform	A flat area on a flake, where the core was struck to remove the flake (striking platform)
Pleistocene	While the Pleistocene epoch began approximately 1.64 million years ago, it is the late Pleistocene period between about 60,000 and 10,000 years that is of greatest interest to those studying Australian archaeology, as it was within this time that Indigenous people first arrived and flourished on the Australian continent.
Quartzite	A hard, conchoidally fracturing rock with a sugary texture and comprising sand grains cemented by silica. When the rock fractures, the fracture line follows the grain boundaries rather than passing through the grains as is the case with silcrete
Reduction	The deliberate working of a core to produce flakes, increasing the by-products while at the same time decreasing the mass of the core
Retouch	The removal of flakes from a stone artefact, typically a flake, to either sharpen a blunted edge or to deliberately blunt an edge to assist in its handling or hafting
Silcrete	Stone type made up of silicified sandstones and conglomerates, fracturing with a glassy fracture that made it suitable for the manufacture of stone tools
Site	Any location bearing evidence of past human activity
Site clearance	Inspection of prospective development area, identifying areas of high archaeological or cultural sensitivity, where development should not proceed. This contrasts with a standard archaeological survey where sites are identified for avoidance. A site clearance permits traditional owner groups the opportunity to protect culturally significant areas without necessarily revealing the reason for that significance.
Stone artefact scatter	Surface scatter of stone tools and/or stone refuse discarded in their manufacture
Trigonal blades	Blades (elongate flakes) with a triangular or trapezoidal cross section, removed from long cores, often following platform preparation. These

long blades were mostly produced for trade, rather than for domestic use. They are thought to have been used as knives, or broken into segments and reworked, by the people who acquired them. Few trigonal blades are found at local campsites through the Cooper Basin, while many traces of their manufacture are found at workshops in the Innamincka district

Workshop

Often dense scatter of flaked stone, made from the same raw material that has been knapped at the same time. Workshops can potentially be reconstructed, with the flakes being refitted to the cores from which they were struck.

APPENDIX C – ALIEN SPECIES FLORA ASSESSMENT



**Alien Flora Species Assessment
Geodynamics Operations,
Cooper Basin, SA**

Alien Flora Species Assessment, Geodynamics Operations, Cooper Basin, SA

20 November 2012

Version 2

Prepared by EBS Ecology for Geodynamics Pty Ltd.

Document Control					
Revision No.	Date issued	Authors	Reviewed by	Date Reviewed	Revision type
1	16/11/2012	A. Sinel	T. How	16/11/2012	Draft
2	20/11/2012	A. Sinel	T. How	20/11/2012	Final

Distribution of Copies			
Revision No.	Date issued	Media	Issued to
1	16/11/2012	Electronic	Steve Fermio, Steve Fermio Environmental
2	20/11/2012	Electronic	Steve Fermio, Steve Fermio Environmental

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CITATION: EBS Ecology (2012) *Alien Flora Species Assessment, Geodynamics Operations, Cooper Basin SA*. Report to Geodynamics Pty Ltd. EBS Ecology, Adelaide.

Front cover photo: *Argemone ochroleuca* (Mexican Poppy) at Habanero 1 camp area.

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1 INTRODUCTION

EBS Ecology was engaged by Geodynamics Pty Ltd. to undertake an assessment to indicate the presence and density of alien flora species in and around their operational areas in the Cooper Basin near Innamincka, in the north-eastern pastoral zone of South Australia. This specifically involved all existing geothermal well sites, camp areas and lay down (storage) yards.

It is understood that the results of this survey will guide and contribute to future weed management strategies required as part of the responsible stewardship of Cooper Basin exploration lease areas.

1.1 Objectives

The objectives of the project were to:

- Record the incidence of alien flora species within and in the vicinity of operational areas
- List species of higher priority due to legislative listings, invasiveness and frequency of occurrence
- Highlight flora species not recorded at the time of the survey but likely to be in the area periodically
- Manage the overall spread of weeds
- Recommend management strategies and methods for control of specific species.

2 BACKGROUND INFORMATION

2.1 Site details

Geodynamics Pty Ltd has a number of well sites located in the Cooper basin area, south of Innamincka, South Australia (Figure 1). These are located within the Innamincka Regional Reserve which is 13,818 km² in size and located in the far north-east of South Australia, approximately 1,100 km from Adelaide. Innamincka Regional Reserve is bounded to the east by the South Australia / Queensland border. The township of Innamincka is located within the Reserve's boundaries, but is not included as part of the Reserve. The project area falls within the Marree Soil Conservation District (Far North Region Department of Environment and Land Management 1993; North Region Heritage and Biodiversity 1998).

2.1.1 Threatening processes

The main cause of degradation is over-grazing by stock, however, a number of pest species such as Rabbits (*Oryctolagus cuniculus*), Camels (*Camelus dromedarius*), Pigs (*Sus scrofa*), Goats (*Capra hircus*), Foxes (*Vulpes vulpes*), and feral Cats (*Felis catus*) are also present (Australian Natural Resources Atlas 2007).

2.1.2 Location and land use

The dominant land uses in Innamincka Regional Reserve are pastoralism, tourism, petroleum and natural gas production. The Bioregion is located in the Eromanga Basin, which contains major oil and natural gas deposits. Wildlife and landscape conservation is also a key purpose of the Reserve, as well as the conservation of historic structures. Innamincka Regional Reserve has been declared a State Heritage Area. The Reserve has been grazed since the 1870's and is currently leased and managed by Kidman and Co. Pastoral Company. The area is significant to Aboriginal people of the Yandruwandha, Yarrawarka and Dieri groups.



Figure 1. Location of Geodynamics operational areas.

2.1.3 Climate

Data averages were obtained from the nearest Bureau of Meteorology weather station with long term data at Moomba Airport. Data obtained from the Moomba Airport weather station show that the average annual rainfall is 189.8 mm. 2012 has so far received 184.8mm of rainfall with most of that falling early this year (Figure 2). The period in the three months leading up to the survey have been dry with 2.8mm of rainfall falling from the start of July 2012.

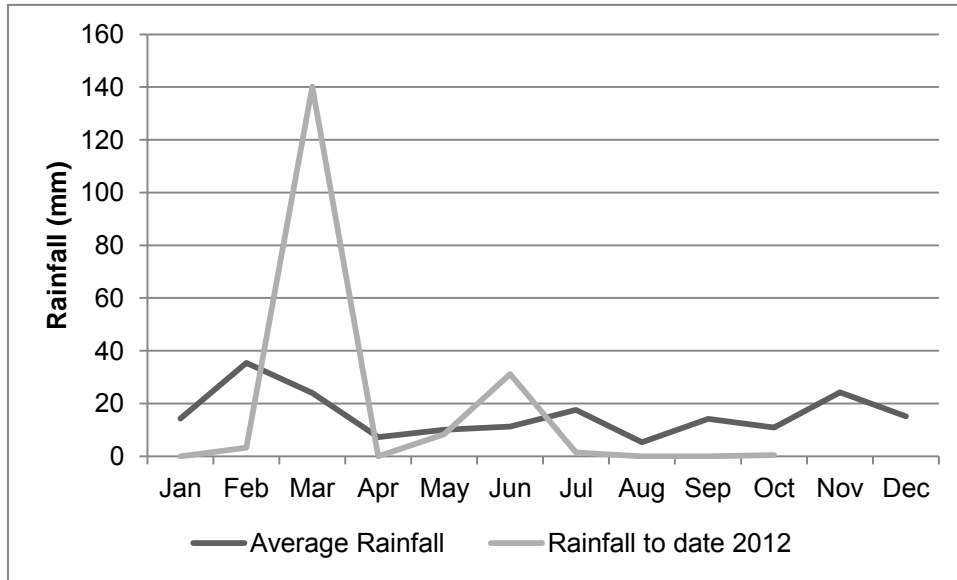


Figure 2. Average annual rainfall and 2012 to end October rainfall at Moomba Airport.

2.1.4 Statutory requirements

This report fulfils obligations stated under the Statements for Environmental Objectives for Drilling and Well Operations and the 1MW Power Plant which is a requirement of the Petroleum and Geothermal Regulations 2000 sections 12 and 13 under the Petroleum and Geothermal Act 2000.

3 METHODS

3.1 Field survey

Field survey was conducted on the 24 - 25th October 2012. This was undertaken on foot at each location where the general area was surveyed using a ramble method with a priority on targeting areas such as dam overflow areas, tracks and camp areas. Outbreaks of individual significant weeds and patches was marked using a hand held GPS unit which gives an accuracy of +/-5m. Photos of individual alien species were taken to aid in identification for ongoing weed management purposes.

4 RESULTS

4.1 Field survey

Six individual sites were assessed as part of this survey and are listed below;

- Habanero 1, includes the camp and main administrative areas, with water treatment areas, storage facility and car parks
- Habanero 2, primarily well pad with associated water storage area
- Habanero 3, well site and Habanero 4 well site and associated infrastructure for ongoing works including drill sump and soil stockpiling area.
- Habanero Lay down yard and associated storage compound
- Jolokia 1, rehabilitated well pad, camp pad and associated water storage dam
- Savina 1, Well pad and fenced stock proof operational area which has undergone rehabilitation.

4.1.1 Alien flora species

Ten alien flora species were observed across all sites assessed (Table 1). The majority of these were recorded at the Habanero 1 site which includes the camp, workshops and storage area. Jolokia recorded two weed species while the remaining sites each recorded one alien flora species.

Table 1. Alien flora species recorded at individual sites during assessment.

Species	Common name	Habanero 1	Habanero 2	Habanero 3&4	Lay Down	Jolokia	Savina
<i>Argemone ochroleuca</i>	Mexican Poppy	✓					
<i>Brassica tournefortii</i>	Wild Turnip	✓					
<i>Citrullus colocynthis</i>	Colocynth	✓					
<i>Conyza bonariensis</i>	Flax-leaf Fleabane	✓					
<i>Cynodon dactylon</i>	Common Couch	✓					
<i>Lactuca serriola</i>	Prickly Lettuce				✓	✓	
<i>Lepidium bonariense</i>	Cut-leaf Peppergrass	✓					
<i>Malvastrum americanum</i>	Malvastrum	✓					
<i>Solanum nigrum</i>	Black Nightshade	✓					
<i>Sonchus oleraceus</i>	Common Sow-thistle	✓	✓	✓		✓	✓

The most commonly recorded weed species was *Lactuca serriola* (Prickly Lettuce) and *Sonchus oleraceus* (Sow Thistle).

Two individual plants of *Argemone ochroleuca* (Mexican Poppy) were recorded. This species has no herbarium records from the area and is commonly regarded as being restricted more to the south of the pastoral region. It has however, been observed previously by the author on the floodplain of the Cooper Creek. The sample collected during this survey is to be lodged with the state herbarium.

The majority of the alien species recorded in northern South Australia have Mediterranean or South African origins and flourish in periods following good winter rainfall. Although there was above average autumn rainfall in 2012, this did not necessarily result in the growth conditions that could have enabled many species to become prevalent for the spring season. It is still expected however, that species which would normally occur onsite were present at the time of the survey.

Salsola tragus (Buckbush) is the species reported as being the most common alien plant at the camp area by the initial Fatchen 2002 Environmental report and was still observed as being common across all well sites. This species is regarded as a cosmopolitan rather than alien species and so should not be included in the list of alien plants.

4.1.2 Notes on other species recorded

Citrullus colocynthis (Colocynth)

This perennial species is very common in northern South Australia, particularly following late spring and summer rainfall. This was recorded in the drainage channel to the south of the Habanero 1 site. Not considered a high threat for invasiveness and is controlled relatively easily if located and removed prior to fruiting.

Cynodon dactylon (Couch)

Found at the rear of the camp adjacent the soakage pit area. This is a common species along drains and around water points throughout the surrounding pastoral country. Best sprayed with a knockdown herbicide and followed up periodically.

Solanum nigrum (Black Nightshade)

Recorded near the visitors centre, it is common in similar habitats throughout much of the northern pastoral areas of South Australia. This can be controlled with a knockdown herbicide and should be sprayed prior to flowering during periods of active growth. High invasiveness which can rapidly cover large areas.

Sonchus oleraceus (Common Sow-thistle)

Found in the soakage pit areas at the Habanero 1 site, it was also found growing in many other temporarily wet areas at all sites. This is a common species along drains and around water points

Alien Species Flora Assessment, Geodynamics Operations, Cooper Basin, SA throughout the surrounding pastoral country. Very easily controlled with knockdown herbicides and while a prolific seeder, does not overtake areas other than permanently wet sites.

Lactuca serriola (Prickly Lettuce)

Located at the Jolokia well site at the rear of the temporary camp pad and was also recorded in high numbers in the lay down yard. A common species in arid regions often found in sites where disturbance occurs. This species can be invasive, however it is rarely seen in large patches. Best control methods are to spray with a knockdown herbicide or manually removed with a grubber.

4.1.3 Introduced species which occur in the general area but were not recorded within the well lease areas.

Cenchrus ciliaris (Buffel Grass)

This species has been widely planted for stock fodder by pastoralists in northern South Australia. It was present on the sandy rises surrounding the Cooper Creek floodplain. This is a high threat weed that should be removed immediately once observed. Forms a large tussock once established and is a prolific seeder.

Chenopodium murale (Nettle-leaf Goosefoot)

This species is common at many pastoral watering points and stock yards taking advantage of nutrition loading at these sites.

Cucumis myriocarpus (Paddy Melon)

Widespread and common species occurs as an ephemeral species often growing quickly after rainfall with the vine dying down leaving scattered yellow and green lined prickly grape sized fruits.

Sisymbrium irio (London Mustard)

This is a common species in wet, shaded habitats, particularly along watercourses, throughout the surrounding pastoral country.

Carrichtera annua (Wards Weed)

Commonly found in low lying areas with sandy loam soils, often by roadsides and under trees. Associated with areas which have been grazed heavily or soil disturbance has occurred.

4.2 Individual site summaries

4.2.1 Habanero 1

The Habanero 1 area is subjected to the highest levels of potential weed invasion due to the proximity to the Dillon's Highway. There are a high number of vehicles arriving and departing each day including operational vehicles and delivery vehicles. This gives the highest potential for infiltration of seed, from manmade vectors and carried by animals which are attracted to the area for water and food.

Several weed species were present in the immediate area with most of these near the visitors centre and main office. The highest density of weeds was where the septic pit soakage areas were which contained *Sonchus oleraceus* (Sow Thistle) which out competes all other weeds in the area. These were mixed with dense thickets of the native shrubs *Enchylaena tomentosa* (Ruby Saltbush) and *Einadia nutans* (Berry Saltbush). *Lepidium bonariense* (Cut Leaf Peppergrass) was scattered throughout the area, predominantly in the camp area as individuals. The native species *Lepidium phlebopetalum* (Veined peppergrass) was also present throughout the site which is identifiable by its shorter stature, leathery linear leaves and deep purple colour of the fruits. Refer to Figure 3 for locations of weed species occurrences.

Hababero 1

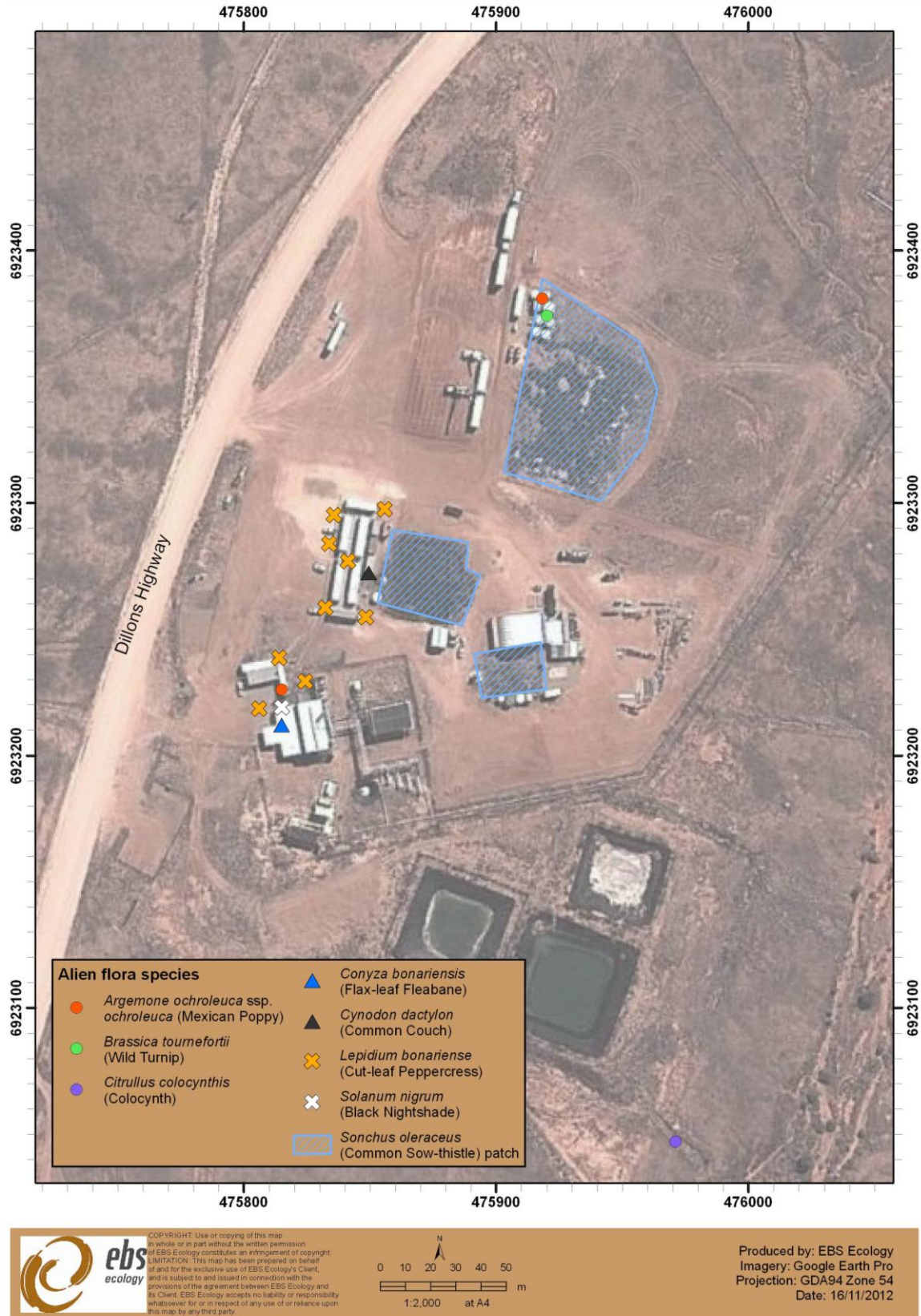


Figure 3. Hababero 1 and Camp weed occurrences.

4.2.2 Habanero 2

This site was within an *Atalaya hemiglauca* (Whitewood) low open woodland on sandy soils with a native understory of grasses such as *Aristida contorta* (Kerosene Grass). Alien species recorded were *Sonchus oleraceus* (Sow Thistle) which was scattered throughout the lowest areas of the site where water pools following rain events. An example of this is at the western edge of the dam complex that was dominated by indigenous species (Figure 4). No other weed species existed onsite and targeted searches in areas where disturbance has occurred turned up no results (Figure 5).



Figure 4. Low area adjacent the dam where weed invasion would be expected.

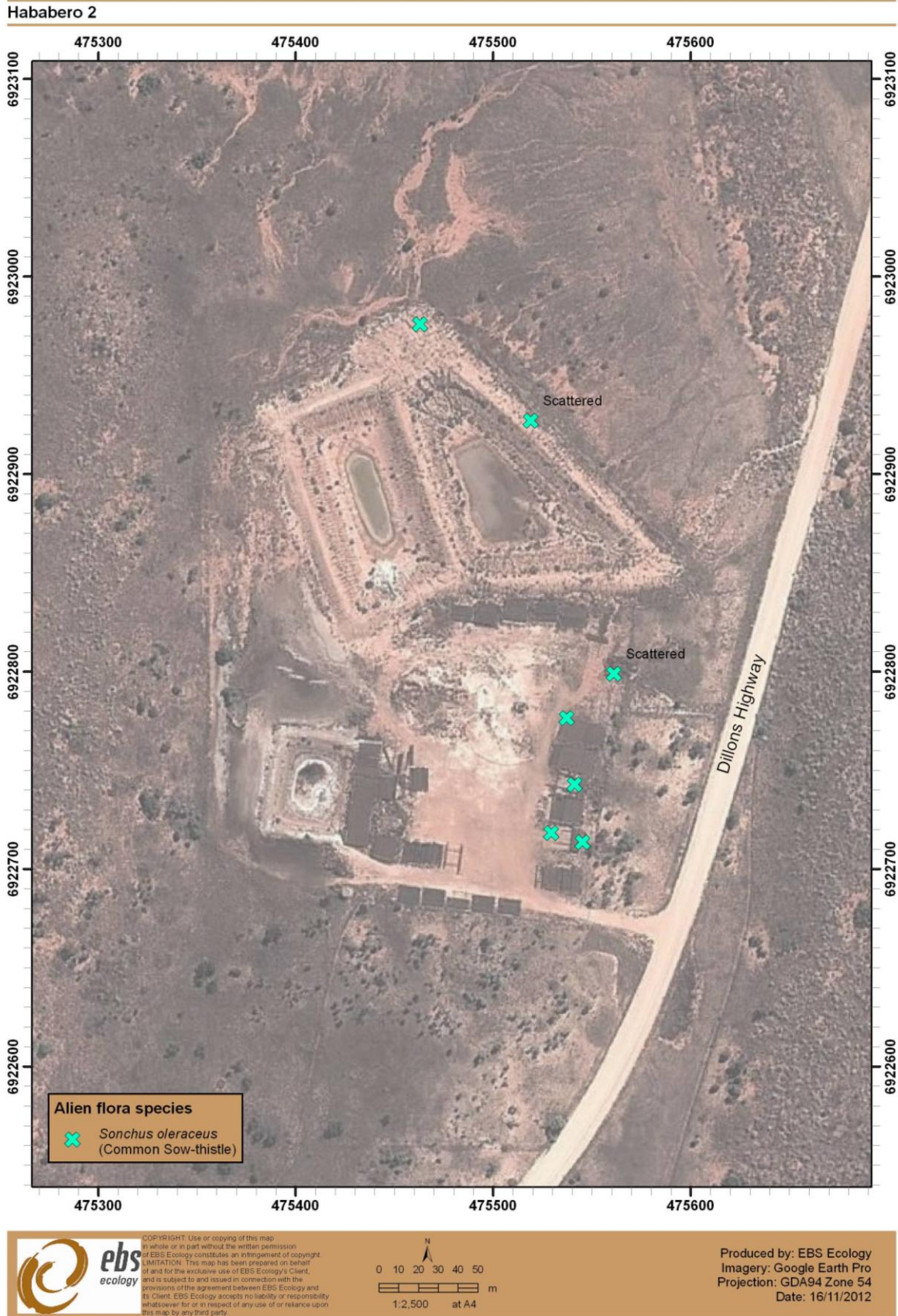


Figure 5. Habanero 2 weed occurrences.

4.2.3 Habanero 3 & 4

The Habanero 4 project was underway at the time of the survey and weed occurrences were limited to the office compound area where a large patch of *Sonchus oleraceus* was present along the fence line, possibly due to water runoff from equipment or infrastructure associated with the project office. Habanero 3 was fenced and had no alien species present in the vicinity (Figure 6).

Surrounding vegetation was dominated by *Astrebla pectinata* (Mitchell Grass) and *Sporobolus actinocladus* (Ray Grass). There was no evidence of weed invasion in the surrounding indigenous vegetation in the vicinity of this site.

4.2.4 Lay down yard and storage compound

Large numbers of *Lactuca serriola* (Prickly Lettuce) were recorded across the entire yard but mostly as individuals or groups of up to five (Figure 6). These could be manually removed using a grubber or shovel. No other alien species were observed in the vicinity of the yard.

4.2.5 Jolokia

Very few alien species were observed in the Jolokia wellsite and associated water retention areas (Figure 7). Overflow areas and low lying depressions were all weed free. One *Sonchus oleraceus* (Sow Thistle) and a group of approximately 30 *Lactuca serriola* (Prickly Lettuce) plants at the former drillers camp area were the alien species observed at the time of the survey. Large numbers of emergent indigenous shrubs such as *Hakea eyreana* (Corkwood) were observed in the area and on the rehabilitated sections of the well pad.

4.2.6 Savina

The Savina well site was recently rehabilitated and contour ripped which has left a large area of disturbed ground. No weed species invasion was visible in these areas however a large number of indigenous species had begun to emerge. These included *Stemodia florulenta* (Bluerod), *Sclerolaena calcarata* (Sclerolaena), *Goodenia fasciculiflora* (Silky Goodenia) and *Sclerolaena bicornis* (Goat head Burr). *Sonchus oleraceus* (Sow Thistle) was present in the remaining undisturbed native vegetation stratum at densities that were consistent with the surrounding floodplain area.

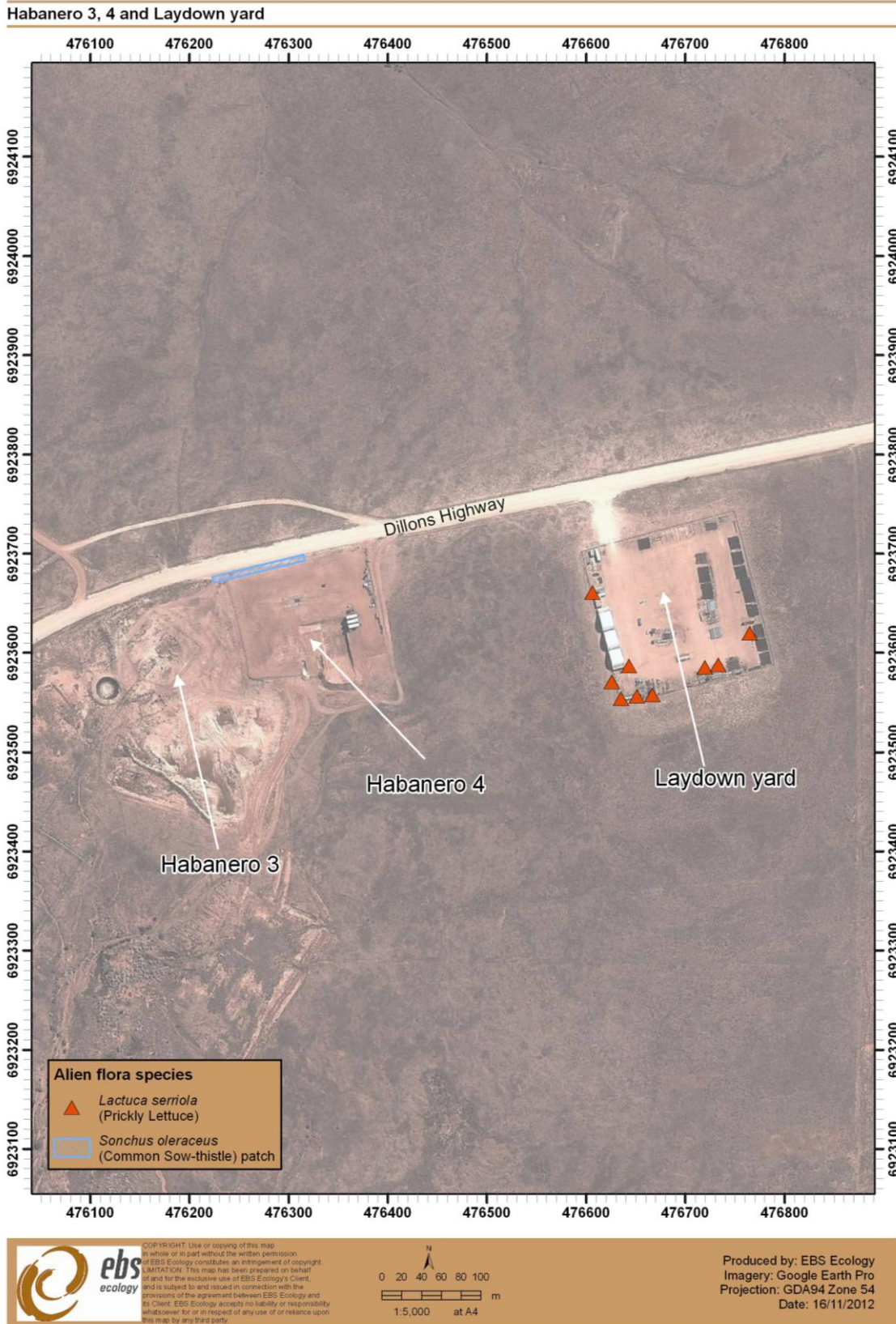


Figure 6. Habanero 3 and 4 and laydown area weed occurrences.

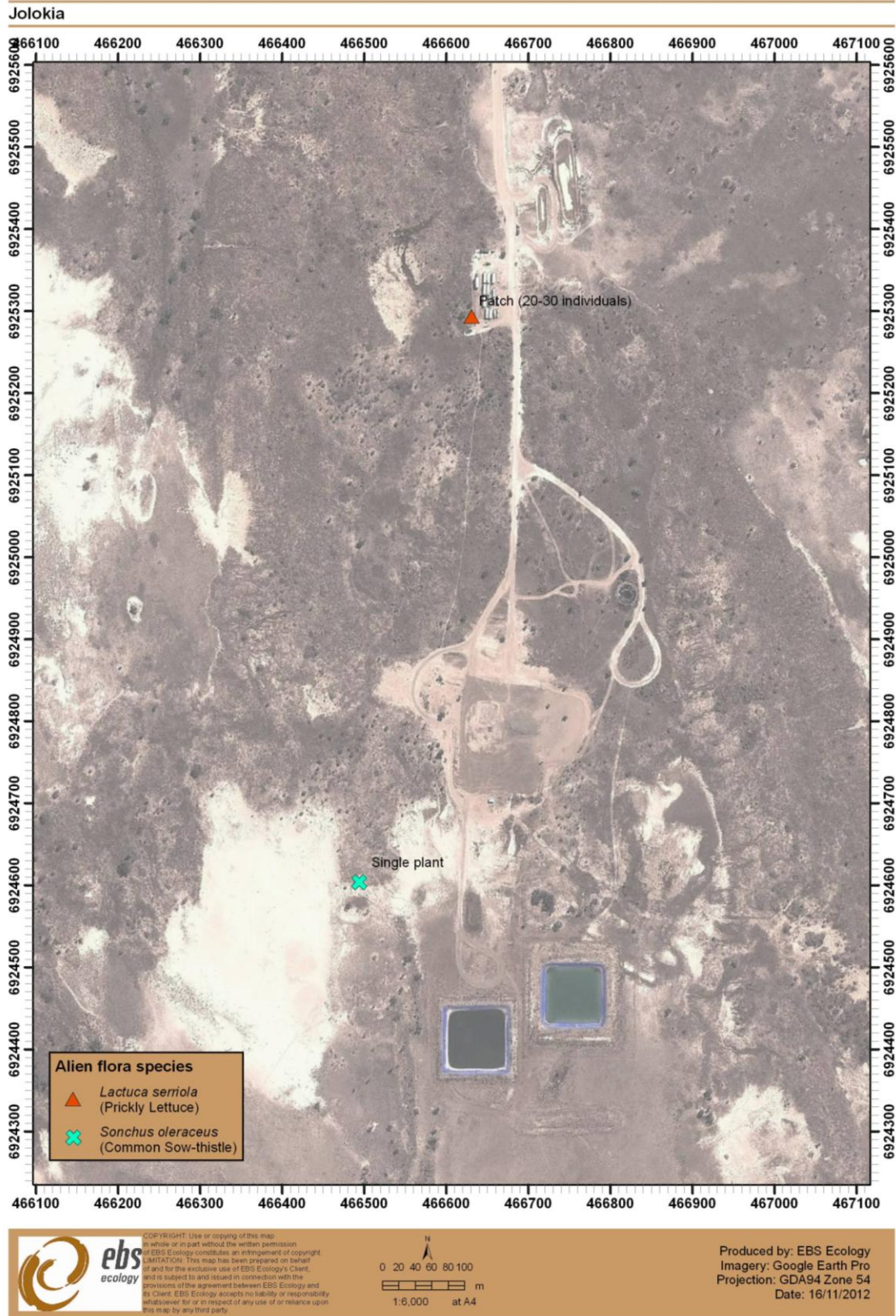


Figure 7. Jolokia weed occurrences.

5 DISCUSSION

Overall weed densities are considered to be low and previous control efforts for many species appeared to have been moderately successful. The Jolokia and Savina well sites have very low weed occurrences and considering their proximity to the Cooper Creek floodplain and previous high rainfall seasons, these would be very good results for any area which has undergone significant activity in recent years. The main campsite has the most species and highest densities of anywhere most likely due to the high incidences of outside transportation of goods from regional areas. A focus on this site for future monitoring is the preferred option considering the proximity to the main road and the geographical proximity to an ephemeral drainage channel south of the camp.

No alien species recorded onsite are listed as weeds of national significance or declared under the Natural Resources Management Act 2004. *Solanum nigrum* (Black Nightshade) has the highest invasion potential but was not recorded in high densities that would indicate a threat to native species diversity.

Target areas for weed monitoring are the low drainage depressions south of the camp area where damp conditions may persist for extended periods. This gives emergent species a better chance of surviving to maturity and may also grow at densities that exclude resources for indigenous species downstream reducing biodiversity values.

Rainfall totals for the region are average or above for 2012 with good fall occurring during March and in June which would have allowed alien species to germinate and maintain growth through the cooler months leading into spring. Despite this, the results show that alien species do not present a significant threat at this point in time. In an effort to ensure that this situation remains a three monthly weed monitoring survey should be conducted with control methods undertaken as necessary. It is imperative that alien species are not given the opportunity to develop to a maturity that allows the next generation of seed to remain behind. A monitoring survey and weed control actions undertaken by Geodynamics staff at intervals of 5-8 weeks following rainfall totals of 10mm or more would result in a reduction in alien species abundances.

6 CONTROL METHODOLOGY

There are a variety of weed control methods that can be utilised to effectively control different weed species. Due to the nature of the weed species found within the project area, it is recommended that weeds are either spot sprayed with a knockdown herbicide (such as a glyphosate based herbicide) or hand pulling / chipping. The way to carry out each method effectively and safely is detailed below:

6.1 Spot spraying

- The most effective time of the year to spray is when the plant is actively growing;
- Look for native plants and cover with plastic bags or sheeting while spraying. If there are too many native plants amongst the weeds then this method should not be used;
- Always read the label on the herbicide container, follow the instructions and wear protective clothing. Dilute the mixture as recommended. Add a dye to the herbicide mixture that will help to indicate where spraying has already been done;
- If spraying near creeks or other water bodies, care needs to be taken due to the aquatic environment. Herbicides can have a negative effect on aquatic fauna such as frogs. It is preferable to use other more accurate methods such as cut and swab and drill and fill along creek lines;
- Surfactants can also be used when spraying plants which have a waxy leaf surface. A surfactant can be added to the herbicide mix which will increase the uptake of the poison through the waxy leaf surface. Surfactants should not be used on or near plants growing in water as they are suspected of affecting frogs;
- Where weeds have narrow vertical leaves, spraying might result in herbicide running off or drifting onto non-target plants. In this situation, wipe on the herbicide mixture with a weed wand, sponge or wick applicator;
- To increase the effectiveness of the herbicide whilst spraying large tussocks of grass, the grass can be slashed and then left to re-grow for several weeks. The regrowth can then be sprayed.

6.2 Hand pulling / chipping

- Hand pulling of smaller plants is easiest when there is moisture in the soil making it soft and the seedlings are much easier to pull out;
- Seedlings: take hold of the plant at ground level and pull. If you pull at any point higher on the stem it may break and the plant will then require swabbing with herbicide;

- **Small woody plants:** Take hold of the stem at ground level and gently rock the plant back and forth until it comes away cleanly;
- If needed, a screw driver or similar can be used to gently lift the bulb out of the ground;
- If possible place both feet or fingers on either side of the plant when pulling out. This helps to keep the soil in place and avoids unnecessary disturbance of the soil.
- To chip plants out, use a mattock to remove plants from the ground. Minimise soil disturbance whilst undertaking this activity but ensure that the entire plant and where possible, all of the roots are removed. A number of plants can re-shoot from roots left in the ground. Ensure that any disturbed soil is replaced and patted down.

6.3 Suitable Products

Listed below are a range of products that are available for use in sensitive environments and areas where translocation due to rainfall runoff is an issue. These products are available from Globe Australia (sales@globeaustralia.com.au) which is a company specialising in chemical products for the turf industry where environmental performance is required.

6.3.1 Herbicides

Gulf Ag, ClearUp Bio 360-

Non selective herbicide for general weed control around urban areas, parks, gardens, bushland and other environmentally sensitive areas. For the control of a range of grass, broadleaf and woody weeds around creeks, rivers, lakes, dams, channels and drains. Apply at rates of 75-100ml/15L knapsack.

Monsanto, Roundup Biactive 360g/L

Controls many weeds, both in aquatic situations and in a wide range of use situations. Roundup Biactive can be used safely for weed control in aquatic and sensitive environmental areas such as channels, drains, streams and rivers.

6.3.2 Additives

Spraymate Liase Liquid Herbicide Adjuvant

Contains 417g/L ammonium sulphate for use with glyphosate based herbicides to minimise antagonism when tank mixing flowable herbicides and improve performance under adverse environmental conditions.

EnviroDye Red Liquid marking dye

Environmentally compatible colourant for use as a spray marker with pesticide sprays to indicate where pesticide has been applied. Excellent compatibility with herbicides and safe to use with Glyphosate.



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APPENDIX D – RISK ASSESSMENT

Table 6 – Risk Assessment

Section No.	Environmental Aspect Event/Activity	Potential Consequences	Mitigation Measures	Likelihood	Consequence	Risk Rating
9.2.1	Erosion	Soil disturbance and erosion	<p>All staff inducted into Precise Outcomes environmental requirements</p> <p>Signage and fencing used to restrict access to undisturbed areas and those undergoing revegetation and rehabilitation</p> <p>Sediment controls installed in eroding areas within the site</p> <p>Areas not required for operations cordoned off to optimise vegetation cover</p> <p>Erosion and sediment control measures regularly inspected and maintained</p> <p>Disturbed areas of the site progressively stabilised and rehabilitated</p> <p>Stormwater flows onto, through and from the site controlled; and</p> <p>Controlled vehicle access to the site through dedicated entry/exit points, roadways and parking areas.</p>	Possible	Moderate	Medium

Section No.	Environmental Aspect Event/Activity	Potential Consequences	Mitigation Measures	Likelihood	Consequence	Risk Rating
9.2.2	Vegetation, weeds and pests	<p>Increased weed occurrence and competition with native species</p> <p>Introduction of weed and pest species</p> <p>Clearance of vegetation due to construction and operational activities</p>	<p>All staff inducted into Precise Outcomes environmental requirements for weed and pest management</p> <p>Regular site inspections to check for weed infestations and control / eradication of any weeds identified</p> <p>Access outside existing site areas restricted through the use of signage and fencing</p> <p>All interstate or high-risk vehicles or equipment checked and cleaned prior to entering the Cooper Basin area</p> <p>All vehicles required to remain on formed roads and tracks within the project area</p> <p>Any new area to be cleared/modified of vegetation will be assessed and important vegetation will be avoided where possible</p> <p>Any new vegetation clearance will also need to be subject to significant environmental benefits (SEB)</p> <p>Disturbance and clearance of native groundcover minimised as far as possible; and</p> <p>Domestic waste stored in covered skips to minimise scavenging.</p>	Unlikely	Minor	Low

Section No.	Environmental Aspect Event/Activity	Potential Consequences	Mitigation Measures	Likelihood	Consequence	Risk Rating
9.2.3	Stakeholders, land use and/or associated infrastructure disturbance	<p>Smothering and reduced plant growth</p> <p>Potential effect on local air quality</p> <p>The disruption to land use and impacts to pastoral and/or other business reputation</p>	<p>Areas of native vegetation on site that are not required for plant operations to be cordoned off and retained; and</p> <p>Cover truck loads to minimise tracking of dust</p> <p>The use of water cart may be used on an as needs basis (e.g., during construction activities) to prevent the generation/accumulation of dust</p> <p>An 10km/hour speed limit enforced on all roads used by site staff and contractors.</p> <p>Areas of native vegetation on site that are not required for plant operations to be cordoned off and retained</p> <p>Construction activities with the potential to generate dust during unfavourable weather conditions within site will be monitored and modified as required.</p>	Possible	Insignificant	Low
NA	Groundwater and Surface Water	<p>Reduction in groundwater levels, availability and quality</p> <p>Contamination of surface soils</p>	<p>Groundwater extracted and used in accordance with licence conditions and exemptions</p> <p>Groundwater bores inspected regularly to check for any potential contamination issues</p> <p>Regular monitoring of the water level in Darby's Bore to detect any significant changes in its recharge which may indicate over extraction and the need for potable water to be tankered from Moomba</p> <p>Also refer to 9.2.7 regarding fuel and chemical storage and handling</p>	Unlikely	Moderate	Low

Section No.	Environmental Aspect Event/Activity	Potential Consequences	Mitigation Measures	Likelihood	Consequence	Risk Rating
9.2.2	Native fauna & flora	<p>Potential mortality due to collisions</p> <p>Risk of introduced species</p> <p>Potential reduction in species due to movement away from the area</p>	<p>All staff inducted into Precise Outcomes environmental requirements</p> <p>An <i>Environmental Control Plan</i> will be posted in prominent areas on site (this will be submitted to the Department as part of each Activity Notification prepared for any activity undertaken under this SEO).</p> <p>Areas of native vegetation on site that are not required for plant operations retained</p> <p>Access outside existing site areas restricted through the use of No-Go Zone signage and fencing</p> <p>Strict site rules adhered to - to minimise off-road driving and access to non-designated work areas</p> <p>Site fencing maintained to avoid, minimise and manage impacts associated with native animals gaining access to any water storage areas</p> <p>Waste management procedures adhered to - to reduce potential food sources for introduced pests and vermin</p> <p>Clearance of native vegetation is avoided as far as reasonably practical; and</p> <p>Facilities, pits/cellars and water storages appropriately fenced/covered to minimise access to native fauna</p>	Unlikely	Minor	Low

9.2.4	Indigenous heritage	Disturbance or interference to sites, objects or remains of Indigenous heritage significance	<p>All site-based staff and contractors to be inducted into Precise Outcomes environmental requirements and provided with guidance on Indigenous heritage control measures</p> <p>An <i>Environmental Control Plan</i> which details Indigenous sensitive areas and no-go zones to be posted in prominent areas on site this will be submitted to the Department as part of each Activity Notification prepared for any activity undertaken under this SEO.</p> <p>Further Indigenous heritage surveys will be undertaken prior to the disturbance of any new ground that has not been previously disturbed.</p> <p>Signage to indicate public versus private roads and access tracks to discourage third party access to infrastructure, hence impacts to sites of cultural heritage significance.</p> <p>Sites of potential cultural and heritage significance are managed in liaison with relevant stakeholders</p> <p>Consultation with stakeholders in relation to the possible existence and management of heritage sites</p> <p>Surface water run off flows onto, through and from the site controlled,</p> <p>Sensitive area signage to be used to provide further protection of Indigenous sensitive areas in proximity of operating areas</p> <p>Precise Outcomes may consider removing the gate and closing off access to the existing track to Darby's Bore as a means to protect Aboriginal site 7042-4151. In this case an alternative access track to the bore would be identified and constructed in consultation with the YYTLOAC. ; and</p> <p>Work to be stopped and the Aboriginal Affairs & Reconciliation Division of the Department of Premier and Cabinet to be notified if aboriginal heritage objects are discovered and a</p>	Unlikely	Minor	Low
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Section No.	Environmental Aspect Event/Activity	Potential Consequences	Mitigation Measures	Likelihood	Consequence	Risk Rating
			heritage specialist to be commissioned to record and assess the item(s) and provide management advice on the most appropriate impact mitigation measures and any consultation required with traditional owners.			

Section No.	Environmental Aspect Event/Activity	Potential Consequences	Mitigation Measures	Likelihood	Consequence	Risk Rating
9.2.5	Fuels and chemicals	Impact on soil, groundwater and surface water from inappropriate storage and handling of fuels and chemicals	<p>Fuels and chemicals stored in accordance with EPA requirements</p> <p>All staff inducted into Precise Outcomes environmental requirements</p> <p>Fuels and chemicals stored in accordance with the requirements of the South Australian EPA's bunding guideline 080/16 Bunding & Spill Management (May 2016)</p> <p>Spills cleaned up immediately and any contaminated soil treated and disposed of in accordance with the waste management procedure</p> <p>Spill kits located in close proximity to fuel and chemical storage and refuelling areas</p> <p>Sites regularly inspected to ensure chemicals and fuels stored in bunded and/or double skinned storage tanks and areas in accordance with EPA requirements.</p> <p>Incident Response and reporting procedures implemented in accordance with Precise Outcomes corporate management system requirements; and</p> <p>Material Safety Data Sheets available on site for all fuels and chemicals stored on site</p> <p>Where possible refuelling areas should be located on a hardstand and bunded area. Where this is not possible any soil contaminated during refuelling operations will be collected for appropriate treatment and disposal in accordance with the waste management procedure</p>	Unlikely	Minor	Low

9.2.6	Waste storage, handling and disposal	<p>Impact on soil, groundwater and surface water</p> <p>Impact on local air quality and environment</p> <p>Health impacts from toxic and hazardous substances on personnel and public</p>	<p>All wastes to be disposed of at Moomba or other EPA licensed facility. No wastes are to be disposed of at the Innamincka landfill</p> <p>Wastewater must be treated and disposed of in accordance with the SA Public Health (Wastewater) Regulations 2013 and the SA Health On Site Wastewater Systems Code, April 2013</p> <p>All staff inducted into Precise Outcomes environmental requirements</p> <p>Production of waste minimised and waste products reused and recycled wherever practically possible</p> <p>Domestic and potentially wind-borne waste (e.g., paper, plastic etc.) stored in covered skips</p> <p>Waste segregated for recycling</p> <p>No burial or burning of waste on-site</p> <p>Contaminated soil and other material requiring disposal to special facilities stored separately</p> <p>Wastes covered when transported offsite</p> <p>Listed Wastes managed in accordance with the EPA requirements including no such wastes to be removed from site without the necessary authorisation and paperwork completed</p> <p>Solid or liquid waste removed from opened equipment items shall be treated as hazardous and contained in suitable containers for off-site processing or disposal in accordance with EPA requirements.</p> <p>Wastewater treatment plants regularly inspected and maintained by manufacturer's service representatives; and</p> <p>Effluent disposal/transpiration areas regularly inspected to ensure the edge of the infiltration area is located at least 50m</p>	Unlikely	Minor	Low
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Section No.	Environmental Aspect Event/Activity	Potential Consequences	Mitigation Measures	Likelihood	Consequence	Risk Rating
			from the nearest drainage line and is fenced off to restrict access.			
9.2.7	Public Safety	Operations causing risk or harm to members of the public	<p>Necessary measures (e.g., signage/fencing) to prevent the public accessing operational areas</p> <p>Driving on designated areas only (i.e., Access tracks and designated operational areas) – unauthorised off-road driving is prohibited</p> <p>Use of existing routes/disturbed areas where practicable</p> <p>Setting of appropriate vehicle speed limits for Precise personnel and contractors</p> <p>Induction of employees and contractor personnel with respect to road use and driver behaviour; and</p> <p>Storage of equipment and materials within operational site boundary</p>	Unlikely	Minor	Low

Section No.	Environmental Aspect Event/Activity	Potential Consequences	Mitigation Measures	Likelihood	Consequence	Risk Rating
9.2.8	Decommissioning and site rehabilitation	<p>Unsuccessful rehabilitation</p> <p>Unacceptable erosion rates</p> <p>Loss of critical vegetation</p> <p>Sub-optimal regrowth of vegetation</p> <p>Impact on visual amenity of site</p>	<p>The rehabilitation measures implemented during operations would be:</p> <p>Site areas no longer required for operations cordoned off to encourage regrowth of vegetation</p> <p>Stock proof fencing of any remaining vegetation or regrowth within site areas maintained until vegetation is sufficiently established</p> <p>Implementation of erosion and sediment controls as required</p> <p>Ripping of compacted surfaces (other than gibber surfaces) to encourage regrowth</p> <p>And in the event of decommissioning:</p> <p>All equipment (including ancillary equipment) decommissioned and removed from site</p> <p>Any stockpiled topsoil material respread over the site</p> <p>Ground surface re-contoured to approximate pre-existing contours.</p> <p>On final abandonment the surface will be revegetated to ensure compliance with the required GAS criteria of at least ≥ 0 for facilities and tracks; and</p> <p>Development of a Decommissioning and Rehabilitation Management Plan at conclusion of the project, this will be developed in consultation with DEM and relevant stakeholders.</p>	Possible	Moderate	Medium

APPENDIX E – FLORA & FAUNA IMPACT ASSESSMENT



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FLORA AND FAUNA IMPACT ASSESSMENT FOR GEODYNAMICS GEOTHERMAL LICENCE AREA:

SEPTEMBER 2009



FLORA AND FAUNA IMPACT ASSESSMENT FOR GEODYNAMICS GEOHERMAL LICENCE AREA: AUGUST 2009

Report to Geodynamics Pty Ltd

Supplementary report to March 2009 flora and fauna survey

Document Control					
Revision No.	Date issued	Author	Approved by	Date approved	Revision type
1.0	17/08/2009	Deb Frazer / Luke Einoder	Travis How	18/08/2009	1 st Draft
2.0	25/08/2009	Deb Frazer / Luke Einoder	Minor Changes		2 nd Draft

Distribution of copies				
Revision No.	Issue date	Quantity	Media	Issued to
1.0	18/08/2009	1	Electronic	Steve Milne (RPS)
2.0	4/09/2009	1	Electronic	Steve Milne (RPS)

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1 OVERVIEW

Environmental and Biodiversity Services (EBS) was commissioned by Geodynamics Ltd. (Geodynamics) to undertake a flora and fauna survey within their South Australian geothermal exploration site area near Innamincka, South Australia. The initial ecological survey was conducted within four separate survey areas by EBS and completed in March 2009. For further details on site descriptions, results and discussion of this survey refer to the original Innamincka Report '*Innamincka / Moomba Biological Survey - March 2009*' (EBS 2009).

This Impact Assessment is subsequent to the March 2009 survey report, and presents additional considerations of the potential impacts on threatened species and communities associated with the construction and operation activities within the Geodynamics Geothermal Licence Area. This report assesses the likelihood of significant impacts by considering: habitat clearance, the construction of infrastructure such as powerlines and buildings, and the potential impact of transmission lines. The potential impact of habitat clearance has been assessed by considering the proportion of habitat removed within the project footprint relative to the amount of habitat available across the region.

At the time of writing this report specific boundaries or locations of operational infrastructure and associated activities were not available. Consequently, broad discussions of the proposed and potential impacts resulting from geothermal operations on the surrounding environment could only be inferred. More specific quantitative analysis requires further details of the exact size and location of the intended infrastructure project footprint.

Specifically, the objectives of the impact assessment are to determine the:

1. potential impacts of project activities on threatened species recorded during the March 2009 survey (both State and nationally listed species and communities) with reference to *Environment Protection and Biodiversity Conservation Act 1999* (EBPC Act) significance guidelines where appropriate;
2. potential impacts of project activities on threatened species or migratory species that may occur on site, but were not recorded in the March 2009 survey;

3. potential impacts of the transmission lines on bird species using the Coongie Lakes Ramsar wetland;
4. potential impacts of project activities on the ecological character of the Ramsar wetland in relation to bird populations and migratory species;
5. size and scale of the project footprint and the associated vegetation clearance in relation to overall available habitat or significant vegetation within the wider region;
6. possible SEB ratios of broad vegetation habitats and provide broad discussions; and
7. key recommendations and mitigation measures that may facilitate avoidance of impacts or minimise impacts.

1.1 Potential Impacts

Overall, three key potential impacts that may occur as a result from geothermal operations have been identified. The degree to which the impact will have on the ecological value of the area (individual species, vegetation communities, and available habitat) is discussed in the following sections. The three potential impacts are defined as:

- Habitat clearance
- Bird collisions with transmission lines (low and high)
- Potential for the creation of artificial waterbodies attracting birds from Coongie Lakes and Cooper Creek areas.

The assessment considered the potential impacts resulting from installation of geothermal power plant sites, transmission lines between power plants, and other associated facilities, as well as the two proposed transmission line options to Moomba surveyed within the March 2009 survey (refer to the March 2009 survey report for description and locations of the transmission line options).

1.2 Assessment Methodology

1.2.1 Habitat Availability Assessment

The degree of floristic mapping available for the project area, as defined by GIS datasets developed by Department for Environment and Heritage (DEH), is incomplete in some areas, and limited in other areas. As a result, to determine the impact of proposed vegetation / habitat clearance of the project in relation to the wider region and on individual flora / fauna species, EBS has utilised land system data within IBRA sub-regional boundaries¹ whereby the environmental landscape has been categorised into overall land system habitats.

The Geodynamics Geothermal Licence Area spans three sub-regional boundaries which are: Coongie (CHC6), Sturt Stony Desert (CHC2) (which both fall within the Channel Country Bioregion), and Strzelecki Desert (SSD5) (which falls within the Simpson-Strzelecki Dunefield Bioregion; predominantly, most of the Licence Area falls within the Coongie sub-region. In total there are three land system habitats that fall within the boundaries of the Geothermal Licence Area and are Cooper, Merninie, and Tingana, which can generally be associated as floodplain, gibber tableland, and sand dunes, respectively (Figure 1.1).

The total area of the three land system habitats within the Geothermal Licence Area were compared to the total available habitat of the same three land systems within the wider region (i.e. within the borders of the three sub-regions) (Table 1.1). These comparisons permitted an overall assessment of the size and scale of the project footprint and potential vegetation clearance within the Geothermal Licence Area to overall available habitat or significant vegetation remaining within the wider region (see Section 4 for discussion). The below figures do not represent the actual area of impact, as only a small portion of land within the Geothermal Licence Area will be impacted, not the entire licence area.

¹IBRA: Interim Biogeographic Regionalisation for Australia (Version 6.1) is divided into biogeographical regions, of which the regions are further divided into biogeographical sub-regions

Table 1.1. Total landsystems available within each IBRA sub-region compared to ha available within Geodynamics Geothermal Licence Area

Total Landsystems within each IBRA Subregion			
IBRA Sub-region	Cooper	Merninie*	Tingana*
Coongie	1263000	9848	21330
Strzelecki Desert	165300	6701	1158000
Sturt Stony Desert	14880	172000	4205
Total (ha)	1443180	188549	1183535
			Combined Total (ha)
			2815264

Total Landsystems within Geodynamics Geothermal Licence Area			
IBRA Sub-region	Cooper	Merninie*	Tingana*
Coongie	153558	2527	1167
Strzelecki Desert	3103	49	9677
Sturt Stony Desert	6794	16278	3508
Total (ha)	163455	18854	14352
Total % of each IBRA sub-region present inside Licence Area	11.3%	10.0%	1.2%
			Combined Total (ha)
			196661

*Please note: total calculations for both Merninie and Tingana land systems are incomplete and underrepresented as IBRA sub-region data was only available for SA and not Qld or NSW, which the sub-regions also occur within.

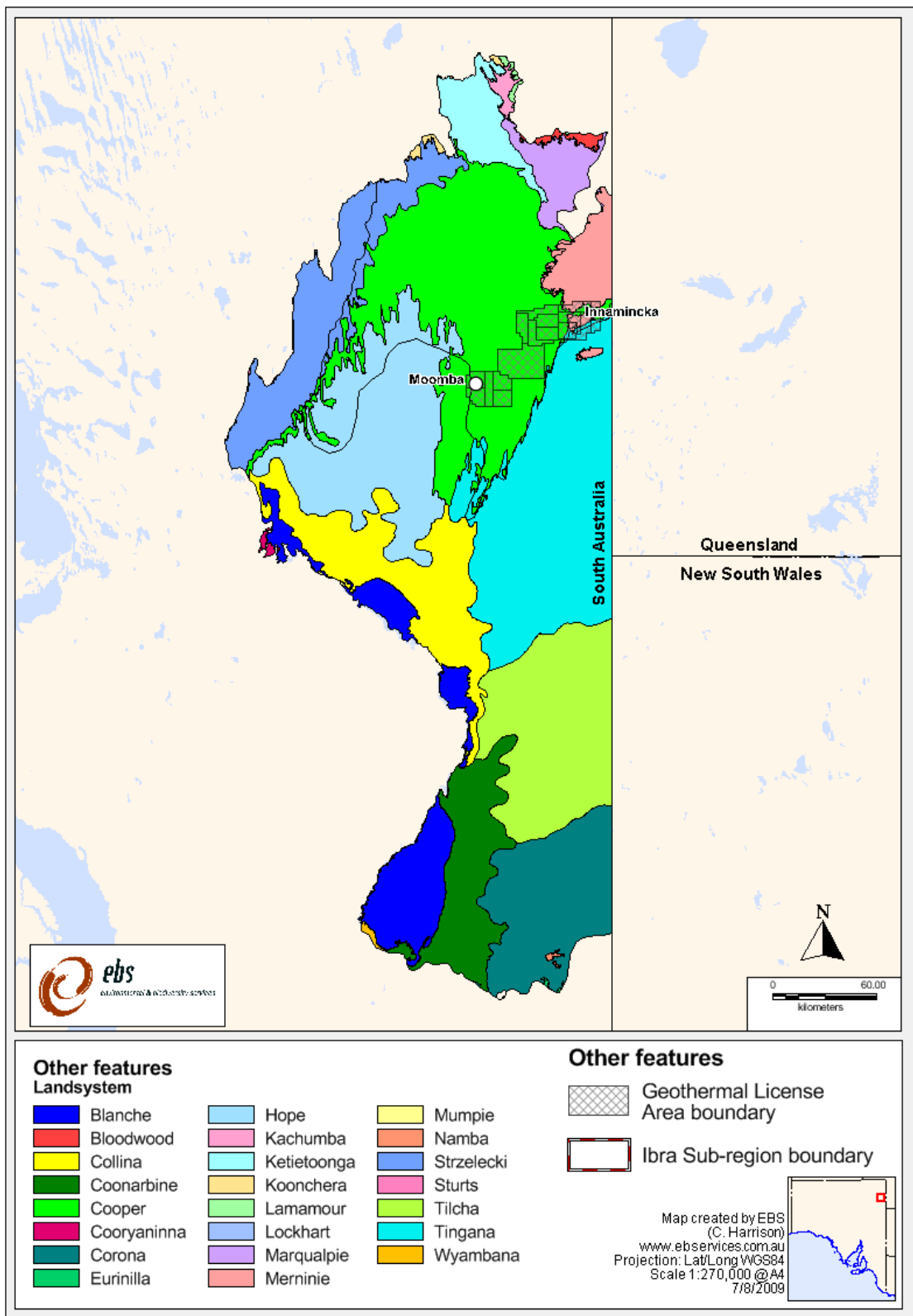


Figure 1.1. Location of Geodynamic Geothermal Licence Area within IBRA sub-regional boundaries, showing land system habitats both within and outside the Licence Area

1.2.2 Threatened species impact assessment

1.2.2.1 Selection of Species Assessed

The threatened species impact assessment reviews the likelihood of the potential impacts (detailed in section 1.1) resulting in a significant impact on conservation listed species (national and state) known to occur on site (recorded during the March 2009 survey) and those with the potential to occur on site (as detailed in governmental databases).

For the March 2009 survey, an EPBC Act Protected Matters database search was undertaken to determine any flora or fauna species that may occur within the project area. The query was undertaken for an 85 x 100 km area (approx. 8,500 km² search area with an additional 5 km buffer). Similarly, a search of the Biological Database of South Australia (BDBSA) was conducted by Department for Environment and Heritage, within the same search area (including a 20 km buffer) to obtain an inventory of flora and fauna records previously recorded within the region. All fauna and flora species known to occur, or that may occur within the project area were categorised as occurring within one of the three individual land system habitats, based on their known habitat preferences.

1.2.2.2 Assessment Guidelines - EPBC listed species

The significance of the impacts of the construction and operation within the Geothermal Licence Area on EPBC Act listed species (excluding migratory species) was determined through the EPBC Act Policy Statement 1.1 '*Significant Impact Guidelines*' (Australian Government 2006).

The '*Significant Impact Guidelines*' were utilised to determine if the project area supports '*important populations*', or represents '*critical habitat*' for any threatened species.

An 'important population' is defined as being either:

'a key source population for breeding or dispersal, a population that is necessary for the maintenance of genetic diversity, and/or a population that is near the limit of a species range'

The definition of 'critical habitat' is defined as habitat used for:

'activities such as foraging, breeding, roosting, or dispersal; the long-term maintenance of the species; the reintroduction of populations or recovery of a species; or to maintain genetic diversity and long term evolutionary development',

Where the impacts of the proposed actions may affect an 'important population', or 'critical habitat', they have been highlighted as potentially presenting a significant impact on a non-migratory EPBC

listed species. Whether or not an action is actually likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (Australian Government 2006). Also, in determining the nature and magnitude of an action's impact, it is important to consider all direct and indirect impacts, the total impact which can be attributed to that action over time, and the degree of confidence with which the impacts of the action are known and understood. This detailed determination has been addressed where possible, but given the uncertainty in exact project locations and footprints, has not been conclusively addressed for most species.

1.2.2.3 Assessment Guidelines - Migratory EPBC listed bird species

The significance of the impacts of construction and operation within the Geothermal Licence Area on migratory EPBC listed species was determined by identifying whether the site contains '*important habitat*'. Important habitat for these species is defined as an area that:

'supports an 'ecologically important proportion of population'; is at the limit of the species range; is of critical importance to life-cycle stages; and/or, is in an area where the species is declining'

For migratory species there is no definition of an '*ecologically significant proportion*' of the population under the *EPBC Act 1999*. For migratory birds it is considered that the criteria used to identify areas of national importance, also provides an adequate indication of an '*ecologically significant proportion*' of the Australian population of a species. These criteria are outlined by Watkins (1993), whereby an area that supports greater than 1% of the Australian population of a migratory species is considered a site of national importance.

Where the impacts of construction and operation within the Geothermal Licence Area affect an '*ecologically significant proportion of the population*', or '*important habitat*', they have been highlighted as potentially presenting a significant impact on migratory EPBC listed species. While the Geodynamics geothermal operations may not have a significant impact in the context of the Significant Impact Guidelines (Australian Government 2006), it may still be deemed as having the potential to impact on the State or regional population. For species where no significant impact was identified, the impact on the State or regional population was assessed by defining whether impacts are highly likely, likely, or unlikely (as described below for *NPW* listed species).

1.2.2.4 Assessment Guidelines - State listed species / communities

The impact of the proposed construction and operation within the Geodynamics Geothermal Licence Area on species or vegetation communities of state conservation significance was considered. Unlike

nationally listed species (*EPBC Act 1999*) there are no clearly defined parameters or guidelines for identifying important populations or habitats for state listed species (*NPW Act 1972*). As it is difficult to determine exact population numbers of state rated species or communities due to lack of available information, this appraisal is based on an assessment of the likelihood of potential impact of the geothermal operations on each species. We broadly assessed the likelihood of potential impact, via either the removal of preferred habitat, or from direct fatalities. Four broad categories have been used to assess the degree of impact on individual species and communities. These categories are;

Highly Likely – Where there is a good possibility that geothermal operations will result in an impact:

Likely – Where there is a possibility that geothermal operations will result in an impact:

Unlikely – Where there is a limited possibility that geothermal operations will result in an impact:
and,

Very Unlikely – Where there is an extremely low possibility that geothermal operations will result in an impact.

2 THREATENED FAUNA SPECIES IMPACT ASSESSMENT

2.1 Overview

Overall, 37 threatened fauna species (2 mammals, 33 birds, 2 reptiles) are reviewed within this impact assessment. Table 2.1 details the threatened fauna species identified as likely to inhabit the Geodynamics Geothermal Licence Area, specifying the source used (i.e. EBS March 2009 survey or database searches). This assessment reviews terrestrial mammals and reptiles (section 2.2) and birds (section 2.3) separately.

Table 2.1. Threatened fauna species that occur or may occur within the Geodynamics Geothermal Licence Area

Family	Species name	Common name	AUS	SA	Source
AVES	<i>Actitis hypoleucos</i>	Common Sandpiper		R	BDBSA
AVES	<i>Amytornis barbatus barbatus</i>	Grey Grasswren (Bulloo)	VU	R	EPBC BDBSA
AVES	<i>Amytornis barbatus diamantina</i>	Grey Grasswren		R	BDBSA
AVES	<i>Anas rhynchotis</i>	Australasian Shoveler		R	BDBSA
AVES	<i>Anhinga novaehollandiae</i>	Australasian Darter		R	BDBSA
AVES	<i>Aprosmictus erythropterus</i>	Red-winged Parrot		R	BDBSA
AVES	<i>Apus pacificus</i>	Fork-tailed Swift	Mm, Lis		EPBC
AVES	<i>Ardea alba</i>	Great Egret,	Mi, Mm, Lis		EPBC
AVES	<i>Ardea ibis</i>	Cattle Egret	Mi, Mm, Lis		EPBC
AVES	<i>Ardea intermedia</i>	Intermediate Egret		R	BDBSA
AVES	<i>Ardeotis australis</i>	Australian Bustard		V	BDBSA
AVES	<i>Biziura lobata</i>	Musk Duck		R	BDBSA
AVES	<i>Cacatua leadbeateri</i>	Major Mitchell's Cockatoo		R	BDBSA
AVES	<i>Cladorhynchus leucocephalus</i>	Banded Stilt		V	BDBSA
AVES	<i>Egretta garzetta</i>	Little Egret		R	BDBSA
AVES	<i>Elanus scriptus</i>	Letter-winged Kite		R	BDBSA
AVES	<i>Falco hypoleucos</i>	Grey Falcon		R	BDBSA
AVES	<i>Falco peregrinus</i>	Peregrine Falcon		R	BDBSA
AVES	<i>Grantiella picta</i>	Painted Honeyeater		R	BDBSA
AVES	<i>Grus rubicunda</i>	Brolga		V	BDBSA
AVES	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard		R	BDBSA
AVES	<i>Lophoictinia isura</i>	Square-tailed Kite		E	BDBSA
AVES	<i>Microeca fascinans fascinans</i>	Jacky Winter		R	BDBSA
AVES	<i>Merops ornatus</i>	Rainbow Bee-eater	Mt, Lis		EPBC
AVES	<i>Myiagra inquieta</i>	Restless Flycatcher		R	BDBSA

Family	Species name	Common name	AUS	SA	Source
AVES	<i>Ninox connivens</i>	Barking Owl		R	BDBSA
AVES	<i>Oxyura australis</i>	Blue-billed Duck		R	BDBSA
AVES	<i>Phaps histrionica</i>	Flock Bronzewing		R	BDBSA
AVES	<i>Pedionomus torquatus</i>	Plains-wanderer	VU	E	EBS
AVES	<i>Plegadis falcinellus</i>	Glossy Ibis		R	BDBSA
AVES	<i>Podiceps cristatus</i>	Great Crested Grebe		R	BDBSA
AVES	<i>Stictonetta naevosa</i>	Freckled Duck		V	BDBSA
AVES	<i>Rostratula australis</i>	Australian Painted Snipe	VU	V	EPBC
MAMMALIA	<i>Notomys fuscus</i>	Dusky Hopping-mouse	VU	V	BDBSA EPBC EBS
MAMMALIA	<i>Pseudomys australis</i>	Plains Mouse (Plains Rat)	VU	V	BDBSA
REPTILIA	<i>Aspidites ramsayi</i>	Woma		R	BDBSA
REPTILIA	<i>Emydura macquarii</i>	Macquarie Tortoise		V	BDBSA

KEY**Regions:****AUS:** Australia (*Environment Protection and Biodiversity Conservation Act, 1999*)**SA:** South Australia (*National Parks and Wildlife Act, 1972*)**Conservation Codes:****En or E:** Endangered**Vu or V:** Vulnerable**R:** Rare**Mm:** Migratory Marine species**Mi:** Migratory wetland species,**Lis:** Listed overfly marine area**BDBSA** – Threatened species records detailed within the Biological Database of South Australia**EPBC** – Threatened species identified within the EPBC Act Protected Matters Database Search**EBS** – Threatened species observed or captured within the EBS March 2009 survey

2.2 Terrestrial Mammals and Reptiles

Two nationally rated species listed as *Vulnerable* have been identified for the area, the Dusky Hopping-mouse (*Notomys fuscus*) and the Plains Rat (*Pseudomys australis*). Two species with a state conservation rating under the NPW Act identified on the BDBSA have been previously detected within the project area and were the *Rare* Woma (*Aspidites ramsayi*) and the *Vulnerable* Macquarie Tortoise (*Emydura macquarii*). Table 2.2 details the habitat preferences of the above mammal and reptile species and the likelihood of their occurrence on site.

The potential impacts that are most likely to affect mammals and reptile species are habitat clearance associated with the installation of all infrastructure. Table 2.3 details the potential impacts on terrestrial fauna species and the extent of the impact.

2.2.1 EPBC Act listed Species

2.2.1.1 Dusky Hopping-mouse

One individual of the Dusky Hopping-mouse was caught during the March 2009 survey, and another 12 records have been identified on the BDBSA (Figure 2.1). The Dusky Hopping-mouse was also identified on the EPBC protected matters database search.

This species inhabits soft sandy habitats, preferring dunes with Sandhill Canegrass, Sandhill Wattle, Nitrebush, Sticky Hopbush and other ephemeral plants (Moseby *et al.* 1999). In South Australia, well-known populations predominantly exist within the Simpson Strzelecki Dunefields Bioregion. The Dusky Hopping-Mouse is known from locations along the Strzelecki Track at Carraweena ruins, Montecollina Bore and near Lake Crossing Bore, Waraninna Creek (Murnpeowie Pastoral Lease), and locations within Quinyambie Pastoral Lease (Neagle 2003).

Within the Geodynamics Geothermal Licence Area, the preferred land system of the Dusky Hopping-mouse would be Tingana within the Strzelecki Desert sub-region. Within the Tingana land system across all IBRA sub-regions, the Licence Area contains 1.2 % of the total and therefore only a small proportion of the Licence Area would be impacted by Geodynamics activities. As a result 98.8% of this land system is located outside the Licence Area, with most of the remaining habitat falling within the Strzelecki Desert IBRA sub-region.

Generally, most of the habitat clearance is to be concentrated within the Coongie sub-region in the northern section of the Licence Area. Preferred habitat of the Dusky Hopping-mouse is considered to exist within the Strzelecki Desert sub-region, which largely remains unaffected by any operations or disturbance resulting within the Geodynamics Licence Area. Based on the known evidence and locations of BDBSA records, it is considered that the activities associated with the Geodynamics geothermal operations are unlikely to have a 'significant impact' on the Dusky Hopping-mouse considering the amount of critical habitat remaining; however, to conclusively determine if the outcome of proposed development will have a significant impact on this species (particularly in relation to transmission line Option 2), clearly defined areas to be disturbed are necessary for detailed analysis. If most of the disturbance is concentrated away from dunefield country, the impact of habitat clearance is considerably lowered. There has been little survey effort through the region for the Dusky Hopping-

mouse; therefore the lack of records for this species in particular areas does not necessarily indicate their absence. The impact assessment has relied on grouping large land systems together, with disregard to detailed habitat descriptions throughout the project area. It should be noted that patches of dune systems and preferred habitat for this species is available within the Coongie IBRA sub-region, despite not being detected in the overall analysis.

2.2.1.2 Plains Rat

After a review of available habitat for the Plains Rat it is considered possible, but very unlikely an 'important population' would be found within the project area. A Plains Rat has been recorded only once before within the project area (GPS coordinates: 461960, 6912004); this record is from 1957 and exists within the Strzelecki Desert sub-region on the fringe of the Merninie (gibber) and Tingana (sand dunes) land systems, not the preferred gibber tableland habitat (Figure 2.1). Neagle (2003) lists the Plains Rat as 'presumed extinct' in the Channel Country Bioregion, as it has not been located east of Lake Eyre since 1975.

While the area supports chenopod shrublands that have the potential to provide habitat, the Geodynamics Licence Area does not support large expanses of gibber plains and mild slopes containing gilgais and cracking clays that are commonly associated with preferred Plains Rat habitat. However, Plains Rat populations can rapidly increase after good rainfall and then decline severely within months as conditions deteriorate (Ehmann, 2005; Moseby 2006). In times of good years (high rainfall and available resources), it is possible that the Plains Rat may utilise the sandy interdune swales within the project area if they were to occur.

Within the Geodynamics Geothermal Licence Area, the preferred land system of the Plains Rat would be Merninie within the Sturt Stony Desert Sub-region. Within the Merninie land system across all IBRA sub-regions, the Licence Area contains 10.0 % of the total and only a small proportion of the Licence Area would be impacted by Geodynamics activities. A total of 90.0% of this land system is located outside the Licence Area with, most of the remaining habitat falling within the Sturt Stony Desert sub-region, whereby the figures are underrepresented due to the Queensland data being unavailable.

Based on the known evidence, it is considered that the activities associated with the Geodynamics geothermal operations will not have a 'significant impact' on the Plains Rat as the area does not support a 'significant population' or 'critical habitat' for the species.

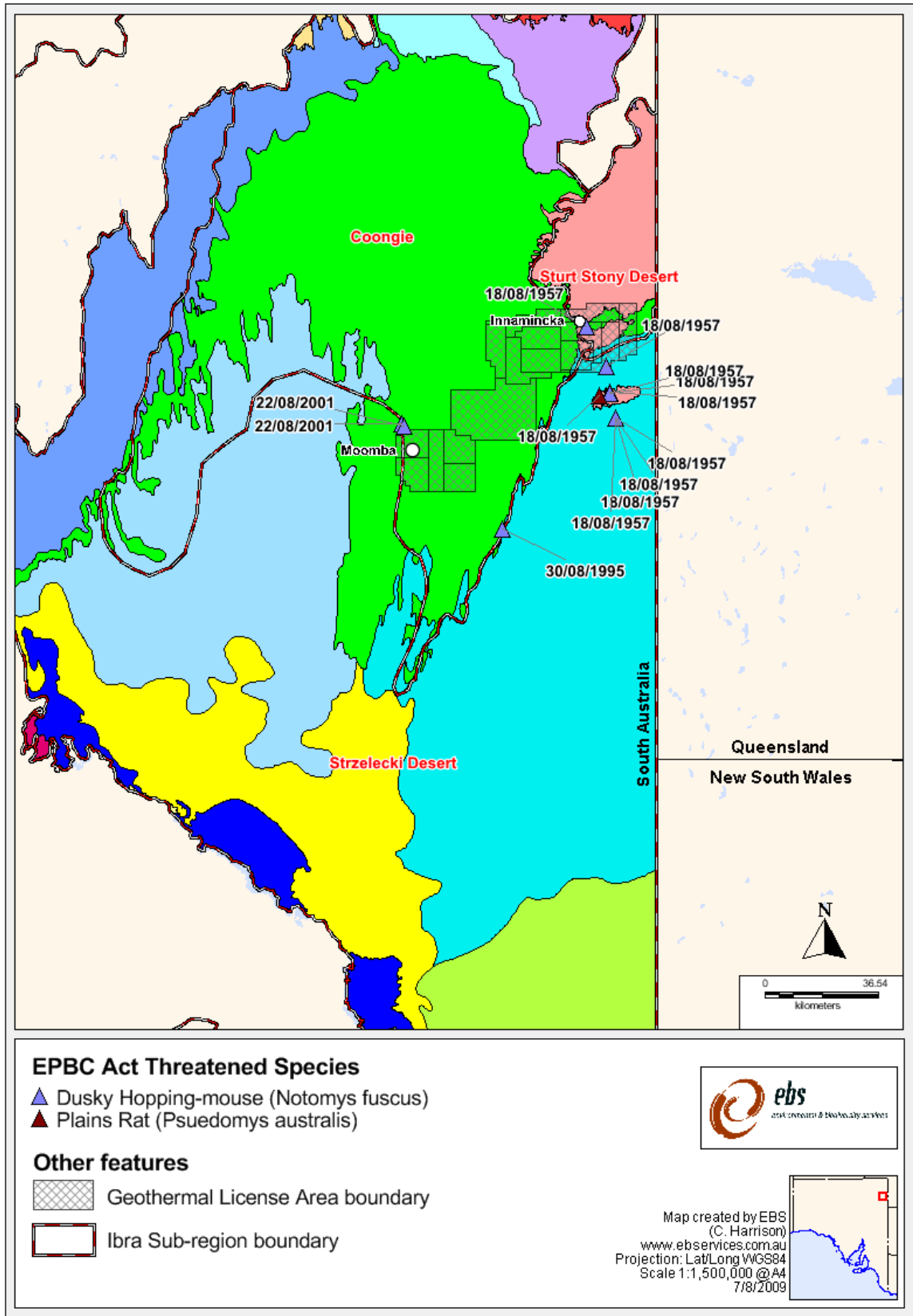


Figure 2.1. Location of EPBC listed species, Dusky Hopping-mouse and Plains Rat, records within IBRA sub-regional boundaries, showing land system habitats both within and outside the Licence Area

2.2.2 NPW Act Listed Species

Impact Assessment within Geodynamics Geothermal Licence Area

2.2.2.1 *Woma*

Four records of the Woma have been identified on the BDBSA. The Woma is a cryptic species and is often hard to detect (Ehmann 2005), despite its presence on site. While this species was not detected during the March 2009 survey, anecdotal evidence suggests the Python is definitely present within the area.

The Woma inhabits desert dunefields and sandy plains, usually with hummock grasses but also other natural vegetation. They often inhabit rabbit burrows but may also shelters under hummock grasses or dense bushes. Many sightings of Woma Pythons in South Australia have come from sandy areas in the north-east of the state, predominantly along the Birdsville and Strzelecki Tracks (Wilson & Swan 2005).

Similar to the Dusky Hopping-mouse the Woma is most suited to utilising habitat within Tingana land systems within the Strzelecki Desert sub-region. As detailed for the Dusky Hopping-mouse, within the Tingana land system the Licence Area contains 1.2 % of the total and therefore only a small proportion of the Licence Area would be impacted by Geodynamics activities. As a result 98.8% of this land system is located outside the Licence Area.

Based on the known evidence and locations of BDBSA records, it is considered the Woma would be plausibly common within the area. However, the activities associated with the Geodynamics geothermal operations are unlikely to have a 'significant impact' on the Woma considering the amount of critical habitat remaining (dunefield habitat) in the wider region, which should generally remain undisturbed; it is expected there will be some impact on this species from habitat clearance, noise and associated vibration disturbances.

2.2.2.2 *Macquarie Tortoise*

Four records of the Macquarie Tortoise have been identified on the BDBSA. As the Macquarie Tortoise is restricted to larger rivers and associated large waterholes on floodplains (Cogger 2000) it is hard to detect within terrestrial fauna surveys. While this species was not detected during the March 2009 survey, it is most probable this species exists within the main channel of the Cooper Creek and associated tributaries.

Within the Geodynamics Geothermal Licence Area, the Macquarie Tortoise would mostly inhabit the Cooper land system (i.e. floodplain habitat), of which 11.3% is within the Licence Area; therefore, within the wider region, 88.7% (1 279 725 ha) of the Cooper land system is outside the Licence Area.

However, it is expected this species is confined to larger watercourses which will not be significantly impacted upon by geothermal operations.

Table 2.2. Potential for occurrence of threatened species on-site considering habitat preferences

SPECIES NAME	COMMON NAME	STATUS		PRIMARY HABITAT	IDENTIFIED LAND SYSTEM HABITAT	LIKELIHOOD OF OCCURRENCE ON SITE
		AUS	SA			
<i>Notomys fuscus</i>	Dusky Hopping-mouse	VU	V	Dusky Hopping Mice inhabit soft sandy habitats, preferring dunes with Sandhill Canegrass, Sandhill Wattle, Nitrebush, Sticky Hopbush and other ephemeral plants (Moseby <i>et al.</i> 1999).	Tingana (sand dunes)	High - This species was detected during survey and has been recorded 12 times on the BDBSA.
<i>Pseudomys australis</i>	Plains Mouse (Plains Rat)	VU	V	Cracking clay habitats in northern South Australia. Plains Rats are found on stony (gibber) plains and mild slopes that have gilgais, predominantly within chenopod shrubs as well as ephemeral plants that require good rains to flourish. In very good years they can occur on adjoining sandy plains and may also occur on gypseous clay soils with deep cracks and sparse perennial vegetation (Ehmann, 2005; Menkhorst & Knight 2004; Moseby, 2006; Bandle & Moseby, 1999).	Merninie (gibber tableland)	Very Unlikely, but possible – One record of the species has been recorded within the BDBSA previously in 1957. Most of the project area does not support 'preferred habitat'; however, the gibber tableland in the northern section of the project area could potentially provide suitable habitat.
<i>Aspidites ramsayi</i>	Woma	n/a	R	Woma Pythons are found in desert dunefields and on sandy plains, usually with hummock grasses but also other natural vegetation. They often inhabit rabbit burrows but may also shelters under hummock grasses or dense bushes.	Tingana (sand dunes), Merninie (gibber tableland)	High – This species has been recorded 4 times on the BDBSA and the project area is within their known distribution.
<i>Emydura macquarii</i>	Macquarie Tortoise	n/a	V	Murray / Darling River System. Restricted to larger rivers and associated large waterholes on floodplains (Cogger 2000).	Cooper (floodplain)	Very Unlikely, but possible - This species has been recorded 6 times on the BDBSA and the project area is within their known distribution; however, the species inhabits major channels and waterholes, which will not be cleared by geothermal operations.

KEY**Regions:****AUS:** Australia (*Environment Protection and Biodiversity Conservation Act, 1999*)**SA:** South Australia (*National Parks and Wildlife Act, 1972*)**Conservation Codes:****Vu or V:** Vulnerable**R:** Rare**E:** Endangered

Table 2.3. Potential for significant impacts on EPBC Act and NPW Act listed species (highly likely, likely, unlikely, very unlikely). Assessments relate to the varied impacts of each proposed development, such as habitat loss (clearance) and installation of the Transmission Line assessed within March 2009 survey.

SPECIES NAME	COMMON NAME	POTENTIAL FOR SIGNIFICANT IMPACT		
		Overall Habitat Loss	Transmission Line Option 1 – Habitat Loss	Transmission Line Option 2 – Habitat Loss
<i>Notomys fuscus</i>	Dusky Hopping-mouse	Unlikely - sand dune country (Tingana land system) within the Licence Area is considered to comprise a small portion of overall habitat within the wider region (1.2%) and only a fraction of this would be impacted. Habitat clearance may have an impact, but it will most likely not be a 'significant impact' due to available habitat existing within the wider region, primarily within the Strzelecki Desert sub-region.	Unlikely - The location of Transmission Line Option 1 spans floodplain country within the Coongie sub-region, which most supports floodplain habitat (Cooper land system) which is not the preferred habitat of the Dusky Hopping Mouse. Most records or known populations of the Mouse fall within the Strzelecki Desert sub-region.	Likely - The location of Transmission Line Option 2 spans some sand dune country within the Strzelecki Desert sub-region, which supports preferred habitat of the Dusky Hopping Mouse, which is the land system where most known records or populations of this species occur. Due to the broad nature of this assessment further impact assessment would need to be completed if this option is chosen for installation.
<i>Pseudomys australis</i>	Plains Rat	Very Unlikely - gibber tableland (Merninie land system) within the Licence Area is considered to comprise a small portion of overall habitat within the wider region (10 %) and only a fraction of this would be impacted. The gibber habitat available on site is not considered 'optimal' Plains Rat habitat and is marginal.	Unlikely – The location of Transmission Line Option 1 spans floodplain country which is not preferred habitat of the Plains Rat.	Very Unlikely – The location of Transmission Line Option 1 spans sand dune country which is not preferred habitat of the Plains Rat.
<i>Aspidites ramsayi</i>	Woma	Unlikely – sand dune country (Tingana land system) within the Licence Area is considered to comprise a small portion of overall habitat within the wider region (1.2%) and only a fraction of this would be impacted. Habitat clearance may have an impact, but it will most likely not be a 'significant impact' due to available habitat existing within the wider region, primarily within the Strzelecki Desert sub-region.	Unlikely – - The location of Transmission Line Option 1 spans floodplain country within the Coongie sub-region, which most supports floodplain habitat (Cooper land system) which is not the preferred habitat of the Woma	Likely – The location of Transmission Line Option 2 spans some sand dune country within the Strzelecki Desert sub-region, which supports the preferred habitat of the Woma
<i>Emydura macquarii</i>	Macquarie Tortoise	Very Unlikely - habitat clearance of rivers and main water channels within the Licence Area is not part of clearance.	Very Unlikely – main water channels and waterholes will not be affected by the installation of the Transmission Line	Very Unlikely – main water channels and waterholes will not be affected by the installation of the Transmission Line

KEY

Highly Likely – Where there is a good possibility that geothermal operations will result in an impact

Likely – Where there is a possibility that geothermal operations will result in an impact

Unlikely – Where there is a limited possibility that geothermal operations will result in an impact

Very Unlikely – Where there is an extremely low possibility that geothermal operations will result in an impact

2.3 Birds

Five bird species of national conservation significance (*Vulnerable* and/or *Migratory* or *Marine*), were identified using the EPBC protected matters search (Table 2.1). During the March 2009 survey the nationally *Vulnerable* Plains Wanderer (*Pedionomus torquatus*) was also identified on site (EBS 2009). An additional twenty-seven bird species with a state conservation rating under the NPW Act were identified by the BDBSA and have previously been detected, or are likely to occur within the project area.

Table 2.4 details the habitat preferences of all threatened bird species, and outlines the likelihood of their occurrence on site. The likelihood of each species occurring on-site depends upon the availability of suitable foraging, breeding or roosting habitat. Birds considered to fly over the site are also included.

The potential impacts most likely to affect these bird species include; habitat clearance associated with the installation of all infrastructure; bird collisions with transmission lines (low and high); and, the potential for the creation of artificial waterbodies attracting birds from Coongie Lakes and Cooper Creek. The removal of habitat under the proposed construction has the potential to impact a number of threatened bird species, however this is highly unlikely to present a significant impact under the Significant Impact Guidelines (2006). The species effected by habitat removal and the extent of impact will vary depending upon the type of habitat that is removed. Four broad habitat types are considered to occur across the site, which are largely influenced by the landforms. These include; dunes, floodplains, gibber and woodland. The potential need to construct holding ponds to accommodate water pumped from underground has a range of implications on the resident and migratory bird community at the site. Estimating the likely impacts of these holding ponds is not possible within this risk assessment due to the uncertainty surrounding the size and number of ponds, their longevity and the quality of the water in the ponds.

Table 2.5 and 2.6 provides an assessment of the likelihood of each of these sources of impact affecting each bird species, and estimates the extent of these impacts on the state and national populations.

The following sections provide a description of each species potential occurrence within the study site, and the likelihood they will be impacted by the proposed developments. Due to the large numbers of threatened birds likely to occur within the site, they have been grouped by habitat preferences (i.e. waterbird/shorebirds, woodland birds, gibber/sandplain birds).

2.3.1 EPBC Act listed Species

2.3.1.1 EPBC listed shorebirds and waterbirds

While the Transmission Line route from Innamincka to Moomba, and between the power plants (i.e. Jolokia to Savinia), may present a collision risk to the EPBC listed Great Egret or Australian Painted Snipe, it is unlikely to impact an ecologically significant proportion of the population of these species (Table 2.5). This is based on a number of species-specific factors that are outlined below.

Great Egrets are common along rivers, wetlands and floodplains throughout Australia, with many records from the Cooper Creek and Coongie Lakes region (Barrett *et al.* 2003). The numbers of Great Egret inhabiting the study site is likely to be highly variable depending upon the suitability of habitat across the area. These Egrets forage in both shallow water and mudflat habitat of saltwater and freshwater wetlands. During dry times numbers will be low across the site, as Great Egrets will be confined to the Cooper Creek. In contrast, when the Cooper Creek is in flood, and the floodplain is inundated numbers will likely increase, however, the site is unlikely to support an important population, as defined under the Significant Impact Guidelines (2006). Therefore it is highly unlikely that mortality arising from collisions with either the high or low Transmission Lines from Innamincka to Moomba, or low Transmission Line between the power plants, will present a significant impact to Great Egrets.

The proposed Transmission Lines are unlikely to impact the Australian Painted Snipe (*Rostratula australis*) as there are no known records of this species from the area (Barrett *et al.* 2003). This does not mean that they are entirely absent from the Cooper Creek and Coongie Lakes region, as their distribution within South Australia is limited according to available records. In general, the distribution of the Painted Snipe across South Australia is patchy, and its presence in any particular area is usually unpredictable, hence they are recorded irregularly (Garnett and Crowley 2000). Painted Snipe have been recorded in a wide range of locations, from freshwater or brackish wetlands, which are either permanently or temporarily filled, to wet vegetation in swamps, along drainage lines or within tall grasslands. The Murray–Darling drainage system appears to be a key area for this species, with regular records from the South Australian Riverland (Rogers 2005), and the south east of the state. Their occurrence at any site is often dependent upon the suitability of the site for foraging and breeding. While some individuals are believed to be resident in areas where suitable habitat exists, most individuals are nomadic in the non-breeding season, and are believed to travel widely across the landscape in search of suitable foraging areas. Despite the absence of any records from the study site, a small number of birds may occur on site irregularly, when the floodplains are inundated. The Transmission Line would not reduce the area of occupancy, or disrupt the breeding cycle of any

important population of the Painted Snipe, as defined under the Significant Impact Guidelines (DEH 2006).

Collision risks with transmission lines are undoubtedly higher for some species due to their body size, flight behavior, and use of on-site habitat. Of the low and high Transmission Lines proposed, the high option, using 40 – 50 m steel towers is considered to increase bird impacts compared to the low option using 10 – 20 m stobie poles. This is because the high collision risk birds using the site are considered to fly at greater heights. High collision risk birds include waterbirds and shorebirds. These bird groups are of most concern as they are among the larger bodied faster-flying birds in the local community, and they also often travel in large flocks. In general, larger-bodied species such as Ibis and Egrets are deemed more likely to collide with power lines. This is because they are less agile in the air, and therefore less able to rapidly adjust their flight path at the last second when power lines come into view. Fast flying species such waterbirds and shorebirds are also at higher risk of collision, as they are less able to quickly adjust their flight paths compared to slower flying birds.

The size and number of holding ponds directly influences the number and range of bird species that will be attracted to the site. Considering that ponds and dams as small as 10 x 10 m attract a range of waterbirds within the semi-arid and arid regions of SA, larger ponds have the potential to attract a great number of waterbirds. Artificial ponds located anywhere within the site are considered highly likely to attract a range of waterbird species due to the close proximity of the Cooper Creek. Threatened waterbird species that currently inhabit the Cooper Creek, and are therefore highly likely to be attracted to small to moderate sized ponds include the Great Egret, Intermediate Egret, and Little Egret (Table 2.6). Other waterbirds that may use Cooper Creek, but definitely over-fly the study site on their way to Coongie Lakes (60 km north) include the Freckled Duck, Blue-billed Duck, and Australasian Shoveler (Table 2.6). Shallow ponds (<50 cm), or drying ponds with areas of mudflat are also likely to attract a shorebirds. Threatened shorebird species that are known to overfly the site on their way to Coongie Lakes include the Common sandpiper, and Banded Stilt (Table 2.6).

The impacts associated with the diversion of birds from their natural movement paths and foraging areas within the arid zone are unclear. Possible impacts include: the starvation of migratory birds with low energy reserves who visit the ponds expecting a feed (although this is mitigated for much of the Licence Area by the presence of permanent waterholes on the nearby Cooper Creek); increased predation of waterbirds and shorebirds along the banks of ponds by predators attracted to artificial water bodies; collision with infrastructure around ponds; and/or, the uptake of toxins from the water. Chemical analysis results from initial samples of the water that may be held in ponds indicates that it contains high levels of a number of heavy metals and other potential poisons such as arsenic. The

toxicity of this water to waterbirds and shorebirds is currently unclear, and requires an extensive review of current literature and reports from other parts of Australia, and the International community. Also, the extent of exposure of these toxins to birds is unclear due to the uncertainties regarding the size and number of ponds that may be used and the length of time that ponds may hold water. This topic warrants further review when development details become available.

Other artificial water bodies proposed for the site include a small sewerage treatment facility. Sewerage ponds located at other remote camps in arid areas of SA are well known to attract a small number of waterbirds. Where sewerage ponds do not contain any vegetation (sedges, reeds, rushes), they are unlikely to attract any of threatened species identified in Table 2.6, and are therefore unlikely to pose any threat to these species.

Based on the current expectation of non-toxic water being held in 1 to 2 ponds of a maximum 2 ha, and a small sewerage treatment pond, impacts on all threatened birds are considered to be highly unlikely (Table 2.6).

2.3.1.2 EPBC listed woodland birds

Rainbow Bee-eaters are unlikely to collide with transmission lines, as they are highly agile species that fly fairly slowly. This flight behaviour means that they will be more able to see, and avoid, powerlines.

2.3.1.3 EPBC listed grassland/gibber birds

The Plains Wanderer is considered unlikely to collide with powerlines as they would rarely fly at the heights required to collide with the cables. The largest issue regarding this species concerns the removal and disturbance of gibber habitat. More specifically, areas of gibber containing grassland and mixed shrublands are of importance to the EPBC listed Plains Wanderer (Table 2.6). Habitat removal would only influence a small number of birds, and not constitute a significant impact under the Significant Impact Guidelines (2006). However, habitat removal is likely to influence a significant proportion of the regional population of this species (i.e. >10 %). This is due to the expectation that Plains Wanderers occur across the region at very low densities. Therefore, the pair that were recorded on-site (EBS 2009) likely represent a large proportion of the regional population. Impacts on the Plains Wanderer can be reduced or avoided by limiting the removal of Mitchell-grass grassland and shrubland. These habitats occur patchily across the site, in areas of gibber. Future surveys targeting Plains Wanderers would be useful in identifying the size of the local population, and in identifying their preferred habitat.

2.3.2 NPW Act listed Species

2.3.2.1 NPW listed shorebirds and waterbirds

Collisions by shorebirds and some waterbirds using the site are deemed highly unlikely as they are only considered to overfly the site when transiting to the Coongie Lakes 60 km north. This includes species such as the Common Sandpiper, Banded Stilt, Blue-billed Duck, and Freckled Duck (Table 2.5). Waterbirds that visit the Cooper Creek during their movement north to Coongie Lakes are at increased risk of impact as they will likely be flying at lower heights upon their approach to the river.

Areas of increased collision risk along the direct Transmission Line route from Innamincka to Moomba are likely to occur within floodplain habitats, especially in areas of Coolibah woodlands that occur in close proximity to Cooper Creek (i.e. north eastern end). The proposed Transmission Line connecting the Jalokia and Savina power stations is considered to pose larger threats to birds through collision risk, due to its close proximity with Cooper Creek. Option 2, involving the use of high stobie poles will increase the likelihood of collision risk compared to the lower transmission line of Option 1 (Table 2.5). However, none of the transmission lines are deemed to present a significant impact as they are unlikely to impact a significant proportion of the regional population of each species (Table 2.5).

The possibility of bird collisions with the Transmission Line route from Innamincka to Moomba, and the Transmission Line connecting the Jalokia and Savina power stations is likely to be highest when the Cooper Creek is in flood, and the floodplain is inundated. This is because bird numbers will be elevated at this time, as inundated floodplains in the arid lands provide substantial foraging habitat for a wide range of waterbirds and shorebirds. The increased number of birds using the site during floods has been considered in the assessment of the likelihood of impact on each species, as shown in Table 2.5. The likelihood of significant impact was deemed unlikely for each species, as collisions are unlikely to influence more than 10 % of the regional population of any species.

2.3.2.2 NPW listed woodland birds

The Transmission Line routes from Innamincka to Moomba, and between the power plants (i.e. Jolokia to Savinia) may cross habitat that supports a large proportion of the regional population of some NPW listed species (Table 2.5). However, not all of these birds will be impacted through collision with the power line. Therefore, impacts are unlikely to impact a significant proportion of the regional populations

of these species. For example, on-site habitat may be a part of the home range of a number of breeding pairs of Grey or Peregrine Falcons. These raptor species occur at low densities in semi-arid and arid habitats, so the site may support a large proportion of the total regional population. However, the likelihood of resident falcons colliding with the power lines would be low, due to the low probability of collisions, as well as their avoidance behavior. This would reduce the incidence of mortality to a low level, meaning that collisions are unlikely to significantly impact these state threatened species.

A number of woodland birds such as Red-winged Parrots and Flock Bronzewing are also fast-flying, and therefore may be at higher risk of collision than slower flying NPW listed woodland birds (e.g. Restless Flycatchers, Rainbow Bee-eaters Table 2.5). The low option for the Transmission Line from Innamincka to Moomba is considered to have a larger impact on these species compared to the high option, as woodland birds more commonly fly at heights of 10 – 20 m. The likelihood of any transmission line having a significant impact on any NPW listed woodland birds was deemed unlikely, as shown in Table 2.6. This assessment was based on the expectation that collisions are unlikely to influence more than 10 % of the regional population of any species.

Habitat removal in dunes is unlikely to impact any threatened birds, as most birds using the dunes also frequent other habitat types (Table 2.5). Developments within the floodplain are unlikely to impact on any woodland species, as the removal of Coolabah Trees will be minimised. Of the few Coolabahs that are removed, those containing hollows may be used as breeding habitat by Red-winged Parrots or Barking Owls. Trees that contain nest sites should be inspected to identify the species inhabiting the nests. If nests belong to any of the threatened birds of prey species (Table 2.5), then their removal should be avoided. It is recommended that disturbance to the breeding pair be further reduced by respecting a buffer distance, and avoiding that area all together. Buffer distances of 300m have been used for other birds of prey species at wind farms. Removal of chenopod habitat on floodplains may influence the NPW listed subspecies of the Grey Grasswren *Amytornis barbatus diamantine*, but impacts are not deemed significant (Table 2.5). The EPBC listed Bulloo subspecies *Amytornis barbatus barbatus* was not considered in the impact assessment, as it occurs outside the Licence Area.

Table 2.4. Potential for occurrence of threatened or migratory species on-site, ordered in terms of their habitat preferences.

Species Name	Common Name	Status EPBC- AUS	NPW- SA	Primary habitat	Habitat Preferences	Likelihood of Occurrence On-site
<i>Ardea alba</i>	Great Egret	Migratory		Floodplains, Rivers, Wetlands	Will use on-site floodplains when inundated, but prefers wetlands and waterways such as nearby Cooper Creek, and Coongie Lakes 60km NE	High likelihood of fly-over to use nearby Cooper Creek, and High likelihood of on-site visit when floodplain is inundated
<i>Ardea intermedia</i>	Intermediate Egret		R	same as above	same as above	same as above
<i>Egretta garzetta</i>	Little Egret		R	same as above	same as above	same as above
<i>Ardea ibis</i>	Cattle Egret		R	same as above	same as above	same as above
<i>Anhinga novaehollandiae</i>	Australasian Darter		R	same as above	same as above	same as above
<i>Plegadis falcinellus</i>	Glossy Ibis		R	Floodplains, Wetlands	Will use on-site floodplains when inundated, but prefers wetlands especially Coongie Lakes 60km NE	High likelihood of seasonal fly-over to Coongie Lakes, and High likelihood of on-site visit when floodplain is inundated
<i>Podiceps cristatus</i>	Great Crested Grebe		R	same as above	same as above	same as above
<i>Biziura lobata</i>	Musk Duck		R	same as above	same as above	same as above
<i>Oxyura australis</i>	Blue-billed Duck		R	same as above	same as above	same as above
<i>Stictonetta naevosa</i>	Freckled Duck		V	same as above	same as above	same as above
<i>Anas rhynchotis</i>	Australasian Shoveler		R	same as above	same as above	same as above
<i>Grus rubicunda</i>	Brolga		V	same as above	same as above	No-Uncommon in area
<i>Rostratula australis</i>	Australian Painted Snipe	VU	V	same as above	same as above	No-Uncommon in area
<i>Actitis hypoleucos</i>	Common Sandpiper		R	Wetlands, Mudflats	Prefers wetlands and waterways with mudflats, especially Coongie Lakes 60km NE	High likelihood of seasonal fly-over to Coongie Lakes
<i>Cladorhynchus leucocephalus</i>	Banded Stilt		V	same as above	same as above	same as above
<i>Myiagra inquieta</i>	Restless Flycatcher		R	Woodlands	Prefers scrubland and lightly timbered arid lands	Low
<i>Merops ornatus</i>	Rainbow Bee-eater	Migratory		Woodlands, Wetlands	Prefers arid grassland and shrublands with scattered trees	High
<i>Aprosmictus erythropterus</i>	Red-winged Parrot		R	Woodlands, Shrublands	Occurs in open forests and woodlands of mulga, brigalow, callitris and casuarina	High

Table 2.4. Continued

Species Name	Common Name	Status EPBC- AUS	NPW- SA	Primary habitat	Habitat Preferences	Likelihood of Occurrence On-site
<i>Ardeotis australis</i>	Australian Bustard		V	Woodlands, Shrublands, Grasslands, Dunes	Prefers arid scrub and grasslands	No-Uncommon in area
<i>Elanus scriptus</i>	Letter-winged Kite		R	same as above	Hunts over grassland and arid scrub and breeds along tree-lined creeks	High-as preferred habitat of tree-lined creeks and coolabahs over grasslands occur on-site, but thinly distributed
<i>Falco hypoleucos</i>	Grey Falcon		R	same as above	Prefers lightly timbered inland plains, gibber plains, arid scrubland and tree-lined watercourses	High-as preferred habitat occurs on site, but thinly distributed
<i>Falco peregrinus</i>	Peregrine Falcon		R	same as above	Occurs in open woodland, grassland with scattered trees, tree-lined watercourses, wetlands, and open plains	same as above
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard		R	same as above	Occurs in grassland, sand hills, gibber plains, tree-lined watercourses	same as above
<i>Ninox connivens connivens</i>	Barking Owl		R	same as above	Open country with stands of trees, and tree-lined watercourses	same as above
<i>Phaps histrionica</i>	Flock Bronzewing		R	same as above	Prefers arid grassland and shrublands with open spaces, and dry tree-lined riverbeds	High- as preferred habitat occurs on site
<i>Apus pacificus</i>	Fork-tailed Swift	Migratory		Woodlands, Shrublands, Grasslands, Dunes, Wetlands	Migratory visitor to Australia, and entirely aerial, rarely perching on trees	High-fly-over only, as totally aerial
<i>Amytornis barbatus barbatus</i>	Grey Grasswren (Bulloo)	VU	R	Wetlands, Shrublands, Dunes	Prefers periodically flooded overflow swamps, dense clumps of lignum/cane grass/sedges/rushes and saltbush	No-Outside their current range
<i>Amytornis barbatus diamantina</i>	Grey Grasswren		R	Wetlands, Shrublands, Dunes	Prefers periodically flooded overflow swamps, dense clumps of lignum/cane grass/sedges/rushes and saltbush	No-Uncommon in area, and little suitable habitat
<i>Pedionomus torquatus</i>	Plains Wanderer	VU	E	Gibber, Grasslands	Prefers sparse lowland native grasslands	High- as preferred habitat of native grassland on gibber occurs on-site

Table 2.5. Potential for significant impact of Transmission lines on EPBC listed birds under the Significant Impact Guidelines, and potential for impacts on NPW listed birds (highly likely, likely, unlikely, very unlikely), that are likely to occur within project area (species outside their current range have been excluded-see Table 2.4). Assessments relate to the varied likelihood of collision risk with transmission lines due to their proposed height and location. Species are ordered according to habitat preferences (see Table 2.4).

Common Name	Transmission Line to Moomba-floodplain route-Option 1-Low	Transmission Line to Moomba-floodplain route-Option 2-High	Transmission Line- between power plants (Jolokia-Savina)-Option 1-Low	Transmission Line- between power plants (Jolokia-Savina)-Option 2-High
Great Egret	Unlikely-While collision risk is likely, due to proximity with floodplains, it is unlikely to impact a sig proportion of population due to the infrequency of flooding, and irregularity of visits by only a low number of birds.	Unlikely-While collision risk is likely, and is higher than the Low Transmission Line, it is not likely to impact a sig proportion of the population.	Unlikely-While collision risk is likely, due to proximity to Cooper Ck. and floodplains, it is unlikely to impact a sig. proportion of population. Higher likelihood of impacts compared to both Low and high Transmission Line to Moomba	Unlikely-While collision risk is more likely than Option 1, due to increased height, it is unlikely to impact a sig. proportion of population. Highest likelihood of impacts of all transmission line proposals.
Intermediate Egret				
Little Egret				
Cattle Egret				
Australasian Darter				
Glossy Ibis				
Great Crested Grebe	Unlikely-While collision risk is likely, due to proximity with floodplains, it is unlikely to impact a sig proportion of population, as visits to site will be irregular	Unlikely-While collision risk is likely, and is higher than the Low Transmission Line, it is not likely to impact a sig proportion of the population	Unlikely-While collision risk is likely, due to proximity to the Cooper Ck. and floodplains, it is unlikely to impact a sig. proportion of population	
Musk Duck				
Blue-billed Duck				
Freckled Duck	Unlikely-Collision risk of birds flying overheard to Coongie Lakes is unlikely, due to low height of Transmission Line	Unlikely-Collision risk of birds flying overheard to Coongie Lakes is unlikely, but is higher than impacts from Low Transmission Line	Unlikely-Collision risk of birds flying overheard to Coongie Lakes is unlikely, due to low height of Transmission Line	Unlikely-Collision risk of birds flying overheard to Coongie Lakes is unlikely, but is higher than impacts from Low Transmission Line
Australian Painted Snipe				
Common Sandpiper				
Banded Stilt				

KEY

Highly Likely – Where there is a good possibility that geothermal operations will result in an impact

Likely – Where there is a possibility that geothermal operations will result in an impact

Unlikely – Where there is a limited possibility that geothermal operations will result in an impact

Very Unlikely – Where there is an extremely low possibility that geothermal operations will result in an impact

Table 2.5. Continued

Common Name	Transmission Line to Moomba-floodplain route-Option 1-Low	Transmission Line to Moomba-floodplain route-Option 2-High	Transmission Line- between power plants (Jolokia-Savina)-Low	Transmission Line- between power plants (Jolokia-Savina)-Option 2-High
Restless Flycatcher	No-Unlikely to collide as very agile in flight, and will only impact low numbers, but higher likelihood of collision compared to high Transmission Line	No-Unlikely to collide as very agile in flight, and too high, and will only impact low numbers	No-Unlikely to collide as very agile in flight, and will only impact low numbers, but higher likelihood of collision compared to high Transmission Line	No-Unlikely to collide as very agile in flight, and too high, and will only impact low numbers
Rainbow Bee-eater	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population, but is likely to have reduced impact compared to Option 1, as too high	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population, but is likely to have reduced impact compared to Option 1, as too high
Red-winged Parrot				
Australian Bustard	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population due to low density across site	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population, due to low density across site	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population, due to low density across site	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population, due to low density across site
Letter-winged Kite	Unlikely-While collision risk is likely, due to proximity with preferred habitats, it is unlikely to impact a sig proportion of population	Unlikely-While collision risk is likely, due to proximity with preferred habitats, it is unlikely to impact a sig proportion of population	Unlikely-While collision risk is likely, due to proximity with preferred habitats, it is unlikely to impact a sig proportion of population	Unlikely-While collision risk is likely, due to proximity with preferred habitats, it is unlikely to impact a sig proportion of population
Grey Falcon				
Peregrine Falcon				
Black-breasted Buzzard				
Barking Owl	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population	Unlikely-Lower level of impact compared to Option 1, as too high	Unlikely-While collision risk is likely, due to proximity with woodland habitats, it is unlikely to impact a sig proportion of population	Unlikely-Lower level of impact compared to Option 1, as too high
Flock Bronzewing	No-Possibility of collision, especially in woodland areas, but agile in flight.	No-Possibility of collision, especially in woodland areas, but agile in flight.	No-Possibility of collision, especially in woodland areas, but agile in flight.	No-Possibility of collision, especially in woodland areas, but agile in flight.
Fork-tailed Swift				
Grey Grasswren	No-Unlikely to collide, as Transmission Line is above bird flight height	No-Unlikely to collide, as Transmission Line is above bird flight height	No-Unlikely to collide, as Transmission Line is above bird flight height	No-Unlikely to collide, as Transmission Line is above bird flight height
Plains Wanderer				

Table 2.6. Potential for significant impact of habitat loss and disrupted movements on EPBC listed birds under the EPBC Act Significant Impact Guidelines and potential for impacts on NPW listed birds (highly likely, likely, unlikely, very unlikely) that are likely to occur within project area (species outside their current range have been excluded-see Table 2.4).

Please note: Assessments relate to the varied impacts of habitat loss based on estimates of proposed habitat clearance, and the disruption of bird movements due to the creation of artificial water bodies. Species are ordered according to habitat preferences (see Table 2.4).

Common Name	Habitat Clearance (all infrastructure and construction)	Artificial ponds
Great Egret	No-As no loss of Rivers or wetlands	Unlikely-Birds may be attracted to ponds, but it is unlikely to impact a sig. proportion of the population
Intermediate Egret		
Little Egret		
Cattle Egret		No
Australasian Darter		
Glossy Ibis		
Great Crested Grebe		
Musk Duck		Unlikely-While it is highly likely a large number of birds may be attracted to ponds, diverting their movement to Coongie Lakes, impacts are considered to be low
Blue-billed Duck		
Freckled Duck		
Australian Painted Snipe		
Common Sandpiper	No-No loss of wetland or mudflat habitat	Unlikely-While it is highly likely a large number of birds may be attracted to ponds, diverting their movement to Coongie Lakes, impacts are considered to be low
Banded Stilt		
Restless Flycatcher	No-No loss of woodland habitat	No
Rainbow Bee-eater		
Red-winged Parrot		
Australian Bustard	No-No loss of critical habitat	
Letter-winged Kite		
Grey Falcon		
Peregrine Falcon		
Black-breasted Buzzard		
Barking Owl		
Flock Bronzewing		
Fork-tailed Swift		
Grey Grasswren	Unlikely-While suitable foraging habitat may be cleared, this is unlikely to impact a sig. proportion of the national population, but may impact a sig. proportion of the regional population	
Plains Wanderer	Likely-While low numbers may be impacted by grassland removal, this may impact a large proportion of the regional population	

3 THREATENED FLORA SPECIES IMPACT ASSESSMENT

3.1 Overview

Overall, 12 flora species of state conservation significance and 3 ecological communities considered to be of state significance were reviewed within the impact assessment. No flora species or ecological communities of national conservation significance have been recorded within the area or considered to possibly occur within the project area. Table 3.1 details the threatened flora species assessed and the source they were identified from (i.e. EBS March 2009 survey or database searches). The assessment reviews state flora species and state threatened vegetation communities separately.

Table 3.1. Threatened flora species that occur or may occur within the Geodynamics Geothermal Licence Area

Family	Species name	Common name	Status	
			AUS	SA
CALLITRICHACEAE	<i>Callitriche sonderi</i>	Matted Water Starwort	n/a	R
CHENOPODIACEAE	<i>Osteocarpum acropterum</i> var. <i>deminutum</i>	Wingless Bonefruit	n/a	R
CHENOPODIACEAE	<i>Osteocarpum pentapterum</i>	Five-wing Bonefruit	n/a	E
CRUCIFERAE	<i>Phlegmatospermum ermaeum</i>	Spreading Cress	n/a	R
ELATINACEAE	<i>Bergia occultipetala</i>		n/a	V
FRANKENIACEAE	<i>Frankenia cupularis</i>		n/a	R
LEGUMINOSAE	<i>Acacia tenuissima</i>	Slender Wattle	n/a	R
LEGUMINOSAE	<i>Swainsona oligophylla</i>		n/a	R
MYOPORACEAE	<i>Eremophila polyclada</i>	Twiggy Emubush	n/a	R
STERCULIACEAE	<i>Gilesia biniflora</i>	Western Tar-vine	n/a	R
THYMELAEACEAE	<i>Pimelea penicillaris</i>	Sandhill Riceflower	n/a	R
ZYGOPHYLLACEAE	<i>Zygophyllum humillimum</i>	Small-fruit Twinleaf	n/a	R

KEY

Regions:

AUS: Australia (*Environment Protection and Biodiversity Conservation Act, 1999*)

SA: South Australia (*National Parks and Wildlife Act, 1972*)

Conservation Codes:

V: Vulnerable

R: Rare

E: Endangered

3.2 Flora species

3.2.1 EPBC Act Listed Species

No flora species of national conservation significance were detected within the project area during the survey nor are any highlighted on the BDBSA or the EPBC protected matters database search.

3.2.2 NPW Act Listed Species

No state conservation rated flora species were detected within the project area during the March 2009 survey. However, the BSBSA search highlights 12 state rated flora species as being previously detected within, or near the project area (Table 3.1). These species include 10 species with a *Rare* rating, one with a *Vulnerable* rating and one with an *Endangered* rating. Table 3.2 details the habitat preferences of flora species assessed within this report and the likelihood of their occurrence on site.

The potential impacts that are most likely to affect flora species present within the area are habitat clearance associated with the installation of infrastructure. Table 3.3 details the potential impacts on flora species and the extent of the impact.

Table 3.2. Potential for occurrence of state threatened flora species occurring on-site considering habitat preferences

SPECIES NAME	COMMON NAME	STATUS		PRIMARY HABITAT	IDENTIFIED LAND SYSTEM HABITAT	LIKELIHOOD OF OCCURRENCE ON SITE
		AUS	SA			
<i>Callitriche sonderi</i>	Matted Water Starwort	n/a	R	A rarely collected species, it has been generally recorded in inundation areas such as creek banks	Cooper (Floodplain)	Unlikely – This species was not detected during the March survey and the single record on the BDBSA is adjacent to the main channel of the Cooper Creek which will not be impacted upon by geothermal operations
<i>Osteocarpum acropterum var. deminutum</i>	Wingless Bonefruit	n/a	R	Wingless Bonefruit are found in a variety of habitats, often found in Bladder Saltbush and Bluebush communities on scalds or slightly saline locations	Cooper (Floodplain)	Unlikely – not recorded during the March survey, one record on the BDBSA approximately 30km north of Moomba well outside the likely impact area
<i>Osteocarpum pentapterum</i>	Five-wing Bonefruit	n/a	E	Similar to the Wingless Bonefruit, with regional records in close proximity to major creeks or tributaries	Merninie (Gibber Tableland); Cooper (Floodplain)	Unlikely – not recorded during March survey, however, two records on the BDBSA, one several km south-west of Innamincka and one approximately 15km north east of the town, both records adjacent to the Cooper Creek or major tributaries
<i>Phlegmatospermum eremaeum</i>	Spreading Cress	n/a	R	Generally occurs on heavier soils associated with floodplain areas, however, has also been recorded chenopod shrublands	Cooper (Floodplain)	Likely – not recorded during the March survey, however, one record on the BDBSA on the Strzelecki Track between Transmission Line Options 1 and 2
<i>Bergia occultipetala</i>		n/a	V	Limited information on the species, appears to prefer wetter areas	Cooper (Floodplain); Tingana (Sand Dunes)	Unlikely, but possible – not recorded during the March survey, one record on the BDBSA approximately 15 km east of Innamincka.
<i>Frankenia cupularis</i>		n/a	R	Limited information on the species, Frankenia's in general can occupy a range of habitat types	Cooper (Floodplain) – based on previous record	Unlikely – based on the previous record (one) of the species on the BDBSA, approximately 30km north west of Innamincka. It was not recorded during the March survey. Little is known about the preferred habitat of the species.
<i>Acacia tenuissima</i>	Slender Wattle	n/a	R	Only one record of the species in SA, several km's south west of Innamincka, common	Cooper (Floodplain); Tingana (Sand Dunes)	Unlikely, but possible – not recorded in the March survey, but one recorded in close proximity to the geothermal project area (only known record for SA).

SPECIES NAME	COMMON NAME	STATUS		PRIMARY HABITAT	IDENTIFIED LAND SYSTEM HABITAT	LIKELIHOOD OF OCCURRENCE ON SITE
		AUS	SA			
				in northern states. Found on red sandy plains.		
<i>Swainsona oligophylla</i>		n/a	R	Occurs on sandy soils of sand dunes and swales	Cooper (Floodplain); Tingana (Sand Dunes)	Likely – a total of 10 BDBSA records within or adjacent to project area, likely to be present when rainfall stimulates germination
<i>Eremophila polyclada</i>	Twiggy Emubush	n/a	R	Found on clay and duplex soils of floodplain areas	Cooper (Floodplain)	Unlikely, but possible – total of three BDBSA records, all of which occur adjacent to the Cooper Creek or a major tributary, potential habitat across the lower lying floodplain areas
<i>Gilesia biniflora</i>	Western Tar-vine	n/a	R	Has been recorded on saline stony soils, possibly restricted to saltbush communities	Tingana (Sand Dunes); Mernie (Gibber Tableland)	Unlikely – two BDBSA records for the region, both approximately 25km east of Dillons Highway
<i>Pimelea penicillaris</i>	Sandhill Riceflower	n/a	R	Occurs on sand dunes with deep sandy soils	Tingana (Sand Dunes); Cooper (Floodplain)	Unlikely, but possible – previously recorded close to Innamincka (two records), extensive available habitat within project area
<i>Zygophyllum humillimum</i>	Small-fruit Twinleaf	n/a	R	Recorded growing on red-brown cracking clay and sandy loam with gypsum	Tingana (Sand Dunes); Mernie (Gibber Tableland); Cooper (Floodplain)	Unlikely, but possible – a total of seven records in close proximity to project site, all outside the potential infrastructure areas

KEY

Regions:

AUS: Australia (*Environment Protection and Biodiversity Conservation Act, 1999*)

SA: South Australia (*National Parks and Wildlife Act, 1972*)

Conservation Codes:

V: Vulnerable

R: Rare

E: Endangered

Table 3.3. Potential for significant impacts on NPW Act listed flora species (highly likely, likely, unlikely, very unlikely). Assessments relate to the varied impacts of each proposed development, such as habitat loss (clearance), and installation of the Transmission Line assessed within March 2009 survey

SPECIES NAME	COMMON NAME	POTENTIAL FOR SIGNIFICANT IMPACT		
		Overall Habitat Loss	Transmission Line Option 1 – Habitat Loss	Transmission Line Option 2 – Habitat Loss
<i>Callitriche sonderi</i>	Matted Water Starwort	Unlikely – the species appears to be confined to areas which are regularly inundated, such as creek banks, therefore unlikely to be significantly impacted upon	Unlikely – Option 1 does not impact on any areas of major or minor creekline habitat	Unlikely – Option 2 does not impact on any areas of major or minor creekline habitat
<i>Osteocarpum acropterum var. deminutum</i>	Wingless Bonefruit	Unlikely – limited chenopod shrubland will be impacted upon by the project, therefore unlikely to significantly impact this species	Unlikely – several short sections of chenopod shrubland within Option 1 alignment, areas are small, no records of species and therefore unlikely to be a significant impact	Unlikely – no chenopod shrubland areas will be impacted upon by Option 2.
<i>Osteocarpum pentapterum</i>	Five-wing Bonefruit	Unlikely – the records for this species, within the region, appear to be confined to areas which are regularly inundated, such as creek banks, therefore unlikely to be significantly impacted upon	Unlikely – Option 1 does not impact on any areas of major or minor creekline habitat	Unlikely – Option 2 does not impact on any areas of major or minor creekline habitat
<i>Phlegmatospermum eremaeum</i>	Spreading Cress	Unlikely but possible – species is likely to occur within the Floodplain area, but small area of this land system to be impacted upon and no records closer than 10km to transmission lines	Unlikely but possible – species is likely to occur within the Floodplain area, more suitable habitat than Option 2 for the species	Unlikely – species is unlikely to occur within the Option 2 area as the majority of the area is sand dune and the species prefers heavier soils
<i>Bergia occultipetala</i>		Unlikely – the species appears to prefer wetter areas, such as creek banks, therefore unlikely to be significantly impacted upon	Unlikely – Option 1 does not impact on any areas of major or minor creekline habitat	Unlikely – Option 2 does not impact on any areas of major or minor creekline habitat
<i>Frankenia cupularis</i>		Unlikely – closest record is over 30km from project area, if present, would occur within Floodplain area which provides a significant amount of habitat in the area	Unlikely – species is likely to occur within the Floodplain area, more suitable habitat than Option 2 for the species	Unlikely – species is unlikely to occur within the Option 2 area as the majority of the area is sand dune and the species possibly prefers heavier soils
<i>Acacia tenuissima</i>	Slender Wattle	Unlikely – Species appears to prefer red sandy plains which are not a dominant habitat type in the area,	Unlikely – Based on the only record in the region, it is considered that Transmission Line Option 1 is	Unlikely, but possible – Preferred habitat is sandy plains, with extensive areas of sand dunes and

SPECIES NAME	COMMON NAME	POTENTIAL FOR SIGNIFICANT IMPACT		
		Overall Habitat Loss	Transmission Line Option 1 – Habitat Loss	Transmission Line Option 2 – Habitat Loss
		possible habitat occurs within the sand dune and swale areas.	unlikely to have a significant impact on the species. This is due to the amount of similar available habitat for the species present in the region and the lack of records of the species in the area.	sandy swales present within Transmission Line Option 2. Unlikely to have a significant impact on the species due to the amount of similar available habitat for the species present in the region, the lack of records of the species in the area and the low amount of vegetation clearance within this corridor.
<i>Swainsona oligophylla</i>		Unlikely, but possible – A number of records in the area, generally prefers sand dunes and swales and therefore preferred habitat is present. Total area of sand dune habitat within the Tingana is extensive, with a small proportion occurring within the project area	Unlikely – Transmission Line Option 1 does not span any sand dune country and therefore, it is unlikely to impact on any <i>Swainsona oligophylla</i> .	Likely – Transmission Line Option 2 spans some of the sand dune area and the alignment is very close to known records of the species. However, only a small proportion of available habitat would be affected Due to the broad nature of this assessment, further impact assessment would need to be completed if this option was selected
<i>Eremophila polyclada</i>	Twiggy Emubush	Unlikely – appears that the species occurs in close proximity to major watercourses and tributaries which will not be impact upon.	Unlikely – Based on the records in the region all occurring within very close proximity to the Cooper Creek and one of its main tributaries, it is considered that Transmission Line Option 1 is unlikely to have a significant impact on the habitat of the species.	Unlikely – Based on the records in the region all occurring within very close proximity to the Cooper Creek and one of its main tributaries, it is considered that Transmission Line Option 1 is unlikely to have a significant impact on the habitat of the species.
<i>Gilesia biniflora</i>	Western Tar-vine	Unlikely – limited saline habitat present within the project area, isolated lower lying areas present within the Merninie and Cooper Land Systems. Impact to these areas is likely to low, therefore unlikely to have significant impact on the species.	Unlikely – limited saline habitat present within the project area, isolated lower lying areas present within the Cooper Land Systems. Impact to these areas is likely to low, therefore unlikely to have significant impact on the species	Unlikely – Option 2 is predominantly sand dune and Coolibah Open woodland, therefore considered unlikely that suitable habitat is present.
<i>Pimelea penicillaris</i>	Sandhill Riceflower	Unlikely, but possible – majority of project area does not provide suitable habitat, except for within sand dune and swale areas. Likely	Unlikely – Transmission Line Option 1 does not span any sand dune country and therefore, it is unlikely to impact on any <i>Pimelea penicillaris</i> .	Likely – Transmission Line Option 2 is spans some of the sand dune area and therefore is likely to impact on suitable habitat for this species. Due

SPECIES NAME	COMMON NAME	POTENTIAL FOR SIGNIFICANT IMPACT		
		Overall Habitat Loss	Transmission Line Option 1 – Habitat Loss	Transmission Line Option 2 – Habitat Loss
		to be present but the extensive area of suitable habitat in the region along with a small proportion occurring within the project area, suggest the impact is unlikely to be significant		to the broad nature of this assessment, further impact assessment would need to be completed if this option was selected
<i>Zygophyllum humillimum</i>	Small-fruit Twinleaf	Unlikely – based on previous records, this species could be widespread and scattered across the region and project area (although no records occur within project area). Therefore, the amount of available habitat for the species and the scattered nature of the records, it suggests that any impacts would not be significant	Unlikely, but possible – habitat is present within the area, but as the species appears to occur within a range of habitats, any impact is unlikely to be significant. No records occur within the project area.	Unlikely, but possible – habitat is present within the area, but as the species appears to occur within a range of habitats, any impact is unlikely to be significant. No records occur within the project area.

KEY

Highly Likely – Where there is a good possibility that geothermal operations will result in an impact

Likely – Where there is a possibility that geothermal operations will result in an impact

Unlikely – Where there is a limited possibility that geothermal operations will result in an impact

Very Unlikely – Where there is an extremely low possibility that geothermal operations will result in an impact

3.3 Threatened Ecological Communities

3.3.1 EPBC Act Listed Threatened Ecological Communities

No nationally conservation rated flora species were detected within the project area during the survey nor are any highlighted on the EPBC protected matters database.

3.3.2 NPW Act Listed Threatened Ecological Communities

Within the project area three vegetation communities listed as '*of concern*' in lists of threatened ecosystems of the Non-Agricultural Region in South Australia occur (Neagle 2003; DEH Provisional list 2005). These three threatened ecosystems exist within the Channel Country bioregion, and include: 1) *Eucalyptus coolabah* ssp. *arida* (Coolibah) Woodland on levees and channel banks of regularly inundated floodplains; 2) *Atriplex nummularia* (Old-man Saltbush) Open Shrubland with occasional emergent *Eucalyptus camaldulensis* (River Red Gum) or *E. coolabah* ssp. *arida* (Coolibah) on low sandy rise of floodplains; and 3) *Chenopodium auricomum* (Golden Goosefoot) Shrubland on cracking clay depressions subject to periodic water-logging (Table 3.4). All of these communities are listed as '*of concern*' as they are generally at threat due to grazing of introduced herbivores resulting in removal of vegetation and changes in species composition. For more details of these communities and their locations within Transmission Line Option 1 and 2, please refer to the March Report (EBS 2009).

Table 3.5 details the general habitat preferences of these threatened ecological communities assessed within this report and the likelihood of their occurrence on site. The potential impacts that are most likely to affect threatened ecological communities present within the area are habitat clearance associated with the installation of all infrastructure. Table 3.6 details the potential impacts on threatened ecological communities and the extent of the impact.

Table 3.4. Threatened ecological communities that occur within the Geodynamics Geothermal Licence Area

Threatened Ecological Community	Conservation Status	Source
	SA	
<i>Eucalyptus coolabah</i> ssp. <i>arida</i> (Coolibah) Woodland on levees and channel banks of regularly inundated floodplains	Of concern	EBS Neagle (2003) DEH (2005)
<i>Atriplex nummularia</i> (Old-man Saltbush) Open Shrubland with occasional emergent <i>Eucalyptus camaldulensis</i> (River Red Gum) or <i>E. coolabah</i> ssp. <i>arida</i> (Coolibah) on low sandy rise of floodplains	Of concern	Neagle (2003) DEH (2005)
<i>Chenopodium auricomum</i> (Golden Goosefoot) Shrubland on cracking clay depressions subject to periodic waterlogging	Of concern	EBS Neagle (2003) DEH (2005)

KEY

EBS – Threatened species observed or captured within the EBS March 2009 survey

Neagle (2003) – An inventory of the Biological Resources of the Rangelands of South Australia

DEH (2005) - Provisional List of Threatened Ecosystems of South Australia (unpublished and provisional)

3.3.2.1 *Eucalyptus coolabah* ssp. *arida* (Coolibah) Woodland

Eucalyptus coolabah ssp. *arida* (Coolibah) Woodland on levees and channel banks occurs within regularly inundated floodplains and is listed by Neagle (2003) as one of the most characteristic ecological communities of the riverine and floodplain land systems of the rangelands of South Australia. Its distribution across the state is said to occur extensively in association with major river channels in the north (Brandle & Hudspith 1998; Neagle 2003). This ecological community occurs extensively near major river channels within the Channel Country Bioregion, which includes the Coongie and Sturt Stony Desert sub-regions, found within the Geodynamics Geothermal Licence Area. It is less common within the Simpson-Strzelecki Dunefields Bioregion, which includes the Strzelecki Desert sub-region, whereby occurrences of the community are found along major watercourses.

This Woodland is considered widespread, but is poorly conserved. It is conserved within the Stony Plains Bioregion within Witjira National Park and within Innamincka Regional Reserve; however, it is still subject to heavy grazing pressure from cattle. The Woodland is better conserved within the Channel Country Bioregion within Queensland (Neagle 2003).

3.3.2.2 *Atriplex nummularia* (Old-man Saltbush) Open Shrubland with occasional emergent *Eucalyptus camaldulensis* (River Red Gum) or *E. coolabah* ssp. *arida* (Coolibah)

Atriplex nummularia (Old-man Saltbush) Open Shrubland with occasional emergent *Eucalyptus camaldulensis* (River Red Gum) or *E. coolabah* ssp. *arida* (Coolibah) is generally found on low sandy rises of floodplains, floodouts and swamps. It is widely scattered throughout arid river floodplains, but frequently occurs in areas that are only occasionally inundated. In general, it is known to occur throughout the northern rangelands of South Australia in the above environments. This ecological community is widespread within the Channel Country Bioregion, which includes the Coongie and Sturt Stony Desert sub-regions, found within the Geodynamics Geothermal Licence Area. It is less common within the Simpson-Strzelecki Dunefields Bioregion, which includes the Strzelecki Desert sub-region, whereby occurrences of the community are found along a few of the major watercourses that pass through this bioregion.

This shrubland is conserved within the Stony Plains Bioregion within Witjira National Park and within Innamincka Regional Reserve; however, it is still subject to heavy grazing pressure from cattle (Neagle 2003).

3.3.2.3 *Chenopodium auricomum* (Golden Goosefoot) Shrubland

Chenopodium auricomum (Golden Goosefoot) Shrubland is generally found on cracking clay depressions subject to periodic waterlogging (DEH 2005). The shrubland occurs in association with river floodplains and larger watercourses in the far north and particularly north-east of South Australia. Neagle (2003) details this community as occurring extensively within the Channel Country Bioregion, which includes the Coongie and Sturt Stony Desert sub-regions found within the Geodynamics Geothermal Licence Area. Specifically, the shrubland is found in the less frequently flooded areas of the Warburton/Diamantina and Cooper Creek floodplains. The Shrubland is less common within the Simpson-Strzelecki Dunefields Bioregion, which includes the Strzelecki Desert sub-region, where it is found along the Macumba River, Warburton, and Cooper Creeks.

Innamincka Regional Reserve is the only reserve this shrubland is currently conserved within.

Table 3.5. Potential for occurrence of state threatened ecological communities occurring on-site considering habitat preferences

THREATENED ECOLOGICAL COMMUNITY	STATUS		PRIMARY HABITAT	IDENTIFIED LAND SYSTEM HABITAT	LIKELIHOOD OF OCCURRENCE ON SITE
	AUS	SA			
<i>Eucalyptus coolabah</i> ssp. <i>arida</i> (Coolibah) Woodland on levees and channel banks of regularly inundated floodplains	n/a	Of Concern	Levee and channel banks of regularly inundated floodplains (DEH 2005). This community can occur in areas that retain water for sustained periods of time between floods, waterholes, or near subsurface water in sandy channel beds	Cooper (floodplain)	High – found on site during the March 2009 survey
<i>Atriplex nummularia</i> (Old-man Saltbush) Open Shrubland with occasional emergent <i>Eucalyptus camaldulensis</i> (River Red Gum) or <i>E. coolabah</i> ssp. <i>arida</i> (Coolibah) on low sandy rise of floodplains	n/a	Of Concern	Low sandy rises of floodplains and in areas that are only occasionally inundated.	Cooper (floodplain)	High – Known to occur throughout the Channel Country Bioregion
<i>Chenopodium auricomum</i> (Golden Goosefoot) Shrubland on cracking clay depressions subject to periodic waterlogging	n/a	Of Concern	Cracking clay depressions subject to periodic waterlogging (swamps) found on low lying fringes of floodplains or fringing Cane-grass Grasslands in swamps.	Cooper (floodplain)	High – found on site during the March 2009 survey

KEY

Regions:

AUS: Australia (*Environment Protection and Biodiversity Conservation Act, 1999*)

SA: South Australia (*National Parks and Wildlife Act, 1972*)

Table 3.6. Potential for impacts (highly likely, likely, unlikely, very unlikely) on State listed threatened ecological communities. Assessments relate to the varied impacts of each proposed development, such as habitat loss (clearance), and installation of the Transmission Line assessed within March 2009 survey

THREATENED ECOLOGICAL COMMUNITY	STATUS		POTENTIAL FOR SIGNIFICANT IMPACT		
	AUS	SA	Overall Habitat Loss	Transmission Line Option 1 – Habitat Loss	Transmission Line Option 2 – Habitat Loss
<i>Eucalyptus coolabah</i> ssp. <i>arida</i> (Coolibah) Woodland on levees and channel banks of regularly inundated floodplains	n/a	Of Concern	Unlikely – General habitat clearance within the project area could result in loss of this community; however this community occurs extensively near major river channels within the Channel Country Bioregion. On a regional scale small clearance of this woodland would not result in a substantial impact	Likely – The location of Transmission Line Option 1 mostly spans floodplain country within the Coongie sub-region, which is known to support this community. Within the March 2009, 304 ha was recorded along the transmission line and it is therefore likely there will be some impact. However, on a regional scale small clearance of this woodland would not result in a substantial impact	Likely – The western section of Transmission Line Option 2 spans floodplain country within the Coongie sub-region, which is known to support this community. Within the March 2009, 257 ha was recorded along the transmission line and it is therefore likely there will be some impact. However, on a regional scale small clearance of this woodland would not result in a substantial impact
<i>Atriplex nummularia</i> (Old-man Saltbush) Open Shrubland with occasional emergent <i>Eucalyptus camaldulensis</i> (River Red Gum) or <i>E. coolabah</i> ssp. <i>arida</i> (Coolibah) on low sandy rise of floodplains	n/a	Of Concern	Unlikely – In general, it is known to occur throughout the northern rangelands of South Australia in the above environments. This ecological community is widespread within the Channel Country Bioregion. On a regional scale small clearance of this shrubland would not result in a substantial impact	Unlikely – It is widely scattered throughout arid river floodplains, and was not recorded within the March 2009 survey	Unlikely - It is widely scattered throughout arid river floodplains, and was not recorded within the March 2009 survey
<i>Chenopodium auricomum</i> (Golden Goosefoot) Shrubland on cracking clay depressions subject to periodic waterlogging	n/a	Of Concern	Unlikely – It is widely scattered throughout arid river floodplains, and is known to occur throughout the northern rangelands of South Australia. This ecological community is widespread within the Channel Country Bioregion. On a regional scale small clearance	Likely – The location of Transmission Line Option 1 mostly spans floodplain country within the Coongie sub-region, which is known to support this community. Within the March 2009, 114 ha of a similar vegetation association was recorded along the transmission line and it is therefore likely there	Likely – The western section of Transmission Line Option 2 mostly spans floodplain country within the Coongie sub-region, which is known to support this community. Within the March 2009, 151 ha of a similar vegetation association was recorded along the transmission line and it is therefore likely there

THREATENED ECOLOGICAL COMMUNITY	STATUS		POTENTIAL FOR SIGNIFICANT IMPACT		
	AUS	SA	Overall Habitat Loss	Transmission Line Option 1 – Habitat Loss	Transmission Line Option 2 – Habitat Loss
			of this shrubland would not result in a substantial impact	will be some impact. However, on a regional scale small clearance of this shrubland would not result in a substantial impact	will be some impact. However, on a regional scale small clearance of this shrubland would not result in a substantial impact

KEY

Highly Likely – Where there is a good possibility that geothermal operations will result in an impact

Likely – Where there is a possibility that geothermal operations will result in an impact

Unlikely – Where there is a limited possibility that geothermal operations will result in an impact

Very Unlikely – Where there is an extremely low possibility that geothermal operations will result in an impact

4 REGIONAL IMPACT ASSESSMENT

Within the wider region (IBRA sub-regions) the three identified land systems habitats of Cooper (floodplain), Merninie (gibber tableland), and Tingana (sand dunes) that fall within the Geodynamics Geothermal Licence Area are well represented outside of the Licence Area. As the Licence Area lies predominantly within the Cooper land system, habitats within this land system will likely be subject to the greatest disturbance. This land system is well represented within the wider region, with the majority falling within the Coongie sub-region (Figure 1.1).

The exact size and locations of each component of the infrastructure and its operations could not be specified, so the exact quantities and proportions of each available habitat type could not be calculated. Instead, the estimates provided within this report provide only a crude estimate, and their application is limited. The Licence Area represents 11.3%, 10.0%, and 1.2% of the Cooper, Merninie, and Tingana land systems within the IBRA sub-region boundaries, respectively (Table 1.1). It is important to note that the total calculations for both Merninie and Tingana land systems are incomplete and underrepresented as IBRA sub-region data was only available for South Australia and not Queensland or New South Wales. Therefore, the percentage of these land systems within the Licence Area compared to 'actual' available habitat is likely to be lower than presented.

To provide an indication of potential clearance or disturbance to available habitat in the Licence Area a crude estimate of a clearance footprint of 250 ha has been used to estimate possible disturbances to each land system habitat. This estimate is based on the current 'worst case' estimates of the possible project footprint that will result from all potential infrastructure and associated activities (excluding the Transmission Lines to Moomba) and is likely to exceed actual disturbance. If all infrastructure and associated clearance were distributed evenly in the Cooper, Merninie and Tingana land systems and impacted a total footprint of 250 ha, this would represent less than 0.05%, 0.5%, and 0.6% of each land system within the Geodynamics Geothermal Licence Area, respectively. If infrastructure and associated clearance was located predominantly in any one of the Cooper, Merninie or Tingana land systems, a total of 250 ha would represent clearance of 0.15% or 1.3% or 1.7% of the land system within the Licence Area, respectively.

In relation to the total land system area within the IBRA sub-region boundary, a clearance of 250 ha in any one of the land systems would represent a very small proportion of the land system area (0.02% for Cooper and Tingana and 0.1% for Merninie).

5 SEB DISCUSSION

During the March 2009 survey, the condition of all vegetation associations within the project area ranged between moderate and good quality. It is mostly likely the SEB ratios of the vegetation (as observed during the field survey) would range between 4:1 to 8:1 (see Table 5.1 for the definitions of SEB ratios). Overall, the dune fields support vegetation associations of higher diversity compared to gibber tableland and floodplain land systems. Consequently, the vegetation condition increased in the eastern section of the Geodynamic Geothermal Licence Area where the primary dunes are located.

The current low rainfall in the area has influenced the vegetation condition, and few herbs or ephemeral species were observed during the March 2009 survey. It is likely that after a significant rainfall event, flora species diversity and abundance will increase significantly. Generally, the vegetation over the entire project area was considered to be showing some signs of drought stress; with many chenopod shrubs and *Eucalypt* species being either dead, dormant, or showing signs of foliage dieback. Few weed species were observed across the project area at the time of the survey, with three being observed overall. It is suspected more weed species exist within the area.

Grazing of shrubs and grasses by rabbits and/or cattle was evident as blunt end tips to branches and/or grass tussocks were noticed. Signs of rabbit grazing was more evident within the dunes, but was also evident throughout the project area.

Grazing pressure and soil disturbance from cattle is also affecting the condition of vegetation within the project area, particularly in close proximity to artificial water points. Grazing pressure and soil disturbance is increased in these areas through high stock volumes and therefore, very little recruitment of native plants was seen to be occurring. As expected, the condition of vegetation increases away from disturbance areas, such as artificial watering points, tracks, and existing infrastructure.

Table 5.1. SEB ratios and associated vegetation condition

Vegetation Condition	SEB ratio
Clearance consists of lopping of limbs, not affecting the health of the tree/shrub	0
<p>Weed-dominated with only scattered areas or patches of native vegetation</p> <p>Indicated by: Vegetation structure no longer intact (eg. Removal of one or more vegetation strata) Scope for regeneration , but not to a state approaching good condition without intensive management Dominated by very aggressive weeds Partial or extensive clearing (> 50% of area) Evidence of heavy grazing (tracks, browse limes, species changes, no evidence of soil surface crust)</p>	2:1 (area)
<p>Native vegetation with considerable disturbance</p> <p>Indicated by: Vegetation structure substantially altered (e.g. One or more vegetation strata depleted) Retains basic vegetation structure or the ability to regenerate it Very obvious signs of long-term or severe disturbance Weed dominated with some very aggressive weeds Partial clearing (10 – 50% of area) Evidence of moderate grazing (tracks, browse lines, soil surface crust extensively broken)</p>	4:1 (area)
<p>Native vegetation with some disturbance</p> <p>Indicated by: Vegetation structure altered (e.g. One or more vegetation strata depleted) Most seed sources available to regenerate original structure Obvious signs of disturbance (e.g. tracks, bare ground) Minor clearing (<10% of area) Considerable weed infestation with some aggressive weeds Evidence of some grazing (tracks, soil surface crust patchy)</p>	6:1 (area)
<p>Native vegetation with little disturbance</p> <p>Indicated by: Vegetation structure intact (e.g. all strata intact) Disturbance minor, only affecting individual species Only non-aggressive weeds present Some litter build-up</p>	8:1 (area)
<p>Intact vegetation</p> <p>Indicated by: All strata intact and botanical composition close to original Little or no signs of disturbance Little or no weed infestation Soil surface crust intact Substantial litter cover</p>	10:1 (area)

6 RECOMMENDATIONS

The following recommendations have been made as a result of preparing this impact assessment report:

- Conduct further detailed assessment of EPBC Act listed species if infrastructure is to be located in areas where this report highlights further assessment as necessary (e.g. transmission line Option 2).
- Locate the alignment of transmission lines, access tracks, and other infrastructure to follow a path that minimises disturbance to prominent stands of large trees, and avoids the removal of trees as far as possible, especially *Eucalyptus coolabah* (Coolibah) Woodland;
- A lower transmission line is expected to reduce the collision risk to over-flying waterbirds and shorebirds travelling from and to the Coongie Lakes;
- Limiting the size and availability of freestanding waterbodies will reduce the likelihood of attracting large numbers of shorebirds and waterbirds;
- Minimising the removal of grassland and shrubland habitat on gibber plains and in dune swales will limit the impact of habitat clearance on the Nationally Vulnerable Plains Wanderer;
- Further surveys for Plains Wanderer should be conducted where clearance of suitable habitat is required;
- Use existing access tracks where possible, such as 15 mile track to minimise vegetation clearance; and
- Conduct site-specific ecological assessments for infrastructure sites located in areas not covered by previous assessments;
- Once the final infrastructure siting has been determined, EBS can provide further comment on general recommendations for the construction phase of the alignment, to achieve minimal disturbance and attain best practice outcomes.

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APPENDIX F – STAKEHOLDER / AGENCY CONSULTATION ON EIR / SEO - SUMMARY OF COMMENTS AND RESPONSES

Table 7 – PRECISE OUTCOMES CONSULTATION

No.	Stakeholder	Response received	Comments	Response
1	APA Group	<ul style="list-style-type: none"> Nil comments received 		-
2	Beach Energy	<ul style="list-style-type: none"> Nil comments received 		-
3	Department Environment and Water (DEW)	<ul style="list-style-type: none"> 19 October 2021 	<ul style="list-style-type: none"> The nearest EPA septic disposal facility is the Innamincka Township system. This may not be big enough to handle the extra volume and still have sufficient capacity for the proposed expansion of the town. If you want to use this you will need to raise this with the Innamincka Progress Association and the Outback Communities Authority 	<ul style="list-style-type: none"> All wastewater is proposed to be treated in an onsite treatment system approved by SA Health. There will be no disposal of effluent to Innamincka township
4	Department for Infrastructure and Transport (DIT)	<ul style="list-style-type: none"> DIT acknowledged receipt of documents on 21 September. 	No comments received at date of this report	-
5	Landuse Coordination Unit Department Planning, Transport and Infrastructure (DPTI)	<ul style="list-style-type: none"> Nil comments received 		-

No.	Stakeholder	Response received	Comments	Response
6	Environmental Protection Agency (EPA)	<ul style="list-style-type: none"> 15 October 2021 	<ul style="list-style-type: none"> Refuelling areas should avoid the generation of hydrocarbon impacted soil (if not located on a hardstand and bunded area) and a method for appropriate treatment and/or disposal path for the impacted soil should be developed and stated A reference to the <i>Environment Protection (Water Quality) Policy 2015</i> should be incorporated under SEO Objectives 4 and 7 as a guide to how objectives can be achieved It is unclear if light vehicle, heavy vehicle and machinery wash-down water will be generated from the HRLSH. If so, details relating to the generation and management of wash-down water should be incorporated into the documents 	<ul style="list-style-type: none"> Additional reference made in Appendix D Risk Assessment section 9.2.7. and in the guide to how objective 7 can be achieved in the SEO. Further details of refuelling area/s will also be provided in the Activity Notification prepared for specific activities carried out under this EIR / SEO in the future Reference to Policy added to SEO objectives 4 and 7 No vehicle wash down facilities are intended to be established due to the limited water supply on site
7	Energy Resources Division Department for Energy and Mining	<ul style="list-style-type: none"> Nil comments received 		-
8	Innamincka Station	<ul style="list-style-type: none"> Nil comments received 		-
9	Innamincka Trading Post	<ul style="list-style-type: none"> Nil comments received 		-
10	Kidman Co	<ul style="list-style-type: none"> Nil comments received 		-
11	Outback Communities Authority	<ul style="list-style-type: none"> 21 October 2021. 	<ul style="list-style-type: none"> OCA has no comments at this time regarding the process but does however remain very interested in this proposal and its potential impact on the community of Innamincka. We would therefore ask that we remain on your stakeholder engagement list as this project progresses 	<ul style="list-style-type: none"> Noted and Precise will ensure that OCA is consulted for any specific activities at the site via the Activity Notification process

No.	Stakeholder	Response received	Comments	Response
12	ReNu Energy	<ul style="list-style-type: none"> 19 October 2021 	<ul style="list-style-type: none"> References to Geodynamics Limited in the documents that are not historical should be amended to ReNu Energy Limited. Amend introductory section of EIR & SEO to include the following: <i>ReNu Energy Limited (formerly Geodynamics Limited) has on behalf of the GRL3 licensees, been maintaining infrastructure associated with the now abandoned 1MW Geothermal Power Plant (Power Plant) within the boundaries of Geothermal Retention Licence 3 (GRL3) near Innamincka in the South Australian Cooper Basin whilst finalising the abandonment of the two remaining geothermal wells. This abandonment was completed in April 2021 and the licensees are intending to surrender the GRL3 permit during the 2021/22 financial year. ReNu Energy Limited is the Operator of GRL3. As a result of the GRL3 licensees no longer requiring the infrastructure, the Hot Rock Joint Venture (including Precise Outcomes) is proposing to take control of a portion of GRL3 known as "Area A" to develop and operate a</i> Land use descriptions in section 8.1 of EIR should be expanded to include "geothermal exploration" Suggest text in section 8.4 regarding transfer of Derbys Bore to be reworded to say: <i>"The Hot Rock Joint Venture is in discussions with ReNu on behalf of the GRL3 licensees to have possession of Derbys Bore 2 transferred in "as is condition"</i> Include GDY REF: ENV-FN-EX-RPT-00674-1.0 in cover page of Appendix B Include ENV-FN-EX-RPT-00446-1.0 in cover page of Appendix C 	<ul style="list-style-type: none"> EIR and SEO have been amended accordingly throughout Introductory sections to be both EIR & SEO amended accordingly Section 8.1 amended accordingly Section 8.5 amended accordingly Reference included on cover page of Appendix B Reference included on cover page of Appendix C

No.	Stakeholder	Response received	Comments	Response
13	SA Arid Lands Natural Resources Management Board	Nil		-
14	SA Health	<ul style="list-style-type: none"> 27 September 2021 	<ul style="list-style-type: none"> Need to check size of wastewater treatment system is based on 'Equivalent People' and as per Section 8 of the Onsite Wastewater Systems Code you will need to get a suitably qualified engineer to carry out a report on the proposed system 'Food Business Notification Form' required to be submitted to SAH if caterer used on site (unless the caterer is already a 'notified business') 	<ul style="list-style-type: none"> This will be assessed in detail at the Activity Notification stage This will be assessed at Activity Notification stage
16	SA Native Title Services (SANTS) - YYTLOAC	<p>DEM received direct contact from SANTS on 21 September 2021</p> <p>No written comments received at time of this report.</p>	<ul style="list-style-type: none"> YYTLOAC contacted DEM to advise that they would welcome an opportunity for Precise to present to members to provide an overview of planned operations but that this may be of more benefit towards Stage 3 of the approval process i.e., at Notice of Entry stage once more specifics are known. 	
17	SANTOS	<p>Acknowledgement of draft received and circulated for comment 24 September 2021.</p> <p>No comments received at time of this report.</p>		
18	National Parks and Wildlife Service South Australia (NPWSSA)	<ul style="list-style-type: none"> See DEW comments above. 		

Table 8 – DEM AGENCY CONSULTATION

No.	Stakeholder	Response received	Comments	Response
1	Aboriginal Affairs and Reconciliation Department of Premier and Cabinet	<ul style="list-style-type: none"> 11 February 2022 	<ul style="list-style-type: none"> Concerns about the continued use of the existing track to Darby's Bore which aligns with the location of Aboriginal site 7042-4151 Recommended that the Proponent engage with Traditional Owners, through YYTLOAC, to identify any non-tangible heritage that may exist within the Project area. AAR notes that the term 'impact mitigation' implies that some impacts may occur to the heritage, but that these would be mitigated where possible. The Heritage Act makes it an offence to damage, disturb or interfere with Aboriginal heritage, no matter the level of impact. To increase accuracy, AAR recommends the final dot point of section 9.2.4 be re-worded to: <i>"If Aboriginal heritage (sites, objects or remains) are discovered, work to be stopped and the Department of the Premier and Cabinet, Aboriginal Affairs and Reconciliation notified. A heritage specialist to be commissioned to record and assess the item(s) and provide advice on the most appropriate impact avoidance measures, and any consultation required with Traditional Owners."</i> 	<ul style="list-style-type: none"> Precise Outcomes may consider removing the gate and closing off access to the existing track to Darby's Bore as a means to protect Aboriginal site 7042-4151. In this case an alternative access track to the bore would be identified and constructed in consultation with the YYTLOAC. The Traditional Owners will be consulted as required for any new activities as part of the Indigenous Land Use Agreement that Precise Outcomes are a party to. Section 9.2.4 amended
2	Department Environment and Water (DEW)	<ul style="list-style-type: none"> 13 January 2022 	<ul style="list-style-type: none"> Email from DEW of 13 January 2022 confirmed that issue raised above has been adequately addressed in the Precise round of consultation on the EIR/SEO 	-

No.	Stakeholder	Response received	Comments	Response
3	Environment Protection Agency (EPA)	<ul style="list-style-type: none"> 19 January 2022 	<ul style="list-style-type: none"> Email from EPA dated 19 January 2022 confirmed that the issues raised in response to the Precise round of consultation have been addressed in the EIR/SEO 	-
4	SafeWork SA	<ul style="list-style-type: none"> 13 January 2022 	No comments raised	-
5	SA Health	<ul style="list-style-type: none"> 27 January 2022 	Email from SA Health dated 27 January 2022 indicated satisfaction with the response to their issues raised in the Precise round of consultation on the EIR/SEO	-

