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Drover - 01
Exploration Well

Supplement to EPA Referral Document

Document produced to support the referral of this proposal to the Environmental Protection Authority (EPA) under Section 38(1) of the Environmental Protection Act 1986

DOCUMENT APPROVAL	
Name	**Signature**
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1.0 ABBREVIATIONS

Abbreviation	Meaning
AHD	Australian Height Datum
APPEA	Australian Petroleum Production and Exploration Association
AWE	Australian Worldwide Exploration Limited
BHA	Bottom Hole Assembly
BOM	Bureau of Meteorology
BOP	Blow Out Preventer
°C	Degrees Celsius
DER	Department of Environment and Regulation
DoW	Department of Water
DFES	Department of Fire and Emergency Services
DMP	Department of Mines and Petroleum
DPF	Dongara Production Facility
DPAW	Department of Parks and Wildlife
DRF	Declared Rare Flora
EAG	Environmental Assessment Guidelines
EP	Exploration Permit/Environment Plan
EPA	Environmental Protection Authority
EPBC	Environmental Protection and Biodiversity Conservation (Act)
ESA	Environmentally Sensitive Area
Ha	Hectares
HDPE	High Density Poly Ethylene
HSEQ	Health, Safety, Environment and Quality
HFS	Hydraulic Fracture Stimulation

Abbreviation	Meaning
HPF	Hovea Production Facility
IBRA	Interim Biogeographic Regionalisation for Australia
JSEA	Job Safety & Environmental Analysis
KCL	Potassium Chloride
MBRT	Metres Below Rotary Table
MSDS	Material Safety Data Sheet
MHOF	Mt Horner Oil Field
NGO	Non-Governmental Organisation
OSCP	Oil Spill Contingency Plan
OSA	Oceaneering Services Australia Ltd. Pty.
PEC	Priority Ecological Communities
PGER	Petroleum and Geothermal Energy Resources Act 1967
PPE	Personal Protective Equipment
PTW	Permit to Work
SMS	Safety Management Systems
SMP	Safety Management Plan
SWALSC	South West Aboriginal Land and Sea Council
TEC	Threatened Ecological Community
VSA	Vegetation Substrate Association
WC	Wildlife Conservation (Act)
WGF	Woodada Gas Field
WIA	Well Intervention Activities

2.0 INTRODUCTION

2.1 BACKGROUND

ARC Energy Limited ("ARC") is a wholly owned subsidiary of AWE Limited ("AWE").
AWE Limited is an Australian based oil and gas exploration and production company. AWE currently has oil and gas interests in Australia, New Zealand, Indonesia, USA and is actively reviewing additional growth opportunities.

AWE produces gas and oil from onshore Oil and Gas Fields in the Perth Basin and has an active onshore exploration program. AWE has a Sydney head office with a Western Region Office in Perth and Perth Basin field operations at the Hovea Production Facility (HPF), Dongara Production Facility (DPF), Woodada Gas Field (WGF) and Mt Horner Oil Field (MHOF). AWE has contracted the operation of these facilities to Oceaneering Services Australia (OSA) Field Operations in the Perth Basin.

AWE Limited is proposing to undertake exploratory drilling to evaluate the hydrocarbon potential of the lower Kockatea Shale, Carynginia shales, Irwin River Coal Measures and the High Cliff sandstone. The primary objective being the High Cliff Sandstone. Dependent on the results, hydraulic fracture stimulation (HFS) of one or all of the above zones will be conducted on Drover-01 to test the capacity of the technique for enhancing hydrocarbon recovery from the well.

The first phase of the proposal will be to drill an exploration well to a depth of ~2350m.

2.2 LOCATION

The Drover-01 site is located 220km north-northwest of Perth in the Perth Basin oil and gas fields of Western Australia (Figure 1 & 2). The nearest village is Green Head which is located ~17.3 km to the West. The Kooringa homestead is located approximately 7.2 km north-east of the site.

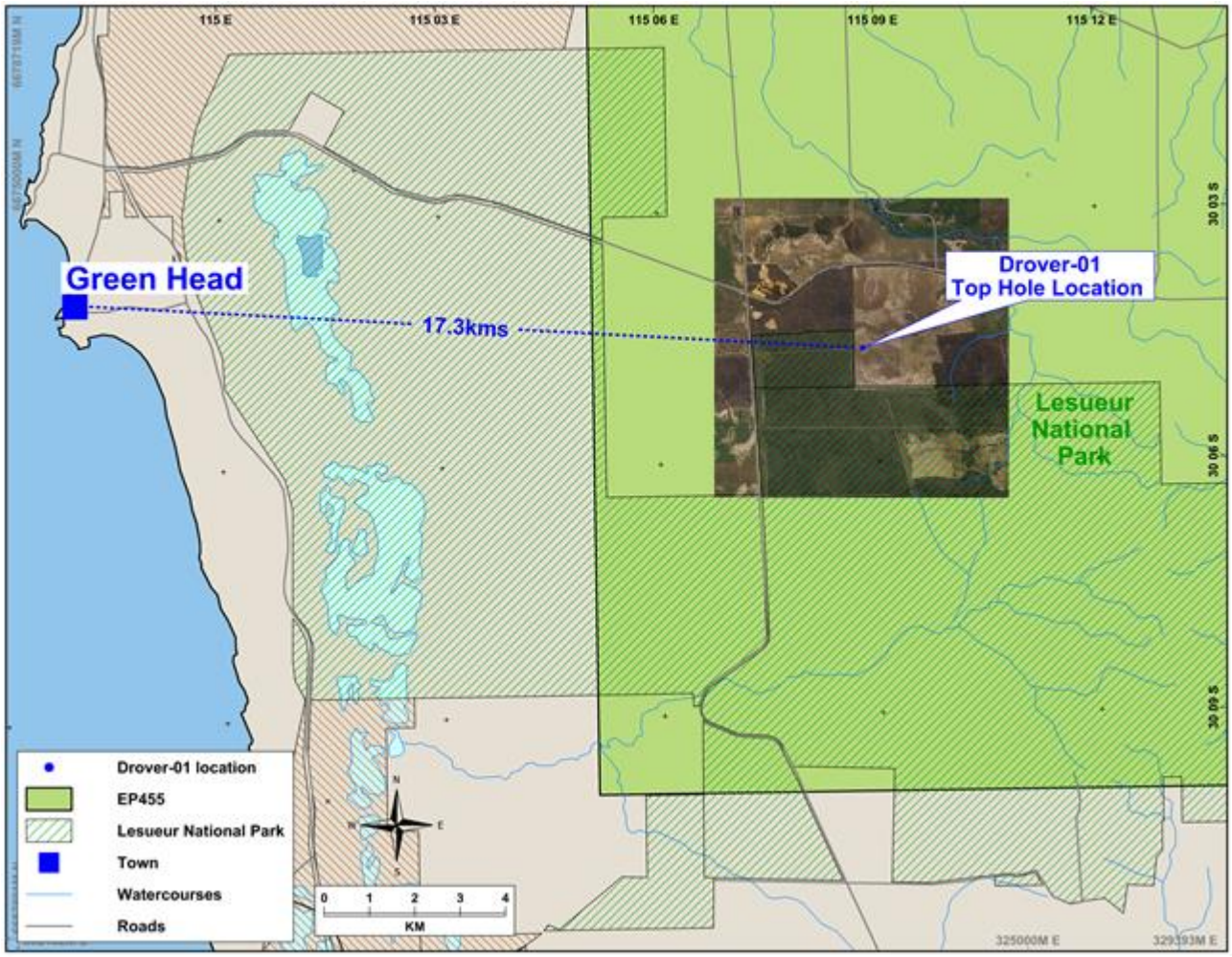

Figure 1 Drover-01 Locality Map- Broad Scale

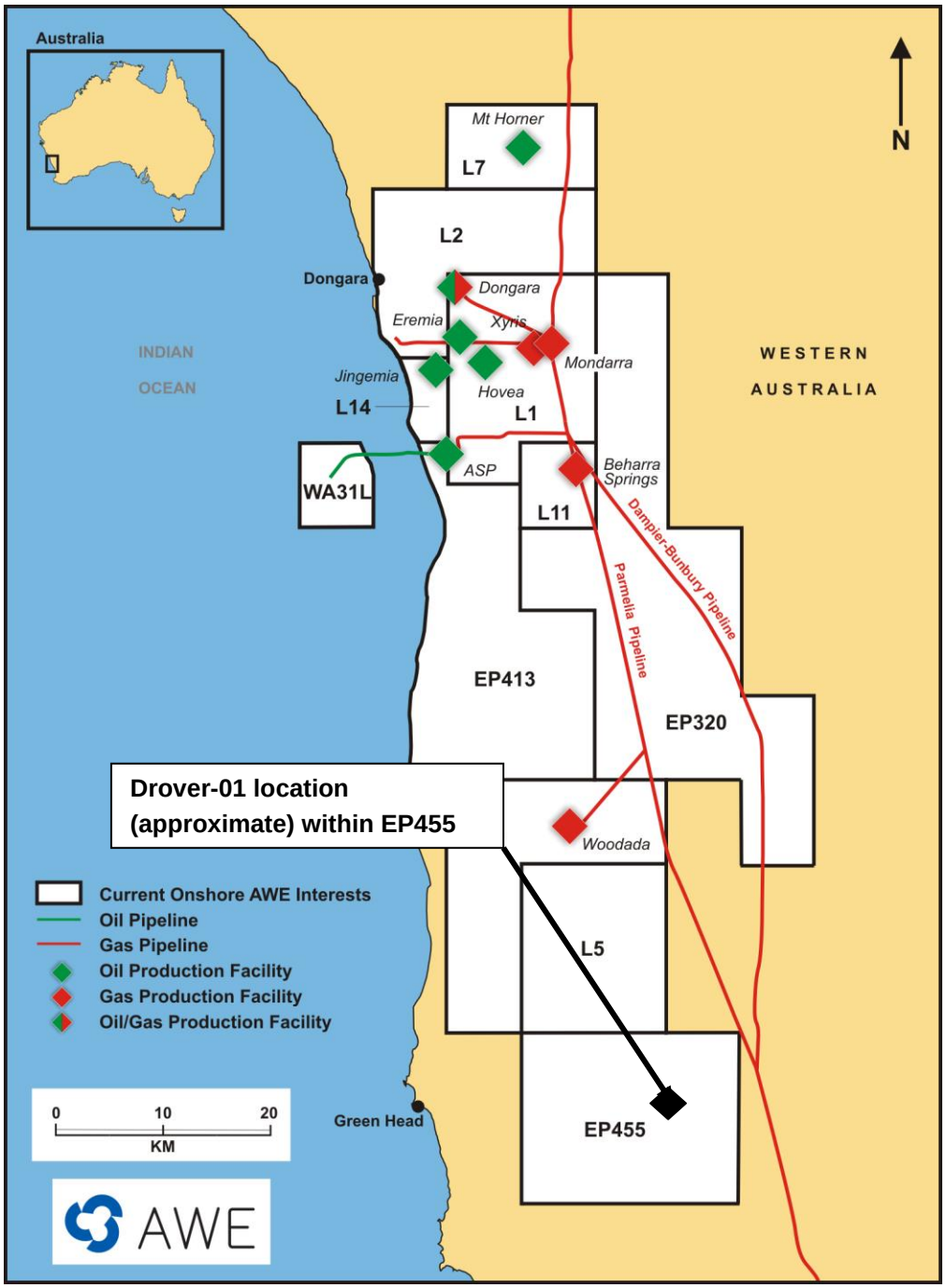

Figure 2 Drover-01 location within EP455 (approximate)

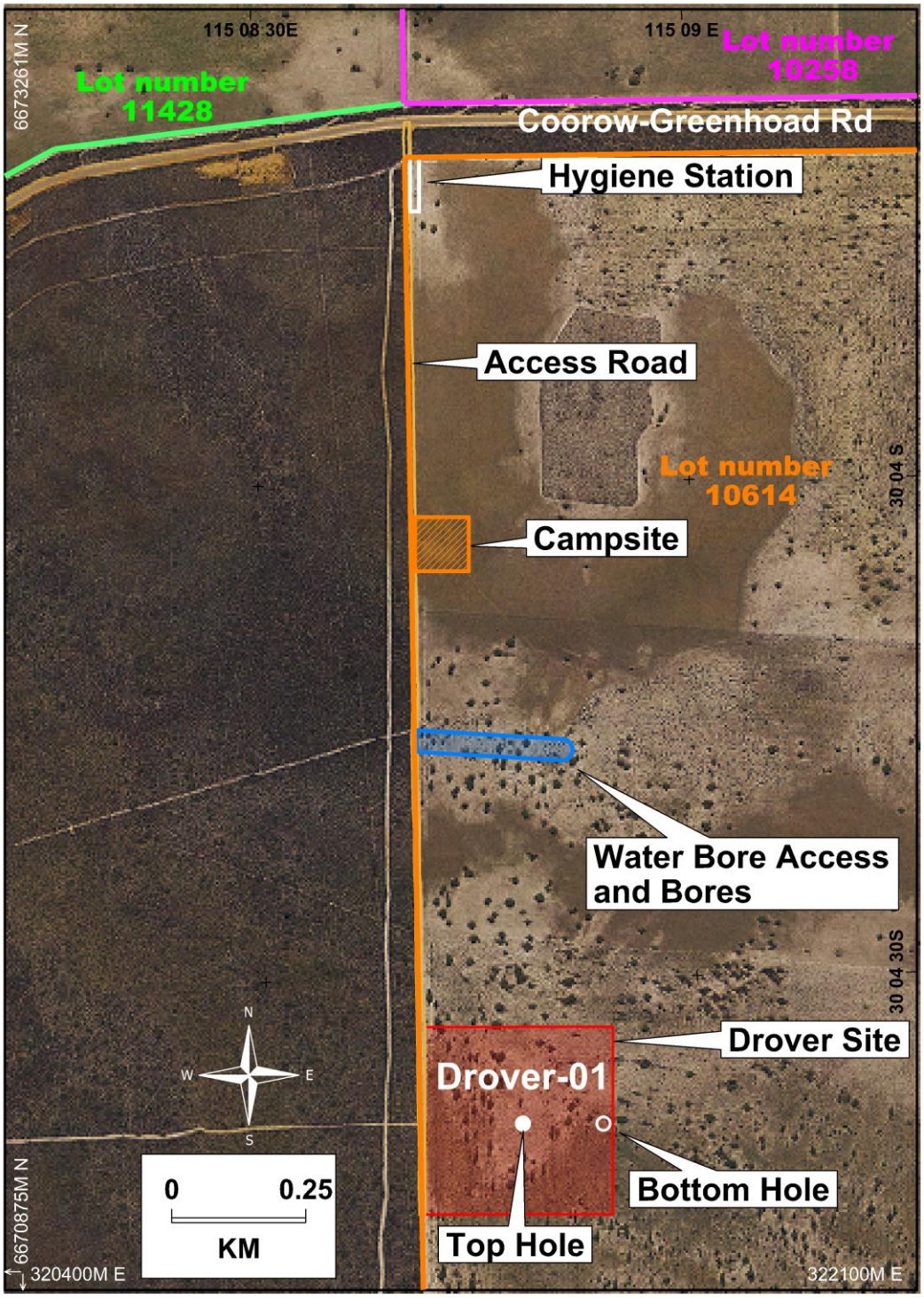

Figure 3 Drover-01 Site Plan- Proposal Details

2.3 TENURE

The Drover-01 exploration well is located within private agricultural land adjacent to Lesueur National Park (Figure 1).

The project is located within Exploration Licence EP455 (Figure 2).

2.4 APPROVAL HISTORY

Gairdner-01 exploration well (EP-100), located within the same property, was drilled by Arrow Energy on 29 October 1990. The well has since been plugged and abandoned by Arrow Energy.

The Environmental Management Plan (EMP) for Well Intervention Activities (WIA's) for hydrocarbon wells in the North Perth Basin was approved by the Department of Mines and Petroleum (DMP) on the 24 June 2011. The WIA Environment Plan (EP) is currently under amendment in accordance with the requirements set out within the Petroleum & Geothermal Energy Resources (Environment) Regulations 2012.

A native vegetation clearing permit is not required as the activity is exempt under Regulation 5, Item 24 Clearing under a Petroleum Act, Environmental Protection (Clearing of Native Vegetation) Regulations 2004. There are no Environmentally Sensitive Areas (ESA's) within the project area.

A summary of the environmental approvals gained for the project is summarised in Table 1.

Table 1 Summary of environmental approvals

Agency/Authority	Approval Required	Application lodged Yes / No
Department of Mines and Petroleum (DMP), Environment Division, Petroleum Environment Branch	Approval of Onshore North Perth Basin WIA Environmental Management Plan (21/HSEQ/ENV/PL01)	Lodged and approved. New version (HSE-E-075) currently under assessment.
	Approval of Drover-01 Environment Plan (HSE-077)	Lodged 09/09/2013 and awaiting assessment.
	Approved Oil Spill Contingency Plan (OSCP) for Drilling and WIA.	Lodged 12/08/2013 and awaiting assessment.
DMP, Resources Safety Division, Petroleum Safety Branch	Once a drilling contract has been awarded the contractor will in conjunction with AWE develop an Emergency Response Plan for the Drover-01 project.	Under development
DMP, Environment Division, Petroleum Environment Branch.	Approval of Works Program	Under development
Department of Water, Midwest – Gascoyne Region	Advice on Drover-01 Proposal	Consulted and advice provided.
Department of Water, Midwest – Gascoyne	26D Licence to alter/construct well	Application lodged to alter existing well.

Agency/Authority	Approval Required	Application lodged Yes / No
Region		
Department of Water, Midwest – Gascoyne Region	5C Licence to abstract groundwater	Application lodged to take water.
Department of Parks & Wildlife	Advice on Drover-01 proposal	Briefing held and advice provided.

2.5 OBJECTIVES

AWE proposes to drill, then Hydraulic Fracture Stimulate (HFS) the Drover-01 well which is located within private farmland.

The objective of this referral document is to provide the EPA with a summary of the proposed works and environmental impacts associated with the drilling and HFS activities for the Drover-01 well and set out the associated environmental management strategies to mitigate any potential impacts.

This document has been produced to accompany the Environmental Protection Authority (EPA) referral form under Section 38(1) of the *Environmental Protection Act 1986* to assist the EPA in determining the level of assessment for this project.

Section 8 provides an assessment of the project against the EPA Environmental Assessment Guidelines- EAG 8. Section 8 also references the other relevant statutory EIA decision-making processes (e.g. EP approval by DMP) the Drover-01 proposal will be subject to prior to commencing.

3.0 DESCRIPTION OF ACTIVITIES TO BE CONDUCTED

The following are to be conducted in conjunction with the Drover-01 operations:

- Site preparation
- Mobilise equipment and personnel
- Exploration drilling programme
- Conduct wireline and slickline operations
- Conduct coil tubing operations
- Hydraulic Fracture Stimulation
- Well Testing
- Demobilisation.

The description of the above Well Intervention Activities (WIA's) is provided within the Onshore North Perth Basin WIA Environment Plan [HSE-E-075].

Figure 2 presents the site layout plan for the Drover-01 site. Table 2 presents a description of the Drover-01 well site design features. Figure 4 presents the schematic layout for the Drover-01 HFS operations. The bottom hole location is approximately 350m east of the Lesueur National Park boundary.

Table 2 Design Characteristics of proposed Drover-01 wells

Well Design Feature	Description
Location	220km north-northwest of Perth and 17.3km east of Green Head.
Permit	EP455
Approximate Surface Hole Coordinates	Latitude: 30 04 38.78S Longitude: 115 08 47.7E Easting: 321,365.68mE Northing: 6,671,185.33mS
Approximate Bottom Hole Coordinates	Latitude: 30 04 38.86S Longitude: 115 08 53.3E Easting: 321,515.68mE Northing: 6,671,185.33mS
Drilling timing	1 March 2014 – 31 August 2014.
Drilling duration	25-30 days.
Work pad	Approximately 150 m x 150 m plus 10 m x 20 m cuttings pit.
Clearing required	~12 ha (maximum) a high percentage of the land is already cleared and currently used for agricultural purposes. Clearing permit not required as activities are exempt under the *Petroleum and Geothermal Energy Resources Act 1967.* No ESAs have been identified within the project area.
Drilling mud type	Water Based Mud (WBM).
Disposal of muds and cuttings	Water-based muds and cuttings discharged into a lined earthen sump during drilling allowed to evaporate and chemically tested at the completion of drilling. Test results will determine method of disposal either in situ or within a licenced facility.
Drill rig	Drilling contractor Rig type (TBA)
Proposed rig mobilisation route	Access to the proposed well site will be via Brand Highway and Coorow-Greenhead Road.

3.1 SITE ACCESS

Access to the Drover-01 well site will be via the existing farm access track located on the western edge of the property. All access to the Drover-01 will be conducted in accordance with the AWE Drover-01 Biosecurity Procedure (Appendix 4).

3.2 BASELINE SAMPLING

Base line sample of soil and ground water will be obtained prior to commencing drilling operations. The method of sampling and the location of samples will be agreed with the landowner. The sampling will be conducted by a suitably qualified sample technician with signoff from the landowner and company at the time of acquisition. The samples will be comprehensively analysed by a certified laboratory and copies of the analysis provided to the landowners and appropriate regulatory body.

3.3 SITE PREPARATION

Site preparation for the Drover-01 well includes:

- Clearing additional areas for hygiene station, access road, campsite, water bore access and the Drover-01 pad.
- Drilling of superficial aquifer water abstraction bore and monitoring bores in existing cleared areas (as required).
- Prepare access track and pad to allow for equipment.
- Construct lined flare pit, retention pond and two water storage ponds.
- Install fencing to exclude ground-dwelling native fauna around the flare pit and retention pond.
- Provision of septic holding tanks for grey water and toilet effluent.

3.4 MOBILISATION OF EQUIPMENT, PERSONNEL AND SUPPLIES

The drilling and HFS equipment, personnel and supplies will be mobilised by road to the Drover-01 Well site.

The former Gairdner campsite location (approximately 1km north of the Drover-01 well site) will be utilised to accommodate approximately 40 people. A new campsite will be established within the proposed 100m x 100m area and will contain the facilities to house the drilling contractors for the duration of the Drover-01 drilling programme.

3.5 DRILLING EXPLORATION PROGRAMME

AWE Limited is proposing to undertake exploratory drilling to evaluate the hydrocarbon potential of the lower Kockatea Shale, Carynginia shales, Irwin River Coal Measures and the High Cliff sandstone. The primary objective being the High Cliff Sandstone. Dependent on the results a HFS of one or all of the above zones will be conducted on Drover-01 to test the capacity of the technique for enhancing hydrocarbon recovery from the well.

Once the drill rig is established, all activities associated with drilling (e.g. refuelling, batching of drilling muds and cement) will only occur on the drill pad.

The Drover-01 project involves the following key stages:

- Mixing KCl brine and well control
- Pulling / running tubing and packers
- Drilling the well with a rotary drilling rig using recirculated water-based mud (primarily bentonite, KCl and polymer)
- Taking core samples from the newly drilled section of the well

- Conducting wireline logging of the constructed well bore
- Cementing the well casings
- Abandoning or completing the well
- Cementing the well casings

A safety and environmental audit of the drilling operation is to be carried out annually. A pre-start safety and environmental meeting will be held with all crew and other stakeholders as required, prior to commencing drilling operations. The drilling crew will be required to undergo an AWE HSE induction or another operator HSE induction, as required.

Drilling activities generally run for approximately 25-30 days, which includes the mobilisation / demobilisation time. Noise and light disturbance to surrounding landowners is not generally a concern due to the remote location of the wells. However, if noise disturbances are considered likely to occur, the AWE Drilling Supervisor will request that the AWE Landowner Liaison consults with the relevant affected landowner.

A blow out preventer (BOP) is used during drilling operations, consisting of a 7 1/16” 5K Hydril and 3K double rams.

If flaring during or after the drilling is required, a purpose built flare pit, with a cleared area to DFES specifications will be constructed following consultation with the AWE Environmental Advisor and Landowner Liaison. This is a rare occurrence and any flaring will be carried out only after consultation with the Department of Fire and Emergency Services (DFES).

In the event that sufficient hydrocarbon indications are observed from mud logs, wireline logs and core the well will be cased in preparation for a HFS program.

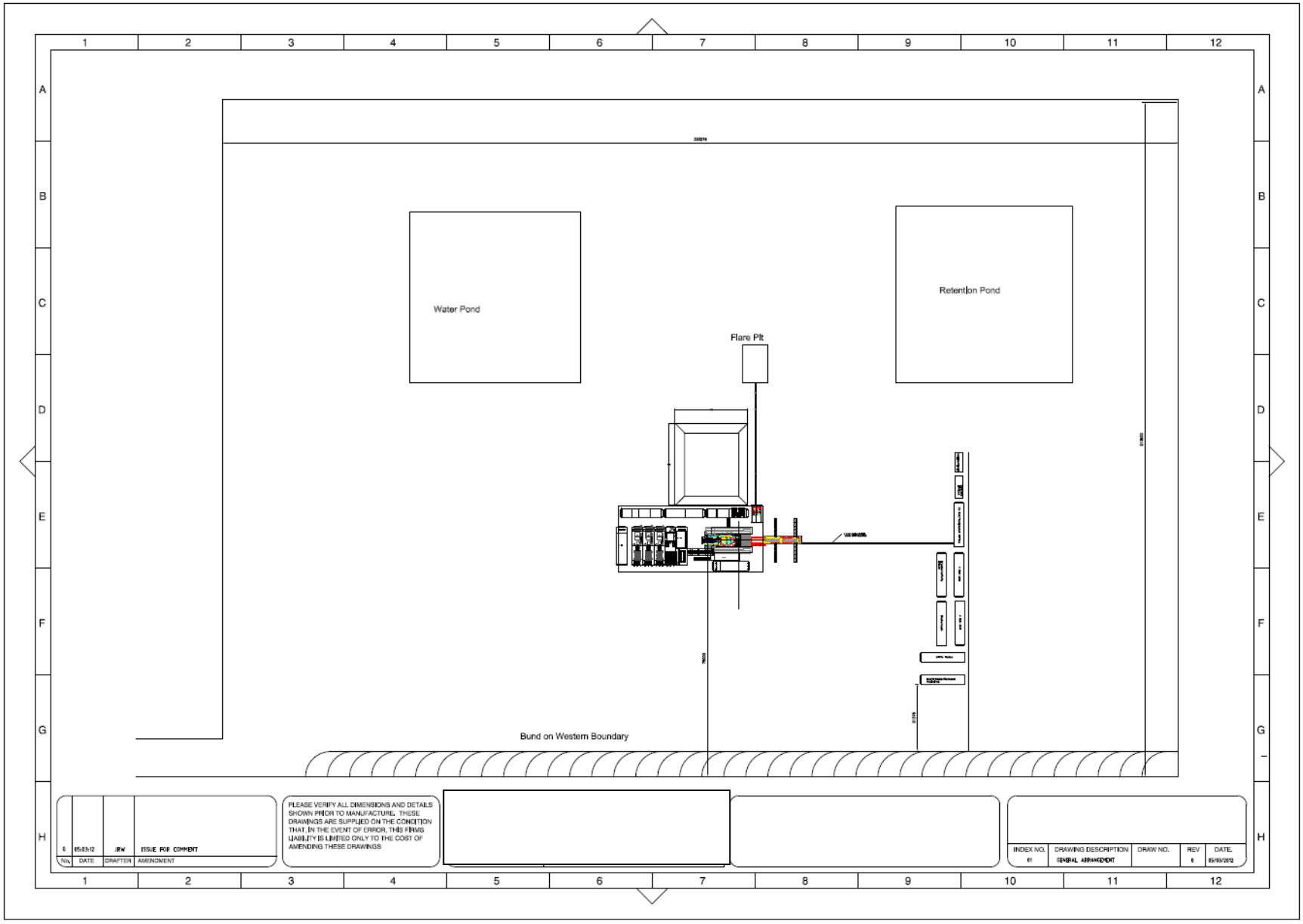

Figure 4 Drover-01 Operations Layout (indicative- not to scale)

3.6 SLICKLINE

Slickline operations may be used for fishing, gauge cutting, setting or removing plugs, deploying or removing wireline retrievable valves and memory logging.

Slickline units use long, smooth, unbraided wire, often shiny, silver/chrome in appearance. It comes in varying lengths, according to the depth of the well. The unbraided wire is spooled off a drum on the back of a slickline truck to use down hole tools in the well. The tools lowered into an oil or gas well are used to perform a specified maintenance job down hole.

The slickline operator monitors at surface the slickline tension via a weight indicator gauge and the depth via a depth counter 'zeroed' from surface to ensure the down hole tool is lowered to the desired depth. The job is completed by manipulating the downhole tool mechanically. Checks are undertaken to ensure the job has been completed (if possible), and then pulls the tool back out by winding the slickline back onto the drum from which it was spooled. The slickline drum is controlled by a hydraulic pump, which is controlled by the operator.

Slickline comes in different sizes and grades (i.e. the larger the size, the higher the grade). This generally means that higher line tension can be pulled before the line snaps at the weakest spot and causes a costly 'fishing' job.

3.7 WIRELINE OPERATIONS

The term wireline usually refers to cabling technology used by operators of oil and gas wells to lower equipment or measurement devices into the well for the purposes of WIA and reservoir evaluation.

Braided line can contain an inner core of insulated wires which provide power to equipment located at the end of the cable, normally referred to as electric line, and provides a pathway for electrical telemetry for communication between the surface and equipment at the end of the cable.

The wireline apparatus resides on the surface, wound around a large portable spool on the back of a special truck. A motor and drive train turn the spool and raise and lower the equipment into and out of the well.

3.8 COILED TUBING OPERATIONS

Coiled tubing refers to metal piping, normally 25 to 83mm (1" to 3.25") in diameter, used for interventions in oil and gas wells and comes spooled on a large reel. Coiled tubing is often used to carry out operations similar to wireline. The main benefits over wireline are the ability to pump chemicals through the coil and the ability to push it into the hole rather than relying on gravity. A coiled tubing operation can be run by a mobile self-contained coiled tubing unit or a smaller service rig.

The bottom hole assembly (BHA) tool string at the bottom of the coil is used for various applications such as a jetting nozzle, for jobs involving pumping chemicals or cement through the coil, to a larger string of logging tools, depending on the operations.

Coil tubing is also used to perform open-hole milling operations. This has the advantage of requiring less effort to trip in and out of the well (the coil can simply be run in and pulled out while drill string must be assembled and dismantled joint by joint while tripping in and out).

Additionally, the coiled tubing is stripped into and out of hole, providing a hermetic seal around the coil allowing the well to flow during drilling operations. Instead of rotating the drill bit by using a rotary table or top drive at the surface, it is turned by a downhole motor, powered by the motion of drilling fluid pumped from surface. Because coiled tubing is rigid, it can be pushed into the well from the surface. This is an advantage over wireline, which depends on the weight of the toolstring to be lowered into the well.

It can also be used to fracture the well. A common use for coiled tubing is circulation. A hydrostatic head (a column of fluid in the well bore) may be inhibiting flow of formation fluids due to its weight. By running coiled tubing into the bottom of the hole and pumping in gas, the kill fluid can be forced out to production. Circulating can also be used to clean out light debris, which may have accumulated in the hole.

3.9 HYDRAULIC FRACTURE STIMULATION (HFS)

The objective of HFS is to increase the amount of exposure a well has to the surrounding reservoir formation and to provide a conductive channel through which the produced natural gas or oil can flow easily to the well. The method is informally called fracturing or hydrofracturing. HFS is a process that results in the creation of fractures in rocks. This petroleum engineering method is used to create fractures that extend from a wellbore into targeted rock formations to enhance oil and natural gas recovery.

Fractures are extended by internal fluid pressure, which opens the fracture and causes it to grow into the rock. Fractures are formed at depth in a borehole and extend into targeted rock formations. The fracture width is typically maintained after the injection by introducing a proppant into the injected fluid. Proppant is a material, such as grains of sand, ceramic, or other particulates that prevent the fractures from closing when the injection is stopped. The proppant is carried into the fracture and the propped hydraulic fracture then becomes a high permeability conduit through which the formation fluids can be produced back to the well.

HFS equipment usually consists of a slurry blender, one or more high pressure, high volume fracturing pumps and a monitoring unit. Associated equipment includes fracturing tanks, high pressure treating pipe, a chemical additive unit (used to accurately monitor chemical addition) low pressure pipes and gauges for flow rate, fluid density, and treating pressure.

The target reservoirs are in the basal Kockatea Shale, Carynginia Shale, Irwin River Coal Measures and High Cliff Sandstone; at depths of greater than 1,600 m. The primary objective being the High Cliff Sandstone at depths of greater than 2,350 m.

Detailed step-by-step fracturing procedures are included in the work program that will be submitted for approval by the DMP. This will include emergency shutdown procedures such as the installation of a pressure relief valve to prevent over-pressuring the system.

3.10 MICROSEISMIC MONITORING

Microseismic monitoring is the practice of listening to passive, microseismic activity caused by HFS operations. The information gathered during HFS monitoring provides a better understanding of the fracture geometry, azimuth, connectivity, density, height and length. This technology can be useful in early field pilot projects and can be deployed either downhole in a dedicated observation well or as a surface array.

Microseismic monitoring was conducted on the Woodada Deep-01 HFS where downhole geophones were used in the Woodada-14 well (located 300 m from the Woodada Deep-01 well to monitor the fracturing process in Woodada Deep-01. The downhole microseismic monitoring results recorded are illustrated in Figure 5.

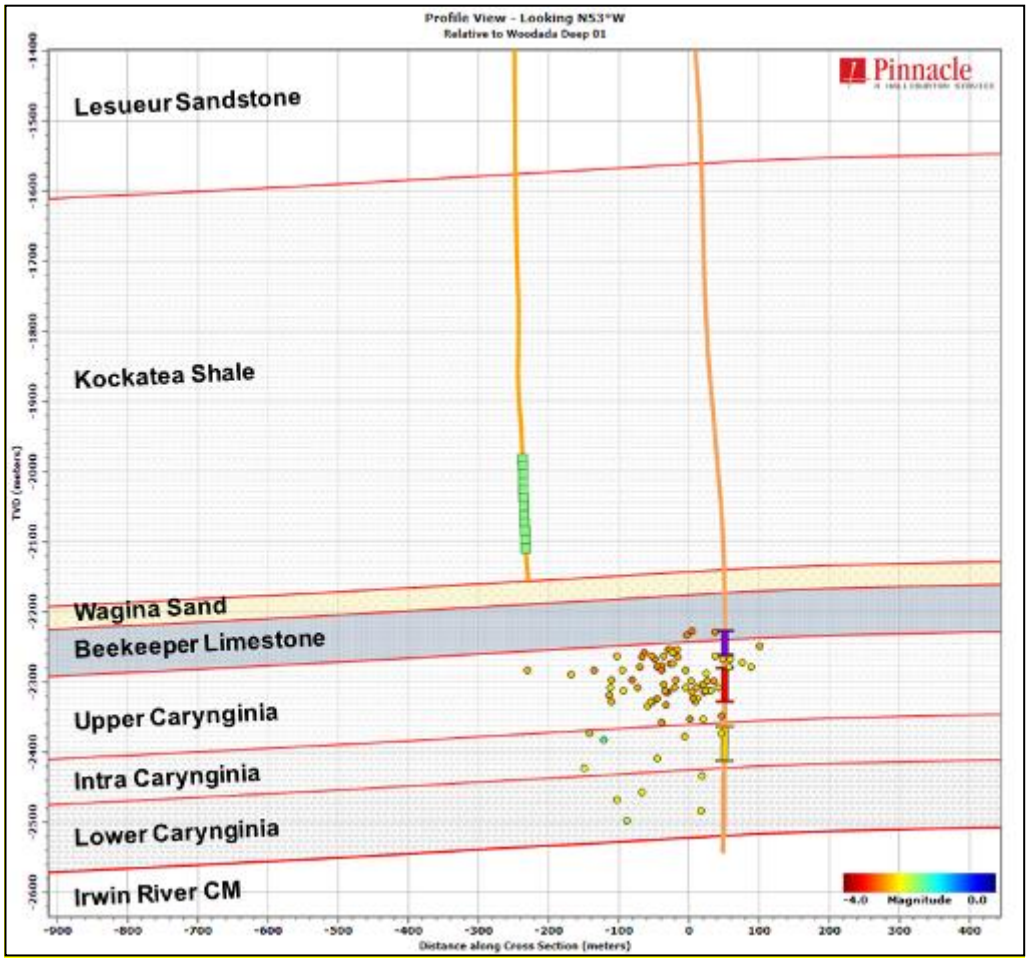

Figure 5 Woodada Deep-01 Microseismic Results

Figure 5 illustrates that the microseismic events are very small with moment magnitude between -3.0 to -1.9. The smallest event that can be felt by a person at surface is 2.0 to 3.0. With each unit in moment magnitude 30 times larger than the unit before, the largest moment magnitude at Woodada Deep-01 was 27,000 times smaller than what could be felt be a person.

Figure 5 also illustrates that the microseismic events stayed within the target zone and in the case of Woodada Deep-01 some 700m vertical distance from the base of the Lesueur Sandstone.

Figure 5 also illustrates that the furthest recorded microseismic event was approximately 260m lateral distance from the Woodada Deep wellbore. The data also indicates a maximum height growth of 256m. Therefore, if a fracture stimulation treatment was conducted in the basal Kockatea section of Drover-01 at an estimated depth of 1500m there would be sufficient rock strata (700m) between the target zone and the planned 9-5/8” casing shoe.

Microseismic monitoring is not planned for the Drover-01 project, but the above observations from the Woodada Deep-01 project would equally apply to Drover-01. The results from

Woodada Deep-01 are consistent with thousands of microseimic recordings of HFS treatments conducted in North America.

3.11 WELL TESTING

Well testing involves producing fluid from a well and flaring to a pit (or producing to a facility through a flowline), and liquids either to a retention pond or producing through a mobile test separator to a tank. Testing is conducted to understand the productivity of the reservoir and the impact of the well bore on the productivity. Testing is an integral part of Reservoir Management and the Onshore Schedule.

3.12 TIMING

The second phase (after initial drilling) of the proposal will be to HFS the well at up to four target intervals. The proposed HFS will be completed within 30 to 90 days dependent on equipment availability and will include:

- Site preparation
- Wireline and slickline operations
- Coil tubing operations
- HFS
- Well flow back

Subject to the success of the HFS, well testing may be conducted for up to 90 days which will include the flaring of gas.

3.13 DEMOBILISATION

Once complete, WIA equipment, personnel and supplies will be demobilised. Equipment will be transferred to the next WIA location.

4.0 SUPPORTING INFORMATION

4.1 WELL CONSTRUCTION

Figure 6 illustrates a typical casing string cross section. These steel pipes commonly referred to (i) the outer Surface Casing (ii) Production Casing (iii) the innermost Production Tubing, are used by the oil and gas industry to isolate and contain the produced and / or injected fluids within the wellbore to the surrounding geological formations below the ground surface. These steel pipes are also typically cemented in place to provide additional integrity.

Figure 6 Casing String Cross Section

The Drover-01 well construction will be made up of three steel casing strings: A 445mm (17.5 inch) hole will be drilled to a depth of 90m and 340mm (13-3/8 inch) steel casing will be run and cemented in place. The cement will form a sheath between the open hole and steel casing from the base of the steel casing to surface. A 311mm (12 1/4 inch) hole will then be drilled to a depth of approximately 765m and 244mm (9 5/8 inch) steel casing will be lowered and cemented in place with the cement sheath from 765m to surface. A 216mm (8-1/2inch) hole will then be drilled to the total well depth of 2350m and 140mm (5-1/2 inch) steel casing will be run and cemented into place. It is planned to place the cement sheath from 2350m up to 765m if possible.

Figure 7 is the planned Drover-01 well completion diagram illustrating each formation and the well construction. A cement bond log will be run over the surface casing and production casing to ensure adequate cement bonding.

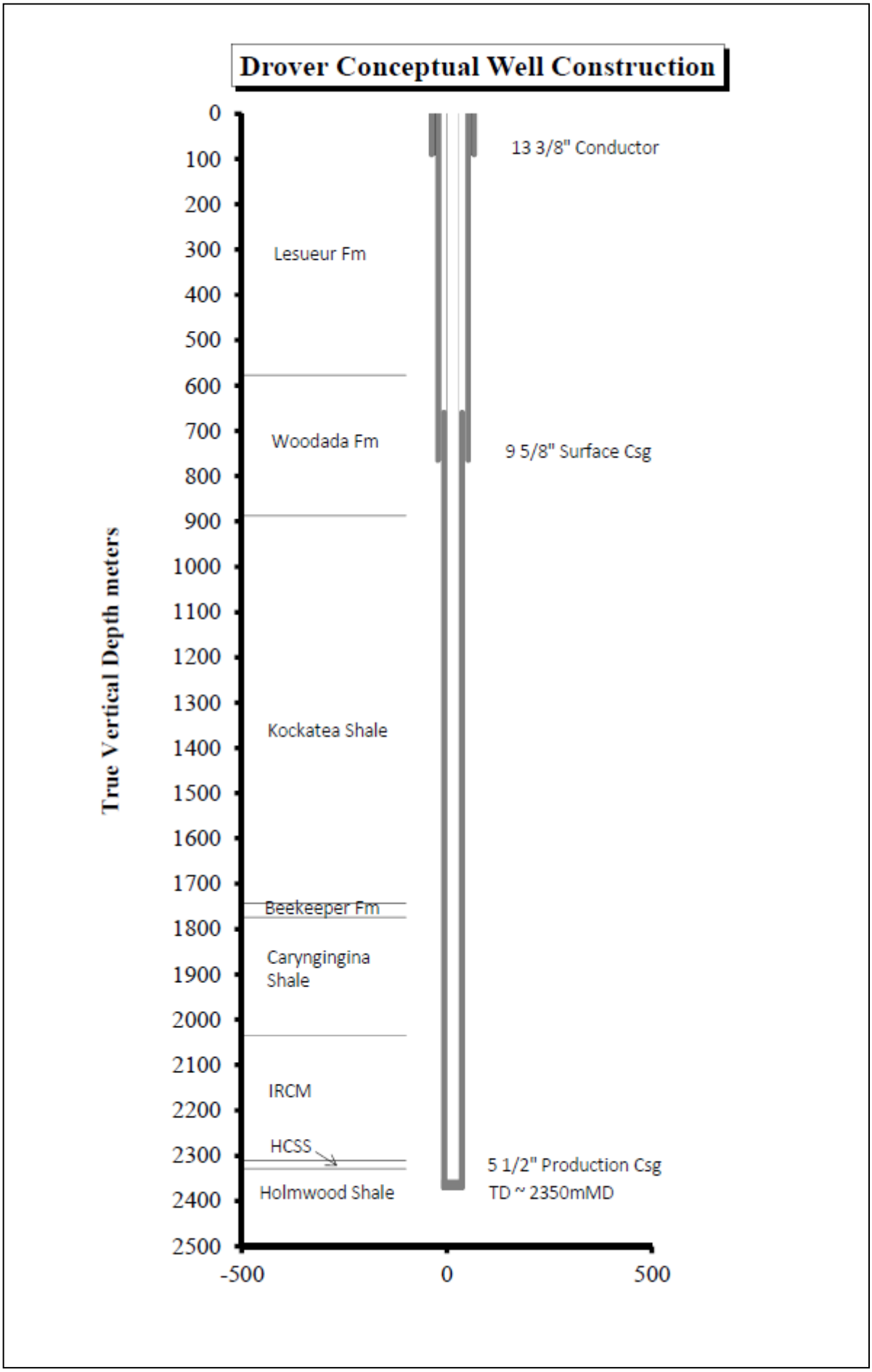

Figure 7 Well Completion Diagram

4.2 AQUIFER INTEGRITY

Physical barriers to protect fresh groundwater aquifers in the Drover-01 area include:

- The principle fresh water aquifer in the region is the Lesueur sandstone. The base of the Lesueur formation is at a depth of 577m below-rotary-table (brt) in the nearby Gairdner-01 well and is predicted to be at a depth of 576m mbrt at the Drover-01 location. This aquifer will be protected by the 244mm (9-5/8 inch) surface casing which will be set at a depth of 765mbrt and cemented to surface.
- An inner most string of 140mm (5-1/2 inch) production casing will be run all the way from surface to the bottom hole depth of 2,370mbrt. Its integrity will be confirmed by a pressure test following installation.
- The inner most string of 140mm production casing (which will transport the frac treatment) will have an manufacturer's burst rating of 110,115 kPa (14,520 psi).
- The deepest fresh water sources identified as the base of the Lesueur sandstone at 577mbrt. This is approximately 1,000mbrt from the highest potential fracture planned perforation depth of 1,600mbrt. The 1,000m of distance consists of low permeable strata of the Kockatea shale and Woodada Formation.
- The casing integrity will be monitored live by pressure gauges connected to the annulus between the 140mm production casing and the 244mm surface casing. Under normal fracture operations, the pressure gauge on the 244mm surface casing annulus should not see any pressure because the 140 mm production casing is designed to contain the fracture treatment pumping pressure. Fracture operations will be suspended immediately upon detection of abnormal pressure in the 244mm surface casing annulus.

4.3 TRAJECTORY MODELLING

Modelling for the Woodada Deep-01 HFS operation has shown that the typical half length (distance of fracture from well bore to fracture tip) would be about 300 to 400 m (i.e. growth in any one direction would be in the order of 400 m). This was confirmed by the microseismic monitoring as discussed in *Section 3.10* The Drover-01 HFS designs will be similar to those applied at Woodada Deep-1 and it is anticipated that fracture half lengths will be of a similar magnitude (i.e. 300 to 400m from well to fracture tip).

Not all faults are considered a risk during HFS operations. There are documented cases where intersection of faults has not produced vertical propagation of hydraulic fractures. If faults are sealing or partially sealing they can actually prevent fracture propagation. The fracture treatments for Drover-01 well are well clear of mapped faults in the local area as illustrated of Figure 8.

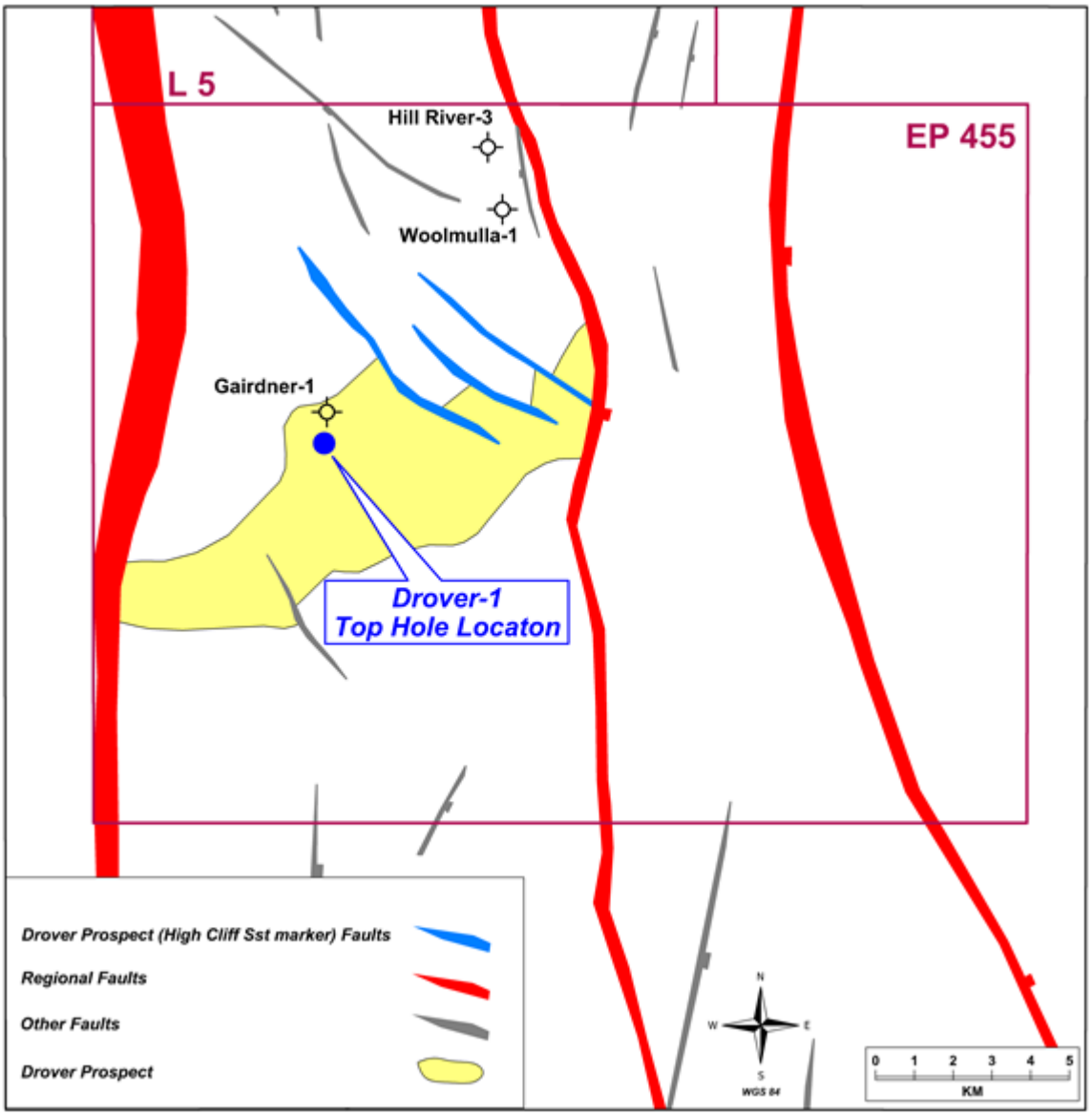

Figure 8 Drover-01 HFS Trajectory Modelling

4.4 ADDITIVES

Disclosure of chemicals used within Drover-01 HFS activities will be provided for within the Drover-01 Exploration Well Environment Plan (HSE-E-077) administered by the DMP. The Department of Mines and Petroleum (DMP) set out the requirements for chemical disclosure within the Chemical Disclosure Guideline released August 2013. It details the chemical disclosure requirements for products, additives, chemicals and other substances used 'down-hole' in petroleum or geothermal related activities regulated under regulation 15(9) of the:

- Petroleum and Geothermal Energy Resources (Environment) Regulations 2012.

Fracture fluids consists of 99.7% water and sand, while the remaining additives are often found in common consumer products. The Drover-01 HFS includes the additives (including total volumes) to be used.

It is important to note the following:

- No chemicals returned to surface will be left *in situ*.

- The tracers are not toxic at the concentrations that they are used.
- Any unused tracers will be removed from site and appropriately disposed of.
- Drover-01 HFS additives will be supplied in 1,000L bulk bins (which are able to be moved with a forklift), chemical storage on site will be in accordance with AS: 1940:2004 specifications.
- All proppant will be free of *Phytophthora spp*., vegetation and weed seed prior to mobilisation to site.

The volume of HFS fluids expected to return to surface for the Drover-01 project is approximately 30 to 50% of that injected.

Returned fluids will be transferred to a retention pond via the flare pit, and allowed to evaporate. The flare pit will be lined with 300 mm Bentonite and the retention pond will be lined with two 200 micron HDPE liners to prevent contamination of surface and subsurface water. The Drover-01 retention pond volume is at least 100% of the volume of injected fluids (5,000 kL) also allowing for rainfall. If water levels rise above design level, water will be pumped out to protect the retention pond from overflow. The water will be transferred to the lined water pond or taken offsite for appropriate disposal.

Samples of the flow back fracture fluid will also be taken to determine the toxicity with appropriate measures taken to either allow the flow back fluid to evaporate or pumped to an onsite tank for disposal. Samples are taken of the dried out materials and disposed to an appropriate landfill in accordance with the “Solid Waste to Landfill Guidelines”.

4.5 REFUELLING

A vehicle mounted diesel tank will be utilised for refuelling during construction activities.

An onsite diesel tanker trailer will be set up for refuelling at the Drover-01 during HFS operations.

4.6 LOSS OF COMBUSTION

There will be a pilot flame in place at the Drover-01 flare pit during flaring operations to prevent loss of combustion.

4.7 WATER REQUIREMENTS

Approximately 10 ML will be abstracted for the Drover-01 HFS operations from

- The Gairdner water bore (abandoned) to be reinstated.

If the Gairdner water bore is not deemed suitable for production purposes, another bore will be drilled at a location nearby the well pad.

Applications have been lodged with the Department of Water to construct/alter (Licence 26D) and take water (Licence 5C) for the Drover-01 operations.

5.0 EXISTING ENVIRONMENT

5.1 CLIMATE

The North Perth Basin has a Mediterranean-type climate characterised by seasonal patterns of hot, dry summers and mild, wet winters. The area is subject to high wind speeds, dust storms, lightning storms, high summer temperatures and low winter night temperatures.

The proposed Drover-01 drilling operations will be located in the EP455 Exploration Permit in the Perth Basin, situated approximately 220 km north of Perth (Figure 2). The region has a Mediterranean-type climate characterised by seasonal patterns of hot, dry summers and mild, wet winters. The area is subject to high wind speeds, dust storms, lightning storms, high summer temperatures and low winter night temperatures.

The nearest Bureau of Meteorology station is at Jurien approximately 50km southwest of the site. Mean climate statistics for the area are included in the following section.

5.1.1 Temperature and Rainfall

The average maximum temperature at Jurien Bay ranges from 19.9^{o}C in July to 30.8^{o}C in April. Average minimum temperatures range between 9.3^{o}C in August and 17.9^{o}C in February (Bureau of Meteorology, 2012).

Average precipitation levels at Jurien Bay ranges between 6.9 mm in January and 112.7 mm in July, while the mean number of rainy days is 80 days per year, with the majority falling between the months of May and September (Bureau of Meteorology, 2012).

5.1.2 Soil

Generally, soils within the North Perth Basin are light and sandy and well drained. Beard (1976) described the soils as “calcareous sand soils of minimal development”. The soils consist of calcareous and siliceous sand underlain by aeolianite, which is often exposed.

In the EP455 permit areas, there are four soil-landscape systems present: the Aeolian limestone system, the ephemeral lake system; the Eneabba sand plain; and the Dandaragan plateau.

Aeolian limestone with shallow yellow sand over limestone is present in places and the exposed limestone is known locally as caprock. The limestone is cavernous and caves occur sporadically either as linear features along drainage lines, collapse structures over deeper caves or as shallow solution features on the surface which are scattered throughout the area.

A line of water bodies (mainly ephemeral lakes) caused by the ponding of water flows which are unable to reach the coast because they have been blocked by the elevated coastal limestone ridge occur along the plain. There are no open river channels locally and all water passes underground through the limestone ridge. These lakes have a variety of soils but are mainly humic or clayey sands, or clayey deposits.

The Eneabba sand plain is a largely flat area of white sands which lie over variable clay loams.

The base of the slope of the Dandaragan plateau is a sand plain mixed with lateritic rises which have shallow white sand over laterite or exposed laterite. This represents the Pleistocene shoreline weathering of the older and more elevated laterite plateau further to the east.

5.2 SITE HYDROGEOLOGY

An assessment of the hydrostratigraphy and aquifers in the area of the Drover-01 Well was undertaken by Rockwater Pty Ltd in May 2013. A copy of this report is attached as Appendix 1. The following sections are extracted directly from this report.

The Drover-01 site is in the Eneabba Plain Sub-Area of the Arrowsmith Groundwater Area, for Department of Water (DoW) management purposes (DoW 2010). The aquifers that are recognised in this subarea are listed in Table 2 (in order from shallowest to deepest).

Table 3 Aquifers in the Eneabba Plains and Twin Hills Sub-Areas

Aquifer	Formation	Typical Bore Yield (kL/day)	Groundwater Quality*	Distribution
Superficial	Bassendean Sand Tamala Limestone	small to moderate	marginal to brackish	Not present in study area –occurs west of Gingin Scarp
Yarragadee	Yarragadee Formation	large >1000	fresh to brackish	Not present at Gairdner-1 but occur beneath the eastern portion of EP455 within the Twin Hills Sub-Area
Cattamarra	Cattamarra Coal Measures	moderate >500	brackish to saline	
Eneabba	Eneabba Formation	moderate 500-1000	fresh to brackish	
Lesueur	Lesueur Sandstone	Large up to 2000	fresh to marginal	Occurs from surface in study area

5.3 LESUEUR AQUIFIER

5.3.1 Groundwater Levels and Flow

Accurate groundwater level data in the vicinity of the study area are limited and data from the DoW WIN database near the site include numerous irregularities (Fig. 7). For example, two bores (WIN ID 20007603 and 20007604) located 900 m and 150 m north-west of the proposed Drover-01 site have recorded water levels of 36 m AHD and 144 m AHD, respectively. Other data to the east of the site (e.g. WIN ID 20007589 and 20007602) indicate that some bores may access perched groundwater resulting in relatively elevated groundwater levels.

Isopotential data for the top of the Mesozoic Formations, recorded in May 1993 and presented by Kern (1997), are considered to provide a better estimate of groundwater heads in the Lesueur aquifer at the site (Fig. 7). These data, which include four measurement points within a 13 km radius of the site, indicate heads in the Lesueur aquifer decline from an elevation of about 76 m AHD, just west of the Peron Fault (2 km east of Drover-01), to about 63 m AHD, 6.4 km to the west where the Kockatea Shale/Carynginia Formation subcrops. The data imply that groundwater flow is towards the west to north-west. However, these 1993 groundwater level data are dated. Hydrographs for the shallower Leeman Shallow Project bores on the

WIN database indicate that water levels have risen by between 0.8 and 2.5 m since 1993. WIN data for the Water Corporation's Leeman 1-91 bore, however, appears to include only pumping water levels (which are drawn down below the standing water level due to the pumping), with the level reported by Kern (1997) the only standing water level that is readily available.

The isopotentials from Figure 7 were used to estimate depth to groundwater at the site (Fig. 8). The derived data indicate that the depth to groundwater in the vicinity of Drover-01 and in the areas of Lesueur National Park, directly to the west and south of the site, is considerable (>100 m below ground level). To the west, near the boundary of the impermeable Kockatea Shale, the data suggest that the groundwater heads may approach artesian. To the east, the plotted depth to groundwater and the WIN database data again do not correlate well, and the actual depth to groundwater is uncertain as discussed previously.

Refer to Appendix 1 for Figures 7 & 8 mentioned within text.

5.3.2 Groundwater Recharge and Discharge

Groundwater recharge to the Lesueur aquifer in this area is derived predominantly from rainfall where the aquifer occurs at the surface or beneath thin surficial deposits. The aquifer outcrops within the Lesueur National Park, to the south, and sub-crops beneath a thin cover of Tertiary laterite and sand over the remainder of the area between the Beagle and Peron Faults.

Therefore, there is a considerable area over which there is potential for rainfall recharge to occur. Some groundwater flow into the Lesueur aquifer, from the Eneabba Formation and Cattamarra Coal Measures, is likely to occur from the east across faults.

The water level data presented in Figures 7 and 8 suggest that groundwater discharge from the Lesueur aquifer occurs near the edge of the Beagle Fault system, along the eastern boundary of the Kockatea Shale. Upwards hydraulic head gradients in the Lesueur aquifer near this boundary result in discharge into the Superficial aquifer, which is present west of the Gingin Scarp (Fig. 8). Several springs occur close to this boundary.

Refer to Appendix 1 for Figures 7 & 8 mentioned within text.

5.3.3 Groundwater Quality

Groundwater in the Lesueur aquifer typically has fresh to marginal salinity which most likely increases with depth. Salinities of water sampled from bores within the study area screened

in the upper portion of the aquifer range from 450 mg/L to 1,435 mg/L Total Dissolved Solids (TDS). However, one bore, Amax Greenhead No.1 (WIN ID 20007614) which is constructed deeper in the aquifer (680 m bgl), has a reported salinity of 3,620 mg/L TDS. It is likely that the groundwater salinity in the Lesueur aquifer is slightly higher close the contact with the Eneabba Formation, which is known to contain more brackish groundwater; however, there are limited data within the study area to support this.

5.3.4 Aquifer Connectivity

The major regional confining layer between the hydrocarbon exploration targets (the basal 100 m of the Kockatea Shale, Carynginia Formation, Irwin River Coal Measures and the High Cliff Sandstone) and the overlying aquifers is the Kockatea Shale. The formation is 852 m thick in Gairdner-1 and geophysical logs indicate consistently shaley strata (Fig. 2).

Elsewhere in the area the Kockatea Shale may be more than 1,100 m thick (in Eneabba-1 oil well; Mory 1994). The Kockatea Shale is recognised as a primary regional seal for hydrocarbon plays in the northern Perth Basin (D'Ercole 2003) and, as such, would also form a major hydraulic confining layer.

The major aquifer, the Lesueur aquifer, and the underlying minor aquifer, the Woodada Formation, are likely to have some degree of hydraulic connection. However, they, both contain minor confining layers, which may impede or restrict vertical groundwater movement.

The hydraulic properties along faults in the area are difficult to assess without specific investigations, which have not been undertaken. There could be groundwater flow between adjacent aquifers where permeable strata are juxtaposed across a fault, such as the contact between the Lesueur aquifer and Eneabba Formation across the Peron.

Additionally, faults that cut the strata are potential conduits for vertical movement of fluids. No significant faults have been identified in the vicinity of the hydraulic fracturing operations.

Refer to Appendix 1 for Figure 2 mentioned within text.

5.3.5 Groundwater users

Groundwater extraction is licensed by the DoW and the available resources are managed for allocation purposes within defined areas. The Drover-01 site is located within the Eneabba Plain Sub-Area of the Arrowsmith Groundwater Area, although EP455 also intersects the Twin Hills Sub-Area of the Arrowsmith Groundwater Area, to the east, and the Cervantes, Nambung and Bagingarra Sub-Areas of the Jurien Groundwater Area, to the south.

Active DoW licences to extract groundwater (GWLs) near Drover-01 are shown in Figure 10 and are summarised in Table 3. Only shallow domestic and stock watering bores are exempt from licensing. Such bores provide only small supplies, generally from the Superficial aquifer, and are the most numerous water-supply bores in the area.

Table 4 Groundwater users within Eneabba Plain Sub-Area

GWL	GW Area Name	GW Sub area Name	Aquifer Name	Allocation (kL/a)
65700	Arrowsmith	Eneabba Plains	Lesueur	470,000
57960		Twin Hills	Yarragedee	70,000
171512		Twin Hills		24,000
167278		Dongara	Superficial	3,000
111221	Jurien	Cervantes	Superficial	55,000
175401				400,000

The data show that there is limited licensed groundwater use in the area directly surrounding Drover-01. The closest licence, GWL 65700 held by the Water Corporation (Leeman 1-91) allowing 470,000 kL/a of groundwater to be extracted from the Lesueur aquifer, is located 4.2 km north-west of the proposed Drover-01 site. This is the only current GWL in the Lesueur aquifer within this sub-area and represents 26% of the allocation limit of 1,800,000 kL; with 1,330,000 kL/a currently available for allocation. The proposed 10 ML to be used by AWE in the drilling and hydraulic fracturing testing at Drover-01 would represent only 0.5% of the total annual allocation of the Lesueur aquifer.

The Yarragadee aquifer in the Eneabba Plains and Twin Hills Sub-Areas is the major groundwater resource, with the largest available allocation and currently allocated resources. Most of the extraction from this aquifer occurs in the north-eastern parts of these sub-areas where this aquifer outcrops or occurs at shallow depth.

5.3.6 Surface Water

No drainage lines or permanent surface water bodies are located within or in the vicinity of the project area.

Surface water flow at the site is expected to follow topographic gradients, which generally slopes downwards towards the west to north-west.

5.4 REGIONAL VEGETATION

The vegetation of the Swan area was mapped at a scale of 1:1 000 000 by J.S. Beard (Beard, 1980). The Study Area is located within the Arrowsmith Slopes unit of the Greenough natural region of the Irwin botanical district within the South-west botanical province of Western Australia.

Beard's vegetation mapping has been digitised and updated by DAFWA (2012c), and the Study Area is mapped as one broad structural vegetation association (Map 9.6, Section 9):

- 1031 (hSZc/dZc): Hakea spp., Allocasuarina spp. open tall shrubland over Allocasuarina spp., Banksia spp.mid shrubland.

Vegetation association 1031 is mapped in the Avon Wheat belt, Geraldton Sand plains and Swan Coastal Plain IBRA regions and its pre-European extent is 269,491 ha. Of this, 88,865 ha (32.98%) currently remains. Of this current extent 13.48% is protected for conservation

and 42.23% is located in DPaW managed lands generally (Government of Western Australia, 2013).

5.5 SITE VEGETATION AND FLORA

A targeted DRF and Priority flora survey (with reconnaissance survey) was undertaken by Maia Environmental Consulting (July 2013) of the Drover-01 project area. A copy of this report is attached as Appendix 3 and the following sections are taken directly from the report.

The following information was collected on the general flora of Drover-01:

- 120 taxa were recorded from 71 genera and 33 families (89.17% perennial, 10.83% annual).
- The most common families were Proteaceae (28), Fabaceae (17) and Myrtaceae (14).
- The most common genera were Banksia (9), Hakea (7) and Acacia (5).
- At the time of the survey 48.33% of the 120 taxa were flowering, 11.67% were fruiting and 3.33% were both flowering and fruiting.
- A list of the flora taxa recorded is included as within Appendix 3

Two priority species and one Potentially Significant Taxon (PST) at the Drover- 01 study area. These species are described below and their locations indicated within Appendix 3.

- Chordifex reseminans - Restionaceae (Priority 1) (a potentially significant taxon, PST) was recorded in regenerating vegetation in the proposed exploration area at Drover-01 site.
- Acacia lasiocarpa var. lasiocarpa Cockleshell Gully variant (E.A. Griffin 2039) Fabaceae (Priority 2) was located at six locations at Drover-01 site.
- Leucopogon aff. oldfieldii. (Taxa of Interest) The specimens were atypical in having only sparsely hairy rather than densely hairy ovaries. The white-pink flowers were present on the plant during the survey. L. oldfieldii grows on white/grey or yellow sand and gravelly lateritic sand on the sandplains of the Avon Wheat belt, Geraldton Sandplains, Jarrah Forest and Swan Coastal Plain (WAH, 1998 -).

Vegetation condition at the proposed Drover-01 site is rated mostly as Good (areas cleared in the past but now regenerating), other areas as Completely Degraded (areas that have been cleared) and some areas as Degraded (areas where the vegetation has been mostly cleared).

- No flora species protected by the EPBC Act or WC Act were recorded in the Study Area or the project area.
- The plant community within the project area does not form part of a listed Threatened Ecological Community (TEC) / Priority Ecological Community (PEC).

5.6 WEEDS AND DIEBACK

Various weeds were found growing throughout the project area during the flora survey; the area had previously been cleared in 2005 for agricultural purposes. The regrowth consists of both native and introduced plant species. It is important to note:

- No Declared Pest plant species was recorded at the Study Area.
- No weeds on any of the national weeds lists were recorded at the Study Area.

No known infestations of *Phytophthora* spp. are known in the project area or were observed during the flora survey.

5.7 FAUNA

A Level 1 fauna study was undertaken by Bamford Consulting (July 2013) of the Drover-01 project area. A copy of this report is attached as Appendix 2 and the following sections are taken directly from the report.

The fauna investigations were based on a desktop assessment and site reconnaissance surveys in August 2012 (Old Drover-01) and July 2013 (New Drover-01). The report prepared focusses on the New Drover-01 site, but uses information collected at the Old Drover-01 site where this contributes to the assessment.

The desktop survey identified 213 vertebrate fauna species potentially occurring in the AWE Drover-01 survey area. This comprised 9 frogs, 60 reptiles, 119 birds and 16 native and 9 introduced mammals.

Fauna values within the study area can be summarised as follows:

- Fauna assemblage. Moderately rich but likely to be depauperate compared with surrounding areas due to degraded vegetation.
- Species of conservation significance. A range of significant species may be present. Species of note are the South-west Carpet Python, Western Ground Parrot (probably locally extinct), Carnaby's Black-Cockatoo, Rufous Field-wren, Rainbow Bee-eater and several invertebrates. Significant species likely to be better-represented in intact native vegetation nearby expect for the Rainbow Bee-eater that favours disturbed areas.
- Vegetation and Substrate Associations. Three VSAs were identified across the project area. Two of these consist of regenerating native vegetation following clearing and are thus unusual, but their fauna values are mostly better-represented in nearby intact native vegetation.
- Patterns of biodiversity. Areas of particular significance include VSA1 as the Banksias and Eucalypts may support foraging Carnaby's Black-Cockatoos.
- Key ecological processes. Main processes currently affecting the fauna assemblage in the project area include local hydrology, fire, fauna interactions (feral predators, over-abundant native species) and weed invasion.

Significant species expected to occur within the project area include only three reptile, up to four bird, one mammal and three invertebrate species expected to be present at least

regularly. Of greatest interest, because of their high profile conservation significance and may be present regularly, are Carnaby's Black-Cockatoo (probable evidence of foraging and may visit the project area in small numbers to forage), Western Ground Parrot (presence uncertain but records in the area would be of great conservation interest) and Rainbow Bee-eater (likely to be present but in reality a widespread and common species).

The report outlines the following recommendations to reduce potential impact to fauna from the drilling operations:

- Minimising vegetation clearing; particularly mature trees; and
- Taking a precautionary approach to minimise impacts through changes in hydrology, light pollution, the inadvertent (or deliberate) encouragement of feral species, fire and the spread of weeds.
- Review the impact upon foraging habitat for Carnaby's Black-Cockatoo. It is considered that referral to SEWPaC is not required as there is a low risk of impacts upon the species being considered significant under the EPBC ACT, as the habitat suitable for foraging is degraded, not within the breeding range of the species and there is extensive quality foraging habitat nearby. However, SEWPaC does provide an email to discuss the need for referral and it is suggested that this be used.

5.8 SOCIAL ENVIRONMENT

There are no Aboriginal or European heritage sites of significance in the project area.

6.0 SOCIAL LICENCE

6.1 AWE'S COMMITMENT

AWE's HSE Statement of Principles states "AWE's objective is to benefit the communities in which we conduct our operations". To achieve this objective, we recognise we must build a climate of consent, which underpins our operating licences and creates the opportunity to benefit our communities. This means we must earn the confidence of government bodies, other influential stakeholders, the communities within which we operate, and the general public.

AWE has developed a comprehensive stakeholder management plan which will record and identify all relevant stakeholders consulted, the nature of consultations including the level of information provided, the date of the consultations, the issues and concerns raised by those stakeholders, and how they were resolved. Implementation of this stakeholder management plan, combined with AWE's existing records of previous consultation activities, will provide the basis for approvals reporting requirements as they relate to stakeholder engagement.

AWE defines stakeholders as any individual or group that is affected by AWE activities or has the ability to influence the realisation of specific project objectives. In general we aim to incorporate the following characteristics in our stakeholder engagement programmes.

- All relevant stakeholders are identified (and classified by type and priority)
- The 'stake' each stakeholder holds is well understood
- Stakeholder engagement occurs in a timely manner
- Each stakeholder feels appropriately involved

- Information is consistent according to stakeholder needs

We recognise that effective stakeholder management requires that our internal and external stakeholders are correctly identified, their influence and expectations are well understood, and their information needs are managed consistently and professionally. Moreover, we recognise that the process through which stakeholders are engaged is as important in building a climate of consent as the information we convey about our project, its impacts and our management plans.

The overarching objective of stakeholder engagement during an early approvals phase is to improve the assessment by soliciting the input and managing the concerns of people affected by the project. In the case of the Drover-01 Exploration Well the backdrop of activism and controversy to the unconventional gas industry across Australia means this strategy must also mitigate potential outrage as a factor impeding stakeholders' ability to form realistic judgements about project risks and to participate constructively during engagement activities.

To these ends, AWE has identified the following practical objectives or success measures for the stakeholder management plan.

1. Enable AWE to identify and address stakeholders' concerns during the pre-referral and impact assessment phases of project development.
2. Satisfaction among stakeholders with the process through which they were engaged by AWE
3. Few or no objections or new issues raised by external stakeholders through statutory public comment and/or appeal processes, other than from existing entrenched industry opponents (NGOs/activists).
4. EPA and DMP satisfaction with AWE's reported consultation programme and outcomes for the purpose of impact assessment and statutory approvals.
5. Integration and coordination with broader stakeholder engagement and public communications activities being undertaken by APPEA.

The Drover Stakeholder Management Plan includes:

- Identification and analysis of stakeholder groups
- Adopted method of communication with each stakeholder group
- Determination of the type of information that is required to be communicated and when
- Confirmation of the AWE resource that is responsible for implementing the commitments outlined in this plan
- Reporting responsibilities and relationships during communication and consultation processes
- A list of contacts and the contact details for all key stakeholders, and
- A calendar of activities (including how, when, to and by whom communications and consultations will occur)
- A point of reference for the specific obligations, commitments, and requirements relating to those stakeholders, including those defined within resource consents and third party agreements.

6.2 CONSULTATION UNDERTAKEN

Consultation undertaken to date for the Drover-01 exploration project includes:

- Department of Mines and Petroleum for applicable Work Programs
- Department of Mines and Petroleum - Petroleum Environment Branch
- Department of Water for a licence to construct a water bore and a licence to take water and determination of ground water and surface water protection measures
- Land holder regarding site access agreement and scope of project
- South West Aboriginal Land & Sea Council (SWALSC)
- Environmental Protection Authority- briefed on project description and EPA referral

6.3 COMMITMENT FOR CONSULTATION

- Department of Parks and Wildlife (Formerly DEC) consulted as proposed activity is within close proximity to Lesueur National Park which is managed by DPaW.
- Shire of Coorow to be consulted on timing of activities and likely vehicle movements during proposed operations.
- Community Information Day planned for October.

7.0 ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

7.1 VEGETATION AND FLORA

The proposed Drover-01 exploration well is located on the existing Drover-01 well pad where only small areas of vegetation have been previously cleared.

The proposal is exempt from requiring a native vegetation clearing permit under the exemptions and regulations for clearing native vegetation, Regulation 5, Item 24. This exemption allows clearing for exploration approved under various Petroleum Acts, provided the activity is not within an Environmentally Sensitive Area (ESA).

The vegetation of the project area is not representative of any listed TEC's or PEC's (Maia Environmental Consulting, 2013). In addition the vegetation association is regrowth from previous agricultural activities, i.e. it does not constitute remnant vegetation.

No flora species protected by the EPBC Act were recorded at the Study Area.

No riparian vegetation, wetlands, watercourses, Declared Rare Flora (DRF) or TECs will be affected by the Drover-01 exploration well.

Management measures to reduce the impacts on vegetation and flora are:

- Minimisation of clearing of native vegetation
- Large trees will be retained where possible

7.2 WEEDS AND DIEBACK

The project area consists of both native regenerating shrubs alongside various species of evasive weeds, due to the intensive use of land for agricultural purposes.

All operations will be conducted in accordance with the Drover-01 Biosecurity Procedure (Appendix 5). The procedure details the vehicle hygiene and quarantine/wash down station procedures to be implemented to prevent the introduction and spread of dieback. All vehicles and equipment will be required to complete a 'Weed and Dieback Hygiene Log' following inspection and clean down.

The hygiene station is located on the Drover-01 well site - main access track at the Greenhead-Coorow Road.

Prior to mobilising any equipment into the Drover-01 well site, dieback hygiene measures will be implemented on advice from the Environmental Advisor.

All proppant (sand to inject into the Drover-01 well) will be free of Phytophthora spp., vegetation and weed seeds prior to proppant selection and mobilisation to site.

7.3 FAUNA

A Level 1 fauna assessment identified the fauna values of this project area. The following sections examine possible impacts upon these fauna values based upon the impacting or threatening processes. For more information refer to Appendix 2-Drover-01 Well Fauna Assessment.

- Loss of habitat leading to population decline

  The project area represents a very small proportion of similar habitats in the region (41,875 ha of native vegetation lie within a 15 km radius of the 12 ha site), and thus the impact is expected to be Negligible to Minor. Despite this, VSA1 is suitable for foraging by Carnaby's Black-Cockatoo and possible evidence of foraging was found (Appendix 2 - Figure 4). Impacts with respect to this species are discussed below.

- Loss of habitat leading to population fragmentation

  The project area lies alongside a large block of native vegetation (to the west), with cleared land to the east. Development of the project area will not increase population fragmentation significantly, impact therefore Negligible.

- Degradation of habitat due to weed invasion

  Invasive weed species can replace native species and degrade fauna habitats. Weeds can be spread by vehicles, earthworks and road construction. The survey area is already heavily weed invaded, with most of the ground cover being weed species, and adjacent intact native vegetation may be vulnerable to weed invasion due to increased disturbance. Measures to prevent introduction of new weeds and management of the existing weed problem may provide a long term benefit to the study area.

- Ongoing mortality

  Direct mortality of common species during clearing is unavoidable but can be minimised (see recommendations below). Areas to be disturbed are small within the context of the regional landscape so mortality during clearing is likely to represent only small proportions of regional populations, while activities are unlikely to lead to an increase in mortality (Negligible or Minor impact); although there may be some road kill as a result of the access road running alongside intact native vegetation (see Figure 2). There is nothing to suggest that there are important populations of significant species restricted to the small project area.

- Species interactions

  Feral species are a major conservation concern, with two introduced species detected in the August 2012 visit to the Old Drover-01 area; others are likely to be present. Foxes and feral cats are likely to be attracted by recent disturbance, possibly leading to increased local impacts on native fauna in disturbed areas. Inappropriate waste management may also attract foxes and feral cats, as well as native predators and scavengers, which may exacerbate localised impacts on other native fauna. However, because of the small area of the project, such impacts are considered to be Negligible to Minor.

- Altered fire regimes

  Some conservation significant fauna are particularly susceptible to fire and the entire biota of the region is probably adapted to a particular fire regime. Activities in the project area are a potential source of fire. In the short term, a single fire would be of little consequence, but if activities occurred over a long time-period (years or decades) than a succession of fires could have a Moderate impact.

- Disturbance

  Impacts of dust, light, disturbance and noise upon fauna are difficult to predict. Due to its location these are already factors influencing the fauna of the site and therefore impacts are anticipated to be Negligible. If night operations are carried out under floodlights, there may be an increase in fauna mortality which could need to be considered.

- Summary of impacts

  Impacts from key threatening processes are considered to be Minor or Negligible. This is due to the relatively small footprint of the project which is located within degraded environments.

  Impacts upon Carnaby's Black-Cockatoo require consideration as the project area does contain some foraging habitat suitable for the species (several hectares of VSA 1). The DSEWPaC (2011) guidelines for the species contain a decision-making tool to assist with identification of actions which need further assessment and may require referral to the environment minister or department. Using this tool, the project area does lie within the modelled distribution of Carnaby's Black-Cockatoo. Several hectares of habitat suitable for foraging is present, although this is probably not "quality" habitat as per the DSEWPaC guidelines, since the vegetation is degraded. The foraging habitat is also not within the breeding range of the species, with foraging habitat within the breeding range being of particular significance (as noted by DSEWPaC 2011), and there are no suitable roosting sites nearby. There is also extensive habitat suitable for foraging adjacent. Based on the referral guidelines in DSEWPaC (2011), loss of >1ha of foraging habitat that is not "quality" and lies outside the breeding range could be considered an impact with either an uncertain or low risk of being significant under the EPBC Act. As the habitat is degraded and there is extensive foraging habitat nearby, it is considered that there is a low risk of any impact upon the species being considered significant; on this basis referral is not required.

  The region surrounding the survey area has been well surveyed, providing a high level of knowledge of the fauna assemblages and conservation significant species likely to occur within the survey area.

There are few expected impacts to any conservation significant species due to the small size of the project and the small amount of clearing required.

The clearing of native vegetation will result in a localized loss of habitat, although the majority of fauna species will be able to relocate or find forage in the surrounding area. The surrounding areas particularly Lesueur National Park provide quality habitat for any potentially displaced fauna.

A few small reptile species may be unable to move away from clearance activities and may be lost. The potential loss of habitat and direct loss of individuals will not be significant on a regional scale due to the small size of the proposed clearance area and the abundance of similar habitat in the surrounding area. The greatest potential threat to the fauna and surrounding habitat stems from uncontrolled fires.

AWE will maintain strict fire management and weed abatement and hygiene measures, to prevent the ignition and spread of fires. Following rehabilitation activities, the fauna habitats surrounding the project are expected to recover to their current state.

Management measures to reduce the impacts on fauna are:

- Minimise native vegetation clearing.
- Retain large trees (comprising Banksia, Eucalypt) where possible.
- Enforce a 40km/h speed limit to reduce the potential for fauna-vehicle impact.
- Installation of fencing prior to discharge of fracturing fluid to these sites to exclude ground-dwelling native fauna around the flare pit and retention pond.
- Monitoring of water quality in the flare pit and retention pond on a routine basis, and cover or appropriately dispose of the discharged fracturing fluid (or alternative management as agreed with Department of Environmental Regulation (DER)), should the monitoring show that water quality in the flare pit and/or retention pond is likely to become a potential hazard to native fauna, in particular bird species.
- Waste to be stored in securely covered receptacles to prevent fauna access and litter generation and taken offsite for disposal by a waste management contractor.

7.4 LESUEUR NATIONAL PARK

The Drover-01 project is located within private farmland adjacent to the Lesueur National Park.

The Lesueur National Park covers 26,987 hectares and is managed by the Department of Parks and Wildlife. Its status as a national park recognises the area's outstanding conservation, landscape and recreational importance.

The Drover-01 operations will be restricted to the project area and there will be no vehicle interaction with the neighbouring Lesueur National Park.

7.5 GROUNDWATER

The following information has been sourced from the Drover-01 Groundwater study prepared by Rockwater Pty Ltd (May 2013) as included in Appendix 1.

Groundwater quality

Groundwater in the Lesueur aquifer typically has fresh to marginal salinity which most likely increases with depth. Salinities of water sampled from bores within the study area screened in the upper portion of the aquifer range from 450 mg/L to 1,435 mg/L Total Dissolved Solids (TDS) (Appendix 1-Fig. 9). However, one bore, Amax Greenhead No.1 (WIN ID 20007614) which is constructed deeper in the aquifer (680 m bgl), has a reported salinity of 3,620 mg/L TDS. It is likely that the groundwater salinity in the Lesueur aquifer is slightly higher close the contact with the Eneabba Formation, which is known to contain more brackish groundwater; however, there are limited data within the study area to support this.

Hydraulic fracturing and vertical movement of fluids

The target reservoirs for the hydraulic fracturing stimulations are expected to be at depths of greater than 1.6 km, far below the 580 m bgl base of the Lesueur sandstone, the main aquifer in the area. The hydraulic fracturing targets include the basal 100 m of the Kockatea Shale, at about 1.6 km depth, to the Irwin River Coal Measures at about 2.1 km depth. The Kockatea Shale is expected to be around 850 m thick at Drover-01 and, excluding the basal 100 m, provides a thickness of 750 m of impermeable shale between the planned targets and the overlying aquifer. Therefore, providing that the integrity of the well casing and annular cement grout at the proposed Drover-01 site are not compromised and there are no unforeseen connections of strata, the hydraulic fracturing should not affect overlying aquifers.

Groundwater dependent ecosystems

The depth to groundwater at the Drover-01 site is estimated to be in excess of 100 m based on isopotentials published by Kern (1997), with the closest expression of groundwater of less than 20 m depth being 4 km to the west (Appendix 1-Fig. 8). It appears unlikely that the Lesueur National Park within (at least) a 2 km radius of Drover-01 contains groundwater dependent vegetation considering the comparatively deep water table.

The DoW WIN database contains contradictory information; the depth to groundwater at WIN site 20007604, located 150 m northwest of the proposed Drover-01 site, is recorded to be 24 m bgl, whereas the depth to groundwater at WIN site 20007603, located approximately 900 m north-north-west of the site is recorded as 146 m. The exact depth to groundwater at the site needs to be ascertained but given the relatively high topographic elevation of the site (approximately 170 m AHD), it would be unlikely that the depth to groundwater is shallow (<20 m bgl). Therefore, there is minimal likelihood of GDE in the vicinity of the site.

The study undertaken by Rutherford et. al (2005) identifying groundwater dependent ecosystems (GDE) in the Northern Perth Basin, considered only sites that had a depth to groundwater of less than 20 m to be potentially reliant on groundwater. The closest GDE identified by the study is a natural spring, named “Diamond of the Desert”, located 7 km to the southwest (Appendix 1- Fig. 8). Here the impermeable Carynginia Shale is juxtaposed against the Lesueur Sandstone along the Beagle Fault causing upward discharge of groundwater into the superficial formations. This GDE is well outside the area of influence expected for the operations at Drover-01.

Other groundwater users

There is limited groundwater use in the area. Within the Eneabba Plains groundwater management sub-area, only 26% of the Lesueur aquifer allocation limit of 1,800,000 kL is currently utilised. The closest groundwater user, the Water Corporation, is located 4.2 km north-west of the proposed Drover-01 site, well outside the area of influence expected for the operations at Drover-01.

Management of fluids and hazardous substances

The Drover-01 retention pond volume is at least 100% of the volume of injected fluids (5,000 kL) as well as allowing for rainfall. If water levels rise above design level, water will be pumped out to protect the retention pond from overflow. The water will be transferred to the lined water pond or taken offsite for appropriate disposal.

To prevent potential contamination to groundwater, AWE will implement the following management measures:

- All liquid returned to the surface will be retained in the retention pond.
- Retention pond will be lined with two 200 micron HDPE liners with a volume at least 100% of the volume of injected fluids (as well as 79.5 m^3 (500 bbls) allowance for rainfall).
- Regular inspections of these ponds will be undertaken during operations to ensure they maintain adequate storage capacity.
- If water levels rise above design level, water will be pumped out to protect the retention pond from overflow. The water will be transferred to the lined water pond or taken offsite for appropriate disposal.
- Flow back liquid sampled to determine the toxicity for disposal location determination.
- Dried out materials in ponds sampled and disposed to an appropriate landfill.
- Fracture operations can be stopped if a fracture is propagating in the wrong direction.
- Monitoring of annuli pressures at surface between the 114 mm (4.5 inch) casing and the 178 mm (7 inch) casing will be conducted during the HFS treatment. In the unlikely event that the 114 mm casing string (which will transmit the treatment material) fails, this will be reflected in the pressure measurements at surface and the treatment will be terminated.
- Fracture fluids consist of 99.7% water and sand.
- Chemicals in use are placed in bunded trays.
- Bunded trays of a suitable material for the chemical being handled (e.g. Steel, HDPE) will be utilised during handling. Empty bulk containers will be returned to the semitrailer trucks for removal offsite.
- No chemicals returned to surface will be left insitu.
- Any unused tracers will be removed from site and appropriately disposed of.
- All chemicals brought to site are in suitable containers and checked to ensure that they are in sound order.

- Records kept of chemicals used.
- Material Safety Data Sheets (MSDS) are available at site for personnel carrying out JSEA's, risk assessments or to provide guidance in response to a spill or leak.
- Flammable and corrosive materials are segregated within the well site chemical storage area.
- All containers are maintained in sound order.
- Emergency response plan and Oil Spill Contingency Plan in place and personnel trained in their implementation.
- Personnel trained in the correct procedures for use of materials, including clean-up procedures.
- Clean-up materials available on well site.
- Fuel, oil or chemical spills cleaned up as soon as is practically possible.
- Clean-up materials and wastes appropriately contained for offsite disposal.

Monitoring

There are three existing bores near the proposed Drover-01 site that may be useful for groundwater monitoring). The condition and availability of these bores needs to ascertained but, if deemed suitable, they could be used for groundwater level and quality monitoring.

If the existing bores are unsuitable or unavailable, at least two monitoring bores would be required to be installed; ideally one as close as practical to the Drover-01 hole (say offset 150 m) and one down gradient (say 0.5 to 1.0 km west-north-west depending on access). This would allow the depth to groundwater and the hydraulic gradient to be confirmed. Note that if the existing bores are suitable and available for monitoring these additional bores would not be required. Design and implementation of the Drover-01 groundwater monitoring programme will be done so in consultation with the Department of Water.

To establish whether operations have any effect on the groundwater system, bores should be installed with groundwater loggers which record the groundwater level, electrical conductivity, pH and temperature. These should be installed as soon as possible to establish baseline trends prior to operations. Data should be downloaded and manual groundwater level measurements taken at least quarterly.

Comprehensive water analyses should be undertaken on groundwater samples collected from each of the available monitoring bores prior to commencement of operations and at say six-monthly intervals thereafter. The exact timing will depend on the duration of operations.

Sampling and monitoring should continue for at least two years following the completion of operations. The comprehensive analysis suite should be supplemented with hydrocarbons and any other additives specific to the hydraulic fracturing operations.

AWE will monitor water quality in the flare pit and retention pond on a monthly basis, and cover or appropriately dispose of the discharged fracturing fluid (or alternative management as agreed with DER), should the monitoring show that water quality in the flare pit and/or retention pond is likely to become a potential hazard to native fauna, in particular bird species.

AWE will, upon decommissioning of the flare pit and retention pond and prior to rehabilitation of the Drover-01 Project site, undertake soil sampling below the flare pit and the retention pond to confirm that soil contamination from the fracturing fluid has not occurred.

Establishment of a Groundwater monitoring programme for the Drover-01 site will be done so in consultation with the Department of Water.

7.6 SURFACE WATER

No drainage lines or surface water bodies of significance are located in the project area.

The management measures described above for groundwater management will also prevent any adverse impacts to surface water.

7.7 CONTAMINATED SITES

No known contaminated sites are located within the project area.

7.8 NOISE

As there are no nearby residents (closest noise sensitive premise is located 5 km away) and the closest village, Green Head is located ~17.3 km west of the project, no significant impacts as a result of noise are anticipated.

7.9 AIR QUALITY AND GREENHOUSE GASES

Approximately 25 kL of diesel will be used for the HFS project and less than 200,000m^3 of gas will be flared. This is approximately 0.5 kt CO_2-e emissions.

Given the short time frame for the HFS operation, there are not anticipated to be any adverse impacts to air quality and no significant greenhouse gases produced.

Well testing allows the gas to come to the surface in a controlled manner and disposing of it by flaring.

AWE will maintain records of the date, period and volume of vented or flared gas and dark smoke emissions.

The following management measures will be implemented to reduce air emissions and greenhouse gases:

- No unauthorised venting or flaring.
- Minimise volume of gas to be flared where possible.
- Appropriate measures in place to prevent loss of combustion during flaring.
- Use of Ringelmann (scale) to classify and monitor dark smoke emissions.
- Dark smoke emissions are not to exceed prescribed levels.
- Equipment such as generators, compressors, blow out preventers and other pressure related facilities will be maintained in good working order.
- All other equipment and vehicles will be serviced regularly.

7.10 FIRE

The following management measures will be implemented to reduce the potential for fire:

- Adequate fire equipment on-site and personnel trained in their use.
- No unauthorised venting or flaring. Obtain permit for flaring (if flaring between October to March is required) from DFES.
- If well testing during or after HFS is required, the 300mm clay lined flare pit in place will be utilised.
- Minimise volume of gas to be flared where possible.
- Fire break in place.

7.11 WASTE DISPOSAL

The following management measures will be implemented to ensure adequate waste disposal processes are maintained during the Drilling and HFS program:

- Waste to be stored in securely covered receptacles to prevent fauna access and litter generation and taken offsite for disposal by a waste management contractor.
- Sewage disposed into septic tanks with leach drain or into holding tank for offsite disposal.
- Any hydrocarbon wastes to be stored on bunded trays and disposed of at a licenced facility.
- General waste (including putrescible, empty 1 m^3 bulk bags) – taken offsite to an appropriate landfill
- Additives – reused at other sites, returned to manufacturer or taken to an appropriate landfill.
- Additive waste containers – taken offsite for recycling or to an appropriate landfill.
- Scrap steel and pallets – taken offsite for recycling or to an appropriate landfill.
- Evaporate return fluid solids – taken offsite to an appropriate landfill.
- Maintain a log of wastes generated including type and volumes.
- All wastes are removed via an approved waste disposal contractor in accordance with DER guidelines.
- Solid wastes segregated for offsite recycling or disposal by waste management contractor.
- Waste oils and chemicals labelled and stored appropriately for offsite recycling or disposal.
- All skips covered with lid or screen (except liquids, wood, and steel) and disposed of by a licensed waste management contractor.
- Liquid wastes are labelled and stored in appropriate containers prior to disposal.
- Determine if any waste from site is Controlled Waste prior to sending offsite.
- RapidInduct induction includes section on waste management.

7.12 CAMP

The following management measures are (or will be) implemented to minimise any potential impact on the environment:

- All sand and other fill imported into the reserve is free of *Phytophthora* spp. and weed seed.
- Waste to be stored in securely covered receptacles to prevent fauna access and litter generation and taken offsite for disposal by a waste management contractor.
- No clearing is required.
- Existing access tracks in place.
- Personnel undergo RapidInduct Induction which covers issues regarding operating Environmental Sensitivities.
- All equipment (including camp) to be inspected for soil and plant material and where necessary cleaned down prior to mobilisation into the lease area.
- Fire equipment located on-site and personnel trained in its use.
- Vehicular speed limited to 40 km/hr within lease area.

7.13 REHABILITATION

The completion criteria for the Drover-01 Well Site will be compatible with the land owner requirements and will likely include the following:

- Infrastructure and rubbish removal.
- Contaminated sites management.
- Surface profile and finish.
- Surface stability and erosion.
- Weed status.
- *Phytophthora* disease status.
- Vegetation cover and species composition at key milestones and resilience of the vegetation.
- Monitoring of groundwater and soil against baseline levels

Monitoring will be conducted until completion criteria are achieved and the lease area is returned to the land holder.

8.0 PRINCIPLES OF ENVIRONMENTAL PROTECTION

Table 5 lists the Environmental Issues and Factors associated with the Project in relation to the Principles outlined in Section 4A of the *Environmental Protection Act 1986.*

Table 5 Environmental Principles (*EP Act 1999* Section 4A)

Principle	Relevant (Yes/No)	If yes, consideration
1.The precautionary principle Where there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and An assessment of the risk-weighted consequences of various options.	Yes	AWE has considered a number of alternatives and has chosen the current proposal that provides a suitable option with the least environmental impact. All environmental investigations have been undertaken to ensure adverse environmental impacts are minimised. Comprehensive studies have been undertaken to provide detailed information to address potential environmental impacts. AWE has undertaken flora and fauna surveys and detailed hydrological assessments to provide a detailed assessment of the existing environment in the Project area, and help determine the appropriate management measures to be implemented to mitigate any significant potential impacts. Where a lack of full scientific certainty arises, the precautionary principle has been applied through adopting a risk-based approach to address the uncertainty and by adopting cost-effective measures to minimise the risk of impacts.
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	The only emissions produced will be those from vehicles, equipment and flaring. Given the timeframe and scale of the Project these are considered insignificant on a regional scale. No significant long term emissions or greenhouse gas emissions will be produced for the Project. Vegetation clearing and loss of biodiversity is expected to be at a minimum on this project, due to a small impact footprint which involves the expansion of an existing cleared area. Rehabilitation will be conducted to ensure that disturbed areas are fully rehabilitated to resemble the original vegetation composition. The risks to threatened and restricted species have been assessed within this proposal and are not expected to be significant. Loss of habitat will be minimised, clearing of vegetation will be limited to the project area.

Principle	Relevant (Yes/No)	If yes, consideration
3. The principle of the conservation of biological diversity and ecological integrity The conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	The Project will involve the disturbance of minimal native vegetation. Flora, fauna and hydrological surveys have been completed. Vegetation communities are well represented in the wider known region.
4. Principles relating to improved valuation, pricing and incentive mechanisms (a) Environmental factors should be included in the valuation of assets and services (b) The polluter pays principle – those who generate pollution and waste should bear the cost of containment , avoidance and abatement (c) The user of goods and services should pay prices based on the life cycle of providing goods and services, including the use of natural resources and assets and the ultimate disposal of waste (d) Environmental goals, having been established, should be pursued in the most effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximize benefits and/or minimise costs to develop their own solution and responses to environmental problems.	Yes	The project development has been proposed with recognition of environmental values through-out. Project footprint areas will be minimised and area of conservation significance avoided. Costs associated with the development and operation of the Project, including decommissioning and rehabilitation will be borne by AWE. AWE's commitment to continual improvement and ongoing license to operate and environmental approval is reflected in our Management Plans. Regulator reporting and transparency is offered throughout these policies, plans and management commitments.
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimize the generation of waste and its discharge to the environment.	Yes	AWE has addressed the management measures to minimise the production of waste in this document. All project waste shall be managed and disposed in an off-site facility.

9.0 ENVIRONMENTAL ASSESSMENT GUIDELINES

Table 6 lists the Environmental objectives and factors associated with the Project in relation to the Principles outlined in *EPA Assessment Guideline No.8*

Table 6 EPA Environmental Assessment Factors and Objectives (applicable to Drover-01)

Theme	Factor	Objective	Consideration	Reference (Section/Appendix/Document)
Land	Flora and Vegetation	To maintain representation, diversity, viability and ecological function at the species, population and community level.	• Flora study undertaken by appropriately qualified botanists. No species protected by the EPBC Act or WC Act were recorded in the Study Area. • Project is located within previously disturbed agricultural land. • Biosecurity procedure adopted to prevent spread of invasive plant species or introduction of dieback.	Sections: • Section 4.6 Site Vegetation and Flora • Section 4.7 Weeds and Dieback • Section 6.1 Vegetation and Flora • Section 6.2 Weeds and Dieback Appendix: • Appendix 3- Drover-01 targeted flora survey. • Appendix 4- Biosecurity Procedure Other statutory EIA decision-making processes: • EP approval by DMP
	Landforms	To maintain the variety, integrity, ecological functions and environmental values of landforms and soils.	• Project area is relatively small ~ 12ha. • Site will be Plugged & Abandoned. Rehabilitated will be conducted in accordance with regulatory obligations and landowner requirements.	Sections: • Section 2.10 Demobilisation Other statutory EIA decision-making processes: • EP approval by DMP
	Subterranean fauna	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	• The well design incorporates features to prevent communication with groundwater aquifers affecting subterranean fauna.	Sections: • Section 3.2 Aquifer Integrity Other statutory EIA decision-making processes: • EP approval by DMP
	Terrestrial Environmental Quality	To maintain the quality of land and soils so that the environmental values, both ecological and social,	• Chemicals and Hydrocarbons will be stored in compliance with ASNZ1940: 2004. • Spills will be cleaned up immediately	Sections: • Section 4.2 Soil • Section 6.7 Contaminated sites

Theme	Factor	Objective	Consideration	Reference (Section/Appendix/Document)
		are protected.	• Retention ponds and flare pits will be lined to prevent pollution.	Appendix: • Appendix 4- Biosecurity Procedure Other statutory EIA decision-making processes: • EP approval by DMP
	Terrestrial Fauna	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	• Fauna study undertaken by appropriately qualified Biologists, no species of conservation status likely to be significantly impacted by proposal. • Project is located within previously disturbed agricultural land. • Fencing around retention ponds to prevent fauna ingress. • Fauna egress matting is provided within retention ponds.	Sections: • Section 4.8 Fauna • Section 6.3 Fauna Appendix: • Appendix 4- Biosecurity Procedure Other statutory EIA decision-making processes: • EP approval by DMP
Water	Hydrological Processes	To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.	• Groundwater study commissioned and report findings incorporated into project planning. • No drainage lines or permanent surface water bodies are located within or in the vicinity of the project area. • Monitoring will be undertaken to assess groundwater quality over project period. Monitoring programme to be developed in consultation with DoW. • Water abstraction for project is minor ~ 10ML and not likely to affect allocation for other users.	Sections: • Section 3.7 Water Requirements • Section 4.3 Site Hydrogeology • Section 4.4 Lesueur aquifer • Section 6.5 Groundwater • Section 6.6 Surface Water Appendix: • Appendix 1- Drover-01 Ground Water Study Other statutory EIA decision-making processes: • Department of Water (DoW)

Theme	Factor	Objective	Consideration	Reference (Section/Appendix/Document)
				Abstraction and Well construction licence(s) • DoW endorsed groundwater monitoring programme
	Inland Waters Environmental Quality	To maintain the quality of groundwater and surface water, sediment and biota so that environmental values, both ecological and social, are protected.	• Groundwater study commissioned and report findings incorporated into project design. • No drainage lines or permanent surface water bodies are located within or in the vicinity of the project area. • Monitoring will be undertaken to assess groundwater quality over project period. • Water abstraction for project is minor ~ 10ML and not likely to affect allocation for other users.	Sections: • Section 3.7 Water Requirements • Section 4.3 Site Hydrogeology • Section 4.4 Lesueur aquifer • Section 6.5 Groundwater • Section 6.6 Surface Water Appendix: • Appendix 1- Drover-01 Ground Water Study
People	Amenity	To ensure the impacts to amenity are reduced to as low as reasonably practicable.	• The site location is set back from the Coorow-Greenhead road and no sensitive receivers within immediate vicinity.	Sections: • Section 2 Description of activities to be conducted • Section 4.9 Social Environment
	Heritage	To ensure that historical and cultural associations are not adversely affected.	• Heritage desktop study has been undertaken and no sites of cultural significance identified within the project area.	Sections: • Section 4.9 Social Environment
	Human Health	To ensure that human health is not adversely affected	• Risk assessment was undertaken during the project planning phase, Human health effects were not considered to be a high risk item.	Appendix: • Appendix 4- EnVID Risk Assessment Drover-01
Integrating factors	Offsets	To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.	• Off sets are not applicable to this project, the project is a small scale “proof of concept” proposal.	N/A

Theme	Factor	Objective	Consideration	Reference (Section/Appendix/Document)
	Rehabilitation and Closure	To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.	• The site will be decommissioned and rehabilitated to meet the requirements of the landholder and any regulatory commitments.	Other statutory EIA decision-making processes: • EP approval by DMP

Reference: Environmental Assessment Guideline for Environmental factors and objectives (EAG 8), Environmental Protection Authority, Western Australia, June 2013.

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APPENDICES

Appendix 1
Drover-01 Groundwater Study

Rockwater
PROPRIETARY LIMITED

DROVER-1
GROUNDWATER STUDY

May 2013

REPORT FOR
AWE LIMITED

(Report No. 387-1/13/01)

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1 INTRODUCTION

AWE Limited (AWE) is planning to drill and core a well on their exploration permit, EP455, 16.5 km east of Greenhead. If the results are favourable, a hydraulic fracturing programme will be undertaken. The preferred location of the site, to be known as Drover-1, is on cleared land adjacent to abandoned well Gairdner-1 (Fig. 1). The target reservoirs are in the basal Kockatea Shale, Carynginia Shale, Irwin River Coal Measures and High Cliff Sandstone; at depths of greater than 1,600 m.

As part of the environmental assessment of the project, AWE has commissioned Rockwater to undertake a study of the groundwater system at the site. Groundwater use for the project is estimated to be 6 ML for the drilling operation and up to 4 ML for the hydraulic fracturing programme (assuming 4 stimulations). As anticipated groundwater use is expected to be minimal and the target reservoirs are at significant depths below aquifers, the hydraulic fracturing programme is anticipated to be of negligible risk to the groundwater system. Nevertheless, as the Drover-1 site is located adjacent to Lesueur National Park and has a minor component of surface infrastructure and potential contaminants, AWE is aiming have a thorough hydrogeological understanding of the site so any potential risks can be minimised.

2 GEOLOGY

2.1 STRATIGRAPHY

The stratigraphic sequence beneath EP455 is summarised in Table 1 and incorporates interpretations by AWE, Lipski (1991), Mory and Iasky (1996) and Kern (1997).

Gairdner-1 intersected sedimentary rocks of Permian to Late Triassic age over a total depth of 2,172 m as illustrated in Figure 2. Although not noted in the Gairdner-1 lithological descriptions, the surface geology over the majority of the study area is mapped as Tertiary laterite and associated sand (Fig. 3). A sequence of Jurassic strata is mapped at the surface east of the Drover-1 site.

Table 1: Strata within EP455

Formation	Age	Regional Lithology
Laterite and associated sand	Tertiary	Leached quartz sand over pisolitic to massive ferruginous laterite
Yarragadee Formation	Mid to Late Jurassic	Sandstone with siltstone and claystone beds; up to 2000 – 4000 m thick
Cadda Formation	Mid Jurassic	Shale, siltstone, and sandstone, locally limestone
Cattamarra Coal Measures	Early to Mid Jurassic	Sandstone, carbonaceous siltstone; minor coal
Eneabba Formation	Early Jurassic	Sandstone, multicoloured siltstone and claystone; minor coal
Lesueur Sandstone	Mid to Late Triassic	Sandstone, coarse-grained, pebbly; minor siltstone and conglomerate
Woodada Formation	Early to Mid Triassic	Sandstone, fine-grained, and carbonaceous siltstone
Kockatea Shale	Early Triassic	Shale, dark, siltstone, and minor sandstone and limestone
Carynginia Limestone	Late Permian	Probably equivalent to the Beekeeper Formation (Hall and Kneale 1992) – sandstone, skeletal limestone, and shale
Carynginia Shale	Early Permian	Siltstone, micaceous and carbonaceous, lesser sandstone and conglomerate
Irwin River Coal Measures	Early Permian	Alternating sandstone, siltstone, carbonaceous shale, and coal.

The stratigraphic sequence is described below, from oldest to youngest and a Tertiary subcrop geology map is presented as Figure 4.

2.1.1 Permian

The Permian section consists of the Irwin River Coal Measures and the Carynginia Formation. Although not intersected by Gairdner-1, the High Cliff Sandstone, which comprises interbedded sandstone, conglomerate and minor siltstone, is interpreted to underlie the Irwin River Coal Measures at this location.

The Irwin River Coal Measures, comprising coal and carbonaceous shale interbedded with sandstone and siltstone was intersected over the lowermost 138 m of Gaindner-1 and was not fully penetrated. It has a maximum known thickness of 307 m in Arrowsmith-1, about 25 km to the north (Fig. 3, Mory and Iasky 1996).

The overlying Carynginia Formation is informally divided by AWE and Lipski (1991) into a lower shale member and an upper limestone member (Fig. 2). However, Mory and Iasky (1996) interpret the limestone in this part of the stratigraphic section to correlate with the Beekeeper Formation, which they indicate sits unconformably on the Carynginia Formation. The Carynginia shale member, capping the Irwin River Coal Measures, is 259 m thick in Gairdner-1 and the overlying Carynginia limestone member is 35 m thick.

The High Cliff Sandstone, Irwin Rover Coal Measures and the Carynginia Shale are potential targets of the drilling and hydraulic fracturing investigation.

2.1.2 Triassic

Three formations comprise the Triassic-age strata in Gairdner-1: Kockatea Shale, Woodada Formation and Lesueur Sandstone. Based on the data from Gairdner-1 the base of the Triassic is at 1,740 m below rotary table (brt) and strata of that age continue to the surface.

The lowest unit, the Early Triassic Kockatea Shale, is 852 m thick in Gairdner-1. The geophysical logs indicate consistently shaley strata (Fig. 2). The basal 100 m of this shale is another potential target of the hydraulic fracturing investigation.

The Mid Triassic Woodada Formation, which consists predominantly of sandstone and siltstone, is 311 m thick in Gairdner-1. Geophysical logs from Gairdner-1 suggest that the formation is a thinly-bedded, fine-grained unit (Fig. 2).

The Late Triassic Lesueur Sandstone is predominantly a coarse-grained sandstone with traces of claystone and siltstone. The unit is 577 m thick in Gairdner-1 (Fig.2) and has been logged from the surface where it outcrops in places (Fig. 3 and 4).

2.1.3 Jurassic

Although not intersected by Gairdner-1, four Jurassic-age formations are recognised in the eastern part of EP455: Eneabba Formation, Cattamarra Coal Measures, Cadda Formation and Yarragadee Formation (Fig. 4).

The lowest unit, the Early Jurassic Eneabba Formation, is characterised by multicoloured siltstone and claystone with sandstone interbeds and is known to be up to 854 m thick.

The Early to Mid Jurassic Cattamarra Coal Measures is up to 1,500 thick and consist of fine- to coarse- grained sandstone interbedded with carbonaceous siltstone and claystone, with coal seams of up to 11 m thickness.

The Mid Jurassic Cadda Formation has a maximum known thickness of 290 m (Mory and Iasky 1996) and consists of shale, siltstone and medium to very coarse grained sandstone grading to a shelly limestone at some locations.

The Yarragadee Formation is of Mid to Late Jurassic age and consists of fine to coarse grained feldspathic sandstone, siltstone and claystone with minor conglomerate and coal. It is known to be between 2,000 m to 4,000 m thick, thickening to the east.

2.1.4 Tertiary

Laterite and associated sand are widespread across the Arrowsmith Region, which occurs east of the Gingin Fault where Drover-1 is to be located (Fig. 3). This unit was not noted in the lithological log for Gairdner-1.

2.2 GEOLOGICAL STRUCTURE

The Mesozoic strata of the Perth Basin in the Drover-1 environs dip at very low angles, generally downwards to the east and north. They are cut by regional faults that trend mainly northerly: the Beagle and Coomallo Faults, that delineate the Cadda Terrace (on which Drover-1 is located), and several lesser faults that produce negligible displacement and trend to the north-west and east (Figs 3 and 4). The strata are essentially continuous over the Cadda Terrace, which is about 25 km wide (E-W) and more than 100 km long (N-S).

The faults within the Drover-1 prospect are indicated in Figure 5. The map shows that the proposed Drover-1 is at least 4 km distance from the closest regional fault, the Beagle Fault to the west, and 3.3 km from the High Cliff Sandstone Marker Faults (part of the Peron Fault system) to the north-east.

3 HYDROGEOLOGY

3.1 SETTING

The Drover-1 site is in the Eneabba Plain Sub-Area of the Arrowsmith Groundwater Area, for Department of Water (DoW) management purposes (DoW 2010). The aquifers that are recognised in this subarea are listed in Table 2 (in order from shallowest to deepest).

Table 2: Aquifers in the Eneabba Plains and Twin Hills Sub-Areas

Aquifer	Formation	Typical Bore Yield (kL/day)	Groundwater Quality*	Distribution
Superficial	Bassendean Sand Tamala Limestone	small to moderate	marginal to brackish	Not present in study area –occurs west of Gingin Scarp
Yarragadee	Yarragadee Formation	large >1000	fresh to brackish	Not present at Gairdner-1 but occur beneath the eastern portion of EP455 (Fig. 4), within the Twin Hills Sub-Area
Cattamarra	Cattamarra Coal Measures	moderate >500	brackish to saline	
Eneabba	Eneabba Formation	moderate 500-1000	fresh to brackish	
Lesueur	Lesueur Sandstone	Large up to 2000	fresh to marginal	Occurs from surface in study area

Modified after DoW (2010)
*Fresh = <500 mg/L TDS; Marginal = 501-1500 mg/L TDS; Brackish = 1,501-5000 mg/L TDS; Saline = 5,001-50,000 mg/L TDS; Hypersaline = >50,000 mg/L TDS.

Of these recognised aquifers, the only one that is present at the Drover-1 site is the Lesueur aquifer, which is discussed in detail in Section 3.2. The underlying Woodada Formation is

noted by Kern (1997) to be a minor multilayered aquifer, with confining argillaceous beds, which is in hydraulic connection with the overlying Lesueur aquifer. At one test site (WL12 5 km east of Jurien) it contained relatively fresh groundwater but the salinity is more marginal elsewhere where the formation comprises thicker beds of fine-grained sandstone and siltstone.

The Eneabba, Cattamarra and Yarragadee aquifers occur to the east of the study site within the EP455 boundary (Fig. 4) but are within the adjacent Twin Hills Groundwater Sub-Area.

The relationships between the aquifers in the vicinity of EP455 are depicted in Figure 6.

3.2 LESUEUR AQUIFER

3.2.1 Groundwater Levels and Flow

Accurate groundwater level data in the vicinity of the study area are limited and data from the DoW's WIN database near the site include numerous irregularities (Fig. 7). For example, two bores (WIN ID 20007603 and 20007604) located 900 m and 150 m north-west of the proposed Drover-1 site have recorded water levels of 36 m AHD and 144 m AHD, respectively. Other data to the east of the site (e.g. WIN ID 20007589 and 20007602) indicate that some bores may access perched groundwater resulting in relatively elevated groundwater levels.

Isopotential data for the top of the Mesozoic Formations, recorded in May 1993 and presented by Kern (1997), are considered to provide a better estimate of groundwater heads in the Lesueur aquifer at the site (Fig. 7). These data, which include four measurement points within a 13 km radius of the site, indicate heads in the Lesueur aquifer decline from an elevation of about 76 m AHD, just west of the Peron Fault (2 km east of Drover-1), to about 63 m AHD, 6.4 km to the west where the Kockatea Shale/Carynginia Formation subcrops. The data imply that groundwater flow is towards the west to north-west. However, these 1993 groundwater level data are dated. Hydrographs for the shallower Leeman Shallow Project bores on the WIN database indicate that water levels have risen by between 0.8 and 2.5 m since 1993. WIN data for the Water Corporation's Leeman 1-91 bore, however, appears to include only pumping water levels (which are drawn down below the standing water level due to the pumping), with the level reported by Kern (1997) the only standing water level that is readily available.

The isopotentials from Figure 7 were used to estimate depth to groundwater at the site (Fig. 8). The derived data indicate that the depth to groundwater in the vicinity of Drover-1 and in the areas of Lesueur National Park, directly to the west and south of the site, is considerable (>100 m below ground level). To the west, near the boundary of the impermeable Kockatea Shale, the data suggest that the groundwater heads may approach

artesian. To the east, the plotted depth to groundwater and the WIN database data again do not correlate well, and the actual depth to groundwater is uncertain as discussed previously.

Surface water flow at the site is expected to follow topographic gradients, which generally slopes downwards towards the west to north-west.

3.2.2 Groundwater Recharge and Discharge

Groundwater recharge to the Lesueur aquifer in this area is derived predominantly from rainfall where the aquifer occurs at the surface or beneath thin surficial deposits. The aquifer outcrops within the Lesueur National Park, to the south, and sub-crops beneath a thin cover of Tertiary laterite and sand over the remainder of the area between the Beagle and Peron Faults. Therefore, there is a considerable area over which there is potential for rainfall recharge to occur. Some groundwater flow into the Lesueur aquifer, from the Eneabba Formation and Cattamarra Coal Measures, is likely to occur from the east across faults.

The water level data presented in Figures 7 and 8 suggest that groundwater discharge from the Lesueur aquifer occurs near the edge of the Beagle Fault system, along the eastern boundary of the Kockatea Shale. Upwards hydraulic head gradients in the Lesueur aquifer near this boundary result in discharge into the Superficial aquifer, which is present west of the Gingin Scarp (Fig. 8). Several springs occur close to this boundary (Section 4.2).

3.2.3 Groundwater Quality

Groundwater in the Lesueur aquifer typically has fresh to marginal salinity which most likely increases with depth. Salinities of water sampled from bores within the study area screened in the upper portion of the aquifer range from 450 mg/L to 1,435 mg/L Total Dissolved Solids (TDS) (Fig. 9). However, one bore, Amax Greenhead No.1 (WIN ID 20007614) which is constructed deeper in the aquifer (680 m bgl), has a reported salinity of 3,620 mg/L TDS. It is likely that the groundwater salinity in the Lesueur aquifer is slightly higher close the contact with the Eneabba Formation, which is known to contain more brackish groundwater; however, there are limited data within the study area to support this.

3.2.4 Aquifer Connectivity

The major regional confining layer between the hydrocarbon exploration targets (the basal 100 m of the Kockatea Shale, Carynginia Formation, Irwin River Coal Measures and the High Cliff Sandstone) and the overlying aquifers is the Kockatea Shale. The formation is 852 m thick in Gairdner-1 and geophysical logs indicate consistently shaley strata (Fig. 2). Elsewhere in the area the Kockatea Shale may be more than 1,100 m thick (in Eneabba-1 oil well; Mory 1994). The Kockatea Shale is recognised as a primary regional seal for

hydrocarbon plays in the northern Perth Basin (D'Ercole 2003) and, as such, would also form a major hydraulic confining layer.

The major aquifer, the Lesueur aquifer, and the underlying minor aquifer, the Woodada Formation, are likely to have some degree of hydraulic connection. However, they, both contain minor confining layers, which may impede or restrict vertical groundwater movement.

The hydraulic properties along faults in the area are difficult to assess without specific investigations, which have not been undertaken. There could be groundwater flow between adjacent aquifers where permeable strata are juxtaposed across a fault, such as the contact between the Lesueur aquifer and Eneabba Formation across the Peron Fault (Fig. 6). Additionally, faults that cut the strata are potential conduits for vertical movement of fluids. No significant faults have been identified in the vicinity of the hydraulic fracturing operations.

4 EXISTING GROUNDWATER USE

4.1 GROUNDWATER USERS

Groundwater extraction is licensed by the DoW and the available resources are managed for allocation purposes within defined areas. The Drover-1 site is located within the Eneabba Plain Sub-Area of the Arrowsmith Groundwater Area, although EP455 also intersects the Twin Hills Sub-Area of the Arrowsmith Groundwater Area, to the east, and the Cervantes, Nambung and Bagingarra Sub-Areas of the Jurien Groundwater Area, to the south (Fig. 10).

Active DoW licences to extract groundwater (GWLs) near Drover-1 are shown in Figure 10 and are summarised in Table 3. Only shallow domestic and stock watering bores are exempt from licensing. Such bores provide only small supplies, generally from the Superficial aquifer, and are the most numerous water-supply bores in the area.

Table 3: DoW GWLs Held Near Drover-1

GWL	GW Area Name	GW Subarea Name	Aquifer Name	Allocation (kL/a)
65700	Arrowsmith	Eneabba Plains	Lesueur	470,000
57960		Twin Hills	Yarragadee	70,000
171512		Twin Hills		24,000
167278		Dongara	Superficial	3,000
111221	Jurien	Cervantes	Superficial	55,000
175401				400,000

The data show that there is limited licensed groundwater use in the area directly surrounding Drover-1. The closest licence, GWL 65700 held by the Water Corporation (Leeman 1-91)

allowing 470,000 kL/a of groundwater to be extracted from the Lesueur aquifer, is located 4.2 km north-west of the proposed Drover-1 site. This is the only current GWL in the Lesueur aquifer within this sub-area and represents 26% of the allocation limit of 1,800,000 kL; with 1,330,000 kL/a currently available for allocation. The proposed 10 ML to be used by AWE in the drilling and hydraulic fracturing testing at Drover-1 would represent only 0.5% of the total annual allocation of the Lesueur aquifer.

The Yarragadee aquifer in the Eneabba Plains and Twin Hills Sub-Areas is the major groundwater resource, with the largest available allocation and currently allocated resources (Table 4). Most of the extraction from this aquifer occurs in the north-eastern parts of these sub-area where this aquifer outcrops or occurs at shallow depth.

Table 4: Groundwater Allocation Summary for Eneabba Plains and Twin Hills Groundwater Sub-Areas

Sub-Area	Aquifer	Allocation Limit (kL/a)	Licensed Allocation (kL/a)	Total Allocated, Committed and Requested (kL/a)	Allocated Resources (%)
Eneabba Plains	Cattamarra Coal Measures	100,000	0	0	0%
	Lesueur	1,800,000	470,000	0	26%
	Eneabba	2,000,000	800,000	1,400,000	70%
	Superficial	14,470,000	281,300	1,281,300	9%
	Surficial	0	0	0	0%
	Yarragadee	20,440,000	15,510,711	20,400,711	100%
Twin Hills	Cattamarra Coal Measures	500,000	0	0	0%
	Lesueur	200,000	0	0	0%
	Parmelia	3,400,000	46,000	46,000	1%
	Superficial	0	0	0	0%
	Surficial	490,000	0	0	0%
	Yarragadee	42,830,000	18,138,250	19,138,250	45%

Data from the DoW - dated 25 March 2013

4.2 GROUNDWATER DEPENDENT ECOSYSTEMS

The depth to groundwater at the Drover-1 site is estimated to be in excess of 100 m based on isopotentials published by Kern (1997), with the closest expression of groundwater of less than 20 m depth being 4 km to the west (Fig. 8). It appears unlikely that the Lesueur National Park within (at least) a 2 km radius of Drover-1 contains groundwater dependent vegetation considering the comparatively deep water table.

The DoW WIN database contains contradictory information; the depth to groundwater at WIN site 20007604, located 150 m northwest of the proposed Drover-1 site, is recorded to be 24 m bgl, whereas the depth to groundwater at WIN site 20007603, located approximately

900 m north-north-west of the site is recorded as 146 m. The exact depth to groundwater at the site needs to be ascertained but given the relatively high topographic elevation of the site (approximately 170 m AHD), it would be unlikely that the depth to groundwater is shallow (<20 m bgl). Therefore, there is minimal likelihood of GDE in the vicinity of the site.

The study undertaken by Rutherford *et. al* (2005) identifying groundwater dependent ecosystems (GDE) in the Northern Perth Basin, considered only sites that had a depth to groundwater of less than 20 m to be potentially reliant on groundwater. The closest GDE identified by the study is a natural spring, named "Diamond of the Desert", located 7 km to the southwest (Fig. 8). Here the impermeable Carynginia Shale is juxtaposed against the Lesueur Sandstone along the Beagle Fault causing upward discharge of groundwater into the Superficial formations. This GDE is well outside the area of influence expected for the operations at Drover-1.

5 RECOMMENDED MONITORING

There are three existing bores near the proposed Drover-1 site that may be useful for groundwater monitoring (Fig. 8); the details of which are summarised in Table 5 and locations shown in Figure 8. The condition and availability of these bores needs to ascertained but, if deemed suitable, they could be used for groundwater level and quality monitoring.

If the existing bores are unsuitable or unavailable, at least two monitoring bores would be required to be installed; ideally one as close as practical to the Drover-1 hole (say offset 150 m) and one downgradient (say 0.5 to 1.0 km west-north-west depending on access). This would allow the depth to groundwater and the hydraulic gradient to be confirmed. Note that if the existing bores are suitable and available for monitoring these additional bores would not be required.

To establish whether operations have any effect on the groundwater system, bores should be installed with groundwater loggers which record the groundwater level, electrical conductivity, pH and temperature. These should be installed as soon as possible to establish baseline trends prior to operations. Data should be downloaded and manual groundwater level measurements taken at least quarterly.

Comprehensive water analyses should be undertaken on groundwater samples collected from each of the available monitoring bores prior to commencement of operations and at say 6-monthly intervals thereafter. The exact timing will depend on the duration of operations. Sampling and monitoring should continue for at least 2 years following the completion of operations. The comprehensive analysis suite should be supplemented with hydrocarbons and any other additives specific to the hydraulic fracturing operations.

Table 5: Summary of Lesueur Aquifer Bores for Potential Monitoring Use

WIN Site ID	AWRC Name	MGA mE	MGA mN	Drilled Depth m bgl	Slotted Interval m bgl	Year Constructed	Elevation* m AHD	Water Level m bgl	Water Level m AHD	TDS from WIN	Distance and direction from Drover-1
20007603	BORE	321,282	6,672,132	220	192-198	?	182	146	36	500	150 m NE
20007604	BORE	321,287	6,671,297	91.64	54-60	1990	168	24	144	930	900 m NNE
20007613	FARM NO 1	318,330	6,671,559	51.82	?	1974	108	40	68	1,570	2,900 WNW
* Elevation estimated from Google Earth											

A rainfall and barometric gauge should be set-up at the site to allow climatic influences to be incorporated in the analysis of data.

Bores used for monitoring will need to be surveyed so groundwater levels can be compared accurately.

6 SUMMARY AND CONCLUSIONS

A groundwater study has been undertaken for the area surrounding the proposed Drover-1 site (16.5 km east of Greenhead), where AWE is considering a hydraulic fracturing programme. Although groundwater use is expected to be minimal, totalling 10 ML for the entire project, and adverse risks to the groundwater system are expected to be minimal, AWE is aiming have a thorough hydrogeological understanding of the site so that any potential risks can be minimised.

The target reservoirs for the hydraulic fracturing stimulations are expected to be at depths of greater than 1.6 km, far below the 580 m bgl base of the Lesueur sandstone, the main aquifer in the area. The hydraulic fracturing targets include the basal 100 m of the Kockatea Shale, at about 1.6 km depth, to the Irwin River Coal Measures at about 2.1 km depth. The Kockatea Shale is expected to be around 850 m thick at Drover-1 and, excluding the basal 100 m, provides a thickness of 750 m of impermeable shale between the planned targets and the overlying aquifer. Therefore, providing that the integrity of the well casing and annular cement grout at the proposed Drover-1 site are not compromised and there are no unforeseen connections of strata, the hydraulic fracturing should not affect overlying aquifers.

The main aquifer which sub-crops beneath the site is the Lesueur aquifer, which is composed of 580 m of sandstone and siltstone. Groundwater levels at the site need to be confirmed but are expected to be in excess of 100 m bgl. Groundwater salinity in the Lesueur aquifer is typically fresh to marginal and most likely increases with depth. Given the expected considerable depth to groundwater, it appears unlikely that vegetation within the adjacent Lesueur National Park is groundwater dependent.

There is limited groundwater use in the area. Within the Eneabba Plains groundwater management sub-area, only 26% of the Lesueur aquifer allocation limit of 1,800,000 kL is currently utilised. The closest groundwater user, the Water Corporation, is located 4.2 km north-west of the proposed Drover-1 site, well outside the area of influence expected for the operations at Drover-1.

Existing bores need to be visited to determine if they would be suitable or available for groundwater level and quality monitoring. If they are not, at least two monitoring bores will be required to be installed to determine the groundwater level, hydraulic gradient and

groundwater quality at the site. On-going groundwater level and quality monitoring is recommended before, during and after the operations to ensure the groundwater system is not impacted.

Dated: 10 May 2013

Rockwater Pty Ltd

M J Taylor
Senior Hydrogeologist

J S Moncrieff
Principal Hydrogeologist

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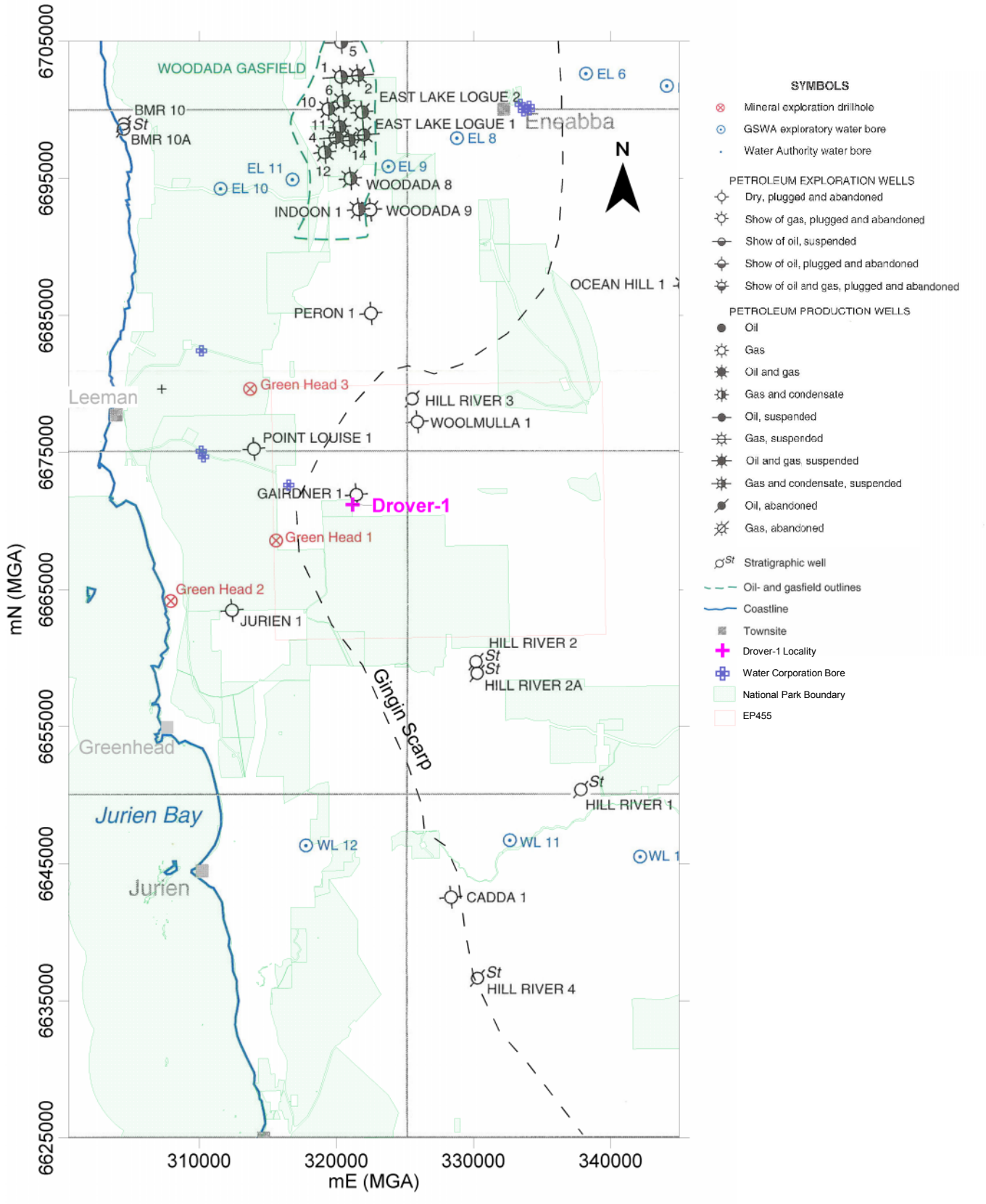
FIGURES

Figure 1



387-1/Surfer/13-01/Fig1. Oil Well Locality.srf

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-1

REGIONAL LOCATION
AND DEEP DRILL HOLES

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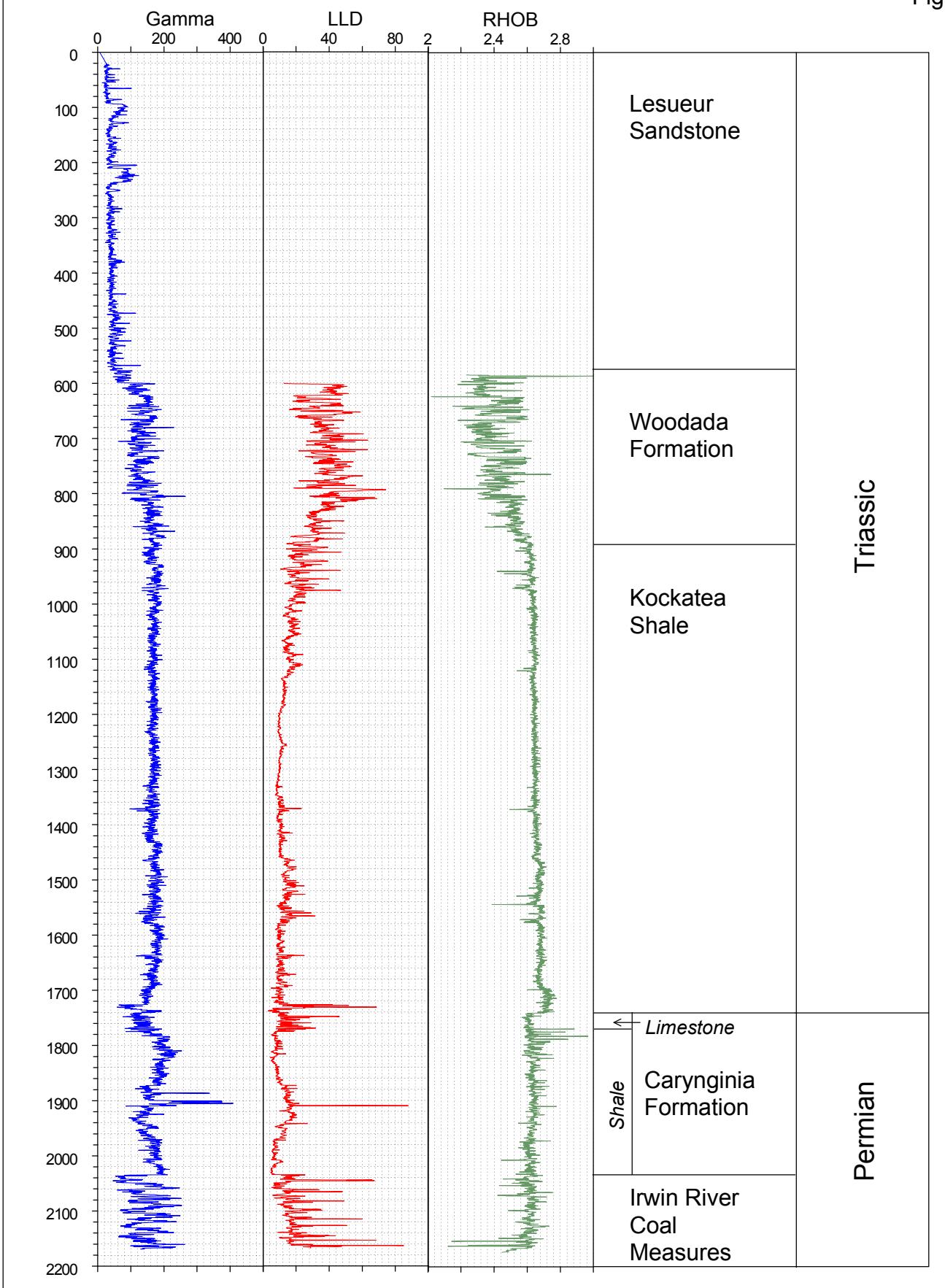
Figure 2



387-1/Grapher/13-01/Fig2. Gairdner Strat & Logs.grf

Client: AWE Limited

Project : Drover-1 Groundwater Study

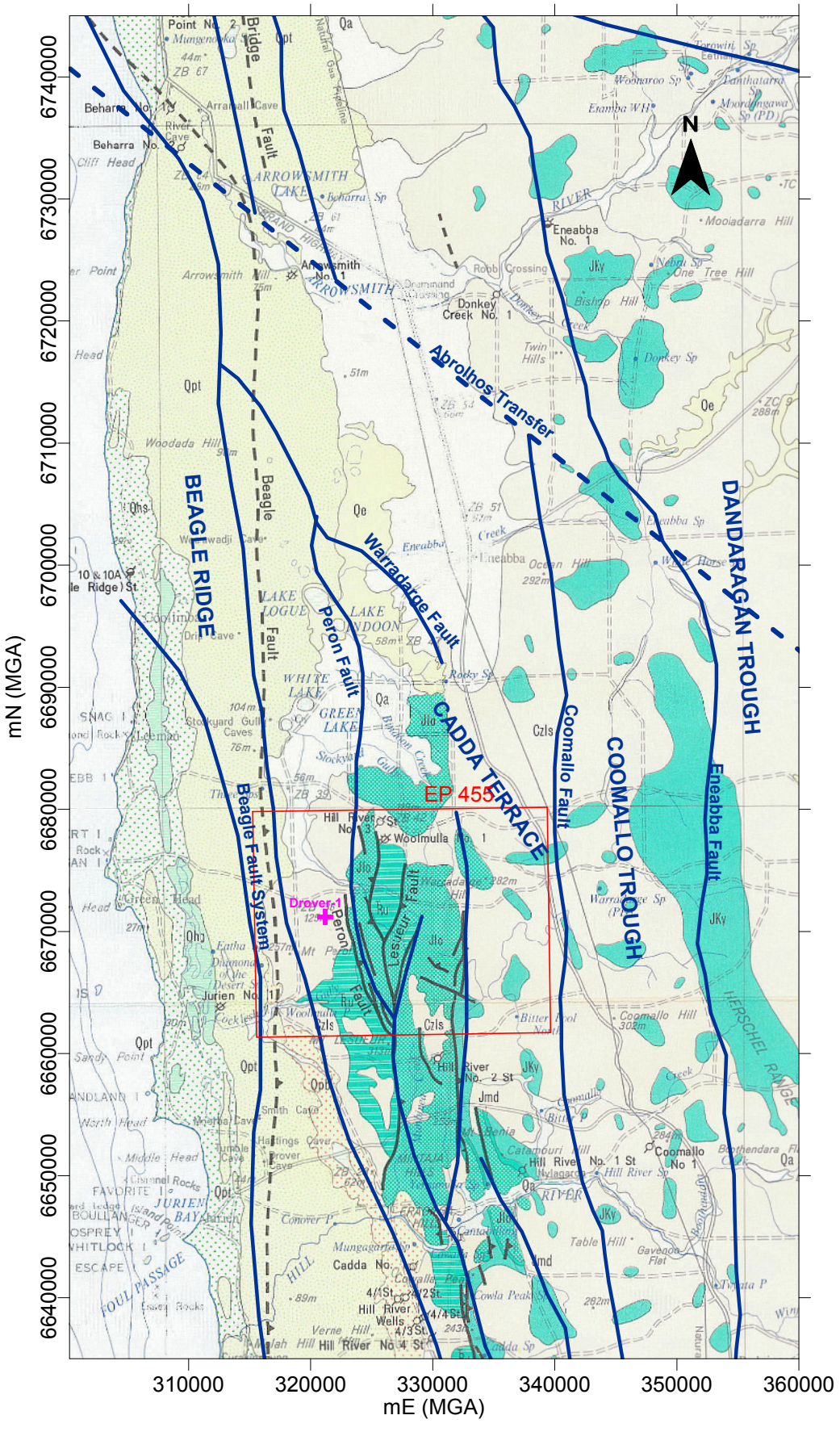
Date : May 2013

Dwg. No: 387-1/13/1-2

GAIRDNER-1
STRATIGRAPHY AND LOGS

Rockwater

Figure 3



387-0/Surfer/11-01/Geology Locality.srf

Geology from Geological Survey of WA.

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-3

GEOLOGICAL STRUCTURE

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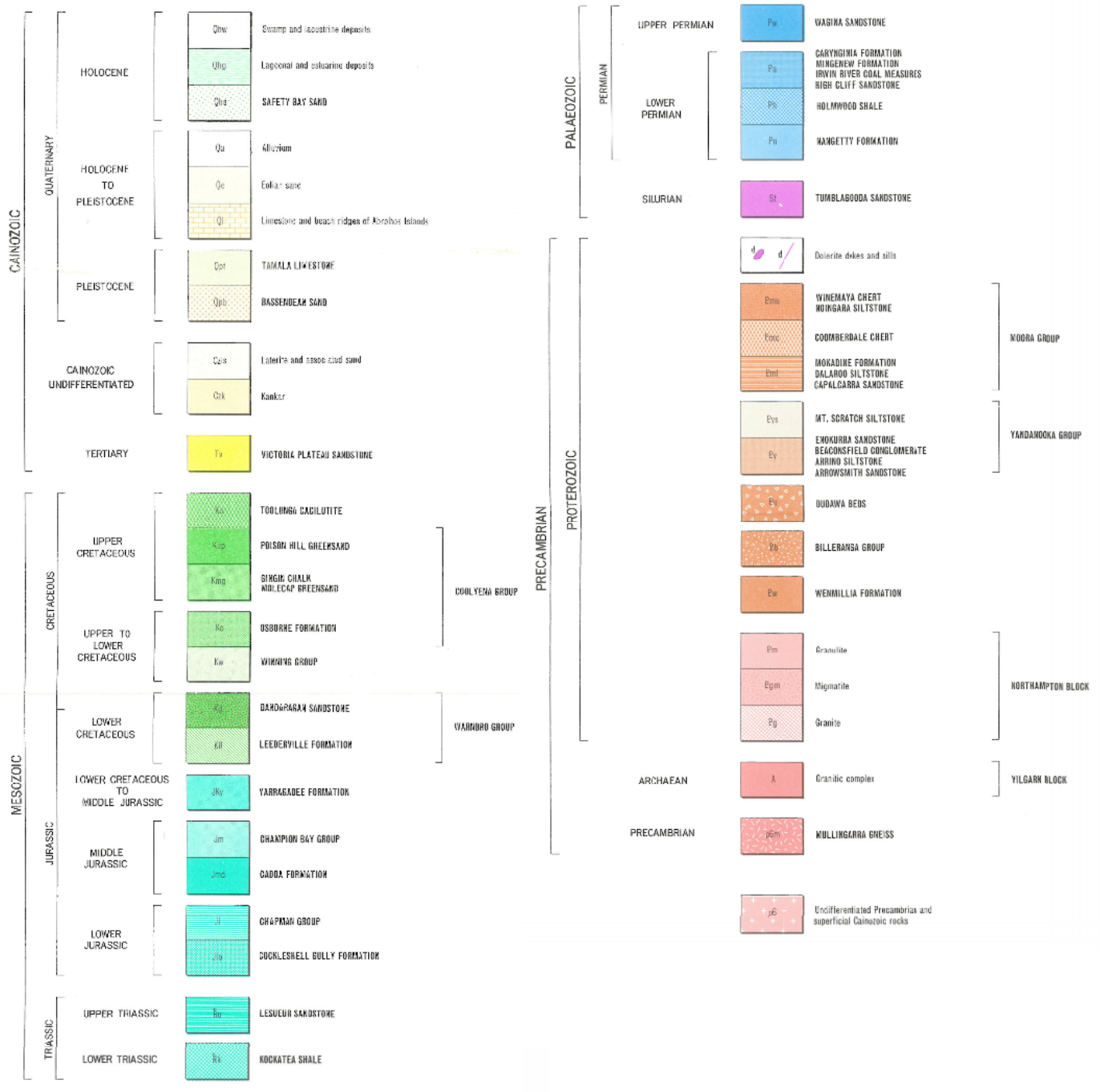
Figure 3a



Geology from Geological Survey of WA.

387-0/Surfer/13-01/Fig3a. Geology Legend.srf

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-3a

GEOLOGICAL LEGEND (FOR FIG. 3)

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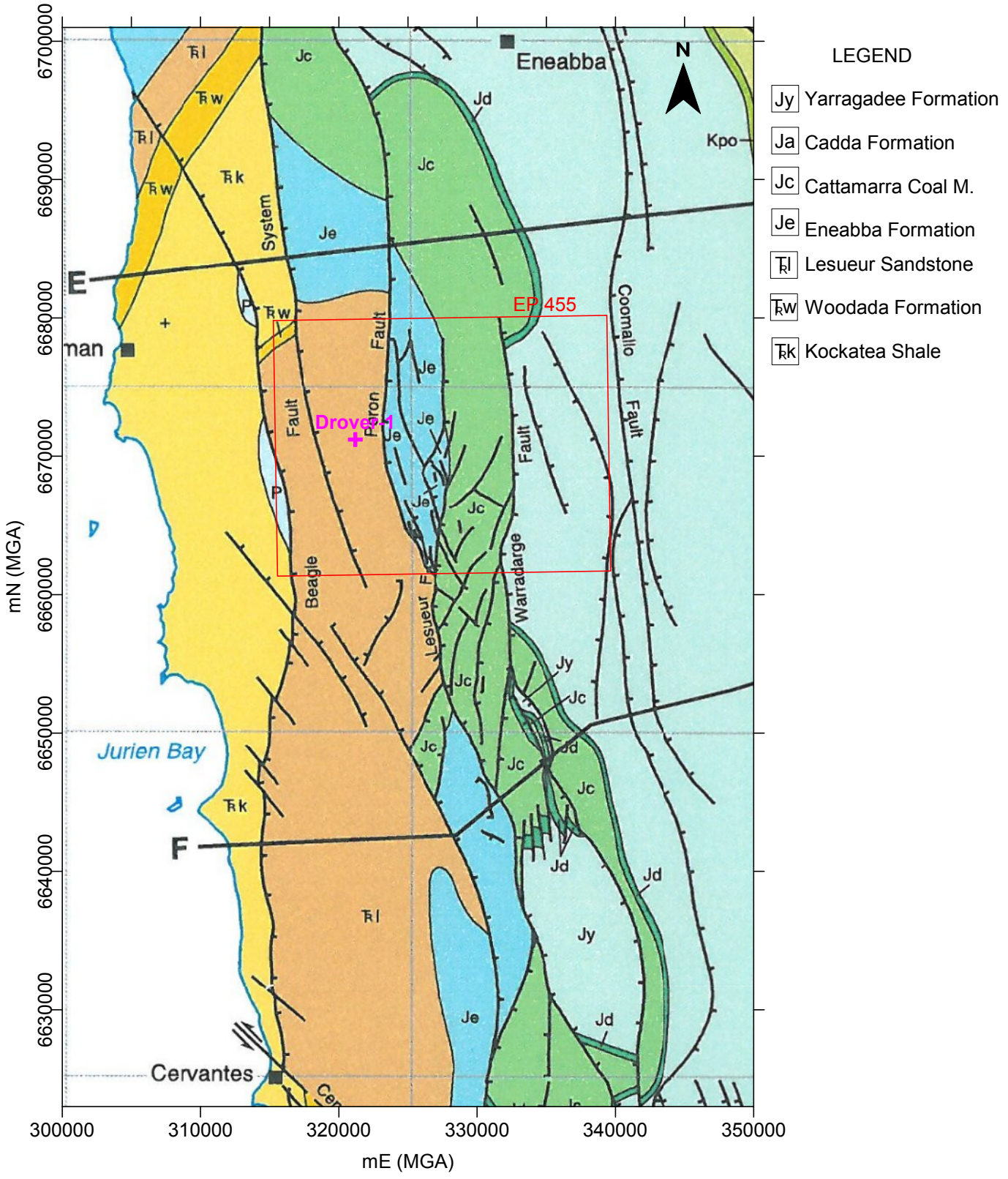
Figure 4



Map after Mory and Iasky, 1996

387-0/Surfer/13-01/Fig4. Subcrop Geology.srf

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-4

TERTIARY SUBCROP GEOLOGY

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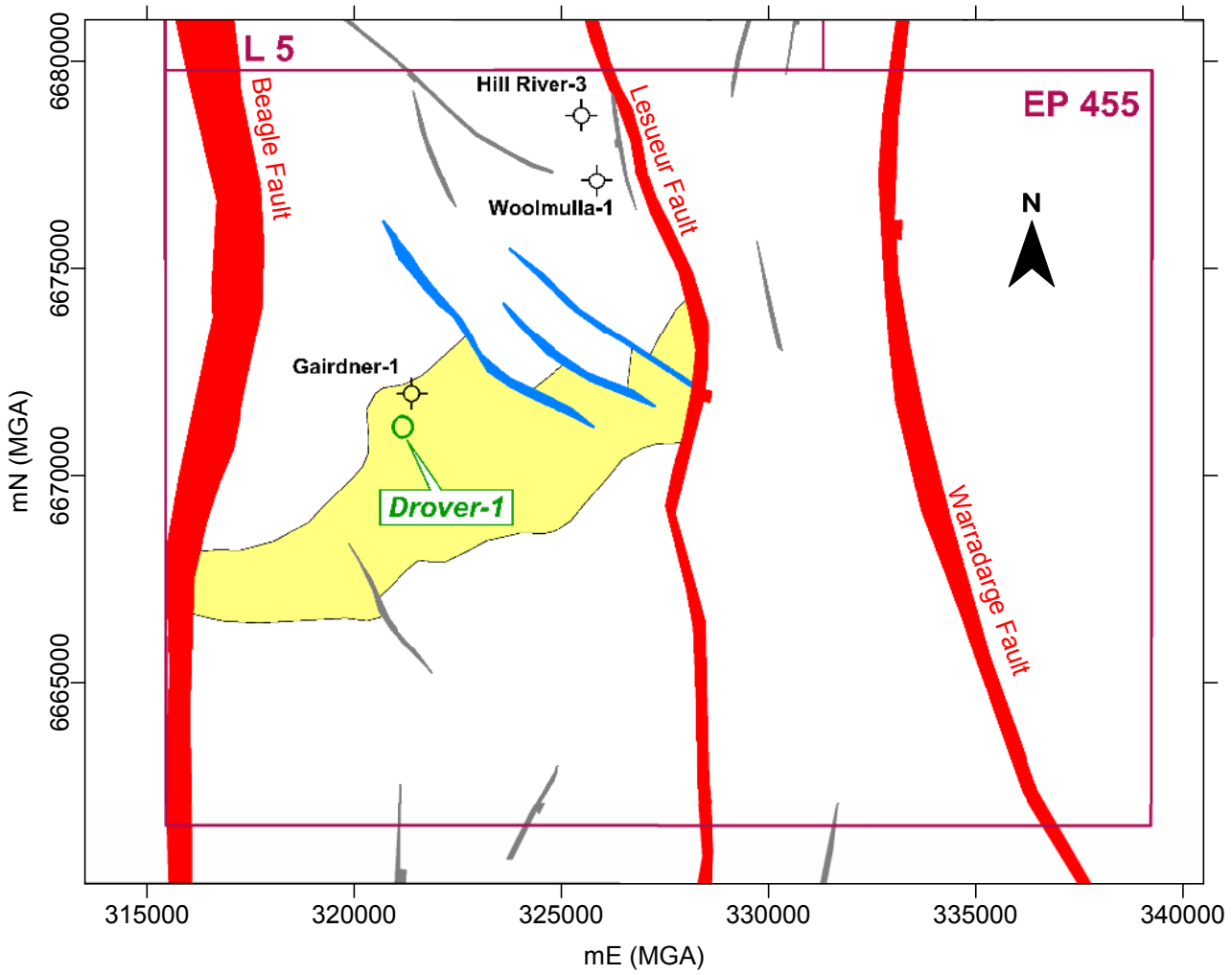
Figure 5



Drover Prospect (High Cliff Sst marker) Faults

Regional Faults

Other Faults

Drover Prospect

387-0/Surfer/13-01/Fig5. Local Faults.srf

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-5

DROVER PROSPECT
WITH MAPPED FAULTS

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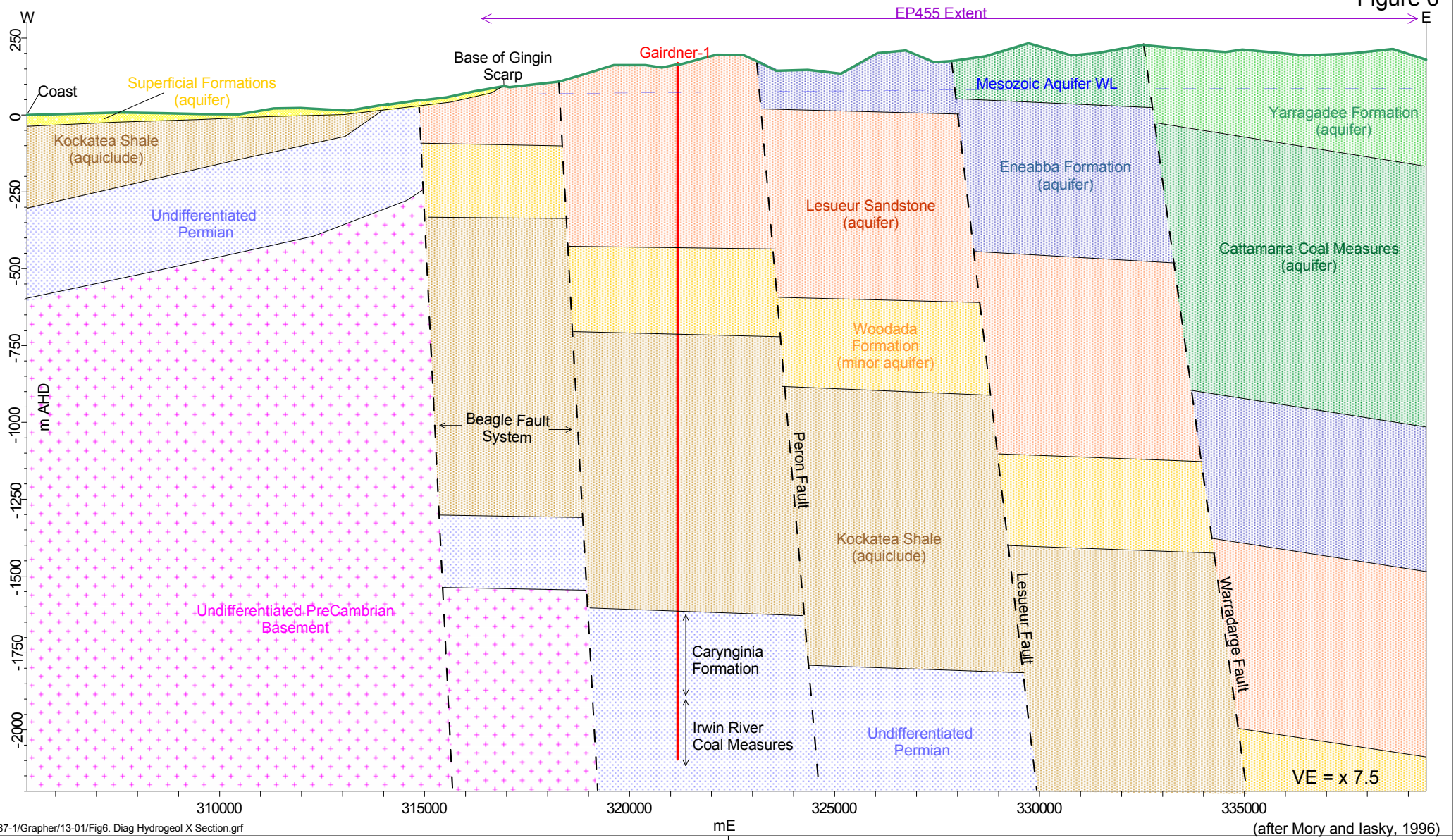
Figure 6



387-1/Grapher/13-01/Fig6. Diag Hydrogeol X Section.grf

(after Mory and Iasky, 1996)

Client: AWE Limited

Project : Drover-1 Groundwater Study

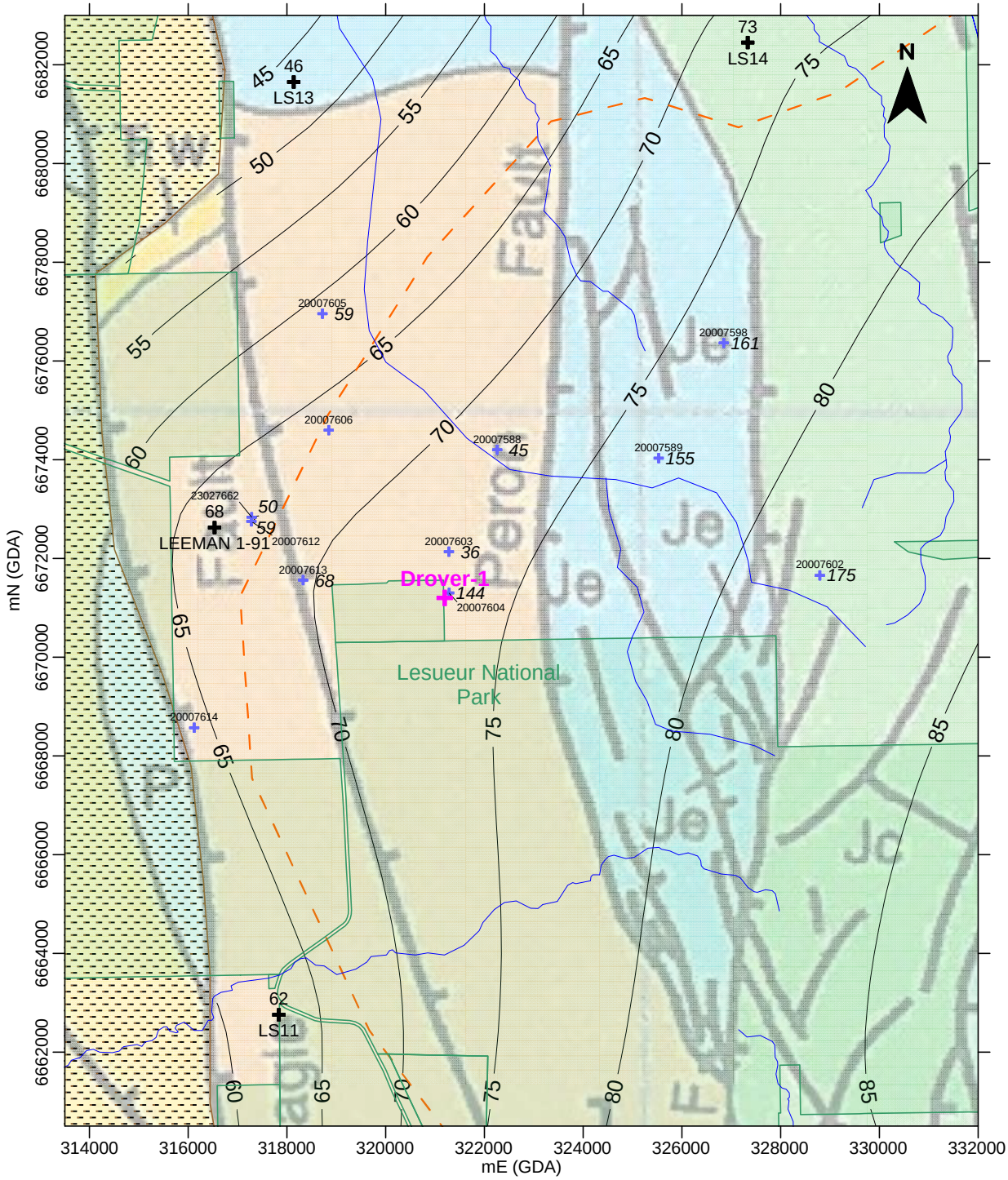
Date : May 2013

Dwg. No: 387-1/13/1-6

DIAGRAMMATIC HYDROGEOLOGICAL CROSS-SECTION THROUGH 6,764,000 mN

Rockwater

Figure 7



—70— Isopotential - Top of Mesozoic Aquifers (m AHD)

62 LS12 Mesozoic Water Level Monitoring Point and Water Level (m AHD)

20076003 36 WIN Database Water Level Monitoring Point and Water Level (m AHD)

Aquiclude - Kockatea Shale/Carynginia Formation

DEC Management Boundary

Water Course

NB - Mesozoic Isopotentials from Kern, 1997
- Sub-Crop Geology Map from Mory and Iasky, 1996 with Legend on Fig. 4

387-0/Surfer/13-01/Fig7. Mesozoic WLs.srf

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-7

ISOPOTENTIALS AT THE TOP OF MESOZOIC FORMATIONS

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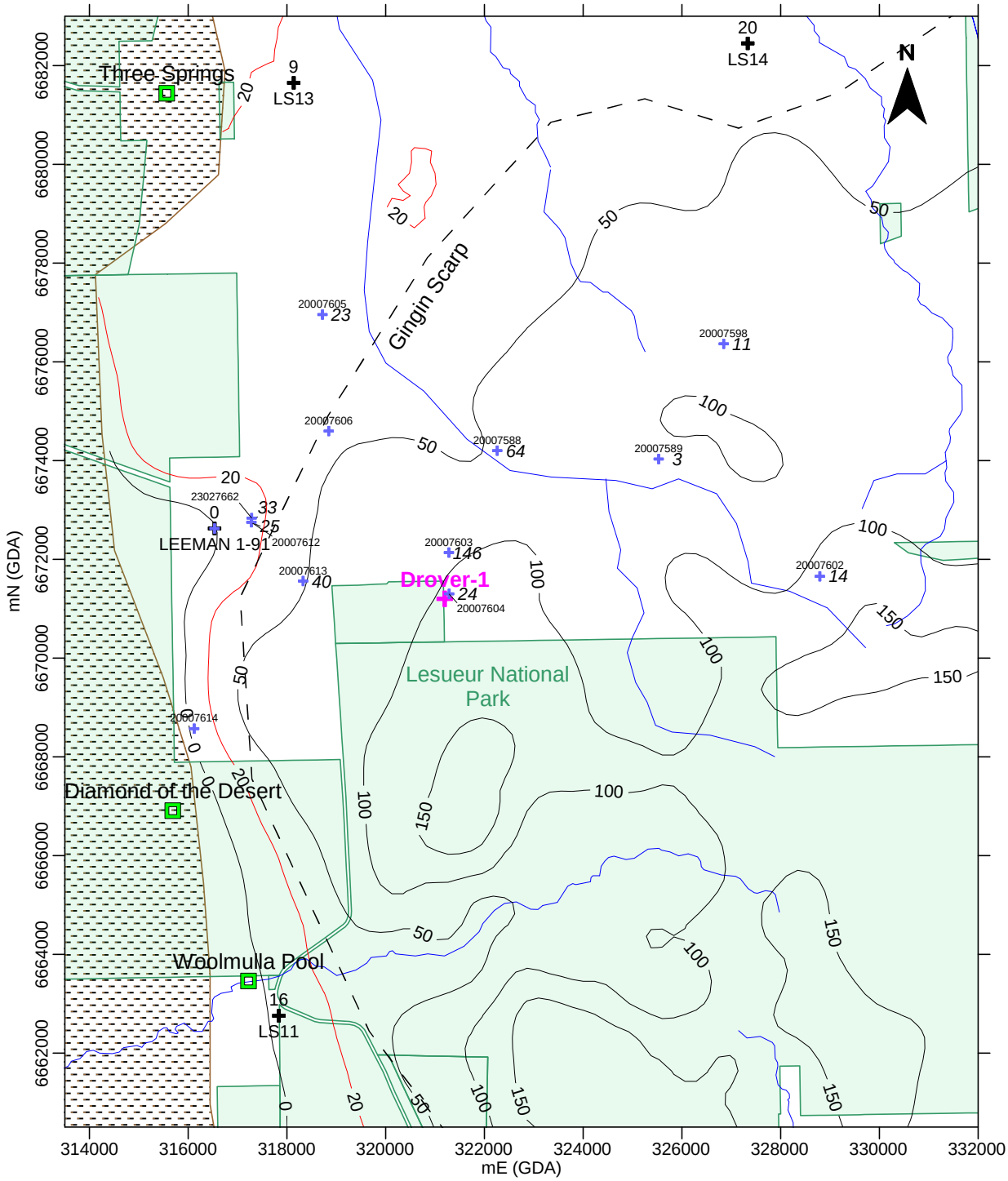
Figure 8



—50— Estimated Depth to Groundwater Contours (m bgl)

16 LS12 Mesozoic Water Level Monitoring Point and Water Level (m bgl)

20076003 146 WIN Database Water Level Monitoring Point and Water Level (m bgl)

Aquiclude - Kockatea Shale/Carynginia Formation

DEC Management Boundary

Water Course

Mapped GDE (Rutherford et al 2005)

NB - Depth to Groundwater Calculated Using Mesozoic Isopotentials from Kern 1997

387-0/Surfer/13-01/Fig8. Est Depth to GW.srf

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-8

ESTIMATED DEPTH TO GROUNDWATER

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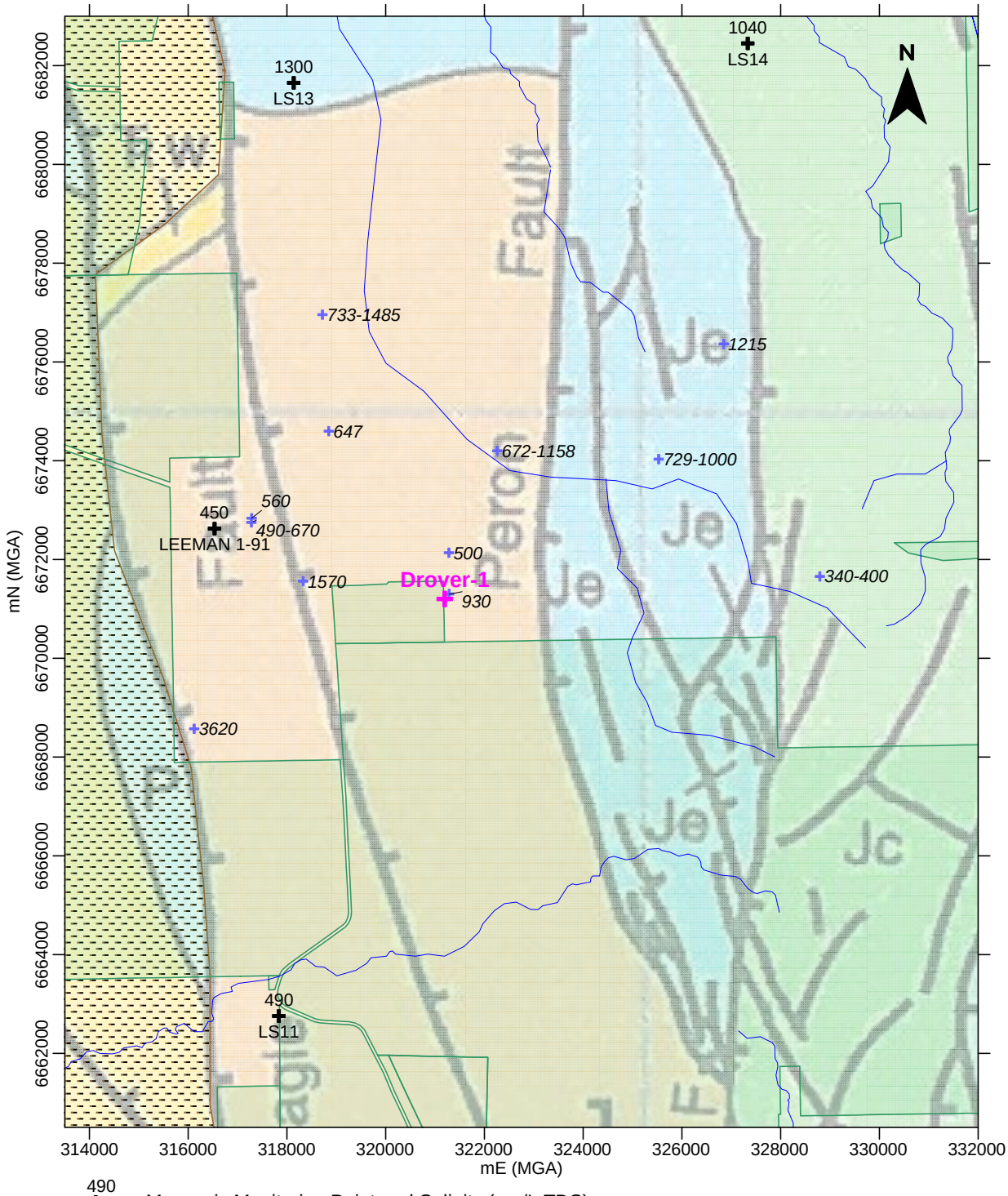
Figure 9



490
LS12 Mesozoic Monitoring Point and Salinity (mg/L TDS)

500 WIN Database Monitoring Point and Salinity (mg/L TDS)

Aquiclude - Kockatea Shale/Carynginia Formation

DEC Management Boundary

Water Course

NB - Sub-Crop Geology Map from Mory and Iasky, 1996 with Legend on Fig. 4

387-0/Surfer/13-01/Fig9. Salinity Map.srf

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-9

GROUNDWATER SALINITY

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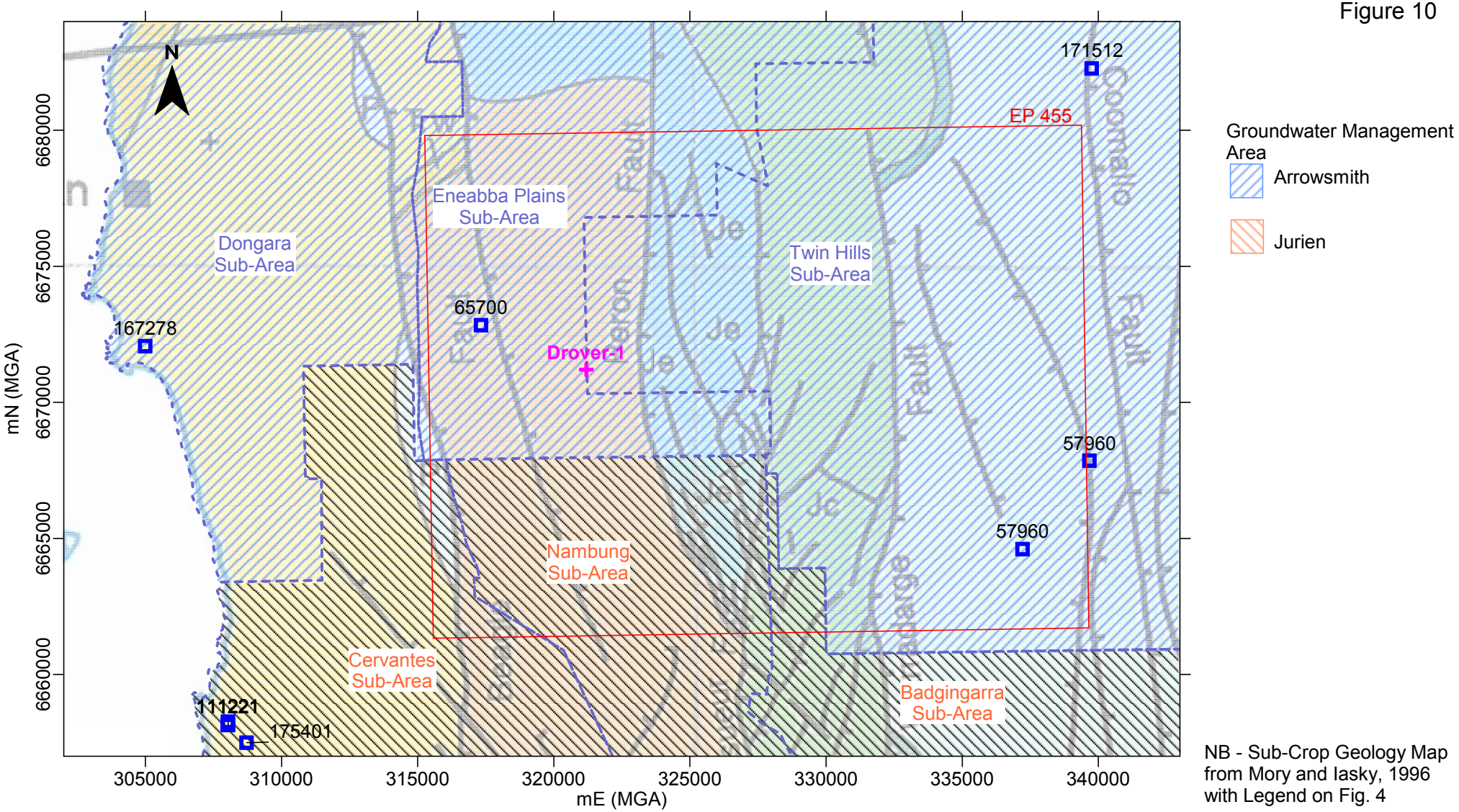
Figure 10



NB - Sub-Crop Geology Map from Mory and Iasky, 1996 with Legend on Fig. 4

Client: AWE Limited

Project : Drover-1 Groundwater Study

Date : May 2013

Dwg. No: 387-1/13/1-10

LICENCES TO TAKE GROUNDWATER IN THE VICINITY OF DROVER-1

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Appendix 2
Drover-01 Well Fauna Impact Assessment

New Drover-01 Well
Fauna Assessment

Prepared for: AWE Limited
Level 1, 679 Murray Street
West Perth, WA 6005
Australia

Prepared by: Katherine Chuk and Mike Bamford
M.J. & A.R. Bamford Consulting Ecologists
23 Plover Way
KINGSLEY WA 6026

10th July 2013

Executive summary

AWE Limited (AWE) is investigating the possibility of exploration drilling centred on the New Drover-01 Well near Eneabba. This replaces the Old Drover01 Well that lies just to the west. As part of the Environmental Impact Assessment for this project, Bamford Consulting Ecologists (BCE) was commissioned by AWE initially to conduct a Level 1 fauna investigation (desktop review and fauna assessment) of the Old Drover-01 Well site, and subsequently to investigate the new location. BCE uses an impact assessment process with the following components:

- The identification of **fauna values**:
    - Assemblage characteristics: uniqueness, completeness and richness;
    - Species of conservation significance;
    - Recognition of vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
    - Patterns of biodiversity across the landscape;
    - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
    - Habitat loss leading to population decline;
    - Habitat loss leading to population fragmentation;
    - Degradation of habitat due to weed invasion leading to population decline;
    - Ongoing mortality from operations;
    - Species interactions including feral and overabundant native species;
    - Hydrological change;
    - Altered fire regimes; and
    - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts.

The fauna investigations were based on a desktop assessment and site reconnaissance surveys in August 2012 (Old Drover-01) and July 2013 (New Drover-01). This report focusses on the New Drover-01 site, but uses information collected at the Old Drover-01 site where this contributes to the assessment. The desktop survey identified 213 vertebrate fauna species potentially occurring in the AWE survey area. This comprised 9 frogs, 60 reptiles, 119 birds and 16 native and 9 introduced mammals. Key **fauna values** are:

Fauna assemblage. Likely to be typical of fauna assemblages in the region but probably slightly depauperate as much of the New Drover-01 site has been disturbed and consists of regenerating vegetation.

Species of conservation significance. Three reptile species, up to four bird species, one mammal species and three invertebrate species of conservation significance may be present regularly. Species of note are the South-west Carpet Python, Peregrine Falcon, Western Ground Parrot (possibly locally extinct), Carnaby's Black-Cockatoo, Rainbow Bee-eater, Rufous Field-wren, Australian Bustard and several invertebrates.

Vegetation and Substrate Associations. Three VSAs were identified across the project area. All of the natural VSAs are regionally widespread.

Patterns of biodiversity. Biodiversity is likely to be spread across the VSAs and the landscape, but areas of particular significance include VSA1 as the Banksias and Eucalypts may support foraging Carnaby's Black-Cockatoos. VSA3 is likely to be highly depauperate.

Key Ecological Processes - Impacts on fauna and for conservation significant species are generally considered to be only minor. This is due to the small footprint of the project (12ha) which is located mostly within widespread and common environments (41,875 ha of native vegetation lie within a 15 km radius of the project area). However, there is some potential for project activities to alter fire regimes and to introduce weeds into native vegetation. Note that there is some uncertainty regarding subterranean impacts and there is insufficient information to comment upon impacts upon subterranean fauna and groundwater hydrology.

Recommendations relate to impacts and include:

- Minimising vegetation clearing; particularly mature trees; and
- Taking a precautionary approach to minimise impacts through changes in hydrology, light pollution, the inadvertent (or deliberate) encouragement of feral species, fire and the spread of weeds.
- Review the impact upon foraging habitat for Carnaby's Black-Cockatoo. It is considered that referral to DSEWPaC is not required as there is a low risk of impacts upon the species being considered significant under the EPBC ACT, as the habitat suitable for foraging is degraded, not within the breeding range of the species and there is extensive quality foraging habitat nearby. However, DSEWPaC does provide an email to discuss the need for referral and it is suggested that this be used.

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1 Introduction

1.1 Introduction

AWE Limited (AWE) is investigating the possibility of exploration drilling centred on the New Drover-01 Well near Eneabba. This replaces the Old Drover01 Well that lies just to the west. As part of the Environmental Impact Assessment for this project, Bamford Consulting Ecologists (BCE) was commissioned by AWE initially to conduct a Level 1 fauna investigation (desktop review and fauna assessment) of the Old Drover-01 Well site, and subsequently to investigate the new location. A level 1 fauna assessment is required to identify the fauna values of a site so that impacts upon these from any proposed development can be assessed and, where possible, minimised.

1.2 General Approach to Fauna Impact Assessment

The purpose of impact assessment is to provide government agencies with the information they need to decide upon the significance of impacts of a proposed development. BCE uses an impact assessment process with the following components:

- The identification of **fauna values**:
  - Assemblage characteristics: uniqueness, completeness and richness;
  - Species of conservation significance;
  - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
  - Patterns of biodiversity across the landscape;
  - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
  - Habitat loss leading to population decline;
  - Habitat loss leading to population fragmentation;
  - Degradation of habitat due to weed invasion leading to population decline;
  - Ongoing mortality from operations;
  - Species interactions including feral and overabundant native species;
  - Hydrological change;
  - Altered fire regimes; and
  - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts.

Descriptions and background information on these values and processes can be found in Appendices 1 to 4. Based on this impact assessment process, the objectives of investigations are to: identify fauna values; review impacting processes with respect to these values and the proposed development; and provide recommendations to mitigate these impacts.

1.3 Description of Survey Area

The New Drover-01 area is approximately about 30 km south-west of Eneabba and 12 ha in area (Figure 1). The study area can be divided into five sections: a small planned hygiene station and larger camp site in cleared farmland the north, bore access and the main site in regrowth heath in the south, and a pre-existing track connecting the sections with Coorow-Green Head Road (Figure 2). Note that the New Drover 01 area replaces the old Drover-01 area (also indicated on Figure 2). Within 15 km of the centrepoint of the project area, 59% of the landscape (41,875 ha) supports substantially undisturbed native vegetation.

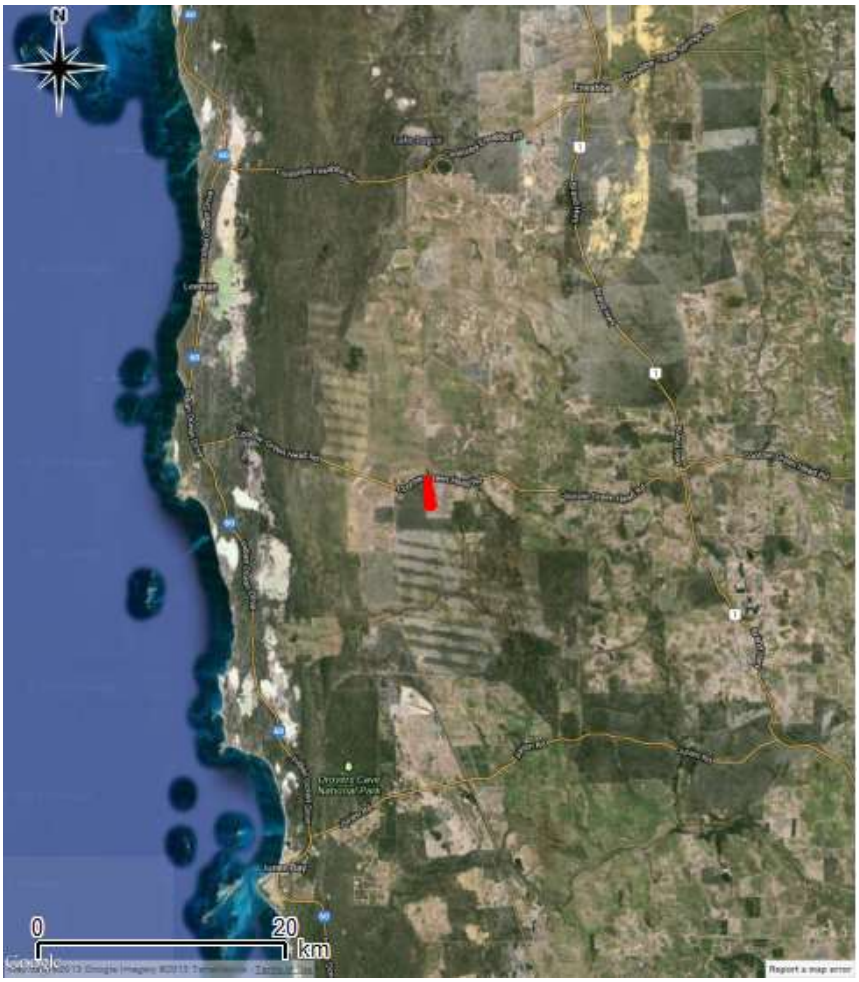

Figure 1. The location of the New Drover-01 Well project area.

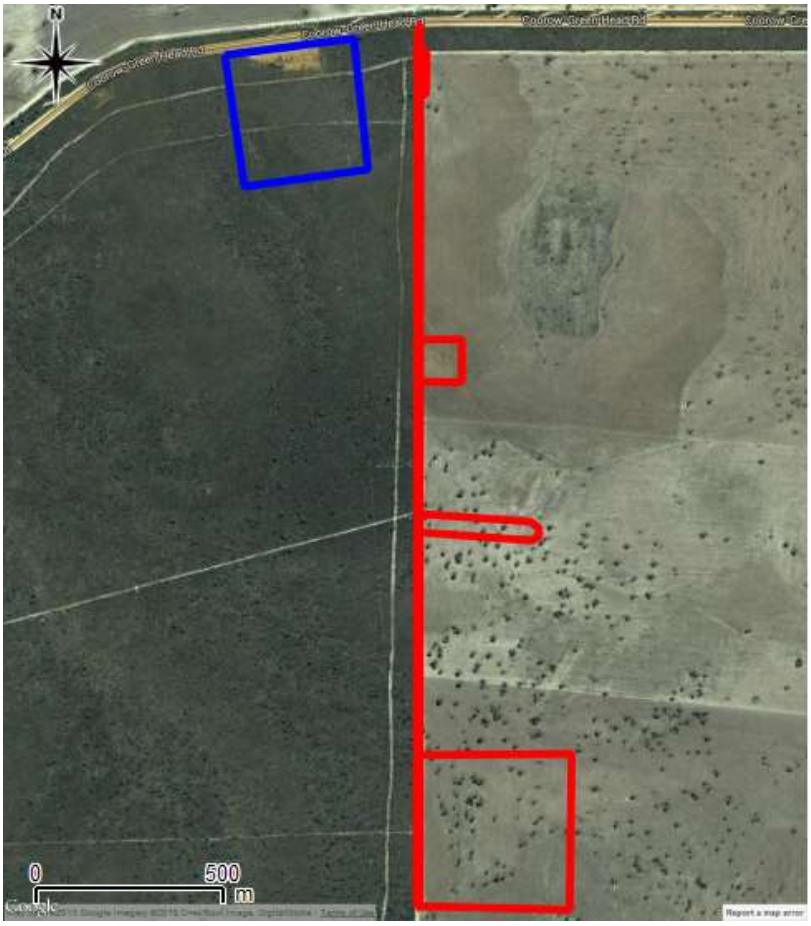

Figure 2. The New Drover-01 survey area (red), the old Drover-01 Well site is shown in blue.

2 Background

2.1 Regional Description

The Interim Biogeographic Regionalisation of Australia (IBRA) (Environment Australia, 2000) has identified 26 bioregions in Western Australia (Figure 3). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell, 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA, 2004).

The AWE survey area lies in the south-west of the Geraldton Sandplain Bioregion and the Lesueur Sandplain Subregion (DSEWPaC 2012b).

Figure 3. IBRA Subregions in Western Australia.

Note the project area lies in GS3 (Lesueur Sandplain) IBRA subregion.

Cowan (2001) describes the Lesueur Sandplain subregion as:
"Shrub-heaths rich in endemics occur on a mosaic of lateritic mesas, sandplains, coastal sands and limestones. Heath on lateritised sandplains along the subregions north-eastern margins. The climate is Mediterranean and the subregional area is 1,358,915 ha.."

The dominant land use in this subregion is dry-land agriculture with smaller areas of conservation, UCL and Crown Reserves. Cowan (2001) describes the Lesueur Sandplain as having a large number of distinct, species rich and geographically restricted floristic communities and stygofauna in cave communities in the Beekeepers' Nature Reserve area.

2.2 Vegetation Units

Beard (1972, 1976) mapped the Eneabba region including the Drover-01 Well area. The vegetation community in the project area is mapped as hSZc/dZc; mosaic of *Hakea obliqua* scrub – heath on sand and Banksia heath on Laterite.

3 Methods

3.1 Overview

The methods used in these investigations are based upon the general approach to fauna investigations for impact assessment as outlined in Section 1.2 and with reference to Appendices 1 to 4. Thus, the impact assessment process involves the identification of fauna values, review of impacting processes and preparation of mitigation recommendations.

In addition, the approach to fauna impact assessment was carried out with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth biodiversity legislation (EPA 2002; EPA 2004b). The EPA proposes two levels of investigation that differ in the approach to field investigations, Level 1 being a review of data and a site reconnaissance to place data into the perspective of the site, and Level 2 being a literature review and intensive field investigations (e.g. trapping and other intensive sampling). The level of assessment recommended by the EPA is determined by the size and location of the proposed disturbance, the sensitivity of the surrounding environment in which the disturbance is planned, and the availability of pre-existing data.

Due to the size and location of the proposed project, AWE requested a Level 1 fauna assessment of the Drover-01 Well areas; initially the Old Drover-01 area, and subsequently the New Drover-01 area. A Level 1 fauna assessment consists of a desktop study and basic ground-truthing through a reconnaissance survey.

The following approach and methods is divided into three groupings that relate to the stages and the objectives of impact assessment:

- Desktop assessment. The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the project area based on unpublished and published data using a precautionary approach.
- Field investigations. The purpose of the field investigations is to gather information on this assemblage: confirm the presence of as many species as possible (with an emphasis on species of conservation significance), place the list generated by the desktop review into the context of the environment of the project area, collect information on the distribution and abundance of this assemblage, and develop an understanding of the project area's ecological processes that maintain the fauna. Note that field investigations cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible in the EIA process. For example, in an intensive trapping study, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford (2010) has found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling.

- Impact assessment. Determine how the fauna assemblage may be affected by the proposed development based on the interaction of the project with a suite of ecological and threatening processes.

3.2 Desktop Assessment

3.2.1 Sources of information

Information on the fauna assemblage of the project area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the DEC Naturemap (incorporating the Western Australian Museum's FaunaBase and the DEC Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA), the EPBC Protected Matters Search Tool and the BCE database (Table 1). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler & Doughty (2009);
- Reptiles: Storr *et al.* (1983); Storr *et al*. (1990); Storr *et al*. (1999); Storr *et al.* (2002) and Wilson & Swan (2008);
- Birds: Blakers *et al*. (1984); Johnstone and Storr (1998, 2004) and Barrett et al. (2003); and
- Mammals: Menkhorst & Knight (2001); Strahan (2004); Churchill (2008); and Van Dyck and Strahan (2008).

A Fauna Investigation has been conducted in the area by BCE for Iluka (IPL North and IPL South), species recorded during this survey are listed in Appendix 5.

Table 1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched / Year
NatureMap (DEC 2012)	Records in the WAM and DEC databases. Includes historical data and records on Threatened and Priority species in WA.	30° 03' 42" S, 115° 08' 29" E – plus 40 km buffer
BirdLife Australia Atlas Database	Records of bird observations in Australia, 1998-2012.	Species list for one degree cell containing: 30° 03' 42" S, 115° 08' 29" E
EPBC Protected Matters	Records on matters of national environmental significance protected under the EPBC Act.	30° 03' 42" S, 115° 08' 29" E – plus 40 km buffer
Eneabba Fauna Investigations	BCE Level 1 Fauna Survey conducted by BCE for Iluka, near Eneabba	2009

3.2.2 Previous Fauna Surveys

Bamford Consulting Ecologists has conducted previous fauna surveys in the general region, including around Eneabba and near Green Head (Bamford Consulting Ecologists 2009 and 2012 respectively. In addition, a level 1 site visit was made to the adjacent old Drover-01 Well site, situated in native heath west of the New Drover-01 study area, in 2012 (Bamford and Turpin 2012).

3.2.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004a), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) *Checklist of the Vertebrates of Western Australia 2008*. The authorities used for each vertebrate group were: amphibians (Doughty and Maryan 2010a), reptiles (Doughty and Maryan 2010b), birds (Christidis and Boles 2008), and mammals (How *et al*. 2009). English names of species, where available, are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

3.2.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey area, meant that it was highly unlikely that these species would be present. Some are also known to be regionally extinct. In general, however, species returned by the desktop review process are considered to be potentially present in the survey area whether or not they were recorded during field surveys. This is because fauna are highly mobile, often seasonal and frequently cryptic. This is particularly important for significant species that are often rare and hard to find. Species returned from databases but excluded from species lists are presented in the Appendix 6.

Interpretation of species lists generated through the desktop review included assigning an expected status within the survey area to species of conservation significance. This is particularly important for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive. The status categories used are:

- Resident: species with a population permanently present in the survey area;
- Regular migrant or visitor: species that occur within the survey area regularly in at least moderate numbers, such as part of annual cycle;
- Irregular Visitor: species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the survey area in at least moderate numbers and for some time;
- Vagrant: species that occur within the survey area unpredictably, in small numbers and/or for very brief periods. Therefore, the survey area is unlikely to be of importance for the species; and

- Locally extinct: species that has not been recently recorded in the local area and therefore is almost certainly no longer present in the survey area.

3.3 Field survey

3.3.1 Overview

The field survey included several components:

- targeted searching for conservation significant fauna;
- opportunistic fauna observations; and
- habitat assessment.

3.3.2 Dates and Personnel

The New Drover-01 study area was assessed on the 1st July 2013 by Ms Katherine Chuk (B.Sc. Hons.) and Matthew McKenna (AWE). The Old Drover-01 Well survey area was assessed from the 19th August to the 20th August 2012 by Dr Mike Bamford (B.Sc. Hons. Ph.D). Three university students (Robyn Pryor, Heather Legge and Stacey Turner) accompanied Dr Bamford in this site inspection. The field survey was conducted under DEC Regulation 17 (Licence to take Fauna for Scientific Purposes) licence number SF008659. This fauna assessment document was prepared by Katherine Chuk and Dr Mike Bamford.

3.3.3 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) throughout the survey area were assessed during the desktop review and as part of both the field investigations. Within the New Drover-01 Well survey area each major VSA was visited to develop an understanding of major fauna habitat types present and to assess the likelihood of conservation significant species being present in the area.

3.3.4 Targeted searching for conservation significant species

Significant species recorded during the desktop assessment include several that can be found by searching for evidence of their activities (e.g. scats, tracks, diggings, burrows) or listening for their call (the Western Ground Parrot is easiest detected when it calls at dawn). Searching for evidence of significant fauna was therefore undertaken by walking through habitat considered suitable for such species, as well as a dawn listening session for the Western Ground Parrot (in the Old Drover-01 area). The dawn aural survey for the Western Ground Parrot took place on the morning of 20th August and began 45 minutes before sunrise, with the session finishing at sunrise. Conditions were very good (little wind) and three personnel listened (M. Bamford, R. Pryor and H. Legge). M Bamford and H. Legge have previous experience in aural surveys for Ground Parrots.

3.3.5 Opportunistic observations

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while travelling through the site.

3.4 Survey limitations

The EPA Guidance Statement 56 (EPA 2004a) outlines a number of limitations that may arise during surveying. These survey limitations are discussed in the context of the BCE fauna survey at the project area in Table 2.

Table 2. Survey limitations as outlined by EPA (2004).

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study and reconnaissance survey). Survey intensity was deemed adequate due to the level of survey and the number of fauna surveys previously conducted in the region.
Competency/experience of the consultant(s) carrying out the survey.	The authors have had extensive experience in conducting desktop reviews and site inspections.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	As a level 1 survey the scope was not to comprehensively sample fauna; the inspection was adequate to define fauna habitats and there was abundant desktop data on the fauna assemblage in the region.
Proportion of fauna identified, recorded and/or collected.	No specimens collected, all fauna observed identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous reports on the fauna of the local area (BCE database); databases (BA, DEC, WAM, EPBC); BCE survey in nearby areas.
The proportion of the task achieved and further work.	Site inspection completed.
Timing/weather/season/cycle.	Site inspection conducted during August 2012 and July 2013. Conditions were mild, no rainfall recorded
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	No disturbances affected the survey.
Intensity. (In retrospect, was the intensity adequate?)	Survey intensity was low (desktop study and site inspection) however was adequate to satisfy EPA guidelines for a small area.
Completeness (e.g. was relevant area fully surveyed).	Desktop study covered survey area and adjacent habitats. Site inspection covered all areas of the project.
Resources (e.g. degree of expertise available in animal identification to taxon level).	All species identified to taxon level.
Remoteness and/or access problems.	No access problems.
Availability of contextual (e.g. biogeographic) information on the region.	Extensive regional information was available and was consulted.

3.5 Impact Assessment

While some impacts are unavoidable during a development, of concern are long-term, deleterious impacts upon biodiversity. This is reflected in documents such as the Significant Impact Guidelines provided by DSEWPaC (see Appendix 4). Significant impacts may occur if:

- There is direct impact upon a VSA and the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.
- There is direct impact upon conservation significant fauna.
- Ecological processes are altered and this affects large numbers of species or large proportions of populations, including significant species.

The impact assessment process therefore involves reviewing the fauna values identified through the desktop assessment and field investigations with respect to the project and impacting processes. The severity of impacts on the fauna assemblage and conservation significant fauna can then be quantified on the basis of predicted population change.

The presentation of this assessment follows the general approach to impact assessment as given in Section 1.2, but modified to suit the characteristics of the site. Key components to the general approach to impact assessment are addressed as follows:

Fauna values

This section presents the results of the desktop and field investigations in terms of key fauna values (described in detail in Appendix 1):

- Assemblage characteristics (uniqueness, completeness and richness) - based upon desktop assessment and information from the site inspection;
- Species of conservation significance – based upon desktop assessment and site inspection;
- Recognition of ecotypes or vegetation/substrate associations (VSAs) - based upon desktop assessment and site inspection;
- Patterns of biodiversity across the landscape - based upon desktop assessment and site inspection;
- Ecological processes upon which the fauna depend - based upon desktop assessment and site inspection.

Impact assessment

This section reviews impacting processes (as described in detail in Appendix 2) with respect to the project and examines the potential effect of these impacts upon biodiversity of the alignment. It thus expands upon the Project Description (Section 1.3) and discusses the contribution of the project to impacting processes, and the consequences of this with respect to biodiversity. A major component of impact assessment is consideration of threats to species of conservation significance as these are a major and sensitive element of biodiversity. Therefore, the impact assessment includes the following:

- Review of impacting processes; will the proposal result in:

  - Habitat loss leading to population decline, especially for significant species;
  - Habitat loss leading to population fragmentation, especially for significant species;
  - Weed invasion that leads to habitat degradation;
  - Ongoing mortality;
  - Species interactions that adversely affect native fauna, particularly significant species;
  - Hydrological change;
  - Altered fire regimes; and
  - Disturbance (dust, light, noise).
- Summary of impacts upon significant species, and other fauna values.

The impact assessment concludes with recommendations based upon predicted impacts and designed to mitigate these.

3.5.1 Criteria for impact assessment

Impact assessment criteria are based on the severity of impacts on the fauna assemblage and conservation significant fauna, and were quantified on the basis of predicted population change (Table 3). Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

The significance of population change is contextual. The EPA (2004) suggests that the availability of fauna habitats within a radius of 15km can be used as a basis to predict low, moderate or high impacts. In this case, a high impact is where the impacted environment and its component fauna is rare (<5% of the landscape within a 15km radius or within the Bioregion), whereas a low impact is where the environment is widespread (10% of the local landscape). Under the Ramsar Convention, a wetland that regularly supports 1% of a population of a waterbird species is considered to be significant. These provide some guidance for impact assessment criteria. In the following criteria (Table 3), the significance of impacts is based percentage population decline within a 15 km radius (effectively local impact) and upon the effect of the decline upon the conservation status of a recognised taxon (recognisably discrete genetic population, sub-species or species). Note that percentage declines can usually only be estimated on the basis of distribution of a species derived from the extent of available habitat.

Table 3. Assessment criteria of impacts upon fauna.

Impact Category	Observed Impact
Negligible	Effectively no population decline; at most few individuals impacted and any decline in population size within the normal range of annual variability.
Minor	Population decline temporary (recovery after end of project such as through rehabilitation) or permanent, but <1% within 15 km radius of centrepoint of impact area (or within bioregion if this is smaller). No change in viability or conservation status of taxon.
Moderate	Permanent population decline 1-10% within 15 km radius. No change in viability or conservation status of taxon.
Major	Permanent population decline >10% within 15 km radius. No change in viability or conservation status of taxon
Critical	Taxon extinction within 15 km and/or change in viability or conservation status of taxon.

4 Results

4.1 Vertebrate Fauna

4.1.1 Overview of fauna assemblage

The desktop study identified 213 vertebrate fauna species as potentially occurring in the New Drover-01 Well project area (see Table 4 and Appendix 5): 9 frogs, 60 reptiles, 119 birds and 16 native and 9 introduced mammals. The assemblage includes at least 25 species of conservation significance (including up to six invertebrate species) (Table 5), with a further 15 significant species returned from databases but which are not considered likely to occur in the project area (Table 6). Significant species are discussed further in Section 4.2.2.

Key features of the fauna assemblage expected in the project area are:

- Uniqueness: The assemblage is typical of the Eneabba region and is likely to be well-represented regionally as the sorts of environments present are widespread.
- Completeness: The assemblage is almost complete but lacks a major component, medium sized ("critical weight range") mammals. These have declined across much of southern Australia due to factors such as predation by feral species (particularly the Red Fox) and altered fire regimes (Burbidge and McKenzie 1989). One bird and one reptile species may also be locally extinct, and some species may be absent or poorly-represented because of the condition of the vegetation.
- Richness: The assemblage is rich but the actual New Drovers-01 area is likely to be depauperate because the vegetation is partly cleared and in some places regenerating. However, the juxtaposition of native vegetation and the proximity and connectivity to Beekeepers' Nature Reserve will enhance richness despite the quality of vegetation on the site.

As a fauna value, the assemblage is expected to be incomplete and slightly depauperate due to the condition of the vegetation.

Table 4. Composition of vertebrate fauna assemblage expected to occur within the survey area.

Taxon	Number of species expected	Number of species recorded	Significant fauna Expected (recorded)		
			CS1	CS2	CS3
Frogs	9	0	-	-	-
Reptiles	60	2	2	2	-
Birds	119	9	5	6	-
Native Mammals	16	2	1	2	1
Introduced Mammals	9	0	-	-	-
Conservation Significant Invertebrates	6	0	1	4	1
Total	**219**	**13**	**9**	**14**	**2**

Table 5. Conservation status of significant fauna species expected to occur (based on desktop review and field investigations).

Common Name	Latin Name	Conservation Status			Expected status in project area
		CS1	CS2	CS3	
REPTILES					
	Ctenotus gemmula		P3		Resident
Woma, Ramsay`s Python	*Aspidites ramsayi*	S1, S4	P1		Locally extinct
Black-striped Snake	*Neelaps calonotos*		P3		Resident
Carpet Python	*Morelia spilota*	S4	P4		Resident
BIRDS					
Peregrine Falcon	*Falco peregrinus*	S4			Irregular visitor
Australian Bustard	*Ardeotis australis*		P4		Irregular visitor
Bush Stone-curlew	*Burhinus grallarius*		P4		Locally extinct
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	En, S1			Regular visitor
Western Ground Parrot	*Pezoporus flaviventris*	Cr, Mig			Possible resident but may be locally extinct
Fork-tailed Swift	*Apus pacificus*	S3, Mig			Irregular visitor
Rainbow Bee-eater	*Merops ornatus*	S3, Mig			Regular visitor
Rufous Fieldwren	*Calamanthus campestris*		P4		Resident
Shy Heathwren	*Hylacola cauta whitlocki*		P4		Irregular visitor
White-browed Babbler	*Pomatostomus superciliosus*		P4		Irregular visitor
Crested Bellbird	*Oreoica gutturalis*		P4		Irregular visitor
Mammals					
Chuditch	*Dasyurus geoffroii*	Vul, S1			Locally extinct
Brush Wallaby	*Macropus irma*		P4		Resident
Ghost Bat	*Macroderma gigas*		P4		Locally extinct
Western Freetail-Bat	*Mormopterus planiceps*			+	Irregular visitor

Common Name	Latin Name	Conservation Status			Expected status in project area
		CS1	CS2	CS3	
Invertebrates					
Millipede	*Antichiropus Eneabba 1*			+	Resident
Cricket	*Hemisaga vepreculae*		P3		Resident
Cricket	*Phasmodes jeeba*		P2		Resident?
Bee Species	*Hylaeus globuliferus*		P3		Resident
Graceful Sunmoth	*Synemon gratiosa*		P4		Irregular visitor
Scorpionfly	*Austromerope poultoni*		P2		Resident?

See Appendix 1 for descriptions of conservation significance levels. Species recorded are indicated and the predicted status of each species in the project is also given (as per Section 2.4.1).

EPBC Act listed species: Cr = Critically Endangered, Vul = Vulnerable, End = Endangered, Mig = Migratory.

WC Act listed species: S1 = Schedule 1, S3 = Schedule3, S4 = Schedule 4, DEC Priority Species: P1 = Priority 1, P4 = Priority 4.

Table 6. Significant species returned from databases but which are not expected to occur in the project area.

Common Name	Species Name	Conservation Status			Expected status in project area
		CS1	CS2	CS3	
Slender Blue-tongue	*Cyclodomorphus branchialis*	S1			Outside known range of species
Spiny-tailed Skink	*Egernia stokesii*	En, S1			Outside known range of species and no suitable habitat
	Lerista axillaris		P2		Outside known range of species
	Lersita humphriesi		P3		Outside known range of species
	Lerista lineata		P3		Outside known range of species
	Lerista yuna		P3		Outside known range of species
Malleefowl	*Leipoa ocellata*	Vul, S1, Mig	S1		Outside known range of species and no suitable habitat
Glossy Ibis	*Plegadis falcinellus*	S3, Mig			No suitable habitat
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	S3, Mig			No suitable habitat
Eastern Osprey	*Pandion cristatus*	Mig			No suitable habitat
Hooded Plover	*Thinornis rubricollis*		P4		No suitable habitat
Greater Sand Plover	*Charadrius leschenaultii*	S3, Mig			No suitable habitat
Lesser Sand Plover	*Charadrius mongolus*	S3, Mig			No suitable habitat
Pacific Golden Plover	*Pluvialis fulva*	S3, Mig			No suitable habitat
Grey Plover	*Pluvialis squatarola*	S3, Mig			No suitable habitat
Shield-backed Trapdoor Spider	*Idiosoma nigrum*	S1			Outside known range of species and no suitable habitat

4.1.2 Species of conservation significance

Details on species of conservation significance returned from the database review are presented in Tables 5 and 6. Only those species in Table 5 are considered ever likely to have occurred in the project area. This list includes four reptile species, 11 bird species, four mammal species and six invertebrate species. At least four of these species are locally extinct and the presence of some of the invertebrates in particular is uncertain, but some are expected to be resident or regularly present. Further information on species that might be present, including observations from the site inspection, is presented below. Note that species extinct in the region and that may have been present on the basis of broad patterns of distribution have not been included in the following descriptions.

South-west Carpet Python (*Morelia spilota imbricata*)

The south-western race of the Carpet Python occurs in south-west Western Australia, from Northampton south to Albany and eastwards to Kalgoorlie. It also occurs in large undisturbed remnant bushland near Perth and the Darling Ranges (Bush *et al.,* 2007). This species occurs in Banksia woodland, Eucalypt Woodland, forests, dense coastal scrub, granite and limestone outcrops and along watercourses (Bush *et al.,* 2007). Carpet Pythons are arboreal, terrestrial, and rock-dwelling and can shelter in burrows made by other animals, hollow tree limbs, or rock crevices. The South-west Carpet Python has declined in distribution due to the loss of habitat (associated with land clearance), and changed fire regimes. Predation by exotic predators (foxes and feral cats) may have also contributed to the decline of python populations (Bush *et al.,* 2007). The Carpet Python is reported to be common around Greenhead, to the west of Drover-01 Well, and at Cooljarloo to the south-east. The Carpet Python is considered likely to occur within the survey area.

Peregrine Falcon (*Falco peregrinus*)

This species is found in a variety of habitats, including rocky ledges, cliffs, watercourses, open woodland and acacia shrublands. The distribution of the Peregrine Falcon is often tied to the abundance of prey as this species predates heavily on other birds. The Peregrine Falcon lays its eggs in recesses of cliff faces, tree hollows or in large abandoned nests of other birds (Birds Australia 2012). Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world. Though it is unlikely that Peregrine Falcons breed in the survey area due to lack of nesting habitat, it is possible that a pair lives in the region and follows over the project area occasionally.

Western Ground Parrot (*Pezoporus flaviventris*)

Although unlikely to be present and therefore unlikely to be impacted, the status of this distinctive sub-species is becoming critical, with the known population on the south coast ca. 100 birds, and an unconfirmed population on the northern sandplains. There is an unconfirmed and anecdotal sighting from the Indian Ocean Drive just north of Leeman (January 2010; R. Snook pers. comm.). The aural survey on the morning of 20th August did not record the species.

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)

This species has been studied in the Eneabba area (about 30km north-east of the site) by Johnstone *et al.* (2007, 2008). It is reported to forage extensively in the area on remnant vegetation and rehabilitated mine site vegetation on a very wide range of plants, including *Banksia* spp., *Lambertia multiflora*, *Hakea* spp., *Melaleuca leuropoma* and *Xanthorrhoea* spp. Also observed feeding on weed seeds in paddocks. Roosting observed in planted eucalypts, notably within Eneabba townsite where about 300 birds roost

regularly during the non-breeding season. The abundance of the species in the area is greatest during the non-breeding period, indicating that the birds migrate elsewhere to breed.

Saunders (extensively cited by Higgins 1999) has studied breeding by the species at Coomallo Creek, about 20km to the south-east, and reported that the breeding birds foraged an average of 1.4km from the nests. There is no breeding (or roosting) habitat in the project area, but the site does support habitat suitable for foraging, particularly *Banksia attenuata* and *Eucalyptus todtiana*. Such foraging habitat is extensive in the region. In July 2013, what appeared to be Carnaby's Black-Cockatoo foraging signs were found on the fruit of *Eucalyptus todtiana* (Figure 4) in the New Drovers-01 area (in the south and along the bore access area) and in the old Drover-01 Well site.

Figure 4. Possible Carnaby's foraging signs on *Eucalyptus todtiana*. These fruit were scattered beneath one tree and were placed together for the photograph

Australian Bustard (*Ardeotis australis*)

The Australian Bustard is nomadic and may range over very large areas, largely dependent on rainfall and hence food availability. It may be an occasional visitor to the project area.

Fork-tailed Swift (*Apus pacificus*) and Rainbow Bee-eater (*Merops ornatus*)

The Fork-tailed Swift is largely aerial but may over-fly the project area occasionally. The Rainbow Bee-eater is an abundant, ground-nesting species that catches insects on the wing over a range of environments). It is a summer, breeding visitor to the South-West and is likely to be present annually in the project area. Paddocks and the edges of tracks are favoured breeding locations, but are not limited in availability.

Rufous Field-wren (*Calamanthus campestris*), Shy Heathwren (*Hylacola cauta*), White-browed Babbler (*Pomatostomus superciliosus*) and Crested Bellbird (*Oreoica gutturalis gutturalis*)

These are all species that are common and widespread in the region, but have declined because of agricultural clearing. The Rufous Field-wren was observed in the Old Drovers-01 area (August 2012), whereas the Crested Bellbird, Shy Heathwren and White-browed Babbler may be only irregular visitors as the vegetation did not appear as suitable for them.

Brush Wallaby (*Macropus irma*)
This species is likely to be present in low numbers through areas of native vegetation in the region and one or two animals may be present within the project area.

Western Freetail-Bat (*Mormopterus planiceps*)
This small bat may be at the northern edge of its range in the region. Trees in the project area were small and unlikely to provide suitable roosting sites, but individuals may roost nearby and forage over the project area.

Significant invertebrates
There are six significant invertebrate species that may be present in the project area. Three of these, the millipede *Antichiropus* Eneabba 1, the cricket *Hemisaga vepreculae* and the bee *Hylaeus globuliferus* have to be assumed to be present. The bee is a solitary species that nests in dead twigs or plant stems and forages on nectar and pollen, including that of *Banksia attenuata*, which is present in the project area. For the remaining three species there may be no suitable habitat.

Larvae of the Graceful Sun-Moth feed only on the underground stems of two species of native sedge *Lomandra* (Bishop *et al.* 2010) and these were not observed in the project area. However, individual adult moths may overfly the site. The cricket *Phasmodes jeeba* also lacks suitable habitat in the project area. It is known only from two locations, in coastal thickets south of Dongara and near Jurien (Rentz 1993), and such vegetation is absent from the project area. Fathfull *et al.* (1985) indicate that the scorpionfly *Austromerope poultoni* is most abundant in moist areas of forests in the south-west, and report on the species being abundant amongst moist leaf-litter near Boddington. Although it is listed for the general region of the project area on the DEC threatened Fauna database, if present it is probably confined to very moist locations; in contrast the project area is high in the landscape and unlikely to support the species.

4.2 Summary of species of conservation significance

Significant species expected to occur within the project area include only three reptile, up to four bird, one mammal and three invertebrate species expected to be present at least regularly. Of greatest interest, because they are of high levels of conservation significance and may be present regularly, are Carnaby's Black-Cockatoo (probable evidence of foraging and may visit the project area in small numbers to forage), Western Ground Parrot (presence uncertain but records in the area would be of great conservation interest) and Rainbow Bee-eater (likely to be present but in reality a widespread and common species).

4.3 Vegetation and Substrate Associations (VSAs)

Three major VSAs were identified in the New Drover-01 area during field investigations. These were:

1. Scattered *Eucalyptus todtiana* over scattered mixed banksia over open heath over weeds on grey sand with some orange gravel (Figure 5);
2. Open mixed heath over weeds on grey sand (Figure 6); and
3. Mostly disturbed with occasional patches of low proteaceous heath over pasture on grey sand with orange gravel (Figure 7).

These are all disturbed but do contain some native vegetation and structure important for fauna. Figure 8 illustrates the native and intact vegetation of the Old Drover-01 area.

Figure 5. VSA1 at the south-east corner of the main southern site.

Figure 6. VSA2 at the north-east corner of the main southern site.

Figure 7. VSA3 at the camp site.

Figure 8. Old Drover-01 area, illustrating undisturbed heath on shallow sand.

The VSAs occurring within the survey area are described below. Their representation within the survey area and conservation significance for fauna is also listed.

1) Scattered *Eucalyptus todtiana* over mixed banksias including *Banksia attenuata*, *Banksia menziesii* and *Banksia prionotes* over open heath over weedy ground cover on sand over lateritic gravel. Previously cleared but regeneration commenced in 2006.
   a. Representation. Occurs in the bore access area and parts of the main southern site. Such regenerating native vegetation is uncommon but it is effectively a degraded version of vegetation widespread in the nearby nature reserve.
   b. Conservation Significance for Fauna. Although not pristine, this VSA is likely to be visited by some significant species such as foraging Carnaby's Black-Cockatoos, and may support the Rufous Fieldwren and breeding Rainbow Bee-eaters. Except for the Bee-eater that favours open environments, significant species are likely to be better represented in nearby intact native vegetation.
2) Open low mixed heath including proteaceous species and scattered banksias over weedy ground cover on grey sand. Previously cleared but regeneration commenced in 2006.
   a. Representation. Occurs in parts of the main southern site. Such regenerating native vegetation is uncommon but it is effectively a degraded version of vegetation widespread in the nearby nature reserve.
   b. Conservation Significance for Fauna. Although not pristine, this VSA is likely to be visited by some significant species and may support breeding Rainbow Bee-eaters. Except for the Bee-eater that favours open environments, significant species are likely to be better represented in nearby intact native vegetation.
3) Occasional patches of low proteaceous heath over pasture on grey sand over lateritic gravel.
   a. Representation. The hygiene station, camp and access track. A widespread VSA in the region.

b. Conservation Significance for Fauna. Unlikely to support conservation significant fauna except as occasional visitors. The Australian Bustard potentially is an irregular visitor in small numbers to such paddocks with patches of native vegetation.

4.4 Patterns of biodiversity

Patterns of biodiversity can be interpreted from information on significant species and the characteristics of the VSAs described above, although intensive field investigations are required to provide detailed information. Key patterns relevant to impact assessment are:

- Banksia shrubland and scattered Eucalypts (primarily VSA1) are more likely to support Carnaby's Black-Cockatoo and some other species of conservation significance, and to be richest in biodiversity of the three VSAS in the area.
- The open and patchy heath of VSA2 may be of value for some significant species but is likely to be lower in overall biodiversity than VSA 1.
- VSA3 is unlikely to support conservation significant species regularly, and can be expected to be low in biodiversity in general.

4.5 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix 4 for descriptions and other ecological processes). These include:

Local hydrology. The project area is high in the landscape with no surface drainage but groundwater is likely to be present. Some of the vegetation, such as the banksias, is likely to be groundwater dependent and thus sensitive to changes in groundwater levels.

Fire. The heaths and low woodlands of the northern sandplains are prone to fire and while appropriate fire regimes can benefit biodiversity, inappropriate regimes can lead to a loss of biodiversity.

Feral predators and interactions with over-abundant native species. The fauna assemblage of the project areas has already been impacted by feral species (loss of a major component of the mammal fauna), and several feral species are likely to be present. Human activity has the potential to alter the abundance of feral species.

Habitat degradation due to weed invasion. The project area currently has high levels of weed invasion. Disturbing the area, particularly with the movement of equipment and vehicles along roads, raises the potential for weed invasion into the adjacent areas that are currently in very good condition.

4.6 Summary of fauna values

Fauna values within the study area can be summarised as follows:

Fauna assemblage. Moderately rich but likely to be depauperate compared with surrounding areas due to degraded vegetation.

Species of conservation significance. A range of significant species may be present. Species of note are the South-west Carpet Python, Western Ground Parrot (probably locally extinct), Carnaby's Black-Cockatoo, Rufous Field-wren, Rainbow Bee-eater and several invertebrates. Significant species likely to be better-represented in intact native vegetation nearby expect for the Rainbow Bee-eater that favours disturbed areas.

Vegetation and Substrate Associations. Three VSAs were identified across the project area. Two of these consist of regenerating native vegetation following clearing and are thus unusual, but their fauna values are mostly better-represented in nearby intact native vegetation.

Patterns of biodiversity. Areas of particular significance include VSA1 as the Banksias and Eucalypts may support foraging Carnaby's Black-Cockatoos.

Key ecological processes. Main processes currently affecting the fauna assemblage in the project area include local hydrology, fire, fauna interactions (feral predators, over-abundant native species) and weed invasion.

5 Impact assessment

5.1 Overview of Impacts

As outlined in section 1.1, AWE is investigating the possibility of exploration drilling centred on the New Drover-01 Well about 30 km south-west of Eneabba, Western Australia. A level 1 fauna assessment identified the fauna values of this project area. The following sections examine possible impacts upon these fauna values based upon the impacting or threatening processes outlined in Appendix 2. Impacts are summarised in Tables 7 and 8. Impact criteria are outlined in Table 3. Recommendations relating to impacts are made in Section 6.

5.1.1 Loss of habitat leading to population decline

The project area represents a very small proportion of similar habitats in the region (41,875 ha of native vegetation lie within a 15 km radius of the 12 ha site), and thus the impact is expected to be Negligible to Minor. Despite this, VSA1 is suitable for foraging by Carnaby's Black-Cockatoo and possible evidence of foraging was found (Figure 4). Impacts with respect to this species are discussed below (Section 5.1.9).

5.1.2 Loss of habitat leading to population fragmentation

The project area lies alongside a large block of native vegetation (to the west), with cleared land to the east. Development of the project area will not increase population fragmentation significantly, impact therefore Negligible.

5.1.3 Degradation of habitat due to weed invasion

Invasive weed species can replace native species and degrade fauna habitats. Weeds can be spread by vehicles, earthworks and road construction. The survey area is already heavily weed invaded, with most of the ground cover being weed species, and adjacent intact native vegetation may be vulnerable to weed invasion due to increased disturbance. Measures to prevent introduction of new weeds and management of the existing weed problem may provide a long term benefit to the study area.

5.1.4 Ongoing mortality

Direct mortality of common species during clearing is unavoidable but can be minimised (see recommendations below). Areas to be disturbed are small within the context of the regional landscape so mortality during clearing is likely to represent only small proportions of regional populations, while activities are unlikely to lead to an increase in mortality (Negligible or Minor impact); although there may be some roadkill as a result of the access road running alongside intact native vegetation (see Figure 2). There is nothing to suggest that there are important populations of significant species restricted to the small project area.

5.1.5 Species interactions

Feral species are a major conservation concern, with two introduced species detected in the August 2012 visit to the Old Drover-01 area; others are likely to be present. Foxes and feral cats are likely to be attracted by recent disturbance, possibly leading to increased local impacts on native fauna in disturbed areas. Inappropriate waste management may also attract foxes and feral cats, as well as native

predators and scavengers, which may exacerbate localised impacts on other native fauna. However, because of the small area of the project, such impacts are considered to be Negligible to Minor.

5.1.6 Hydroecology

Impacts upon groundwater are unknown. If groundwater levels and quality are unaffected, then there is no reason to expect that there will be adverse impacts upon any subterranean fauna that may be present, and no effect on deep-rooted plants that may depend upon groundwater. Impacts thus anticipated to be Negligible.

5.1.7 Altered fire regimes

Some conservation significant fauna are particularly susceptible to fire and the entire biota of the region is probably adapted to a particular fire regime. Activities in the project area are a potential source of fire. In the short term, a single fire would be of little consequence, but if activities occurred over a long time-period (years or decades) than a succession of fires could have a Moderate impact.

5.1.8 Disturbance

Impacts of dust, light, disturbance and noise upon fauna are difficult to predict. Due to its location these are already factors influencing the fauna of the site and therefore impacts are anticipated to be Negligible. If night operations are carried out under floodlights, there may be an increase in fauna mortality which could need to be considered.

5.1.9 Summary of impacts

Impacts from key threatening processes are considered to be Minor or Negligible (Table 7). This is due to the relatively small footprint of the project which is located within degraded environments. Altered fire regimes may be a concern if the project extends over a period of some years and some subterranean impacts are uncertain. Impacts upon key fauna values are summarised in Table 8 and recommendations made in this table are expanded in Section 6.

Impacts upon Carnaby's Black-Cockatoo require consideration as the project area does contain some foraging habitat suitable for the species (several hectares of VSA 1). The DSEWPaC (2011) guidelines for the species contain a decision-making tool to assist with identification of actions which need further assessment and may require referral to the environment minister or department. Using this tool, the project area does lie within the modelled distribution of Carnaby's Black-Cockatoo and several hectares of habitat suitable for foraging is present, although this is probably not "quality" habitat as per the DSEWPaC guidelines, since the vegetation is degraded. The foraging habitat is also not within the breeding range of the species, with foraging habitat within the breeding range being of particular significance (as noted by DSEWPaC 2011), and there are no suitable roosting sites nearby. There is also extensive habitat suitable for foraging adjacent. Based on the referral guidelines in DSEWPaC (2011), loss of >1ha of foraging habitat that is not "quality" and lies outside the breeding range could be considered an impact with either an uncertain or low risk of being significant under the EPBC Act. As the habitat is degraded and there is extensive foraging habitat nearby, it is considered that there is a low risk of any impact upon the species being considered significant. On this basis referral is not required, but note that the guidelines provide an email address (epbc.referrals@environment.gov.au) for discussion of the need to refer under such circumstances.

Table 7. Summary of potential impacts upon ecological processes.

Impacting process	Impact
Habitat loss leading to population decline	**Negligible to Minor.** Only localised and small areas of habitat loss with minor impact upon significant species anticipated.
Population fragmentation and disruption of movement and gene flow due to habitat fragmentation	**Negligible.** Limited fragmentation or disruption of movement is anticipated as the development lies on the edge of widespread habitats.
Increased mortality leading to population decline; e.g. due to ongoing roadkill	**Negligible to Minor.** Mortality expected to be confined to the small project area; some roadkill may occur along the access road but the effect would be very localised and traffic volumes would be low.
Habitat degradation due to weed invasion	**Minor.** Project area already heavily invaded. Low risk of increased weed invasion, management measures may reduce weed presence and may be needed to prevent weed invasion into adjacent native vegetation.
Hydroecology	**Unknown**. Impacts to hydrology are largely unknown. If it is assumed that groundwater levels and quality are not affected, then impacts will be Negligible to Minor.
Species interactions due to feral or over-abundant native species	**Negligible to Minor.** Low risk of increased feral species beyond what is current.
Altered fire regimes	**Minor to Moderate.** There is some potential for adverse impacts if activities in the project area result in a succession of unplanned fires in an ecosystem where fire is an important factor. Management measures may be necessary.
Effects of disturbance, dust and light	**Minor.** Some disturbance may result, however disturbances are mostly within widespread fauna habitats and the change to existing levels of disturbance will be slight. Effects of night operations and consequent floodlighting may need consideration.

Table 8. Summary of potential impacts upon key fauna values, including conservation significant species that are expected to occur in the survey area.

Criteria for significance of impacts are outlined in Section 3.5.1.

Fauna Value	Nature and Significance of Proposal Impact		Action required
	Impacts from Proposal	Significance	
Fauna assemblage	Small loss of habitat but fauna assemblage better-represented in adjacent intact vegetation.	Minor	Minimise footprint
VSAs	Small losses.	Minor	Minimise footprint
Significant fauna	Small losses of habitat, including small loss of foraging habitat for Carnaby's Black-Cockatoo.	Minor	Minimise footprint, especially in VAS1
Ecological processes	Fire regime may be affected. Potential for spread of weeds	Minor to Moderate	Fire management plan around operations required. Prevent spread of weeds into adjacent native vegetation
Subterranean fauna	Impacts uncertain but probably negligible		Confirm that effects upon subterranean environments and especially groundwater will be negligible.

6 Recommendations

Section 5 (Impact Assessment) identified several potential adverse impacts that may occur from the proposed development within the survey area. While impacts are expected to be mostly Negligible to Minor, any reduction in impacts is desirable, while the EPBC listed Carnaby's Black-Cockatoo may require special consideration. Management strategies are recommended below to reduce the potential impacts of this development on fauna species.

Loss of habitat

- Minimise vegetation clearing;
- Minimise the disturbance footprint;
- Clearly delineate areas to be cleared;
- Avoid disturbance to mature trees where possible.

Species interactions

- Discourage the presence of feral species, particularly the feral Cat and Fox, by the use of appropriate waste management procedures.

Hydrological changes

- Develop an understanding of the surface and sub-surface drainage and possible effects of drilling activities upon groundwater in order to identify the potential for hydrological changes that could potentially impact fauna habitats.

Habitat degradation due to weed invasions

- Develop a weed management/hygiene plan.

Changes in fire regime

- Develop a fire management plan (which includes regard for the ecological role of fire).

Dust, noise, light and disturbance

- Minimise the production of dust, noise and light spill.

Impact upon Carnaby's Black-Cockatoo

Loss of several hectares of habitat suitable for foraging is possible. Referral guidelines from DSEWPaC (2011) recommend referral if >1ha of quality foraging habitat is impacted, but note that of greatest concern is foraging habitat within the breeding range, which the Project Area is not, and the foraging habitat is not "quality", being degraded compared with adjacent intact vegetation. Thus there is a low risk of the impact upon Carnaby's Black-Cockatoo being considered significant under the EPBC Act. Where the need for referral is not clear, DSEWPaC suggests a direct query to an advice email for clarification.

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8 Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation/substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a

large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Wildlife Conservation Act 1950* (Wildlife Conservation Act). In addition, the Western Australian Department of Environment and Conservation (DEC) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix 3.

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The Wildlife Conservation Act uses a series of Schedules to classify status, but also recognizes the IUCN categories and ranks species within the Schedules using the categories of Mace and Stuart (1994).

Conservation Significance (CS) 2: Species listed as Priority by the DEC but not listed under State or Commonwealth Acts.

In Western Australia, the DEC has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the Wildlife Conservation Act but for which the DEC feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DEC, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 2. Explanation of threatening processes.

Potential impacts of proposed developments upon fauna values can be related to threatening processes. This is recognised in the literature and under the EPBC Act, in which threatening processes are listed (see Appendix 4). Processes that may impact fauna values are discussed below. Rather than being independent of one another, processes are complex and often interrelated. They are the mechanisms by which fauna can be affected by development. Impacts may be significant if large numbers of species or large proportions of populations are affected.

Loss of habitat affecting population survival

Clearing for a development can lead to habitat loss for a species with a consequent decline in population size. This may be significant if the smaller population has reduced viability. Conservation significant species or species that already occur at low densities may be particularly sensitive to habitat loss affecting population survival.

Loss of habitat leading to population fragmentation

Loss of habitat can affect population movements by limiting movement of individuals throughout the landscape as a result of fragmentation. Obstructions associated with the development, such as roads, pipes and drainage channels, may also affect movement of small, terrestrial species. Fragmented populations may not be sustainable and may be sensitive to effects such as reduced gene flow.

Degradation of habitat due to weed invasion leading to population decline

Weed invasion can occur as a result of development and if this alters habitat quality, can lead to effects similar to habitat loss.

Increased mortality

Increased mortality can occur during project operations; for example from roadkill, animals striking infrastructure and entrapment in trenches. Roadkill as a cause of population decline has been documented for several medium-sized mammals in eastern Australia (Dufty 1989; Jones 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented (Scheick and Jones 1999; Clevenger and Waltho 2000; Jackson and Griffin 2000).

Increased mortality of common species during development is unavoidable and may not be significant for a population. However, the cumulative impacts of increased mortality of conservation significant species or species that already occur at low densities may have a significant impact on the population.

Species interactions, including predation and competition

Changes in species interactions often occur with development. Introduced species, including the feral Cat, Red Fox and Rabbit may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are very sensitive to introduced

predators and the decline of many mammals in Australia has been linked to predation by the Red Fox, and to a lesser extent the feral Cat (Burbidge and McKenzie 1989). Introduced grazing species, such as the Rabbit, Goat, Camel and domestic livestock, can also degrade habitats and deplete vegetation that may be a food source for other species.

Changes in the abundance of some native species at the expense of others, due to the provision of fresh watering points, can also be a concern. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species. Common, water-dependent birds were found to out-compete some less common, water-independent species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species through competition and displacement.

Hydroecology

Interruptions of hydroecological processes can have major effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Fauna may be impacted by potential changes to groundwater level and chemistry and altered flow regime. These changes may alter vegetation across large areas and may lead to habitat degradation or loss. Impacts upon fauna can be widespread and major.

Changes to flow regime across the landscape may alter vegetation and may lead to habitat degradation or loss, affecting fauna. For example, Mulga has a shallow root system and relies on surface sheet flow during flood events. If surface sheet flow is impeded, Mulga can die (Kofoed 1998), which may impact on a range of fauna associated with this vegetation type.

Fire

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (Gill *et al.* 1981; Fox 1982; Letnic *et al.* 2004; Bamford and Roberts 2003). It is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge and McKenzie 1998). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Changes in fire regime, whether to more frequent or less frequent fires, may be significant to some fauna. Impacts of severe fire may be devastating to species already occurring at low densities or to species requiring long unburnt habitats to survive. In terms of conservation management, it is not fire *per se* but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity. Fire management may be considered the responsibility of managers of large tracts of land.

Dust, light, noise and vibration

Impacts of dust, light, noise and vibration upon fauna are difficult to predict. Some studies have demonstrated the impact of artificial night lighting on fauna, with lighting affecting fauna behaviour more than noise (Rich and Longcore 2006). Effects can include impacts on predator-prey interactions,

changes to mating and nesting behaviour, and increased competition and predation within and between invertebrates, frogs, birds and mammals.

The death of very large numbers of insects has been observed around some remote mine sites and attracts other fauna, notably native and introduced predators (M.Bamford pers. obs). The abundance of some insects can decline due to mortality around lights, although this has previously been recorded in fragmented landscapes where populations are already under stress (Rich and Longcore 2006). Artificial night lighting may also lead to disorientation of migratory birds. Aquatic habitats and open habitats such as grasslands and dunes may be vulnerable to light spill.

Appendix 3. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Wildlife Conservation Act 1950*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the WA *Wildlife Conservation Act 1950*

Schedule 1	Rare and Likely to become Extinct.
Schedule 2	Extinct.
Schedule 3	Migratory species listed under international treaties.
Schedule 4	Other Specially Protected Fauna

WA Department of Environment and Conservation Priority species (species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4.	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 4. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule *et al.* 2004):

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 19 key threatening processes listed by the federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC 2011):

- Competition and land degradation by feral/unmanaged Goats (*Capra hircus*);
- Competition and land degradation by feral Rabbits (*Oryctolagus cuniculus*);
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*);
- Incidental catch (bycatch) of Sea Turtles during coastal otter-trawling operations within Australian waters north of 28 degrees South;
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations;
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis;
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris;
- Invasion of northern Australia by Gamba Grass and other introduced grasses;
- Land clearance;
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants;
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean;
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases;
- Predation by exotic rats on Australian offshore islands of less than 1000 km2 (100 000 ha);

- Predation by feral Cats (*Felis catus*);
- Predation by the European Red Fox (*Vulpes vulpes*);
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (*Sus scrofa*);
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species;
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*); and
- The reduction in the biodiversity of Australian native fauna and flora due to the imported Red Fire Ant, *Solenopsis invicta*.

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, DSEWPaC has produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action will reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action will disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action will interfere with the recovery of the species?

Appendix 5. Fauna recorded or expected to occur in the Drover-01 Well survey area (Tables 1 to 5).

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the local area. These are:

- BA = Birds Australia Database: searched September, 2012;
- E = EPBC Protected Matters Search Tool: searched September 2012;
- N = NatureMap Database: searched September, 2012;
- BCE = BCE Level 1 Fauna survey of the Eneabba IPL Project; and
- D 12 = Found in the Old Drover-01 project area in August 2012.
- D 13 = Found in the New Drover-01 project area in July 2013

TABLE 1. Significant Invertebrates expected to occur and recorded in the Drover-01 Well survey areas.

Common Name	Species Name	Status	E	N	BCE	D-12	D-13
Millipede	*Antichiropus* Eneabba 1	CS3					
Cricket	*Hemisaga vepreculae*	CS2		X			
Cricket	*Phasmodes jeeba*	CS2		X			
Bee Species	*Hylaeus globuliferus*	CS2		X			
Graceful Sunmoth	*Synemon gratiosa*	CS2		X			
Scorpionfly	*Austromerope poultoni*	CS2		X			
Total number of species		6	0	6	0	0	0

TABLE 2. Frogs expected to occur and recorded in the Drover-01 Well survey areas.

Common Name	Species Name	Status	E	N	BCE	D-12	D-13
HYLIDAE							
Motorbike Frog	*Litoria moorei*			X	X		
MYOBATRACHIDAE							
Bleating Froglet	*Crinia pseudinsignifera*			X	X		
Western Spotted Frog	*Heleioporus albopunctatus*			X	X		
Moaning Frog	*Heleioporus eyrei*			X	X		
Sand Frog	*Heleioporus psammophilus*			X	X		
Banjo Frog, Pobblebonk	*Limnodynastes dorsalis*			X	X		
Turtle Frog	*Myobatrachus gouldii*			X	X		
Humming Frog	*Neobatrachus pelobatoides*			X	X		
Günther`s Toadlet	*Pseudophryne guentheri*			X	X		
Total number of species	**9**	0	0	9	9		0

TABLE 3. Reptiles expected to occur and recorded in the Drover-01 Well survey areas.

Common Name	Species Name	Status	E	N	BCE	D-12	D-13
AGAMIDAE							
Spotted Military Dragon	*Ctenophorus maculatus*			X	X		
Thorny Devil	*Moloch horridus*				X		
Western Bearded Dragon	*Pogona minor*			X	X		
Western Heath Dragon	*Rankinia adelaidensis*			X	X		
GEKKONIDAE							
Marbled Gecko	*Christinus marmoratus*			X			
Clawless Gecko	*Crenadactylus ocellatus*			X	X		
White-spotted Ground Gecko	*Diplodactylus alboguttatus*						
	Diplodactylus ornatus			X			
Spotted Stone Gecko	*Diplodactylus polyophthalmus*			X	X		
Variegated Dtella	*Gehyra variegata*			X	X		
	Rhynchoedura ornata						
Soft Spiny-tailed Gecko	*Strophurus spinigerus*			X	X		
Barking Gecko	*Underwoodisaurus milii*			X			
PYGOPODIDAE							
Javelin Legless Lizard	*Aclys concinna*			X	X		
Sand-plain Worm-lizard	*Aprasia repens*			X	X		
	Delma fraseri			X	X		
Gray's Legless Lizard	*Delma grayii*			X	X		
Burton's Legless Lizard	*Lialis burtonis*			X	X		
Keeled Legless Lizard	*Pletholax gracilis*			X			
Common Scaly-foot	*Pygopus lepidopodus*			X	X		
SCINCIDAE							
	Cryptoblepharus buchananii			X			
Western Limestone Ctenotus	*Ctenotus australis*			X			
	Ctenotus catenifer						
West Coast Ctenotus	*Ctenotus fallens*			X	X	**X**	
	Ctenotus gemmula	CS2					
South-western Odd-striped Ctenotus	*Ctenotus impar*			X	X		
Leopard Ctenotus	*Ctenotus pantherinus*			X	X		
	Cyclodomorphus celatus			X			
Bull Skink	*Egernia multiscutata*						

	Egernia napoleonis			X			
Bold-striped Lerista	*Lerista christinae*			X	X		
South-western Lerista	*Lerista distinguenda*			X			
West Coast Lerista	*Lerista elegans*			X			
	Lerista lineopunctulata			X			
	Lerista planiventralis			X			
Western Worm Lerista	*Lerista praepedita*			X	X		
Common Dwarf Skink	*Menetia greyii*			X	X		
Western Pale-flecked Morethia	*Morethia lineoocellata*			X			
Southern Pale-flecked Morethia	*Morethia obscura*			X	X		
Western Blue-tongue	*Tiliqua occipitalis*			X	X		
Bobtail	*Tiliqua rugosa*			X	X	**X**	
VARANIDAE							
Sand Goanna	*Varanus gouldii*			X	X		
Black-headed Monitor	*Varanus tristis*			X	X		
TYPHLOPIDAE							
Southern Blind Snake	*Ramphotyphlops australis*			X			
	Ramphotyphlops waitii			X			
BOIDAE							
Stimson`s Python	*Antaresia stimsoni*			X			
Woma, Ramsay`s Python	*Aspidites ramsayi*	CS1					
Carpet Python	*Morelia spilota*	CS1		X			
ELAPIDAE							
Narrow-banded Snake	*Brachyurophis fasciolata*			X			
Shovel-nosed Snake	*Brachyurophis semifasciata*						
Yellow-faced Whipsnake	*Demansia psammophis*			X	X		
Bardick	*Echiopsis curta*			X	X		
Black-striped Snake	*Neelaps calonotos*	CS2		X			
Black-naped Snake	*Neelaps bimaculatus*			X			
Gould`s Snake	*Parasuta gouldii*			X	X		
Mulga Snake	*Pseudechis australis*			X	X		
Ringed Brown Snake	*Pseudonaja modesta*						
Gwardar	*Pseudonaja nuchalis*			X	X		
Jan`s Banded Snake	*Simoselaps bertholdi*			X	X		
	Simoselaps littoralis			X			
Total Number of Species	**60**	**CS = 4**				**2**	

TABLE 4. Birds expected to occur and recorded in the Drover-01 Well survey areas.

Common Name	Species Name	Status	BA	E	N	BCE	D-21	D-13
CASUARIIDAE								
Emu	*Dromaius novaehollandiae*		X		X	X		**X**
PHASIANIDAE								
Stubble Quail	*Coturnix pectoralis*		X		X	X		
Brown Quail	*Coturnix ypsilophora*		X		X			
TURNICIDAE								
Painted Button-quail	*Turnix varia*		X			X		
Little Button-quail	*Turnix velox*		X		X	X		
ACCIPITRIDAE								
Collared Sparrowhawk	*Accipiter cirrhocephalus*		X		X	X		
Brown Goshawk	*Accipiter fasciatus*		X		X	X		
Wedge-tailed Eagle	*Aquila audax*		X		X	X		
Swamp Harrier	*Circus approximans*		X		X			
Spotted Harrier	*Circus assimilis*		X		X			
Black-shouldered Kite	*Elanus axillaris*		X			X		
Whistling Kite	*Haliastur sphenurus*		X		X			
Black-breasted Buzzard	*Hamirostra melanosternon*							
Little Eagle	*Hieraaetus morphnoides*		X			X		
Square-tailed Kite	*Lophoictinia isura*		X					
FALCONIDAE								
Brown Falcon	*Falco berigora*		X		X	X		
Nankeen Kestrel	*Falco cenchroides*		X		X	X		**X**
Australian Hobby	*Falco longipennis*		X		X	X		
Peregrine Falcon	*Falco peregrinus*	CS1	X		X	X		
OTIDAE								
Australian Bustard	*Ardeotis australis*	CS2	X		X			
BURHINIDAE								
Bush Stone-curlew	*Burhinus grallarius*	CS2						
CHARADRIIDAE								
Banded Lapwing	*Vanellus tricolor*		X		X	X		**X**
COLUMBIDAE								
Rock Dove/Feral Pigeon	*Columba livia*	Int	X		X	X		
Crested Pigeon	*Ocyphaps lophotes*		X		X	X		
Common Bronzewing	*Phaps chalcoptera*		X		X	X		
Brush Bronzewing	*Phaps elegans*		X		X	X		
Spotted Dove	*Streptopelia chinensis*	Int	X					
Laughing Dove	*Streptopelia senegalensis*	Int	X		X			
CACATUIDAE								

Western Corella	*Cacatua pastinator*		X		X	X		
Little Corella	*Cacatua sanguinea*		X		X			
Long-billed Corella	*Cacatua tenuirostris*		X					
Carnaby`s Cockatoo	*Calyptorhynchus latirostris*	CS1	X	X	X	X		
Galah	*Eolophus roseicapilla*		X		X	X		**X**
Cockatiel	*Nymphicus hollandicus*		X		X	X		
PSITTACIDAE								
Australian Ringneck	*Barnardius zonarius*		X		X	X		**X**
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*		X					
Budgerigar	*Melopsittacus undulatus*		X		X			
Elegant Parrot	*Neophema elegans*							
Rock Parrot	*Neophema petrophila*		X		X			
Western Ground Parrot	*Pezoporus flaviventris*	CS1			X			
Regent Parrot	*Polytelis anthopeplus*		X		X			
CUCULIDAE								
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		X		X	X		
Pallid Cuckoo	*Cacomantis pallidus*		X			X		
Shining Bronze-Cuckoo	*Chalcites lucidus*		X		X	X		
Black-eared Cuckoo	*Chalcites osculans*		X					
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*		X			X	**X**	
STRIGIDAE								
Southern Boobook	*Ninox novaeseelandiae*		X		X			
TYTONIDAE								
Barn Owl	*Tyto alba*		X			X		
PODARGIDAE								
Tawny Frogmouth	*Podargus strigoides*		X		X			
CAPRIMULGIDAE								
Spotted Nightjar	*Eurostopodus argus*							
AEGOTHELIDAE								
Australian Owlet-nightjar	*Aegotheles cristatus*		X					
APODIDAE								
Fork-tailed Swift	*Apus pacificus*	CS1	X	X	X			
HALCYONIDAE								
Laughing Kookaburra	*Dacelo novaeguineae*	Int	X		X			
Red-backed Kingfisher	*Todiramphus pyrrhopygia*					X		
Sacred Kingfisher	*Todiramphus sanctus*		X		X	X		
MEROPIDAE								
Rainbow Bee-eater	*Merops ornatus*	CS1	X	X	X	X		
MALURIDAE								

Variegated Fairy-wren	*Malurus lamberti*		X		X	X		
White-winged Fairy-wren	*Malurus leucopterus*		X		X	X		**X**
Blue-breasted Fairy-wren	*Malurus pulcherrimus*		X		X	X		
Splendid Fairy-wren	*Malurus splendens*		X		X	X		**X**
Southern Emu-wren	*Stipiturus malachurus*		X		X	X		
PARDALOTIDAE								
Inland Thornbill	*Acanthiza apicalis*		X		X			
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		X		X	X		**X**
Western Thornbill	*Acanthiza inornata*		X		X	X		
Rufous Fieldwren	*Calamanthus campestris*	CS2	X			X	**X**	**X**
Western Gerygone	*Gerygone fusca*		X		X	X		
Shy Heathwren	*Hylacola cauta*	CS2	X					
Spotted Pardalote	*Pardalotus punctatus*		X		X	X		
Striated Pardalote	*Pardalotus striatus*		X		X	X		
White-browed Scrubwren	*Sericornis frontalis*		X		X	X		**X**
Weebill	*Smicrornis brevirostris*		X		X	X		
MELIPHAGIDAE								
Red Wattlebird	*Anthochaera carunculata*		X		X	X		
Western Wattlebird	*Anthochaera lunulata*		X		X			
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		X		X	X		
Western Spinebill	*Acanthorhynchus superciliosus*		X		X			
Black Honeyeater	*Certhionyx niger*							
Pied Honeyeater	*Certhionyx variegatus*							
White-fronted Chat	*Epthianura albifrons*		X		X	X		
Crimson Chat	*Epthianura tricolor*		X		X	X		
Singing Honeyeater	*Lichenostomus virescens*		X		X	X		
Brown Honeyeater	*Lichmera indistincta*		X		X	X		**X**
Yellow-throated Miner	*Manorina flavigula*		X		X	X		
Brown-headed Honeyeater	*Melithreptus brevirostris*		X		X	X		
White-fronted Honeyeater	*Phylidonyris albifrons*					X		
Tawny-crowned Honeyeater	*Phylidonyris melanops*		X		X	X	**X**	**X**
White-cheeked Honeyeater	*Phylidonyris nigra*		X		X	X	**X**	**X**
New Holland Honeyeater	*Phylidonyris novaehollandiae*		X		X	X		
PETROICIDAE								
Hooded Robin	*Melanodryas cucullata*		X			X		

Red-capped Robin	*Petroica goodenovii*		X		X	X		
POMATOSTOMIDAE								
White-browed Babbler	*Pomatostomus superciliosus*	CS2	X		X			
NEOSITTIDAE								
Varied Sittella	*Daphoenositta chrysoptera*		X		X			
PACHYCEPHALIDAE								
Grey Shrike-thrush	*Colluricincla harmonica*		X		X	X		
Crested Bellbird	*Oreoica gutturalis*	CS2	X		X			
Rufous Whistler	*Pachycephala rufiventris*		X		X	X		
DICRURIDAE								
Restless Flycatcher	*Myiagra inquieta*		X					
Magpie-lark	*Grallina cyanoleuca*		X		X	X		
Grey Fantail	*Rhipidura fuliginosa*		X		X	X		
Willie Wagtail	*Rhipidura leucophrys*		X		X	X		**X**
CAMPEPHAGIDAE								
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		X		X	X		**X**
White-winged Triller	*Lalage sueurii*		X			X	**X**	**X**
ARTAMIDAE								
Black-faced Woodswallow	*Artamus cinereus*		X		X	X	**X**	
Dusky Woodswallow	*Artamus cyanopterus*		X		X			
Masked Woodswallow	*Artamus personatus*		X					
Grey Butcherbird	*Cracticus torquatus*		X		X	X		
Pied Butcherbird	*Cracticus nigrogularis*		X		X	X		
Australian Magpie	*Gymnorhina tibicen*		X		X	X	**X**	**X**
Grey Currawong	*Strepera versicolor*		X		X	X		
CORVIDAE								
Australian Raven	*Corvus coronoides*		X		X	X		**X**
Little Crow	*Corvus bennetti*		X		X	X		
MOTACILIDAE								
Australasian Pipit	*Anthus novaeseelandiae*		X		X	X	**X**	
PASSERIDAE								
Zebra Finch	*Taeniopygia guttata*		X		X	X		
DICAEIDAE								
Mistletoebird	*Dicaeum hirundinaceum*		X		X	X		
HIRUNDINIDAE								
White-backed Swallow	*Cheramoeca leucosternum*		X			X		
Fairy Martin	*Hirundo ariel*		X			X		
Welcome Swallow	*Hirundo neoxena*		X		X	X		**X**
Tree Martin	*Hirundo nigricans*		X		X	X		
SYLVIIDAE								

Brown Songlark	*Cinclorhamphus cruralis*		X		X	X	**X**	**X**
Rufous Songlark	*Cinclorhamphus mathewsi*		X		X	X		
ZOSTEROPIDAE								
Silvereye	*Zosterops lateralis*		X		X	X		
Total Number of Species	**119**	**CS = 11 Int = 3**						

TABLE 5. Mammals expected to occur and recorded in the Drover-01 Well survey area.

Common Name	Species Name	Status	E	N	BCE	D-12	D-13
TACHYGLOSSIDAE							
Echidna	*Tachyglossus aculeatus*				X	**X***	
DASYURIDAE							
Fat-tailed Dunnart	*Sminthopsis crassicaudata*			X			
Little Long-tailed Dunnart	*Sminthopsis dolichura*			X			
White-tailed Dunnart	*Sminthopsis granulipes*			X	X		
Grey-bellied Dunnart	*Sminthopsis griseoventer*			X			
MACROPODIDAE							
Western Grey Kangaroo	*Macropus fuliginosus*			X	X	**X***	**X***
Brush Wallaby	*Macropus irma*	CS2		X			
TARSIPEDIDAE							
Honey Possum, Noolbenger	*Tarsipes rostratus*			X			
VESPERTILIONIDAE							
Gould`s Wattled Bat	*Chalinolobus gouldii*			X	X		
Chocolate Wattled Bat	*Chalinolobus morio*			X			
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			X	X		
Southern Forest Bat	*Vespadelus regulus*			X	X		
MOLOSSIDAE							
Western Freetail-bat	*Mormopterus planiceps*	CS3					
White-striped Freetail-bat	*Tadarida australis*				X		
MURIDAE							
House Mouse	*Mus musculus*	Int		X	X		
Ash-grey Mouse, Noodji	*Pseudomys albocinereus*			X	X		
Western Bush Rat, Moodit	*Rattus fuscipes*			X			
Black Rat	*Rattus rattus*	Int					
LEPORIDAE							
Rabbit	*Oryctolagus cuniculus*	Int	X		X		
CANIDAE							
Dog	*Canis lupus*	Int			X		
Red Fox	*Vulpes vulpes*	Int	X	X	X		**X***
FELIDAE							
Cat	*Felis catus*	Int	X	X	X		

BOVIDAE							
European Cattle	*Bos taurus*	Int			X		
Sheep	*Ovis aries*	Int			X		**X**
Goat	*Capra hircus*	Int	X		X		
Total Number of Species	**25**	**CS = 2 Int = 9**				**2**	**3**

*Presence inferred from scats, tracks and diggings

Appendix 6. Vertebrate species returned in database searches but unlikely to be found in the project area.

Database searches often return species that, despite being found nearby, are unlikely to be present in the survey area due to lack of suitable habitat (e.g. aquatic species) or ecological barriers preventing them from reaching the area (e.g. island species). There are also some errors and subtleties of distribution that are not recognised in databases.

Common Name	Species Name	Status	BA	E	N	BCE
FISH						
Grey Nurse Shark	*Carcharias taurus*			X		
Great White Shark	*Carcharodon carcharias*			X		
Porbeagle, Mackerel Shark	*Lamna nasus*			X		
Whale Shark	*Rhincodon typus*			X		
Southern Pygmy Pipehorse	*Acentronura australe*			X		
Gale's Pipefish	*Campichthys galei*			X		
Pig-snouted Pipefish	*Choeroichthys suillus*			X		
Brock's Pipefish	*Halicampus brocki*			X		
Western Spiny Seahorse	*Hippocampus angustus*			X		
Short-head Seahorse	*Hippocampus breviceps*			X		
West Australian Seahorse	*Hippocampus subelongatus*			X		
Prophet's Pipefish	*Lissocampus fatiloquus*			X		
Sawtooth Pipefish	*Maroubra perserrata*			X		
Western Crested Pipefish	*Mitotichthys meraculus*			X		
Bonyhead Pipefish	*Nannocampus subosseus*			X		
Leafy Seadragon	*Phycodurus eques*			X		
Common Seadragon	*Phyllopteryx taeniolatus*			X		
Pugnose Pipefish	*Pugnaso curtirostris*			X		
Gunther's Pipehorse	*Solegnathus lettiensis*			X		
Spotted Pipefish	*Stigmatopora argus*			X		
Widebody Pipefish	*Stigmatopora nigra*			X		
Double-end Pipehorse	*Syngnathoides biaculeatus*			X		
Hairy Pipefish	*Urocampus carinirostris*			X		
Mother-of-pearl Pipefish	*Vanacampus margaritifer*			X		
Western Pygmy Perch	*Edelia vittata*	CS3				
Western Minnow	*Galaxias occidentalis*	CS3				
Mosquitofish	*Gambusia holbrooki*	Int.				X
AMPHIBIANS						
Shoemaker Frog	*Neobatrachus sutor*					
White-footed Frog	*Neobatrachus albipes*					
Kunapalari Frog	*Neobatrachus kunapalari*					
	Neobatrachus wilsmorei					
Sandhill Frog	*Arenophryne xiphorhyncha*					
Sign-bearing Froglet	*Crinia insignifera*					
Water-holding Frog	*Cyclorana platycephala*					
Slender Treefrog	*Litoria adelaidensis*					

Spotted-thighed Treefrog	*Litoria cyclorhyncha*					
REPTILES						
Shark Bay Seasnake	*Aipysurus pooleorum*			X		
Loggerhead Turtle	*Caretta caretta*			X		
Green Turtle	*Chelonia mydas*			X		
Oblong Tortoise	*Chelodina oblonga*				X	
Dinner-plate Tortoise	*Chelodina steindachneri*					
Lancelin Island Skink	*Ctenotus lancelini*			X	X	
Leatherback Turtle	*Dermochelys coriacea*			X	X	
Spectacled Seasnake	*Disteira kingii*			X		
Sea Snake	*Disteira major*	Marine				
Sea Snake	*Hydrophis elegans*				X	
Jurien Bay Skink	*Liopholis pulchra longicauda*			X		
Yellow-bellied Seasnake	*Pelamis platurus*			X		
	Amphibolurus norrisi					
	Ctenophorus butleri					
	Ctenophorus nuchalis					
	Ctenophorus reticulatus					
	Ctenophorus salinarum					
	Ctenophorus scutulatus					
	Lophognathus longirostris					
Western Stone Gecko	*Diplodactylus granariensis*				X	
	Diplodactylus pulcher					
	Heteronotia binoei					
	Lucasium maini					
	Lucasium squarrosum					
	Nephrurus levis					
	Strophurus michaelseni					
	Strophurus strophurus					
	Strophurus ciliaris					
	Aprasia smithi					
	Delma australis					
	Delma butleri					
	Delma tincta					
	Pygopus nigriceps					
Fence Skink	*Cryptoblepharus plagiocephalus*				X	
	Ctenotus alleni					
	Ctenotus mimetes					
	Ctenotus schomburgkii			X	X	
	Ctenotus severus					
Slender Blue-tongue	*Cyclodomorphus branchialis*	CS1		X	X	
	Egernia depressa					
	Egernia kingii			X		
Spiny-tailed Skink	*Egernia stokesii*	CS1		X		
Broad-banded Sand-swimmer	*Eremiascincus richardsonii*					

	Hemiergis quadrilineata			X		
	Lerista axillaris	CS2				
	Lerista bipes					
	Lerista connivens					
	Lerista gerrardii					
	Lerista humphriesi					
	Lerista kendricki					
	Lerista kingi					
	Lerista lineata	CS2				
	Lerista macropisthopus					
	Lerista micra					
	Lerista muelleri					
	Lerista nichollsi					
	Lerista uniduo					
	Lerista yuna	CS2				
	Liopholis inornata					
	Menetia amaura					
	Menetia surda					
	Morethia butleri					
	Varanus caudolineatus					
	Varanus eremius					
	Ramphotyphlops hamatus					
	Ramphotyphlops leptosoma					
	Ramphotyphlops pinguis					
	Parasuta monachus					
	Suta fasciata					
BIRDS						
Malleefowl	*Leipoa ocellata*	CS1	X	X		
Glossy Ibis	*Plegadis falcinellus*	CS1	X	X		
Australian White Ibis	*Threskiornis molucca*		X	X		
Straw-necked Ibis	*Threskiornis spinicollis*		X	X		
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	CS1	X	X	X	
Black Kite	*Milvus migrans*					
Eastern Osprey	*Pandion cristatus*	CS1	X	X	X	
Eurasian Coot	*Fulica atra*		X		X	
Black-tailed Native-hen	*Gallinula ventralis*		X		X	
Buff-banded Rail	*Gallirallus philippensis*		X		X	
Purple Swamphen	*Porphyrio porphyrio*		X		X	
Australian Spotted Crake	*Porzana fluminea*		X		X	
Baillon's Crake	*Porzana pusilla*		X		X	
Spotless Crake	*Porzana tabuensis*				X	
Australian Lesser Noddy	*Anous tenuirostris melanops*			X		
Wandering Albatross	*Diomedea exulans (sensu lato)*			X		
Amsterdam Albatross	*Diomedea exulans amsterdamensis*			X		
Tristan Albatross	*Diomedea exulans exulans*			X		

Gibson's Albatross	*Diomedea exulans gibsoni*			X		
Southern Fulmar	*Fulmarus glacialoides*				X	
Southern Giant-Petrel	*Macronectes giganteus*			X	X	
Northern Giant-Petrel	*Macronectes halli*			X		
Australasian Gannet	*Morus serrator*		X			
White-faced Storm-Petrel	*Pelagodroma marina*			X	X	
Soft-plumaged Petrel	*Pterodroma mollis*			X		
Little Shearwater	*Puffinus assimilis*			X	X	
Wedge-tailed Shearwater	*Puffinus pacificus*			X	X	
Indian Yellow-nosed Albatross	*Thalassarche carteri*			X		
Shy Albatross	*Thalassarche cauta cauta*			X		
Yellow-nosed Albatross	*Thalassarche chlororhynchos*			X		
Black-browed Albatross	*Thalassarche melanophris*			X		
Chestnut Teal	*Anas castanea*		X		X	
Grey Teal	*Anas gracilis*		X		X	X
Northern Mallard	*Anas platyrhynchos*		X			
Australasian Shoveler	*Anas rhynchotis*		X		X	
Pacific Black Duck	*Anas superciliosa*		X		X	X
Hardhead	*Aythya australis*		X		X	
Musk Duck	*Biziura lobata*		X		X	
Black Swan	*Cygnus atratus*		X		X	X
Australian Wood Duck	*Chenonetta jubata*		X		X	
Pink-eared Duck	*Malacorhynchus membranaceus*		X		X	X
Blue-billed Duck	*Oxyura australis*		X		X	
Freckled Duck	*Stictonetta naevosa*				X	
Australian Shelduck	*Tadorna tadornoides*		X		X	X
Great Crested Grebe	*Podiceps cristatus*		X		X	
Hoary-headed Grebe	*Poliocephalus poliocephalus*		X		X	X
Australasian Grebe	*Tachybaptus novaehollandiae*		X		X	X
Australasian Darter	*Anhinga novaehollandiae*		X		X	
Great Cormorant	*Phalacrocorax carbo*		X		C	
Little Pied Cormorant	*Phalacrocorax melanoleucos*		X		C	
Little Black Cormorant	*Phalacrocorax sulcirostris*		X		C	
Pied Cormorant	*Phalacrocorax varius*		X		C	X
Australian Pelican	*Pelecanus conspicillatus*		X		X	
Great Egret	*Ardea alba*	CS1	X	X	X	
Cattle Egret	*Ardea ibis*	CS1		X		
White-necked Heron	*Ardea pacifica*		X		X	X
Little Egret	*Egretta garzetta*		X			
White-faced Heron	*Egretta novaehollandiae*		X		X	X
Eastern Reef Egret	*Egretta sacra*	CS1	X		X	
Nankeen Night Heron	*Nycticorax caledonicus*		X		X	
Yellow-billed Spoonbill	*Platalea flavipes*		X		X	
Double-banded Plover	*Charadrius bicinctus*				X	
Greater Sand Plover	*Charadrius leschenaultii*	CS1			X	
Lesser Sand Plover	*Charadrius mongolus*	CS1	X			

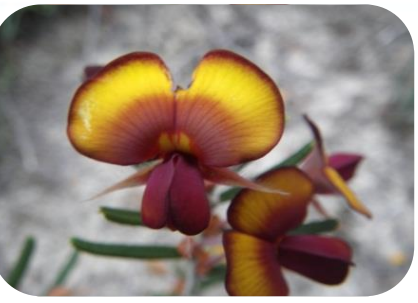
Red-capped Plover	*Charadrius ruficapillus*		X		X	X
Black-fronted Dotterel	*Elseyornis melanops*		X		X	X
Red-kneed Dotterel	*Erythrogonys cinctus*		X		X	
Pacific Golden Plover	*Pluvialis fulva*	CS1	X		X	
Grey Plover	*Pluvialis squatarola*	CS1	X		X	
Hooded Plover	*Thinornis rubricollis*	CS2	X		X	
Banded Lapwing	*Vanellus tricolor*		X		X	X
Australian Pratincole	*Stiltia isabella*					
Common Sandpiper	*Actitis hypoleucos*	CS1	X		X	X
Ruddy Turnstone	*Arenaria interpres*	CS1	X		X	
Sharp-tailed Sandpiper	*Calidris acuminata*	CS1	X		X	X
Sanderling	*Calidris alba*	CS1			X	
Red Knot	*Calidris canutus*	CS1	X			
Curlew Sandpiper	*Calidris ferruginea*	CS1	X		X	
Pectoral Sandpiper	*Calidris melanotos*	CS1	X			
Red-necked Stint	*Calidris ruficollis*	CS1	X		X	X
Long-toed Stint	*Calidris subminuta*	CS1	X			
Great Knot	*Calidris tenuirostris*	CS1	X			
Bar-tailed Godwit	*Limosa lapponica*	CS1	X		X	
Black-tailed Godwit	*Limosa limosa*	CS1	X			
Whimbrel	*Numenius phaeopus*	CS1			X	
Grey-tailed Tattler	*Tringa brevipes*	CS1	X		X	
Wood Sandpiper	*Tringa glareola*	CS1	X		X	
Common Greenshank	*Tringa nebularia*	CS1	X		X	
Terek Sandpiper	*Xenus cinereus*	CS1			X	
Sooty Oystercatcher	*Haematopus fuliginosus*				X	
Australian Pied Oystercatcher	*Haematopus longirostris*		X		X	
Banded Stilt	*Cladorhynchus leucocephalus*		X		X	
Black-winged Stilt	*Himantopus himantopus*		X		X	X
Red-necked Avocet	*Recurvirostra novaehollandiae*		X		X	X
Great Skua	*Catharacta skua*			X		
Whiskered Tern	*Chlidonias hybridus*		X		X	
Caspian Tern	*Hydroprogne caspia*	CS1	X	X	X	
Kelp Gull	*Larus dominicanus*				X	
Silver Gull	*Larus novaehollandiae*		X	X	X	
Pacific Gull	*Larus pacificus*		X	X	X	
Bridled Tern	*Onychoprion anaethetus*	CS1	X	X	X	
Brown Skua	*Stercorarius antarcticus*		X			
Roseate Tern	*Sterna dougallii*	CS1	X	X	X	
Sooty Tern	*Sterna fuscata*			X	X	
Gull-billed Tern	*Sterna nilotica*		X			
Fairy Tern	*Sternula nereis*	CS1	X	X	X	
Arctic Tern	*Sterna paradisaea*				X	
Crested Tern	*Thalasseus bergii*		X	X	X	
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*		X			
Western Rosella	*Platycercus icterotis*		X			

Red-capped Parrot	*Purpureicephalus spurius*		X			
Rainbow Lorikeet	*Trichoglossus haematodus*	Int.	X			
Barking Owl	*Ninox connivens*			X		
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		X		X	
Redthroat	*Pyrrholaemus brunneus*		X		X	
Orange Chat	*Epthianura aurifrons*		X			
White-eared Honeyeater	*Lichenostomus leucotis*		X			
Yellow-plumed Honeyeater	*Lichenostomus ornatus*		X			
White-plumed Honeyeater	*Lichenostomus penicillatus*		X			
White-naped Honeyeater	*Melithreptus lunatus*		X			
Southern Scrub-robin	*Drymodes brunneopygia*				X	
White-breasted Robin	*Eopsaltria georgiana*		X		X	X
Western Yellow Robin	*Eopsaltria griseogularis*		X			
Scarlet Robin	*Petroica boodang*		X			
Golden Whistler	*Pachycephala pectoralis*		X		X	X
Australian Reed-Warbler	*Acrocephalus australis*		X		X	
Little Grassbird	*Megalurus gramineus*		X		X	
MAMMALS						
Chuditch	*Dasyurus geoffroii*	CS1	X			
Euro, Biggada	*Macropus robustus*			X		
Greater Long-eared Bat	*Nyctophilus timoriensis*					
Inland Broad-nosed Bat	*Scotorepens balstoni*					
Ghost Bat	*Macroderma gigas*	CS2		X		
Little Red Flying Fox	*Pteropus scapulatus*			X		
Horse	*Equus caballus*	Int			X	
Pig	*Sus scrofa*	Int	X			
New Zealand Fur-seal	*Arctocephalus forsteri*			X		
Minke Whale	*Balaenoptera acutorostrata*			X		
Bryde's Whale	*Balaenoptera edeni*			X		
Blue Whale	*Balaenoptera musculus*			X		
Pygmy Right Whale	*Caperea marginata*			X		
Common Dophin	*Delphinus delphis*			X		
Southern Right Whale	*Eubalaena australis*			X	X	
Risso's Dolphin	*Grampus griseus*			X		
Dusky Dolphin	*Lagenorhynchus obscurus*			X		
Humpback Whale	*Megaptera novaeangliae*			X	X	
Australian Sea-lion	*Neophoca cinerea*			X	X	
Killer Whale	*Orcinus orca*			X		
Dibbler	*Parantechinus apicalis*	CS1	X	X		
Boullanger Island Dunnart	*Sminthopsis griseoventer boullangerensis*			X		
Spotted Dolphin	*Stenella attenuata*			X		
Indian Ocean Bottlenose Dolphin	*Tursiops aduncus*			X		
Bottlenose Dolphin	*Tursiops truncatus s. str.*			X	X	
Total	**147**	**29**		**75**	**68**	**16**

Appendix 3
Drover-01 Level 1 Flora Assessment

maia
Environmental Consultancy

AWE Limited: Drover-01 Study Area – Reconnaissance and Targeted Flora Surveys, September 2012 & July 2013




12 July 2013

Version 2

maia.net.au

This document describes the results of two reconnaissance and targeted flora surveys carried out by Maia Environmental Consultancy (Maia) at AWE Limited's Drover-01 project area 15 km east of Green Head in the Mid West administrative region of Western Australia. The Drover-01 project area lies within exploration permit (EP) 455.

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Document Revision Number: 2

Document Number: 1205/1307-2

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BACKGROUND

Maia Environmental Consultancy Pty Ltd (Maia) was commissioned by AWE Limited to carry out a combined reconnaissance flora and vegetation assessment and targeted flora survey over two areas at its Drover-01 project area in exploration permit (EP) 455.

Initially, Maia was asked to survey one area at AWE Limited's Drover-01 project area. The survey was carried out in September 2012 over an approximately 300 by 300 m (9.06 ha) polygon and a report was produced on the survey.

Based on the results of that survey, AWE Limited decided to carry out its exploration program on adjacent, already cleared farmland rather than at the initially surveyed area. Maia assessed the alternative farmland area in July 2013.

The initial survey area is referred to as Drover-01A in this combined report and the second area as Drover-01B. Both survey areas are referred to collectively as the Study Area.

Drover-01B includes: an exploration area (350 by 350 m, 12.2 ha); an approximately 2 km long and 10 m wide corridor along an existing access track linking Drover-01B to Coorow-Greenhead Road; a water bore area (270 by 40 m, 1.15 ha); a campsite area (100 by 120 m, 1.17 ha); and, a hygiene station area (20 by 100 m, 0.17 ha).

The Study Area is located approximately 220 km north of Perth and 15 km east of Green Head in the Shire of Coorow, in the Mid-West administrative region of Western Australia (WA).

THE SURVEY

- Both surveys were carried out by two botanists. Drover-01A was surveyed on September 5 and 6, 2012 and Drover-01B on July 1, 2013.
- The botanists walked transects 15 m apart over Drover-01A, and a more intensive search was conducted over an approximately 20 m by 20 m area where drilling was proposed. At Drover-01B the botanists walked transects spaced 20 metres apart at the proposed exploration area and campsite and 10 m apart at the bore and weed hygiene areas. A 10 m wide corridor was surveyed along the existing access track.
- Known and potentially conservation significant flora species and weeds were targeted during the survey.
- Notes were taken on the vegetation of the Survey Area in order to map the vegetation associations.
- Notes on vegetation condition were taken so that it could be mapped also.
- At least one specimen of every taxon encountered during the survey was collected for taxonomic verification in Perth.

RESULTS

Database Searches – Threatened and Priority Ecological Communities (TECs and PECs), Schedule 1 Areas, Environmentally Sensitive Areas (ESAs)

- No TECs or PECs occur in the Study Area.
- The Study Area is located within a Schedule 1 area. The Geraldton Sandplains is a non-permitted area under Schedule 1 of the Environmental Protection (Clearing of Vegetation) Regulations 2004.
- Most of Drover-01A falls within the boundaries of an ESA which extends beyond the boundaries of Lesueur National Park. Drover-01B does not fall within an ESA.
- Drover-01A is also a non-permitted area because it lies within an ESA.
- Drover-01A is located within unnamed Reserve 42031, which is vested in the Shire of Coorow for the purposes of supply of sand and gravel.

Database Searches – Conservation Significant Flora and Introduced Flora

- Five Threatened Flora species were listed in the 5 km NatureMap search results and two of these were listed in the former Department of Environment and Conservation (DEC) Threatened and Priority Flora

(TPFL) database search results: *Acacia forrestiana* and *Eucalyptus suberea* (both Vulnerable under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) and *Wildlife Conservation Act 1950* (WC Act). Based on the typical habitats in which these two species are found, it is unlikely that they will occur in the habitats of the Study Area.

- Twenty-three priority species were listed in the NatureMap and TPFL database search results. Based on similarity of habitat and distance of known populations from the Survey Area, 16 of the 23 priority species produced by the database searches could possibly occur in the Study Area.
- One general environmental weed species was listed in the NatureMap search results: *Lysimachia arvensis* (Pimpernel).

Survey - General Flora

- A combined species list of 204 taxa from 108 genera and 43 families (89.71% perennial, 10.29% annual) resulted from collections from the Study Area. One hundred and fifty-seven of these taxa were recorded at Drover-01A and 120 at Drover-01B.
- The most common families were Proteaceae (43), Fabaceae (25) and Myrtaceae (20).
- The most common genera were *Hakea* (12), *Banksia* (11) and *Acacia* (7).

Survey - Conservation Significant Flora

- No species protected by the EPBC Act or WC Act were recorded at the Study Area.
- Six confirmed priority (P) species were recorded at Drover-01A: *Acacia carens*, *Acacia lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039), *Phlebocarya pilosissima* subsp. *teretifolia* (all P2), *Desmocladus biformis*, (P3), *Diuris recurva* and *Xanthosia tomentosa* (both P4).
- Two confirmed priority species were recorded at Drover-01B: *Acacia carens* and *Acacia lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039) (both P2). One potential P1 species was recorded at Drover-01B – *Chordifex* ?*reseminans*.
- One taxon of interest (TOI) was recorded at both Drover 01 survey areas – *Leucopogon* aff. *oldfieldii*.
- No range extension species were recorded at the Study Area.

Survey - Introduced Flora

- No weeds on any of the national weeds lists were recorded at the Study Area.
- No Declared Plants were recorded at the Study Area.
- Twelve environmental weed species were located in the Study Area.
- Six of these were located at Drover-01A: *Arctotheca calendula* (Cape Weed), *Hypochaeris glabra* (Smooth Catsear), *Ornithopus sativus* (French Serradella), *Solanum nigrum* (Black Berry Nightshade), *Ursinia anthemoides* subsp. *anthemoides* (Ursinia) and *Vulpia myuros* forma *myuros*.
- Ten were located at Drover-01B: *Arctotheca calendula* (Cape weed), *Avena* sp.; *Brassica tournefortii* (Mediterranean Turnip), *Cotula* sp.; *Hypochaeris glabra* (Smooth Catsear), *Lupinus cosentinii*, *Ornithopus sativus* (French Serradella), *Pelargonium capitatum* (Rose Pelargonium), *Raphanus raphanistrum* (Wild Radish) and *Solanum nigrum* (Black Berry Nightshade).

Survey – Vegetation

Four vegetation associations were noted on the sandplains of the Study Area - two in remnant native vegetation at Drover-01A (Sp1 and Sp2) and two in regenerating areas of vegetation at Drover-01B (Sp3 and Sp4):

- Sp1: Mid Sparse Shrubland of *Xanthorrhoea drummondii*, over a Low Heathland of *Banksia armata* var. *armata*, *Hibbertia hypericoides* and *Calothamnus sanguineus* and a Sparse Sedgeland of *Mesomelaena pseudostygia* and *Conostylis teretifolia* subsp. *teretifolia*.
- Sp2: Low Isolated Mallee Shrubs of *Eucalyptus todtiana*, over a Mid to Tall Open Shrubland of *Banksia attenuata* and *Banksia menziesii*, over a Low Heathland of *Banksia armata* var. *armata*, *Hibbertia hypericoides* and *Calothamnus sanguineus* and a Sparse Sedgeland of *Mesomelaena pseudostygia* and *Conostylis teretifolia* subsp. *teretifolia*.
- Sp3: Low Isolated Mallee Shrubs of *Eucalyptus todtiana*, over a Low Open Heathland of *Hibbertia hypericoides*, *Jacksonia floribunda* and *Xanthorrhoea drummondii* and a Sparse Sedgeland of *Patersonia occidentalis* and *Mesomelaena pseudostygia.*

- Sp4: Low Open Mallee Woodland Shrubs of *Eucalyptus todtiana*, over a Mid Sparse Shrubland of *Calothamnus sanguineus* over a Low Sparse Heathland of *Hibbertia hypericoides*, *Stirlingia latifolia and Allocasuarina humilis* and a Sparse Sedgeland of *Patersonia occidentalis.*

Survey - Vegetation Condition

- Vegetation condition at Drover-01A was rated as Excellent (84.22%), Good (6.29%) and Completely Degraded (9.49%). Few weed species were recorded in the area and those that were occurred in an area previously cleared for a gravel pit and along Coorow-Greenhead Road.
- Vegetation condition at Drover-01B was rated as Good (72.46%), Degraded (6.82%) and Completely Degraded (20.71%). Vegetation condition in this area reflects the clearing of the area, its agricultural use and the widespread occurrence of weeds.

Threatened and Priority Ecological Communities

- None of the vegetation associations recorded in the Study Area are the same as any of the currently-listed TECS or PECs occurring in the vicinity of the Survey Area.

CONCLUSION AND RECOMMENDATIONS

- The flora and vegetation at Drover-01A and surrounds is mostly in Excellent condition and is particularly rich and diverse. Only small areas have been disturbed previously.
- Six priority species were located at Drover-01A.
- The flora and vegetation at Drover-01B is mostly in Good or Completely Degraded condition and the flora of the area is not as diverse as at Drover-01A because it is on farmland that has been cleared in the past. While some areas are regenerating others are not and these areas are very weedy.
- Two confirmed and one potential priority species were located at Drover-01B.
- AWE Limited intends to carry out its exploration program at Drover-01B rather than Drover-01A. Based on the previous clearing, the condition of the vegetation, flora diversity and the number of conservation significant species recorded in each area, vegetation clearing at Drover-01B would result in far less environmental impact than at Drover-01A.
- The northern half of the exploration area at Drover-01B should be cleared in preference to the southern section because fewer priority species were located in this area.
- Direct impacts to conservation significant flora located in areas to be cleared should be minimised whenever possible.
- As some of Drover-01B is adjacent to the Lesueur National Park, secondary impacts from vegetation clearing and drilling and associated activities should be considered i.e. dust management, weed management and pest management (particularly Phytophthora Dieback).
- Good weed and Phytophthora Dieback hygiene practices should be employed to avoid the introduction of new weed species to the area, to prevent the spread of existing weeds and to avoid the introduction of Dieback into the area.
- Vegetation clearing and exploration works should be carried out at dry times of the year to reduce the potential for introduction and spread of Phytophthora Dieback into the area and to reduce erosion.

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AWE Limited, Drover-01 Project Area – Reconnaissance and Targeted Flora Surveys, September 2012 & June 2013

1 Scope and Background Information

1.1 Scope of Works

Maia Environmental Consultancy Pty Ltd (Maia) was commissioned by AWE Limited to carry out a combined reconnaissance flora and vegetation assessment and targeted flora survey over two areas at its Drover-01 project area in exploration permit (EP) 455.

1.2 Study Area

Initially, Maia was asked to survey one area in remnant vegetation at AWE Limited's Drover-01 project area. The survey was carried out in September 2012 over an approximately 300 by 300 m (9.06 ha) polygon and a report was produced on the survey (Maia, 2012).

Based on the results of this survey, AWE Limited decided to carry out its Drover-01 exploration program on adjacent farmland. This alternative area was surveyed by Maia in July 2013.

While AWE Limited intends to carry out its exploration program on the already cleared farmland, this report includes the results of both surveys carried out at AWE Limited's Drover-01 project area. The initial survey area is referred to as Drover-01A in this combined report and the second as Drover-01B. Both Drover-01A and Drover-01B are referred to as the Study Area in this report.

Drover-01B includes: an exploration area (approximately 350 by 350 m, 12.2 ha); an approximately 2 km long and 10 m wide existing track corridor which links Drover-01B to Coorow-Greenhead Road (approximately 2.00 ha); a water bore area (270 by 40 m, 1.15 ha); a campsite area (100 by 120 m, 1.17 ha); and, a hygiene station area (20 by 100 m, 0.17 ha).

1.3 Study Area Location

The Study Area is located approximately 220 km north of Perth and 15 km east of Green Head (Map 9.1, Section 9) in the Shire of Coorow, in the Mid West administrative region of Western Australia (WA).

Drover-01A lies in a block of mostly undisturbed remnant vegetation while Drover-01B lies in farmland to the east and south-east of and adjacent to Drover-01A (Map 9.2, Section 9). Some of Drover-01B is cleared farmland and some has been cleared but is now regenerating.

1.4 Bioregional Setting

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies the land surface of Australia from a range of environmental attributes into bioregions. Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. Bioregions are based on factors associated with climate, geomorphology, lithology, landforms and characteristic flora and fauna. The bioregions have been developed at the national level to assess and plan for the protection of biological diversity (Thackway and Cresswell, 1995). IBRA Version 7 defines 89 bioregions and 419 subregions in Australia (Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC, 2013a).

The Study Area is located in the south-western corner of the Geraldton Sandplains IBRA bioregion. The Geraldton Sandplains has been divided into three subregions – Edel, Geraldton Hills and Lesueur Sandplain. The Study Area lies within the Lesueur Sandplain subregion (Map 9.3, Section 9).

The Geraldton Sandplains region is characterised by extensive, undulating, lateritic sandplains, dominated by a proteaceous scrub-heath, rich in endemics (Desmond and Chant, 2001).

The Lesueur Sandplain subregion is characterised by: coastal Aeolian and limestones, Jurassic siltstones and sandstones of central Perth Basin; alluvials associated with drainage systems; and, extensive yellow sandplains (Desmond and Chant, 2001). Shrub-heaths occur on lateritic mesas, sandplains, coastal sands and limestones and heath occurs on the lateritised sandplains along the subregion's north-eastern margins (Desmond and Chant, 2001).

1.5 Climate

The Study Area falls within the subtropical group of the Köppen climate classification system (Köppen, 1931). The Köppen classification is based on the concept that native vegetation is the best expression of climate and climate zone boundaries having been selected with vegetation limits in mind.

The subtropical group is characterised by a hot dry summer and mild winter. Rainfall is winter dominant with between 500 and 800 mm falling annually and the average January maximum temperature is greater than 30°C (Bureau of Meteorology [BoM], 2013).

The closest BoM weather station is at Leeman, BoM station 9199, where rainfall records have been collected since 1983.

The available monthly rainfall record data for 2012 and 2013 are shown in Figure 1.1, along with Leeman's mean and median long-term monthly rainfall (BoM, 2013).

Rainfall recorded in the three months preceding the Drover-01A survey in September 2012 was above June's long-term mean (115.3 mm compared with 109 mm), below July's (10.4 mm compared with 111.8 mm) and slightly above the long-term mean for August (83.4 mm compared with 83.0 mm). Therefore, total rainfall received in the three months before the September 2012 survey (209.1 mm) was less than the long-term mean for the same three months (303.8 mm).

Total rainfall recorded for March, May and June 2013 (April data not available) was 33.6 mm, 24.2 mm and 54.0 mm respectively. The long-term mean monthly rainfall for March, May and June is 17.3 mm, 78.0 mm and 107.1 mm. Therefore total rainfall received in March, May and June before the survey (118.8 mm) was less than the long-term mean total for the same three months (202.4 mm).

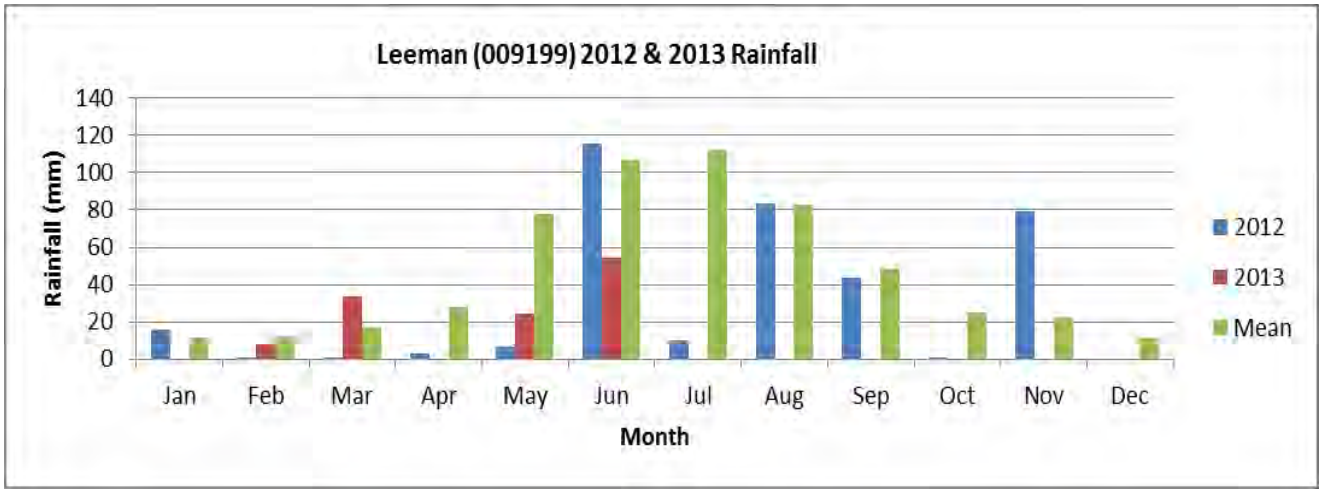


Figure 1.1: Rainfall Records for Leeman, site 009199 (BoM, 2013)

1.6 Geology

Three surface geological units have been mapped at the Study Area) – Czl, Czs and Qrc (Stewart *et al.*, 2008; Map 9.4, Section 9).

- Czl – lateritic duricrust: pisolitic, nodular or vuggy ferruginous laterite; some lateritic soils; ferricrete; magnesite; ferruginous and siliceous duricrusts and reworked products, calcrete, kaolinised rock, gossan; and, residual ferruginous saprolite.
- Czs – sand or gravel plains: quartz sand sheets commonly with ferruginous pisoliths or pebbles, minor clay; and, local calcrete, laterite, silcrete, silt, clay, alluvium, colluvium, aeolian sand.
- Qrc – colluvium sediment: colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; and local calcrete, reworked laterite.

1.7 Soil-landscape Systems

The Department of Agriculture and Food (DAFWA) conducted surveys on the soil and land resources of south-western Australia for regional land use planning and interpretation (DAFWA, 2012a). Information on the soils and landscapes of Western Australia is available as shape files and information relating to each unit as a database that includes information on the landforms, geology, soils and native vegetation of each map unit (DAFWA, 2012b). The Study Area falls within the Badgingarra area.

The Study Area lies over two soil-landscape units (Map 9.5, Section 9):

- Yerramullah 2 subsystem (224Ye_2): plateau residuals, very gently to gently inclined hillcrest and hillslopes; pale sandy gravels, shallow gravel over duricrust, gravelly pale deep sand, pale and yellow deep sands supporting heath.
- Yerramullah 3 subsystem (224Ye_3): colluvial slopes and some plateau remnants, very gently to gently inclined hillslopes and sand filled minor valleys; pale and yellow deep sands, pale sandy gravels, shallow gravel over duricrust, some sandy duplexes and sandy earths supporting heath, occasionally *Banksia attenuata* low open woodland, commonly with *Eucalyptus todtiana*.

1.8 Beard's Vegetation Mapping

The vegetation of the Swan area was mapped at a scale of 1:1 000 000 by J.S. Beard (Beard, 1980). The Study Area is located within the Arrowsmith Slopes unit of the Greenough natural region of the Irwin botanical district within the South-west botanical province of Western Australia.

Beard's vegetation mapping has been digitised and updated by DAFWA (2012c), and the Study Area is mapped as one broad structural vegetation association (Map 9.6, Section 9):

- 1031 (hSZc/dZc): *Hakea* spp., *Allocasuarina* spp. open tall shrubland over *Allocasuarina* spp., *Banksia* spp. mid shrubland.

Vegetation association 1031 is mapped in the Avon Wheatbelt, Geraldton Sandplains and Swan Coastal Plain IBRA regions and its pre-European extent is 269,491 ha. Of this, 88,865 ha (32.98%) currently remains. Of this current extent 13.48% is protected for conservation and 42.23% is located in Department of Environment and Conservation (DEC) managed lands generally (Government of Western Australia, 2013).

Note: on July 1, 2013 the DEC was reorganised into two departments – the Department of Parks and Wildlife (DPaW) and the Department of Environment Regulation (DER).

1.9 Native Vegetation Extent

Native vegetation extent has been digitised and updated by DAFWA (2012d) and the current extent of native vegetation in and around the Study Area is shown on Map 9.7 (Section 9).

1.10 Roadside Conservation Values

The Roadside Conservation Committee (RCC) was formed to coordinate and promote the conservation and effective management of rail and roadside vegetation. Road and rail corridor vegetation is important in providing essential habitats for rare species and in forming linkages for fauna in fragmented landscapes (Jackson, 2002). Roadside surveys record width, diversity of vegetation, native species richness, extent of weed cover and adjoining land use. These scores are then used by road managers to establish areas in need of priority attention or protection. Conservation values are mapped as high, medium high, medium low and low according to the 'conservation score' produced for a section of a road.

The roadside conservation values have been mapped in the vicinity of the Study Area (Map 9.8, Section 9) and the section of the Coorow - Green Head Road adjacent to the Study Area is mapped as having high conservation value (DEC, 2010b).

The roadsides with high conservation values can be designated as special environment areas, often because they have rare flora in them (Lamont and Atkins, 2000).

1.11 Phytophthora Dieback

Phytophthora is a pathogen that travels from the root of the plant via a microscopic water mould in the soil, soil water or through root-to-root contact and causes Phytophthora Dieback (DEC, 2006). Once infected, the root systems of the plants are destroyed thus starving the plants of water and nutrients leading to the eventual death of the plant. Dieback can lead to loss of biodiversity, extinctions of threatened flora and fauna, reduced species richness of plants, loss of key understorey species and loss of habitat and food sources for fauna. Approximately 40% (2,300 species) of flora species recorded in the South-west botanical province are susceptible to Phytophthora Dieback (DEC, 2006). Several *Phytophthora* species are present in native vegetation in the southwest of WA, the most destructive being *Phytophthora cinnamomi*.

Once introduced to an area *Phytophthora* can never be eradicated (DEC, 2006). Devastation is greatest in areas receiving more than 800 mm of rain per annum. Dieback tends to be confined to lakes, wetlands, streams and road verges in areas receiving 400 to 800 mm of rainfall per year.

Indicator species that are reliably susceptible to *Phytophthora cinnamomi* are used in detecting Dieback, as the plants are usually killed by the disease. The DEC's website contains a list of indicator species (DEC, 2012a).

Infestations of Phytophthora Dieback are known to occur close to Eneabba and Jurien, severe infestations have been recorded in Dandaragan National Park and adjacent areas (DEC, 2006) and a species of *Phytophthora* has been recorded in the Lesueur National Park (Department of Conservation and Land Management (CALM), 1995). Figure 1.2 (DEC, 2012b) shows the extent of *Phytophthora* infestation in WA in 2009.

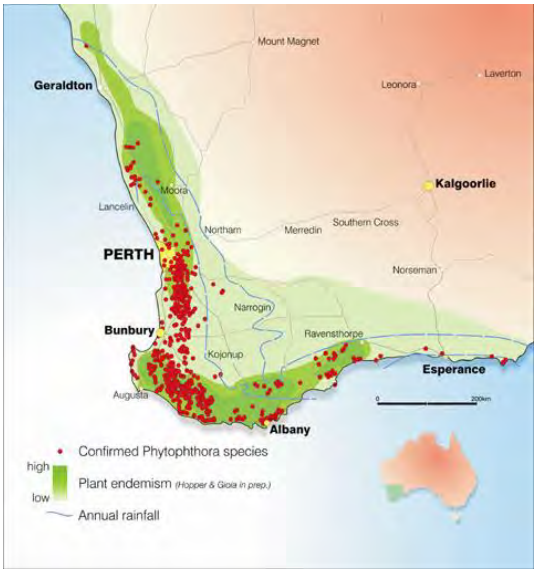


Figure 1.2: *Phytophthora* Infestation in WA (DEC, 2012b)

A Phytophthora Dieback occurrence assessment was conducted at Drover-01A by Glevan Consulting (2012). No infestations associated with Phytophthora Dieback were observed during the survey. Several potential vectors of the disease were observed, however no suspicious plant deaths were identified, and no soil and tissue samples were taken.

2 Survey Methodology, Taxonomy, Vegetation Mapping and Searches

2.1 Field Survey Timing and Methodology

Both Drover-01A and Drover-01B were assessed by two botanists, Drover-01A on September 5 and 6, 2012 (two person days excluding travel) and Drover-01B on July 1, 2013 (one person day excluding travel).

Before the survey AWE Limited indicated the areas needing to be assessed and these were digitised by Maia, converted to shapefiles and uploaded onto GPSs which the botanists then used when carrying out the surveys.

When carrying out the Drover-01A survey in the mostly undisturbed remnant vegetation, the botanists walked transects spaced 15 m apart and more intensively searched an area of approximately 20 m by 20 m at the proposed drilling area. The botanists also extended the search approximately 50 m beyond the western, southern and eastern boundaries of the polygon and up to the edge of Coorow-Greenhead Road along the northern boundary.

When carrying out the Drover-01B survey on farmland, the botanists walked transects spaced 20 m apart at the proposed exploration and campsite areas and 10 m apart at the bore and weed hygiene areas. The whole of the access track polygon was surveyed.

Known and potentially conservation significant flora species and weeds were targeted during the surveys. When either was encountered, their locations were recorded on a GPS and their numbers were counted. When populations were extensive (e.g. weeds at Drover-01B) a percentage cover was estimated.

While carrying out the surveys notes were taken on the vegetation of the Study Area so that vegetation associations could be mapped at a suitable scale.

2.2 Taxonomy and Nomenclature

At least one specimen of every taxon encountered during the surveys was collected for taxonomic verification in Perth. In many cases multiples of flowering or fruiting specimens were collected to assist with identification. Most specimens collected were identified by Dr. Palitha Jayasekara using taxonomic keys and reference specimens at the WA Herbarium; however, specialists at the WA Herbarium were consulted when necessary (particularly Mike Hislop).

Species names used in this report are those adopted by the WA Herbarium and they have been checked against current FloraBase records (Western Australian Herbarium (WAH), 1998 -).

2.3 Vegetation Mapping

Aerial photography available in Bing Maps was used to map the vegetation associations at Drover-01A at a scale of 1:10,000 and at Drover-01B at a scale of 1:8,000. Vegetation associations were described according to the dominant species in each structural class. Notes taken during the surveys were used to delineate the boundaries of each vegetation association.

Statistical analyses were not carried out to define the vegetation associations of the Study Area.

The growth form, height classes and cover characteristics of the mapped vegetation associations are described using the current National Vegetation Inventory System (NVIS) methodology at the association level. At this level up to three strata with a maximum of three taxa per stratum are used to describe the association (Executive Steering Committee for Australian Vegetation Information (ESCAVI), 2003). The NVIS methodology used to describe the vegetation associations is shown in Table A1.1, Appendix 1.

The codes used for the vegetation associations of the Study Area are derived from the dominant habitat in which they were recorded i.e. Sp for Sandy plain.

2.4 Vegetation Condition

Vegetation condition was mapped using notes taken while in the field and is based on the scale developed by Keighery (Government of Western Australia, 2000). A summary of the vegetation scale and criteria is provided in Table 2.1.

Table 2.1: The Vegetation Condition Scale and Criteria Used

Condition Scale	Description
Pristine (1)	Pristine or nearly so, no obvious signs of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good (3)	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good (4)	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded (5)	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded (6)	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

2.5 Literature Search – Previous Biological Surveys

A search of publicly available information was carried out to find any previous flora and vegetation surveys conducted in the area.

2.6 Database Searches

In order to gather information on the flora and ecological communities of the Study Area the sources listed in Table 2.2 were used or searched. Searches were requested of the former DEC's flora and ecological communities databases in August 2012 before carrying out the Drover-01A survey (reference ##75-0812FL and #15-0912EC respectively).

Table 2.2: Databases Used or Searched

Database	Reference or Reference Number	Buffer(s) (km) Used
EPBC Act Protected Matters Search Tool	DSEWPaC (2013b)	5
NatureMap	DEC (2007 -)	5
Threatened and Priority Flora database (TPFL)*	Reference #75-0812FL	5
Threatened and Priority Flora List (TP)*	Reference #75-0812FL	Not applicable
The Western Australian Herbarium (WA Herb)*	Reference #75-0812FL	5
Threatened Ecological Communities database*	Reference #15-0912EC	20
Co-ordinates Searched: 30^0 03' 45.04" S and 115^0 08' 30.35" E - the central point of Drover-01A (indicated by an * in the table) and 30^0 04' 15" S and 115^0 08' 38" E - the central point of the Study Area.		

The following lists were searched to determine whether any weeds produced by the NatureMap searches were any of the following:

- Weeds of National Significance (Australian Government, 2012);
- National Environmental Alert List (Australian Government, 2012);
- Sleeper Weed List (Australian Government, 2012);
- Species Targeted for Eradication (Australian Government, 2012);
- Species Targeted for Biological Control (Australian Government, 2012); and
- A Declared Pest in WA (DAFWA, 2013a).

The following shape files were used and mapped using ArcGIS:

- Soil-landscape mapping of South-Western Australia (DAFWA 2012a & 2012b);
- Pre-European Vegetation (DAFWA, 2012c); and
- Native Vegetation Current Extent (DAFWA, 2012d).

Information from the following sources was downloaded from Landgate's Shared Land Information Platform (SLIP Enabler) (Landgate, 2013) and mapped using ArcGIS:

- DEC Managed Lands and Waters (DEC, 2012c);
- Environmentally Sensitive Areas (DEC, 2013a);
- Environmental Protection Authority (EPA) Redbook Areas (EPA, 2010);
- Schedule 1 Areas (DEC, 2012d);
- Roadside Conservation Values (DEC, 2010a & 2010b); and
- Surface Geology of Australia (Stewart, Sweet, Needham, Raymond, Whitaker, Liu, Phillips, Retter, Connolly & Stewart, 2008).

The results of the database and literature searches are discussed in Section 3.1 and 3.2 of this report. Lists of conservation significant flora collated from the different database searches are included as Tables A2.1 and A2.2 (Appendix 2) and the results of the EPBC Act Protected Matters Search Tool results are also included in Appendix 2.

3 Results - Searches

3.1 Literature Search – Previous Biological Surveys

The Lesueur National Park National Park is a major area of diversity and 821 flora species from 268 genera and 76 families have been recorded within the park; this represents 10% of Western Australia's species. The Lesueur area comprises numerous floristic types and contains some of the most complex vegetation patterns in Australia. Woodlands, shrublands and heaths are the principal formations of the area and sedgelands and occasional herblands also occur (CALM, 1995).

Griffin and Hopkins (1990) provided a review of existing information about the vegetation of the Lesueur area. Vegetation is strongly related to soil type in the northern kwongan and the same can be said for the Lesueur area. The Study Area lies in the Peron Slopes landform and includes two main vegetation communities:

- Lateritic Heath - Low heath (up to 0.5 m) of *Allocasuarina humilis, Calothamnus sanguineus, Hakea conchifolia* and *Lambertia multiflora*, with *Xanthorrhoea drummondii* mid shrubs in areas with more laterite.
- Sand heath - Mid heath (up to 1.5 m) of varying *Banksia candolleana, Adenanthos cygnorum, Banksia attenuata* and *Banksia menziesii* and low shrubs of *Allocasuarina humilis, Melaleuca scabra*, *Conospermum* aff. *triplinervium* and *Hibbertia hypericoides*.

Both of these vegetation communities are abundant within the Peron Slopes landform as well as other landforms mapped in the Lesueur area including the Lesueur Dissected Uplands, Gairdner Dissected Uplands and the Banovich Uplands (Griffin and Hopkins, 1990).

3.2 Database Searches

3.2.1 Conservation Significant Flora

The significant flora species produced by the NatureMap and database searches are listed in Table A2.1 (Appendix 2). Information on each species' rank, flowering time, habitat and their nearest named locations is also included in Table A2.1. A comment on the likelihood of the listed species occurring in the Study Area is included also.

Map 9.9 (Section 9) shows locations of conservation significant species provided in the DEC database search results. The species produced by the TP List search are included as Table A2.2 (Appendix 2). As no locations are provided with these results, these species are not shown on Map 9.9.

3.2.1.1 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

Some flora species are protected under Commonwealth legislation based on the perceived levels of threat to the species population at a national level. These species are placed within one of six conservation categories (Table A3.1, Appendix 3) and four of these categories are specially protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (DSEWPaC, 2013c).

The EPBC Act Protected Matters Search Tool (DSEWPaC, 2013b) results indicated that 17 species or their habitat protected by the EPBC Act may occur in the search area used (Appendix 2). Five of the 17 species were listed in the results of the NatureMap (DEC, 2007 -) and database search results; however, only two have records in the vicinity of the Study Area: *Acacia forrestiana* and *Eucalyptus suberea* (both Vulnerable under the EPBC Act).

The closest *Acacia forrestiana* location is 1.8 km south-east of the Study Area and *Eucalyptus suberea* is located 2.5 km south-east of the Study Area (Map 9.9, Section 9). Based on the typical habitats in which these two species are found (gullies, hills, breakaways), it is thought unlikely that they will occur in the sandy plains habitats of the Study Area (Table A2.1, Appendix 2).

3.2.1.2 WA WILDLIFE CONSERVATION ACT 1950

All flora species native to WA are protected under the State's *Wildlife Conservation Act 1950*. Under this act, the Minister for the Environment may declare species of flora to be protected if they are considered to be in danger of extinction, rare or otherwise in need of special protection: Schedules 1 and 2 list species that are threatened or presumed extinct respectively (DEC, 2013b).

In WA the term Threatened Flora is applied to extant declared rare flora (DRF) and Presumed Extinct Flora to extinct DRF (DEC, 2013b and defined in Table A3.2 Appendix 3). The most recent DRF list was published in November 2012 (Government of Western Australia, 2012).

The two species listed in the results of the DEC database search and protected by the EPBC Act are also listed as Threatened Flora species and are protected by the WC Act. *Acacia forrestiana* and *Eucalyptus suberea* are both listed as Vulnerable under the WC Act.

3.2.1.3 PRIORITY FLORA

Species that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora List under priorities (P) 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in P4; these species require regular monitoring. Conservation Dependent species are placed in P5 (DEC, 2013b).

Definitions for each of the categories discussed above are included in Table A3.3, Appendix 3. The most recent Threatened and Priority Flora List was published on December 20, 2012 (Smith, 2012).

FloraBase (WAH, 1998 - ; July 5, 2013) lists 41 P1, 77 P2, 114 P3, 48 P4 and no P5 flora species with records in the Lesueur Sandplain subregion.

The database and NatureMap search results (DEC, 2007 -) produced a combined list of 23 priority species that have been recorded within 5 km of the centre of the Study Area – 11 P2 flora species, six P3 and six P4 (Table A2.1, Appendix 2).

Based on similarity of habitat and distance of known locations from the Study Area, 16 of the 23 priority species produced by the database and NatureMap searches could possibly occur in the Study Area: *Acacia lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039), *Acacia retrorsa, Andersonia* sp. Mt Lesueur (E.A. Griffin 5536), *Arnocrinum gracillimum* (all P1)*, Persoonia filiformis, Phlebocarya pilosissima* subsp*. teretifolia* (both P2), *Banksia kippistiana* var. *paenepeccata, Haemodorum loratum, Persoonia rudis, Verticordia insignis* subsp*. eomagis, Verticordia muelleriana* subsp. *muelleriana, Verticordia rutilastra* (all P3), *Banksia sclerophylla, Stylidium inversiflorum*, *Thysanotus glaucus* and *Xanthosia tomentosa* (all P4). These are all perennial species.

3.2.2 Introduced Flora

A weed is defined in the Australian Weeds Strategy (Department of Environment and Water Resources [DEWR], 2007) as 'a plant which has, or has the potential to have, a detrimental effect on economic, social or conservation values'. Weeds can include species that have proliferated in bushland without direct human intervention or assistance (referred to as naturalised alien species).

3.2.2.1 WEEDS OF NATIONAL SIGNIFICANCE

A number of lists of weeds of national interest are currently recognised (DEC, 2013c). The nature of the weeds and the resulting actions required determine on which list a species may appear. Some weeds are of particular concern and, as a result, have been listed for priority management or in legislation e.g. weeds of national significance (WoNS).

The search using the EPBC Act Protected Matters Search Tool (DSEWPaC, 2013b) listed no weeds on these weeds lists.

The NatureMap search results (DEC, 2007 -) included two weeds on a weed list as having been recorded within 5 km of the Study Area – *Asparagus asparagoides* (Bridal Creeper) and *Tamarix aphylla* (Athel Tree). *T. aphylla* and *A. Asparagoides* are listed as weeds of national significance (WoNS) (Australian Government, 2012).

3.2.2.2 PLANT PESTS DECLARED IN WESTERN AUSTRALIA

Before 30 April 2013, plants known to adversely affect agriculture (or have the potential to) were known as declared plants and were listed as one or more of five priority category weeds under the *Agriculture and Related Resources Protection Act 1976* (ARRP Act) (Agriculture Protection Board of Western Australia (APBWA), 2013).

On May 1 2013 the *Biosecurity and Agriculture Management Act 2007* (BAM Act) and regulations came into force. Legislation to be repealed is now covered by the BAM Act and its regulations (DAFWA, 2013a).

The Western Australian Organism List (WAOL) has been created to easily find out the declared status of organisms that have now been classified as part of the enactment of the BAM Act (DAFWA, 2013b).

Organisms are grouped into four main classifications: Declared pests; Permitted; Prohibited; and, Permitted requiring a permit.

Under the BAM Act, all declared pests are placed in one of three categories, namely C1 (exclusion), C2 (eradication) or C3 (management) (DAFWA, 2013b). These three categories are described in Table A4.1, Appendix 4.

- Two declared pest plant species – *Asparagus asparagoides* and *Tamarix aphylla* were listed in the results of the EPBC Act Protected Matters Search Tool search. Both plants are listed as C3 declared pests and are both are prohibited for the whole of the state (DAFWA, 2013b).
- No declared pest plant species were listed in the NatureMap search results (DEC, 2007 -).

3.2.2.3 GENERAL ENVIRONMENTAL WEEDS

Environmental weeds are introduced plants that establish themselves in natural ecosystems and adversely modify natural processes, resulting in the decline of the communities they invade (DEC, 2013d).

The EPBC Act Protected Matters Search Tool (DSEWPaC, 2013b) indicated that two invasive species (weeds) could occur at the Study Area – *Asparagus asparagoides* and *Tamarix aphylla.*

The NatureMap search results (DEC, 2007 -) listed one weed species that has been recorded in the vicinity of the Study Area - *Lysimachia arvensis* (Pimpernel).

In WA the Environmental Weed Strategy for Western Australia (EWSWA) (CALM, 1999) provides details of management priorities and general control measures and monitoring for environmental weeds. The EWSWA is still relevant but Appendix 3 of the document - the 'List of Environmental Weed Species of Actual and Potential Significance in WA' is now out of date and the Invasive Plant Prioritisation Process for DEC has been developed (DEC, 2013e). Workshops have been held in each DEC Region to prioritise weed species according to their threat

to the natural environment and these weed assessments are now available. Most of the weeds listed are rated for their invasiveness, distribution and ecological (environmental) impacts among other attributes.

The DEC's Midwest region weed assessment spread-sheet (DEC, 2013f) lists 356 environmental weeds for the Geraldton Sandplains bioregion while FloraBase (WAH, 1998 -) lists 291 and 152 weeds (including declared species) for the Geraldton Sandplains bioregion and Lesueur Sandplain subregion respectively.

3.2.3 Ecological Communities

Some ecological communities are protected by Commonwealth and / or WA legislation (Threatened Ecological Communities – TECs). Others are listed as Priority Ecological Communities (PECs) in WA. The conservation significance rankings for TECs and PECs are listed in Table A3.4 and A3.5 in Appendix 3 (DEC, 2010c).

No TECs protected by the EPBC Act occur in the Geraldton Sandplains bioregion (DSEWPaC, 2013d).

The most recent list of TECs endorsed by the Minister of Environment in WA was released in May 2013 and includes five TECs in the Geraldton Sandplains bioregion: '18.Thetis-microbialite' (Vulnerable B in WA); '42.Greenough River Flats' (Critically Endangered C in WA); '72.Ferricrete Floristic Community' (Vulnerable B in WA), '76.Lesueur-Coomallo Floristic Community D1' (Critically Endangered Bi and Bii in WA); and, '77.Lesueur-Coomallo Floristic Community A1.2' (Endangered Bii in WA) (DEC, 2013g).

The most recent PEC list was released on March 26, 2013 and 75 PECs are listed for the Midwest region (DEC, 2013h).

Information produced by the ecological communities database searches follows:

- The Study Area does not fall within the buffer around any of the currently-listed TECs or PECs.
- The closest PEC to the Study Area is an occurrence of the Priority 2 '*Petrophile chrysantha* low heath on Lesueur dissected uplands' PEC, which occurs at a number of locations south of the Study Area. The closest location is approximately 3 km to the south-east of the southern section of Drover-01B.

The results of the Threatened Ecological Communities database search are shown on Map 9.10 (Section 9). These search results were cross checked with TECs on NatureMap (2007 -) for currency.

3.2.4 Environmentally Sensitive Areas, Conservation Estates, Schedule 1 Areas and EPA Redbook Areas

Data downloaded from Landgate's SLIP Enabler (Landgate, 2013) for environmentally sensitive areas (ESAs), DEC Managed Lands and Waters, Schedule 1 areas and EPA Red Book areas in the vicinity of the Study Area are plotted on Map 9.11, Section 9.

ESAs are areas requiring special protection of rare or threatened flora, sites that have high conservation, scientific or aesthetic values and/or Aboriginal or European cultural sites.

- The majority of Drover-01A falls within the boundaries of an ESA, which extends beyond the boundary of Lesueur National Park almost to Coorow-Green Head Road.
- Drover-01B lies outside the ESA, to the east of and along its boundary.

The National Reserve System (NRS) is Australia's network of protected areas managed for conservation under international guidelines. Conservation Parks have regional or local significance and are set aside to conserve wildlife and the landscape for scientific study and to preserve features of archaeological, historical or scientific interest (DEC, 2013i). DSEWPaC maintains the Collaborative Australian Protected Area Database (CAPAD) which

provides a national perspective on the conservation of biodiversity in protected areas to aid reporting on the status of protected areas (DSEWPac, 2013e). Terrestrial protected areas of WA under the NRS are listed in CAPAD as either: 5(1)(g) Reserves, 5(1)(h) Reserves, Conservation Parks, Indigenous Protected Areas, Miscellaneous Reserves, National Parks, Nature Reserves, NRS Additions – Gazettal in Progress, or Protected Areas (DSEWPaC, 2013e).

- One of the boundaries of the Lesueur National Park is located approximately 1.1 km south of Drover-01A. The Drover-01B proposed exploration area lies just outside, to the east of and along a neighbouring boundary of the National Park. Lesueur National Park is an ESA and some of it is an EPA Redbook Area. The National Park was gazetted as a Class A reserve for national park on 24 January 1992 (CALM, 1995) and is now vested in the Conservation Commission and managed by the DEC (DEC and CCWA, 2008; DoW, 2008). It is one of three major areas of biodiversity in Western Australia (CALM, 1995). The Beekeepers-Lesueur-Coomallo Area and Nambung National Park were listed in the EPBC Act Protected Matters Search Tool results under Matters of National Environmental Significance – National Heritage Properties - as a Nominated place (DSEWPaC, 2013b; Appendix 2). The Mount Lesueur Area and Mount Lesueur Proposed Reserve are also listed as places on the Register of the National Estate (RNE) and Lesueur as a State and Territory Reserve in WA in the EPBC Protected Matters Search Toool results (Appendix 2).

- Drover-01A lies within Reserve No. 42031. The vesting of the reserve was unclear in November 2012 (when the initial report on Drover-01A was finalised). Maia contacted the Tenure Officer at the Information Management Section at DEC (R. Doria) and a reserve enquiry was submitted to Landgate (R. Doria, December 2012). The information received is included as Appendix 5. The reserve is a Class C reserve for the purpose of sand and gravel extraction and it is under a management order to the Shire of Coorow (pers. comm. R. Doria, 19 Dec 2012). The Reserve Enquiry Detail from Landgate indicates that the responsible agency for Reserve No. 42031 is the Director of the Department of Conservation and Land Management; however, this is incorrect and it is the Shire of Coorow (pers. comm. R. Doria, 19 Dec 2012).

- Drover-01B is located on freehold land.

A Schedule 1 Area may require a permit for vegetation clearing resulting from low impact mineral or petroleum activities.

- The Study Area is located within a Schedule 1 Area. The Geraldton Sandplains is a non-permitted area under Schedule 1 of the Environmental Protection (Clearing of Vegetation) Regulations 2004 (AustLII, 2013).

An EPA Redbook Area is an area recommended by the EPA for conservation (EPA, 2010).

- The closest EPA Redbook Area is within Lesueur National Park approximately 4.7 km south of Drover-01A and 3 km south of Drover-01B.

4 Results - Survey

4.1 Flora

4.1.1 General Flora

A combined total of 204 taxa from 108 genera and 43 families were recorded at the Study Area.

The following information was collected on the general flora of Drover-01A:

- 157 taxa were recorded from 93 genera and 37 families (92.36% perennial, 7.64% annual).
- The most common families were Proteaceae (32), Fabaceae (18) and Myrtaceae (17).
- The most common genera were *Hakea* (9), *Banksia* (8) and *Acacia* and *Schoenus* (5).
- At the time of the survey 60.51% of the 157 taxa were flowering, 10.19% were fruiting and 0.64% were both flowering and fruiting.

The following information was collected on the general flora of Drover-01B:

- 120 taxa were recorded from 71 genera and 33 families (89.17% perennial, 10.83% annual).
- The most common families were Proteaceae (28), Fabaceae (17) and Myrtaceae (14).
- The most common genera were *Banksia* (9), *Hakea* (7) and *Acacia* (5).
- At the time of the survey 48.33% of the 120 taxa were flowering, 11.67% were fruiting and 3.33% were both flowering and fruiting.

A list of the flora taxa recorded is included as Table A6.1, Appendix 6.

4.1.2 Regional Endemics

Regional endemics are plants that are geographically restricted to a particular locality or region. The Lesueur area is known to have many regional endemics (Griffin & Hopkins, 1990).

Phlebocarya pilosissima subsp. *teretifolia* (P2) is one of these regional endemics and in 1990, 100% of the known populations occurred in the Lesueur area. This species was located in Drover-01A.

4.1.3 Range Extensions

Species have a typical range which is indicated by their known distribution records. Sometimes species are recorded during a survey, which have not been located previously in the area; these species are described as range extensions. In many cases a range extension reflects a lack of surveys in a particular area or submissions of flora records to the WA Herbarium rather than a true range extension.

No range extension species were recorded at the Study Area.

4.1.4 Conservation Significant Flora

4.1.4.1 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1950

No species protected by the EPBC Act were recorded at the Study Area.

4.1.4.2 WESTERN AUSTRALIAN WILDLIFE CONSERVATION ACT 1950

No species protected by the WC Act were recorded at the Study Area.

4.1.4.3 PRIORITY FLORA

Six priority flora species and one potentially significant taxon (PST) were recorded at the Study Area – six priority species within and in the area surrounding Drover-01A and two priority species and one potentially significant taxon at Drover-01B. These species are described below and their locations indicated on Maps 9.12 and 9.13, Section 9.

Note: the botanists searched the area where the *Stylidium inversiflorum* database locations occur along the Drover-01B access track corridor (Map 9.9, Section 9); however, they could not find these plants It is possible that the locations are actually further west and on the western (park) rather than eastern (farmland) side of the fence.

***Chordifex reseminans* - Restionaceae (Priority 1)**

C. reseminans is an erect sedge growing to 90 cm in height that produces flowers between March and May. This species grows on sand-plains and in slight depressions (WAH, 1998 -).

C. ?reseminans (a potentially significant taxon, PST) was recorded in regenerating vegetation in the proposed exploration area at Drover-01B (Plate 4.1). While *C. ?reseminans* has the erect habit of *C. reseminans* (Plate 4.2), it was not flowering or fruiting when collected in July 2013 and therefore its identity cannot be confirmed.

C. ?reseminans was recorded at one location at Drover-01B (Map 9.13, Section 9). FloraBase lists seven records for *C. reseminans* from two bioregions (Geraldton Sandplains and Swan Coastal Plain) (WAH, 1998 -).

Plate 4.1: Habitat recorded in

Plate 4.2: Pressed specimen

***Acacia carens* – Fabaceae (Priority 2)**

A. carens (Plate 4.3) is an open, broom-like shrub, with striated green branches growing to 0.6 m high (World Wide Wattle, 2012). The globular yellow flowers are produced from April to June and the pods are linear and curved to 10 cm long (Plate 4.4). This species grows on gravel or sandy gravel and lateritic uplands (World Wide Wattle, 2012 and WAH, 1998 -). This species was fruiting in September 2012 and flowering in July 2013.

A. carens was recorded at one location at Drover-01A (Map 9.12, Section 9) and one location at Drover-01B (Map 9.13, Section 9). FloraBase lists 11 records for *A. carens* from the Geraldton Sandplains bioregion (WAH, 1998 -).

Plate 4.3: Growth habit

Plate 4.4: Close-up of pods

***Acacia lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039) – Fabaceae (Priority 2)**

A. lasiocarpa var. *lasiocarpa* Cockleshell Gully variant (Plate 4.5) is a spinose shrub growing to 0.5 m high. The leaves are 1-5 mm long and 0.5 – 1 mm wide (World Wide Wattle, 2012). The globular yellow flowers are produced in August and the pods are flat (Plate 4.6). This species grows on grey-yellow sand with laterite in low open heath (WAH, 1998 -). This species was fruiting in September 2012 and flowering in July 2013.

A. lasiocarpa var. *lasiocarpa* Cockleshell Gully variant was recorded at 17 locations within Drover-01A and three locations just outside (Map 9.12, Section 9). It was located at six locations at Drover-01B (Map 9.13, Section 9). FloraBase lists six records for *A. lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant from the Geraldton Sandplains bioregion (WAH, 1998 -).

Plate 4.5: Growth habit

Plate 4.6: Close-up of leaves and flowers

***Phlebocarya pilosissima* subsp. *teretifolia* – Haemodoraceae (Priority 2)**

P. pilosissima subsp. *teretifolia* (Plates 4.7 and 4.8) is a shortly rhizomatous, loosely tufted herb growing to 0.4 m high. The leaves are green and terete. The flowers are cream-white and are produced from August to October. This species grows on white or grey sand (WAH, 1998 -). This species was flowering in September 2012.

P. pilosissima subsp. *teretifolia* was recorded at one location at Drover-01A (Map 9.12, Section 9). FloraBase lists 17 records for *P. pilosissima* subsp. *teretifolia* from two bioregions (Geraldton Sandplains and Swan Coastal Plain) (WAH, 1998 -).

Plate 4.7: Pressed specimen

Plate 4.8: Close-up of leaves

***Desmocladus biformis* – Restionaceae (Priority 3)**

D. biformis (Plate 4.9) is a rhizomatous, densely tufted perennial herb growing to 0.2 m high. The brown flowers are produced from September to October (Plate 4.10). This species grows on sand to sandy-clay soil with laterite (WAH, 1998 -). This species was flowering in September 2012.

D. biformis was recorded at two locations at Drover-01A (Map 9.12, Section 9). FloraBase lists 28 records for *D. biformis* from five bioregions (Avon Wheatbelt, Esperance Plains, Geraldton Sandplains, Jarrah Forest and Swan Coastal Plain) (WAH, 1998 -).

Plate 4.9: Pressed specimen

Plate 4.10 Close-up of leaves and flowers

***Diuris recurva* – Orchidaceae (Priority 4)**

D. recurva (Plate 4.11) is a tuberous perennial herb that grows to 0.3 m high and its yellow-brown flowers are produced from July to August (Plate 4.12). This species grows on loam soils and in winter-wet areas (WAH, 1998). This species was flowering in September 2012.

D. recurva was recorded at one location at Drover-01A (Map 9.12, Section 9). FloraBase lists 52 records for *D. recurva* from three bioregions (Avon Wheatbelt, Geraldton Sandplains and Jarrah Forest) (WAH, 1998 -).

Plate 4.11: Growth habit

Plate 4.12: Close-up of flowers

***Xanthosia tomentosa* - Apiaceae (Priority 4)**

X. tomentosa is a prostrate to ascending perennial herb growing to 0.9 m high (Plate 4.13). The white-cream-pink flowers are produced from September to December (Plate 4.14). This species grows on lateritic gravelly soils (WAH, 1998 -). This species was flowering and fruiting in September 2012.

X. tomentosa was recorded at 76 locations at Drover-01A. An additional 20 locations were recorded just outside the Drover-01A polygon (Map 9.12, Section 9). FloraBase lists 48 records for *X. tomentosa* from two bioregions (Geraldton Sandplains and Swan Coastal Plain) (WAH, 1998 -).

Plate 4.13: Growth habit

Plate 4.14: Close-up of leaves and flower

4.1.4.4 TAXA OF INTEREST

One taxon of interest (TOI) was recorded at both Drover-01A and 01B: *Leucopogon* aff. *oldfieldii*.

L. aff. *oldfieldii* is an atypical representative of a relatively distinct variation of *Leucopogon oldfieldii*, which is quite common in the area (M. Hislop, pers. comm, October 30 2012). The specimens were atypical in having only sparsely hairy rather than densely hairy ovaries. The white-pink flowers were present on the plant during the survey. *L. oldfieldii* grows on white/grey or yellow sand and gravelly lateritic sand on the sandplains of the Avon Wheatbelt, Geraldton Sandplains, Jarrah Forest and Swan Coastal Plain (WAH, 1998 -).

L. aff. *oldfieldii* was recorded at three locations at Drover-01A (Map 9.12, Section 9) and one location at Drover-01B (Map 9.13, Section 9).

4.1.5 Introduced Flora

4.1.5.1 NATIONAL WEEDS LISTS

No weeds on any of the national weeds lists were recorded at the Study Area.

4.1.5.2 AGRICULTURE AND RELATED RESOURCES PROTECTION ACT 1976

No Declared Pest plant species was recorded at the Study Area.

4.1.5.3 ENVIRONMENTAL WEEDS

Twelve environmental weed species were located at the Study Area. These are listed in Table 4.1 along with the invasiveness, distribution, ecological impact rankings (DEC, 2013f). The overall aggressiveness score in Table 4.1 is the product of the scores for invasiveness and ecological impact. The ratings for invasiveness and a score for each rating follow: rapid (4); moderate (3); slow (2); and, unknown (1). The ratings for ecological impact and a score for each rating follow: high impact (4); medium impact (3); low impact (2); and, unknown (1). Descriptions for and photographs of these 12 environmental weed species are provided in Table 4.2; a map of WA showing the known distribution of these weed species is also included in Table 4.2. Their locations are shown on Maps 9.14 and 9.15 (Section 9).

Two genera were collected that could not be identified to species level – *Avena* sp. and *Cotula* sp. All seven species of *Avena* occurring in WA are weeds and the *Avena* sp. collection has therefore been included in the weed results. Three of the five species of *Cotula* recorded in Western Australia are weeds and, given that the area where the *Cotula* sp. was recorded is a cleared paddock, it also has been included in the weed results.

Table 4.1. Ecological Ratings for Weeds Recorded at the Study Area

Species	Invasiveness Rating	Current Distribution	Ecological Impact Rating	Aggressiveness Score
Arctotheca calendula	Rapid	Extensive	High	8
Avena sp.	Information not available for genus only			
Brassica tournefortii	Rapid	Extensive	High	8
Cotula sp.	Information not available for genus only			
Hypochaeris glabra	Rapid	Extensive	Unknown	5
Lupinus cosentinii	Moderate	Extensive	Moderate	6
Ornithopus sativus	Rapid	Low	Low	6
Pelargonium capitatum	Moderate	Extensive	High	7
Raphanus raphanistrum	Rapid	Extensive	High	8
Solanum nigrum	Rapid	Extensive	Unknown	5
Ursinia anthemoides subsp. *anthemoides*	Rapid	Extensive	High	8
Vulpia myuros forma *myuros*	Rapid	Extensive	Unknown	5

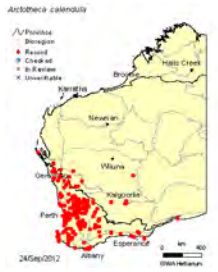
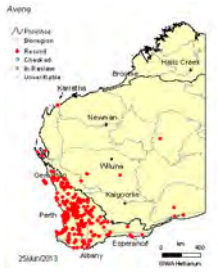
Five environmental weeds are considered to be highly-aggressive weeds based on their score of 7 and 8 – *Arctotheca calendula*, *Brassica tournefortii*, *Pelargonium capitatum Raphanus raphanistrum* and *Ursinia anthemoides* subsp. *anthemoides* (Table 4.1). Five weeds are considered to be moderately aggressive weeds

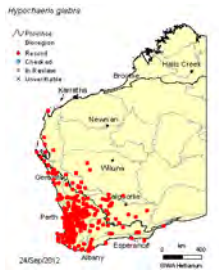
based on their score of 5 and 6 - *Hypochaeris* glabra, *Lupinus cosentinii*, *Ornithopus sativus*, *Solanum nigrum* and *Vulpia myuros* forma *myuros*.

Six of these 12 weed species were located within or just outside the boundaries of Drover-01A: *Arctotheca calendula*; *Hypochaeris glabra*; *Ornithopus sativus*; *Solanum nigrum*; *Ursinia anthemoides* subsp. *anthemoides*; and, *Vulpia myuros* forma *myuros*.

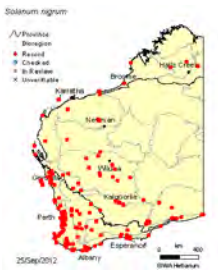
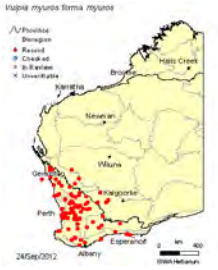
Ten of the 12 weed species were located within the boundaries of Drover-01B: *Arctotheca calendula*; *Avena* sp.; *Brassica tournefortii*; *Cotula* sp.; *Hypochaeris glabra*; *Lupinus cosentinii*; *Ornithopus sativus*; *Pelargonium capitatum*; *Raphanus raphanistrum*; and, *Solanum nigrum.*

Table 4.2: Environmental Weeds Recorded at the Study Area

Weed	Description	Habitat	Known WA Distribution	Distribution in the Study Area	Photograph
Arctotheca calendula	Rosette-forming annual herb to 0.3 m high. Greyish lobed leaves with white hairs on the underside. The flowers are yellow with black centres and are produced from August to November.	Weed of roadsides, waste places and cultivated land.		Scattered (three locations) at Drover-01A. Very common (1 to 10% cover) over Drover-01B.	
Avena sp.	Erect annual grass-like or herb.	Unknown		Not recorded at Drover-01A. Common (1 to 4% cover) over Drover-01B. Often seen in dense patches under trees and shrubs especially at the bore and exploration areas.	
Brassica tournefortii	Annual herb to 0.1 - 0.6 m high. Flowers are yellow-cream-white occurring from June to November.	Sandy soils. Weed of disturbed ground, roadsides, cultivation and seaside.		Not recorded at Drover-01A. Scattered (<1% cover) at the camp in Drover-01B.	

Weed	Description	Habitat	Known WA Distribution	Distribution in the Study Area	Photograph
Cotula sp.	Thin branched annual to 0.2 m high. Flowers yellow or white.	n/a		Not recorded at Drover-01A. Scattered (<1% cover) over Drover-01B, especially at the camp area.	
Hypochaeris glabra	Rosetted annual or perennial herb to 0.5 m high. Smooth leaves. The yellow flowers are produced from January to December but mainly in spring.	Common weed of lawns, horticultural areas, roadsides and bushland.		Scattered (two locations) at Drover-01A and along the roadside (three locations). Very common (1 to 10% cover) over Drover-01B.	
Lupinus cosentinii	A robust, branched annual herb growing to 0.2-1.4 m high. Flowers are blue occurring from August to Novemeber.	Sand, loam, river edges, swamps and roadsides.		Not recorded at Drover-01A. Scattered (<1% cover) at the camp area in Drover-01B.	

Weed	Description	Habitat	Known WA Distribution	Distribution in the Study Area	Photograph
Ornithopus sativus	A sprawling hairy annual to 0.45 m high. The leaves consist of 15 to 18 leaflets. The pink to white flowers are produced from August to November or during March.	Along track edges, disturbed ground.		Scattered (one location) outside Drover-01A. Scattered (1% cover) at Drover-01B.	
Pelargonium capitatum	A straggling, shrubby perennial herb growing to 0.1 to 1 m high. Flowers are pink-purple to white occurring from February to April or August to December.	Sand, coastal sand dunes and limestone.		Not recorded at Drover-01A. Scattered (19 locations) at Drover-01B.	
Raphanus raphanistrum	An erect annual herb to 0.15 to 1 m high. Flowers are yellow-white/pink, occurring from April to May or July to November.	Disturbed areas.		Not recorded at Drover-01A. Scattered (five locations) along the track at Drover-01B.	

Weed	Description	Habitat	Known WA Distribution	Distribution in the Study Area	Photograph
Solanum nigrum	Erect perennial herb or shrub to 1 m high. The white flowers are produced from January to December. It produces dull black or purplish berries.	Gardens, horticultural crops, wastelands, disturbed woodlands, pastures, creeklines and wetlands.		Scattered (one location) outside Drover-01A. Scattered (five locations) at Drover-01B.	
Ursinia anthemoides subsp. *anthemoides*	Erect annual herb to 0.5 m high. It has feathery divided leaves. The solitary yellow-orange-cream to white flowers are produced from July to December.	Various habitats particularly roadsides and waste places.		Scattered (four locations) at Drover-01A. Not recorded at Drover-01B.	
Vulpia myuros forma *myuros*	Tufted annual grass to 0.3 m high. The flowers are green and are produced in spring.	Weed of cereal crops and pastures. Re-vegetation areas and many other vegetation types.		Scattered (one location) outside Drover-01A. *http://keyserver.lucidcentral.org/weeds/data/03030800-0b07-490a-8d04-0605030c0f01/media/Html/Vulpia_myuros.htm* Not recorded at Drover-01B.	

Descriptions and habitats from WAH (1998 -) and Hussey *et al*. (2007). Map showing known WA Distributions from WAH (1998 -). Mapping by Paul Gioia. Images used with the permission of the Western Australian Herbarium, Department of Environment and Conservation (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Monday, 3 July 2013. Descriptions by the Western Australian Herbarium, Department of Environment and Conservation. Text used with permission (http://florabase.dec.wa.gov.au/help/copyright). Accessed on Monday, 29 October 2012 and Tuesday, 9 July 2013. Unless otherwise indicated photographs are by Maia.

4.2 Vegetation

4.2.1 Vegetation Associations of the Study Area

Four vegetation associations occur in the Study Area. These are described in Table 4.4 and their distribution is shown on Maps 9.16 and 9.17 (Section 9). Two of the four associations occur at Drover-01A (SP1 and Sp2) and two at Drover-01B (Sp3 and Sp4).

4.2.2 Vegetation Association Cover in the Study Area

The area and cover of each of the vegetation associations mapped at the Study Area are listed below.

Table 4.3: Area and Cover of Vegetation Associations Mapped at the Study Area

Vegetation Association Code: Broad Floristic Formation	Mapped at the Study Area	
	Area (ha)	Proportion of the Study Area (%)
Sp1: *Banksia*, *Hibbertia* and *Calothamnus* Low Heathland.	7.09	27.36
Sp2: *Banksia*, *Hibbertia* and *Calothamnus* Low Heathland.	1.97	7.61
Sp3 (regrowth): *Hibbertia*, *Jacksonia* and *Xanthorrhoea* Low Open Heathland.	4.60	17.76
Sp4 (regrowth): *Eucalyptus* Open Low Mallee Woodland and *Calothamnus* Mid Sparse Shrubland.	8.76	33.81
C: Cleared Land	3.49	13.51
Total	25.91	100

4.2.3 Vegetation Condition

The condition of the vegetation at Drover-01A and 01B reflects its status i.e. remnant vegetation or farmland (Map 9.15, Section 9).

The condition of the remnant vegetation at Drover-01A is rated mostly as Excellent, small areas as Good (old tracks now regrown) and small areas as Completely Degraded (areas cleared for gravel and access).

Vegetation condition at Drover-01B is rated mostly as Good (areas cleared in the past but now regenerating), other areas as Completely Degraded (areas that have been cleared) and some areas as Degraded (areas where the vegetation has been mostly cleared). Additional information on vegetation condition at the Study Area is included in Table 4.5.

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Table 4.4: Vegetation Associations mapped at the Study Area

Vegetation Code	Association Description	Associated Species	Photograph
Sp1 This association was recorded on white sandy soils, sometimes with lateritic gravel on undulating sandplains. The condition of this association was mostly rated as Excellent.	**Broad Floristic Formation:** *Banksia*, *Hibbertia* and *Calothamnus* Low Heathland. **Vegetation Association:** Mid Sparse Shrubland of *Xanthorrhoea drummondii*, over a Low Heathland of *Banksia armata* var. *armata*, *Hibbertia hypericoides* and *Calothamnus sanguineus* and a Sparse Sedgeland of *Mesomelaena pseudostygia* and *Conostylis teretifolia* subsp. *teretifolia*.	*Allocasuarina humilis* *Baeckea grandiflora* *Calectasia narragara* *Hibbertia huegelii* *Philotheca spicata* *Synaphea spinulosa* subsp. *spinulosa*	
Sp2 This association was recorded on white sandy soils on undulating sandplains. The condition of this association was mostly rated as Excellent.	**Broad Floristic Formation:** *Banksia*, *Hibbertia* and *Calothamnus* Low Heathland. **Vegetation Association:** Low Isolated Mallee Shrubs of *Eucalyptus todtiana*, over a Mid to Tall Open Shrubland of *Banksia attenuata* and *Banksia menziesii*, over a Low Heathland of *Banksia armata* var. *armata*, *Hibbertia hypericoides* and *Calothamnus sanguineus* and a Sparse Sedgeland of *Mesomelaena pseudostygia* and *Conostylis teretifolia* subsp. *teretifolia*.	*Calothamnus sanguineus* *Conospermum triplinervium* *Hakea auriculata* *Johnsonia pubescens* subsp. *pubescens* *Lasiopetalum drummondii* *Leucopogon crassiflorus* *Synaphea spinulosa* subsp. *spinulosa* *Verticordia grandis* *Xanthorrhoea drummondii*	

Vegetation Code	Association Description	Associated Species	Photograph
Sp3 (regrowth) This association was recorded on white sandy soils on undulating sandplains. The condition of this association was mostly rated as Good.	**Broad Floristic Formation:** *Hibbertia*, *Jacksonia* and *Xanthorrhoea* Low Open Heathland. **Vegetation Association:** Low Isolated Mallee Shrubs of *Eucalyptus todtiana*, over a Low Open Heathland of *Hibbertia hypericoides*, *Jacksonia floribunda* and *Xanthorrhoea drummondii* and a Sparse Sedgeland of *Patersonia occidentalis* and *Mesomelaena pseudostygia.*	*Bossiaea eriocarpa* *Leucopogon* aff. *oldfieldii* *Synaphea spinulosa* subsp. *spinulosa* *Hibbertia huegelii* *Conospermum boreale* subsp. *boreale* *Stirlingia latifolia*	
Sp4 (regrowth) This association was recorded on white sandy soils on undulating sandplains. The condition of this association was mostly rated as Good to Degraded.	**Broad Floristic Formation:** *Eucalyptus* Low Open Mallee Woodland and *Calothamnus* Mid Sparse Shrubland. **Vegetation Association:** Low Open Mallee Woodland Shrubs of *Eucalyptus todtiana*, over a Mid Sparse Shrubland of *Calothamnus sanguineus* over a Low Sparse Heathland of *Hibbertia hypericoides*, *Stirlingia latifolia and Allocasuarina humilis* and a Sparse Sedgeland of *Patersonia occidentalis.*	*Banksia attenuata* *Verticordia densiflora* *Nuytsia floribunda*	

Table 4.5: Vegetation Condition at the Study Area

Rating	D-01A	D-01B	Study Area		Notes	Photograph
	Area (ha)	Area (ha)	Total (ha)	Total (%)		
Excellent	7.63	0	7.63	29.45	The majority of the vegetation at Drover-01A is in Excellent condition as it has not been cleared and there are no significant weeds. Similarly the condition of the vegetation on either side of the track close to Greenhead-Coorow Road at Drover-01B is also Excellent. The photograph (right) shows the vegetation rated as in Excellent condition at Drover-01A.	
Good	0.57	12.21	12.78	49.33	The condition of the vegetation along two old tracks running through Drover-01A is rated as Good. These tracks were cleared a number of years ago; however, the vegetation still retains its basic structure and will likely return to a natural condition over time. No weeds were recorded along these tracks. Vegetation condition at the Drover-01B proposed exploration area is also rated as Good. This area has been cleared in the past; however, the vegetation has regenerated substantially and will more than likely improve with time. Weeds were common in this area. The photograph (right) shows regrowth vegetation in Good condition at the proposed exploration area at Drover-01B.	

Rating	D-01A Area (ha)	D-01B Area (ha)	Study Area Total (ha)	Study Area Total (%)	Notes	Photograph
Degraded	0.00	1.15	1.15	4.42	The condition of the vegetation at the water bore area at Drover-01B is rated as Degraded. It has been grazed, the understory is almost non-existent and weeds were very common in the area. The photograph to the right shows the vegetation at the Drover-01B water bore area.	
Completely Degraded	0.86	3.49	4.35	16.80	Vegetation condition at the gravel pit at Drover-01A and along a section of the roadside vegetation to the north of Drover-01A is rated as Completely Degraded. The vegetation is not intact and many weeds occur in these areas. Vegetation condition along the access track and at the campsite and hygiene station areas at Drover-01B is rated as Completely Degraded as it has been cleared and weeds are very common in these areas. The main track and edges at Drover-01B are mostly bare sand with scattered weeds. Weed cover along the edges of the track is high and similar to that recorded at the camp and hygiene station areas. The photograph to the right shows the Completely Degraded vegetation along the track, close to the camp area at Drover-01B.	

4.3 Ecological Communities

4.3.1 TECs

The Critically Endangered TEC 'Lesueur-Coomallo Floristic Community D1' is a species rich low heath, on moderately drained lateritic gravels on lower slopes and low rises and is dominated by: *Allocasuarina microstachya* with *A. ramosissima,* ***A. humilis, Baeckea grandiflora****, Borya nitida, Calytrix flavescens,* ***Calothamnus sanguineous****, Conostylis androstemma, Cryptandra pungens,* ***Banksia armata****,* ***Gastrolobium polystachyum****,* ***Hakea auriculata, H. incrassata****, H.* aff. *erinacea,* ***Hibbertia hypericoides,*** *Hypocalymma xanthopetalum,* ***Melaleuca trichophylla****, Petrophile chrysantha, Schoenus subflavus* and ***Xanthorrhoea drummondii*** (Hamilton-Brown, 2002a). The taxa in bold were recorded at the Study Area, however, this TEC is restricted to the well-drained grey sand over pale yellow sand on the lateritic uplands of the Banovich Uplands and the dominant taxon in the floristic community, *Allocasuarina microstachya,* was not recorded at the Study Area.

The Endangered TEC 'Lesueur-Coomallo Floristic Community A1.2' is a species rich heath with emergent ***Hakea obliqua*** on sand with faithful species of ***Hakea obliqua*** and *Beaufortia* aff. *elegans* and the constant species of *Dasypogon bromeliifolius* and ***Stirlingia latifolia*** over well-drained grey sand over pale yellow sand on lateritic uplands. Associated species include ***Allocasuarina humilis, Calothamnus sanguineous, Hibbertia hypericoides*****,** *Hypocalymma xanthopetalum* and *Schoenus subflavus* (Hamilton-Brown, 2002b). The taxa in bold were recorded at the Study Area, however, this TEC is restricted to the well-drained grey sand over pale yellow sand on the lateritic uplands of the Banovich Uplands. Although *Hakea obliqua* was recorded at the Study Area its distribution was very scattered and *Beaufortia* aff. *elegans* and *Dasypogon bromeliifolius* were not part of the community.

The Vulnerable 'Ferricrete Floristic Community' TEC (Hamilton-Brown, Broun & Rees, 2004) is a tall shrubland located on irregularly inundated red brown sandy loams over ferricrete dominated by *Acacia blakelyi, Allocasuarina campestris, Banksia stricta* and *Labichea lanceolata* subsp. *lanceolata*. Associated species include *Alyogyne hakeifolia, Borya sphaerocephala, Isotoma hypocrateriformis, Petrophile seminuda, Stylidium dichotomum, Thysanotus patersonii* and *Waitzia paniculata*. None of these species were recorded at the Study Area.

- Based on the information above, none of the vegetation associations recorded at the Study Area are the same as those in any of the currently-listed TECs occurring in the surrounding areas.

4.3.2 PECs

The Priority 2 '*Petrophile chrysantha* low heath on Lesueur dissected uplands' PEC is a low heath dominated by *Petrophile chrysantha* on the Lesueur Dissected Uplands. Associated species include ***Banksia armata*** and *Hakea undulata* (DEC, 2013h). The taxon in bold was recorded at the Study Area, however, the dominant species in the PEC, *Petrophile chrysantha*, was not.

The Priority 1 'Lesueur-Coomallo Floristic Community DFGH' PEC is a mixed species-rich heath on lateritic gravel with *Hakea erinacea*, ***Melaleuca platycalyx*** and *Petrophile seminuda* (DEC, 2013h). The taxon in bold was recorded at the Study Area, however, the other dominant species in the PEC, were not.

The Priority 1 'Lesueur-Coomallo Floristic Community M2' PEC is a woodland dominated by *Melaleuca preissiana* along sandy drainage lines, with faithful species of *Anigozanthos pulcherrimus* and constant species of *Chamaescilla corymbosa,* ***Petrophile brevifolia*** and *Xanthorrhoea reflexa* (DEC, 2013h). The taxon in bold was recorded at the Study Area, however, the other dominant species in the PEC, were not.

- Based on the information above, none of the vegetation associations recorded at the Study Area are the same as those in any of the currently-listed PECs occurring in the surrounding areas.

4.4 Species Susceptible to *Phytophthora cinnamomi*

A comparison of the combined species list with a list of Western Australian natives susceptible to *Phytophthora cinnamomi* (Groves, Hardy and McComb, no date) indicates that 26 of the species recorded at the Study Area are susceptible to *Phytophthora cinnamomi* (rows shaded green in Table A6.1, Appendix 6).

5 Clearing Principles and the Environmental Protection Act 1986

Under the *Environmental Protection Act 1986* (EP Act), native vegetation can only be cleared with a clearing permit unless exempt (DEC, 2012e).

An exemption is a kind of clearing activity that does not require a permit. There are two types of exemptions: those under Schedule 6 of the EP Act (referred to as the Schedule 6 exemptions); and, those in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (Regulations) (referred to as exemptions under Regulations) (DEC, 2010d).

The exemptions under Regulations do not apply in ESAs declared under Section 51B of the EP Act (DEC, 2010d). Regulation 5 covers prescribed clearing and includes a table of exemptions referred to as 'items'. Item 24 of Regulation 5 exempts: 'Clearing that is the result of carrying out exploration under an authority under the Petroleum and Geothermal Energy Resources Act 1967, the Petroleum Pipelines Act 1969, or the Petroleum (Submerged Lands) Act 1982'. This exemption allows clearing for exploration approved under various Petroleum Acts but the exemption does not apply in an ESA (DEC, 2010d).

Drover-01A lies within an ESA and, as such, exemptions do not apply.

Drover-01B, where the exploration program will take place, does not lie within an ESA.

While AWE's exploration program is going to be carried out at Drover-01B, which does not require a native vegetation clearing permit in order to clear vegetation in the area, clearing permit requirements are addressed with respect to both Drover-01A and Drover-01B in Table 5.1. The 10 clearing principles are addressed with respect to either the Study Area as a whole or the two survey areas separately in Table 5.1.

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Table 5.1: Clearing Permit Principles and the Study Area

Clearing Principle	Drover-01A	Drover-01B
a) Native vegetation should not be cleared if it comprises a high level of biological diversity.	One hundred and fifty-seven taxa from 36 families and 93 genera were recorded in the approximately 9.06 ha area surveyed at Drover-01A. Biodiversity of the remnant vegetation of the Geraldton Sandplains is generally high, and the flora recorded in this area supports this. Clearing at Drover-01A may be at variance to this principle.	One hundred and twenty taxa from 33 families and 71 genera were recorded in the approximately 16.85 ha area surveyed at Drover-01B. Having been cleared in the past, the flora recorded at Drover-01B is less diverse than in neighbouring remnant vegetation. The area is also generally weedy and therefore clearing at Drover-01B should not be at variance to this principle.
b) Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	The EPBC Act Protected Matters Search Tool results (DSEWPaC, 2013b) listed three protected fauna species (excluding migratory species) as having been recorded within a 10 km radius of the Study Area - *Calyptorhynchus latirostris* (Carnaby's Black Cockatoo), *Leipoa ocellata* (Malleefowl) and *Dasyurus geoffroii* (Chuditch). Woody *Banksia* species are dominant in vegetation association Sp2 and these species could provide significant feeding habitat for Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*). Due to the small area proposed to be cleared and the relatively large uncleared areas in the vicinity of Drover-01A, the proposed clearing is unlikely to be at variance to this principle.	The proposed clearing is unlikely to be at variance to this principle as it is located mostly on cleared farmland. The regrowth vegetation at the exploration area and water bore and access area at Drover-01B is unlikely to be used as a significant habitat by native fauna as there are large areas of remnant natural vegetation adjacent to this area.

Clearing Principle	Drover-01A	Drover-01B
c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No Threatened Flora species were recorded at Drover-01A. Due to the survey methodology adopted and the habitats at Drover-01A it is unlikely that the Threatened species produced by the database searches and with records from within 3 km of the survey area occur in this area. Six Priority Flora species were recorded: *Acacia carens*, *Acacia lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039) and *Phlebocarya pilosissima* subsp. *teretifolia* (all P2); *Desmocladus biformis* (P3); and, *Diuris recurva* and *Xanthosia tomentosa* (both P4). These six priority species have from between six and 52 records on FloraBase. The proposed clearing is therefore unlikely to be at variance to this principle.	No Threatened Flora species were recorded at Drover-01B and it is unlikely that any of the Threatened species produced by the database searches occur in the area given the habitats of the area and the condition of the vegetation. Two P2 species (*Acacia carens*, *Acacia lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039)) and one potentially significant species (*Chordifex* ?*reseminans* potential P1) were recorded. The two priority species currently have six and 11 records respectively on FloraBase. The proposed clearing is unlikely to be at variance to this principle.
d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.	The Study Area does not lie within a buffer in place around a TEC or a PEC. The vegetation is not the same as that in any of the TECs or PECs located in the surrounding areas, therefore any clearing should not be at variance to this principle.	

Clearing Principle	Drover-01A	Drover-01B
e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	Beard (1980) mapped one broad vegetation association at the Study Area: 1031 (hSZc/dZc) – *Hakea* spp., *Allocasuarina* spp. open tall shrubland over *Allocasuarina* spp., *Banksia* spp. mid shrubland. The 2012 Statewide Vegetation Statistics (Government of Western Australia, 2013) indicate that 32.98% of association 1031 remains intact (88,865 ha). Of this current extent 13.48% is protected for conservation and 42.23% is located in DEC managed lands generally. Griffin and Hopkins (1990) provide information about the vegetation of the general Lesueur Area. The vegetation communities recorded at the Study Area resemble the vegetation communities associated with the Peron Slopes landform, which were noted as widespread vegetation communities in the Lesueur Area across various landforms (Griffin and Hopkins, 1990). National objectives and targets for biodiversity conservation in Australia have a target to prevent clearing of communities with less than 30% of their pre-1750 extent remaining (Commonwealth of Australia, 2001). As Beard unit 1031 has more than 30% of its pre-European extent remaining, and the area proposed to be cleared is relatively small, clearing should not be at variance to this principle. In addition to this Drover-01B is on freehold farmland that has been cleared in the past but is now regenerating in some areas.	
f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	The closest water course is approximately 1.4 km north-east of the northern boundaries of the Study Area and no wetlands occur within a 10 km radius of the Study Area. None of the vegetation associations mapped within the Study Area are associated with a watercourse or wetland therefore any clearing should not be at variance to this principle.	
g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	As the area to be cleared is relatively small, and some areas have been already cleared, clearing will unlikely result in increased salinity, water erosion or water logging or flooding. As the soil is sandy in the Study Area wind erosion could occur following clearing. However, much of the Drover-01B area has been cleared already and is already degraded in areas. Clearing should not be at variance to this principle.	

Clearing Principle	Drover-01A	Drover-01B
h) Native vegetation should not be cleared if the clearing of vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	One of the boundaries of Lesueur National Park is located approximately 1.1 km south of Drover-01A. Given this distance, any clearing carried out at Drover-01A would be unlikely to impact the environmental values of the National Park. Clearing in this area should not be at variance to this principle.	A boundary of the Lesueur National Park is adjacent to the western edge of the southern section of Drover-01B. An existing fenceline and track mark this boundary. The track and vegetation east of the track were cleared many years ago and this does not appear to have had any impact on the adjacent conservation area. Additional impacts to the park from secondary clearing are unlikely. Clearing in this area should not be at variance to this principle.
i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	The closest water course is approximately 1.4 km north-east of the northern boundaries of the Study Area and no wetlands occur within a 10 km radius. Vegetation clearing is unlikely to affect the quality of the surface or underground water as the area to be cleared would be small. As the exploration program is to be carried out at Drover-01B, and that area has been cleared already, clearing should not be at variance to this principle.	
j) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	Vegetation clearing at Drover-01A should not exacerbate the incidence or intensity of flooding because the area cleared would be relatively small, the area is not a high rainfall area and the soils are sandy and should have high infiltration rates. Therefore clearing should not be at variance to this principle.	As the majority of the Drover-01B Survey Area is already cleared further clearing is unlikely to exacerbate the incidence or intensity of flooding. Clearing in this area should not be at variance to this principle.

6 Conclusions and Recommendations

Based on the results of this survey, Maia provides the following conclusions and recommendations for reducing impacts to the vegetation and flora of the Study Area during any clearing and exploration activities:

- The flora and vegetation at Drover-01A and surrounds is mostly in Excellent condition and is particularly rich and diverse. Only small areas have been disturbed previously.
- Six priority species were located at Drover-01A.
- The flora and vegetation at Drover-01B is mostly in Good or Completely Degraded condition and the flora of the area is not as diverse as at Drover-01A because it is on farmland that has been cleared in the past. While some areas are regenerating others are not and these areas are very weedy.
- Two confirmed and one potential priority species were located at Drover-01B.
- AWE Limited intends to carry out its exploration program at Drover-01B rather than Drover-01A. Based on the previous clearing, the condition of the vegetation, flora diversity and the number of conservation significant species recorded in each area, vegetation clearing at Drover-01B would result in far less environmental impact than at Drover-01A.
- The northern half of the exploration area at Drover-01B should be cleared in preference to the southern section because fewer priority species were located in this area.
- Direct impacts to conservation significant flora located in areas to be cleared should be minimised whenever possible.
- As some of Drover-01B is adjacent to the Lesueur National Park, secondary impacts from vegetation clearing and drilling and associated activities should be considered i.e. dust management, weed management and pest management (particularly Phytophthora Dieback).
- Good weed and Phytophthora Dieback hygiene practices should be employed to avoid the introduction of new weed species to the area, to prevent the spread of existing weeds and to avoid the introduction of Dieback into the area.
- Vegetation clearing and exploration works should be carried out at dry times of the year to reduce the potential for introduction and spread of Phytophthora Dieback into the area and to reduce erosion.

7 Project Team

This flora and vegetation assessment has been carried out by the botanists listed in Table 7.1.

Table 7.1: Project Team

Project Team			
Name	**Qualification**	**Project Role**	**DEC Flora License Number**
Christina Cox	PhD	Botanist – report	Not applicable
Scott Hitchcock	BSc	Botanist – report	Not applicable
Melissa Hay	BSc (Hons)	Botanist – field and report	Application pending
Rochelle Haycock	BSc	Botanist – report and mapping	Not applicable
Pali Jayasekara	PhD	Botanist/taxonomist – field and plant identifications	SL010517 (exp. 1 April 2014)
David Leach	PhD	Botanist – plant identifications	Not applicable

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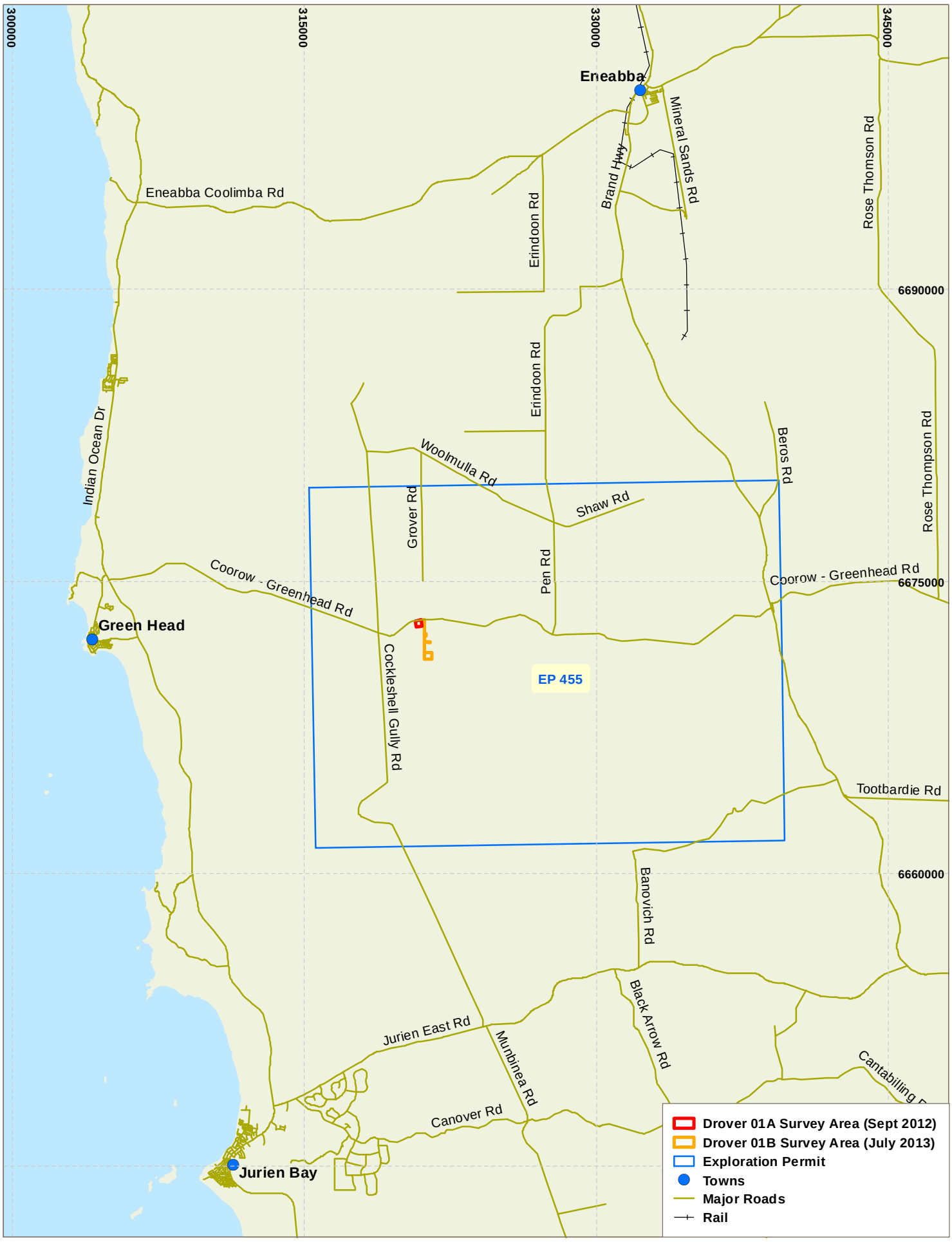
9 Maps



maia

Location Map

General Location

N

0 3.5

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.1

Prepared for: AWE Ltd

Drawn by: RH

Date: 4/07/2013

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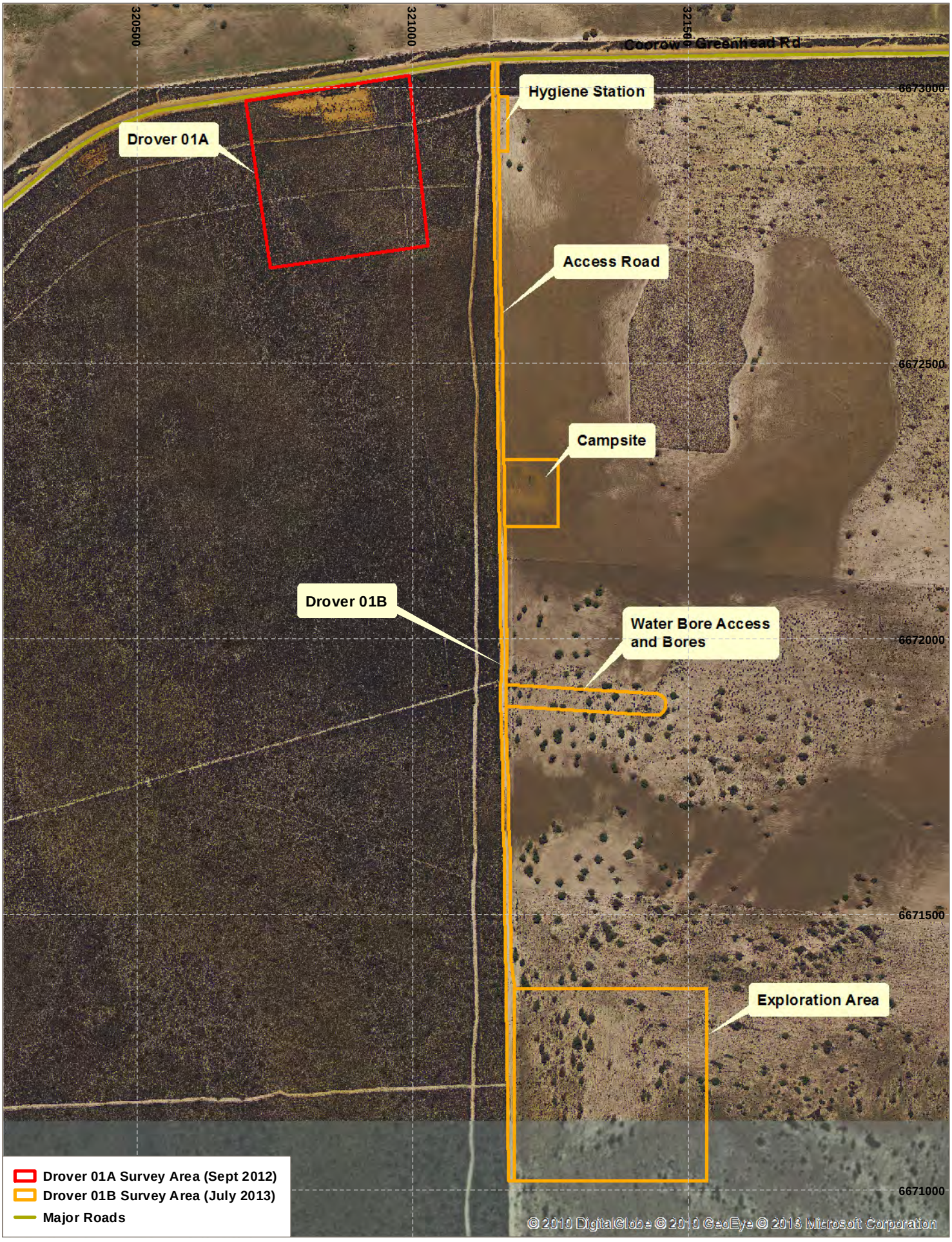

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Location Map

Study Area

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Kilometres

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Prepared for: AWE Ltd

Drawn by: RH

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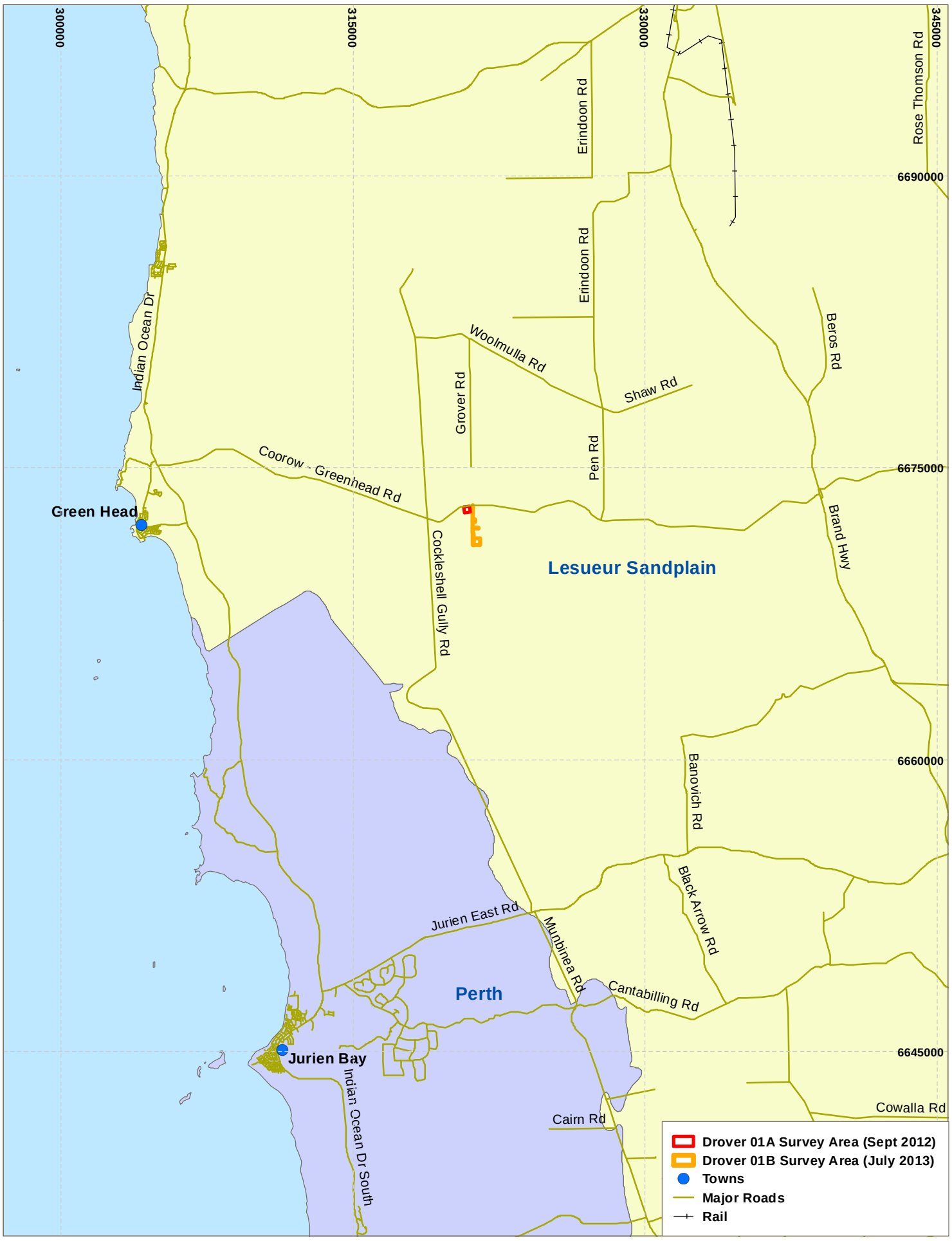

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Location Map

IBRA Subregions

N

0 3.5

Kilometres

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Map: 9.3

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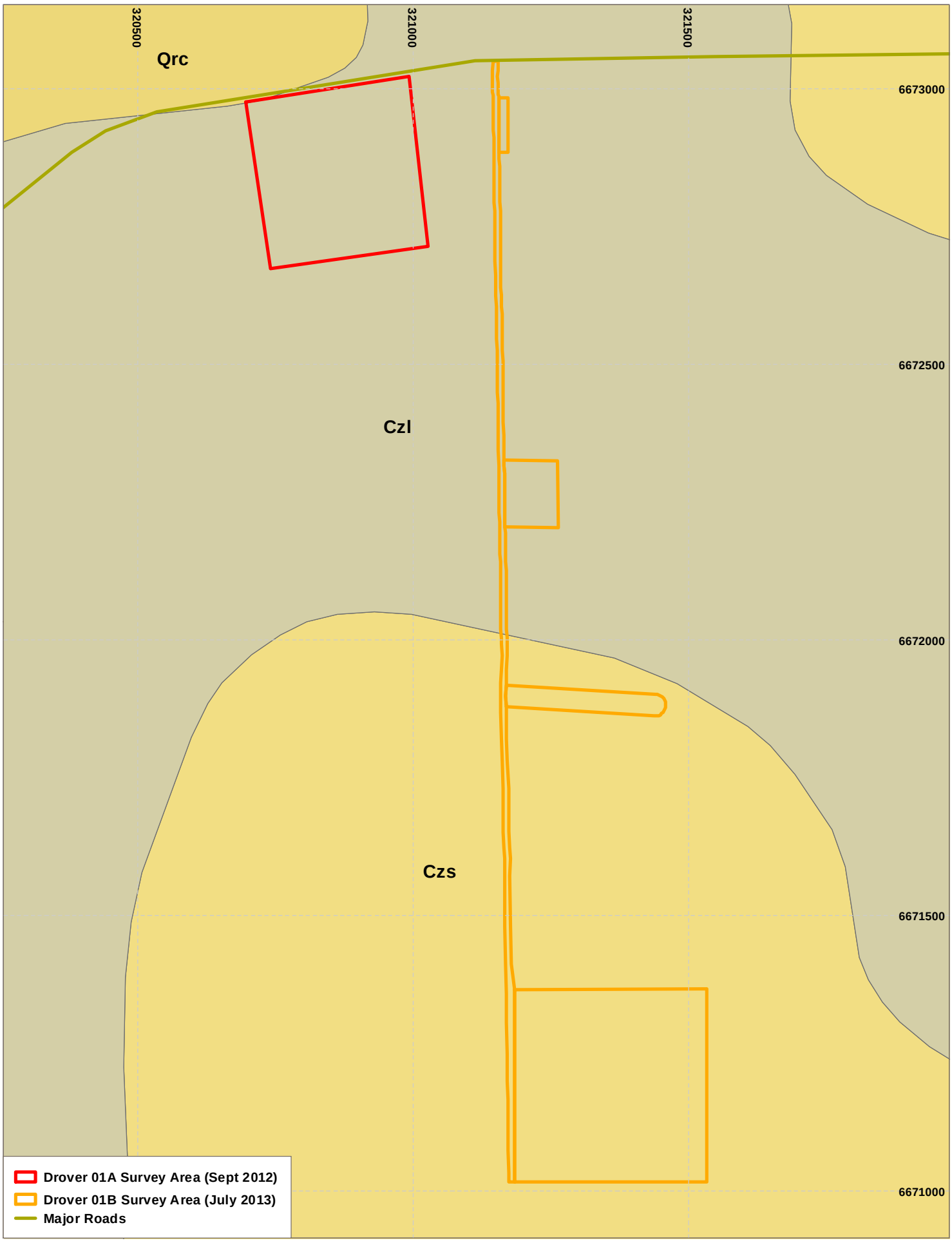

maia

Location Map

Port Hedland
Newman
Wiluna
Geraldton
Kalgoorlie
Perth

Geology

N

0 0.125

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.4

Prepared for: AWE Ltd

Drawn by: RH

Date: 4/07/2013

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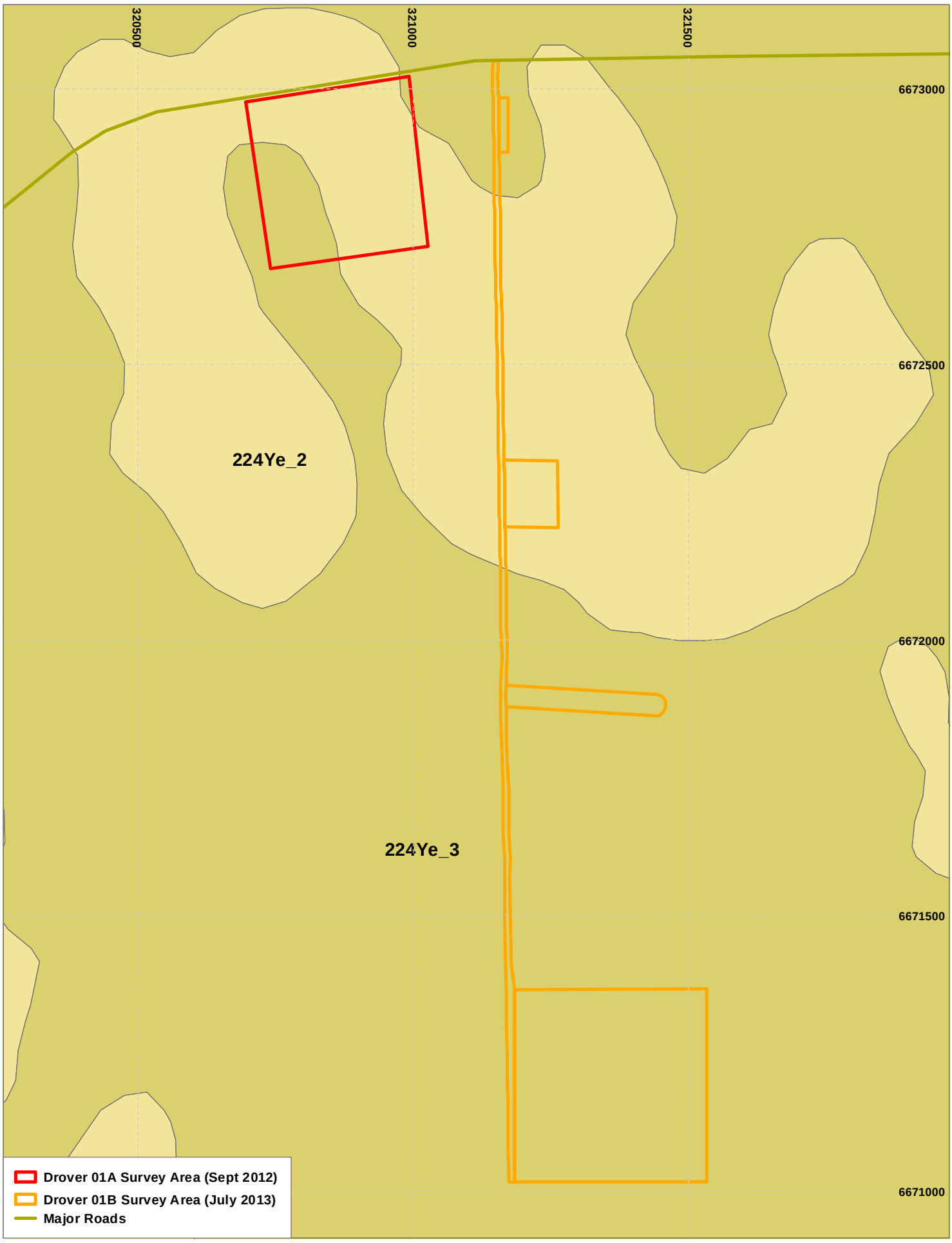

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Location Map

Soil Landscape Systems

N

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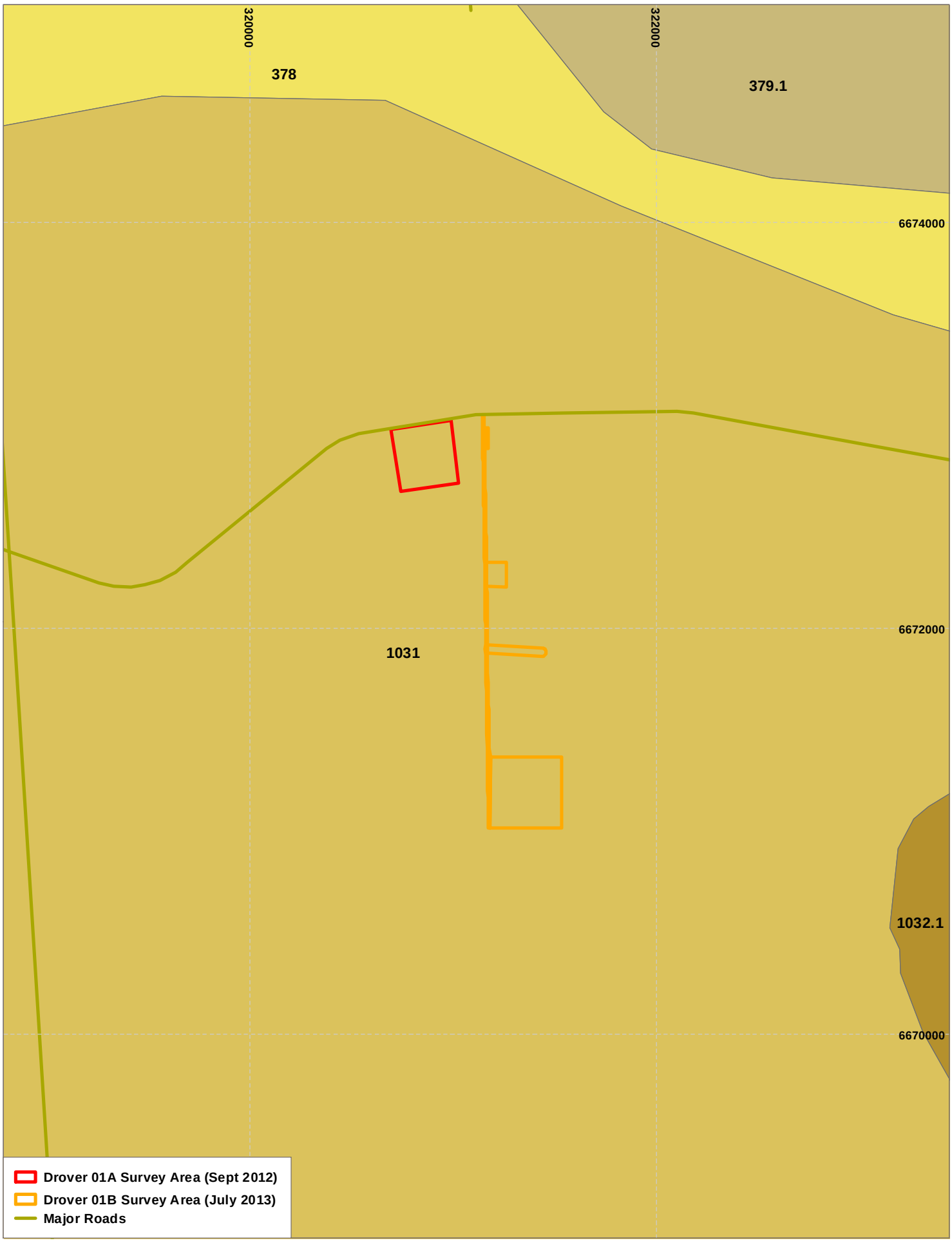

maia

Location Map

Port Hedland
Newman
Wiluna
Geraldton
Kalgoorlie
Perth

Beard's Pre-European Vegetation Mapping

N

0 0.3

Kilometres

Datum: GDA 1994, MGA 50

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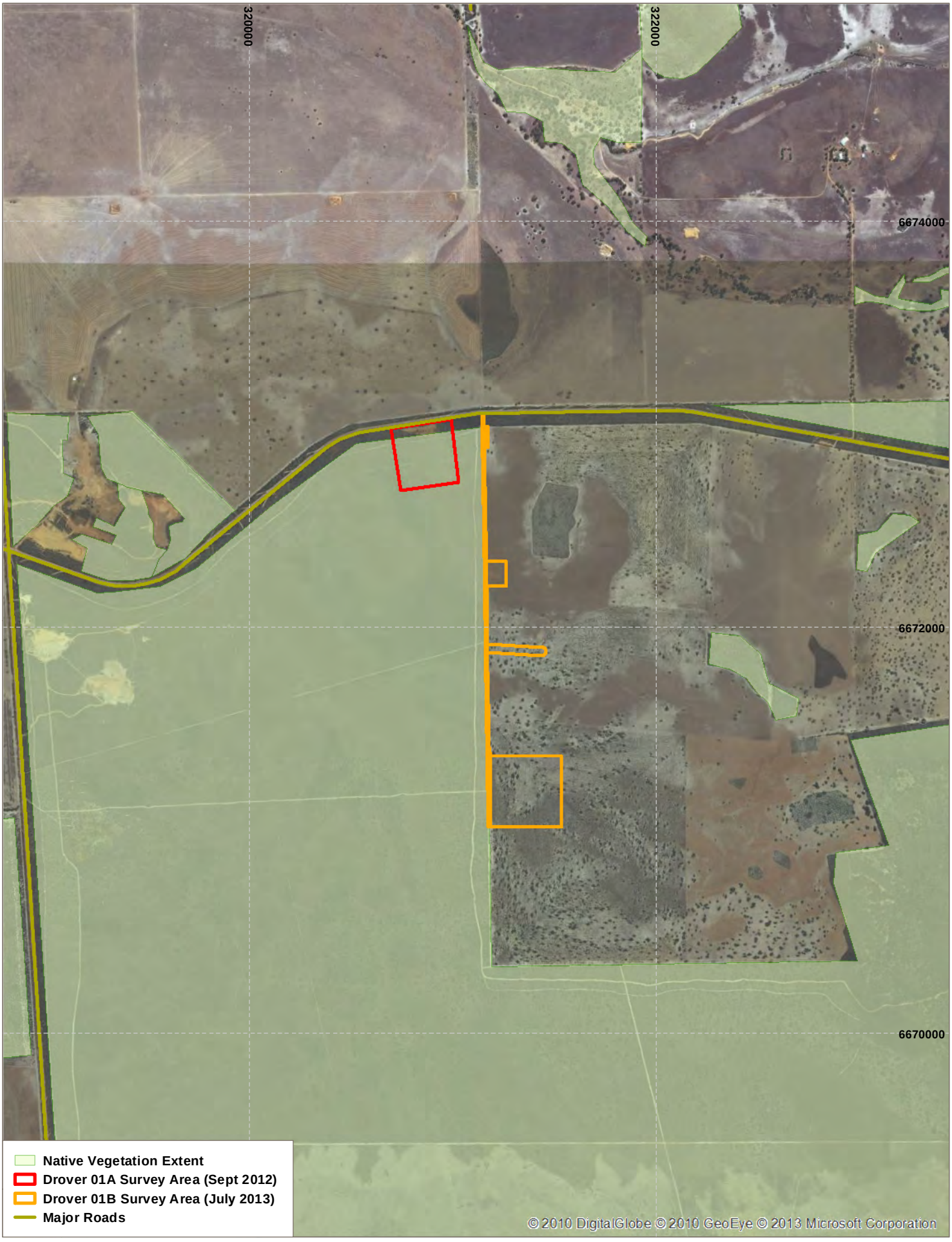

maia

Location Map

Native Vegetation Extent

N

0 0.3

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.7

Prepared for: AWE Ltd

Drawn by: RH

Date: 4/07/2013

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maia

Location Map

Port Hedland
Newman
Wiluna
Geraldton
Kalgoorlie
Perth

Roadside Conservation Values

N

0 0.3
Kilometres

Datum: GDA 1994, MGA 50

Map: 9.8
Prepared for: AWE Ltd
Drawn by: RH
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Version: 1

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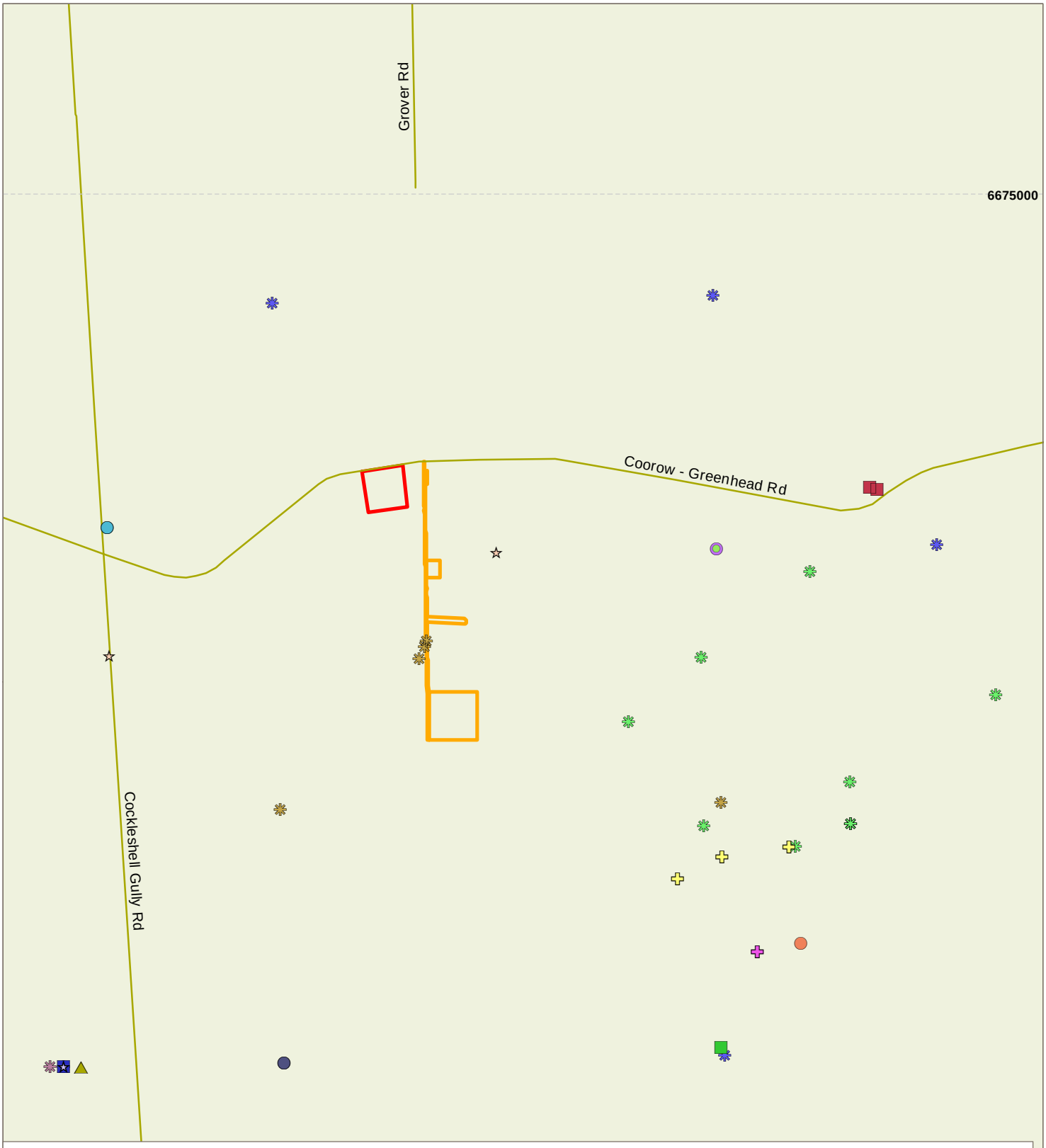

- *Acacia forrestiana* (T)
- *Eucalyptus suberea* (T)
- *Acacia lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant (P2)
- *Acacia retrorsa* (P2)
- *Andersonia longifolia* (P2)
- *Arnocrinum gracillimum* (P2)
- *Beyeria similis* (P2)
- *Grevillea delta* (P2)
- *Leucopogon plumuliflorus* (P2)
- *Persoonia filiformis* (P2)
- *Banksia kippistiana* var. *paenepeccata* (P3)
- *Persoonia rudis* (P3)
- *Verticordia muelleriana* subsp. *muelleriana* (P3)
- *Banksia sclerophylla* (P4)
- *Banksia tricuspis* (P4)
- *Stylidium inversiflorum* (P4)
- *Xanthosia tomentosa* (P4)
- Drover 01A Survey Area (Sept 2012)
- Drover 01B Survey Area (July 2013)
- Major Roads

maia

Location Map

Conservation Significant Flora: TPFL & WA Herb Database Search Results

N

0 0.5

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.9

Prepared for: AWE Ltd

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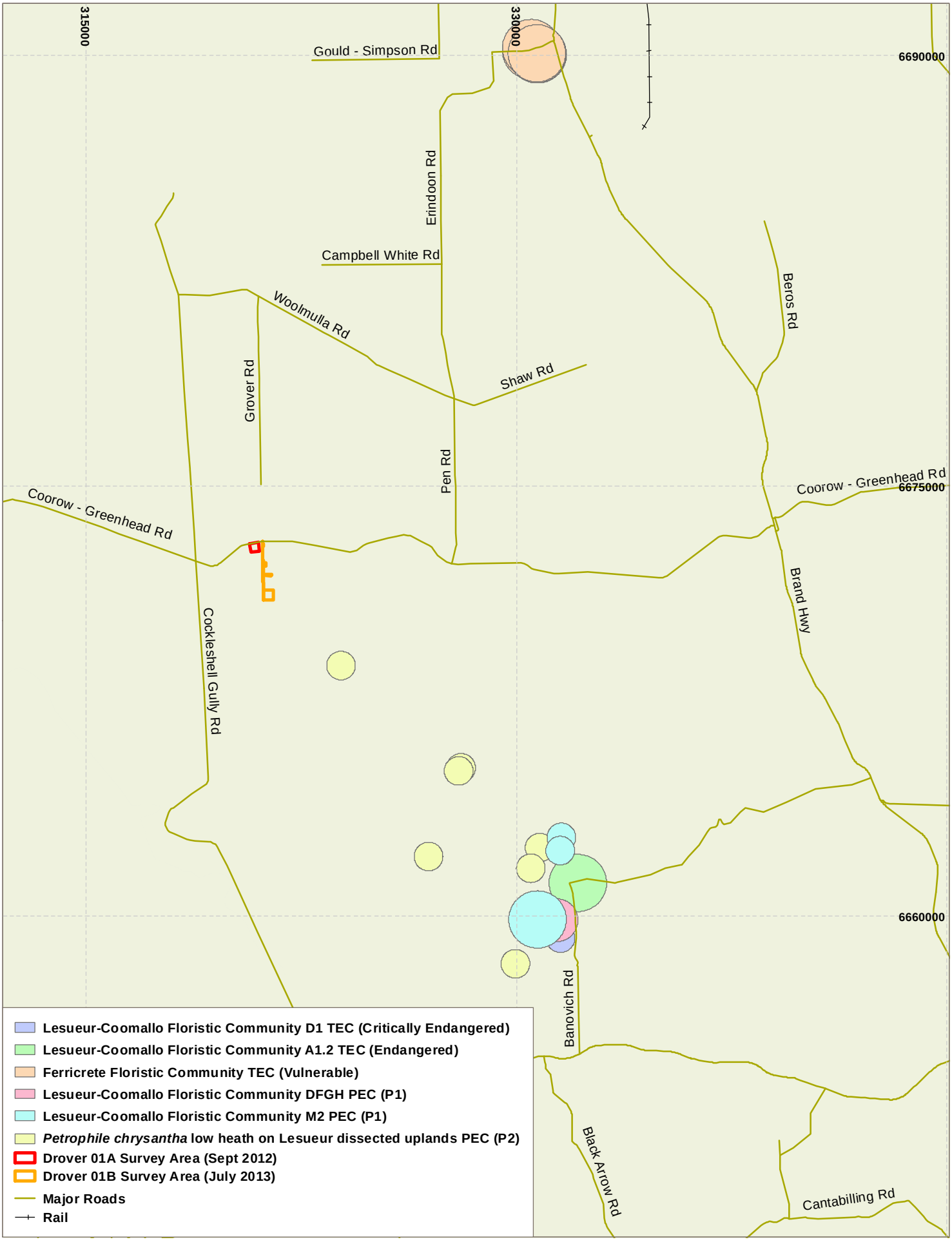

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Location Map

Threatened and Priority Ecological Communities

N

0 2.25

Kilometres

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Map: 9.10

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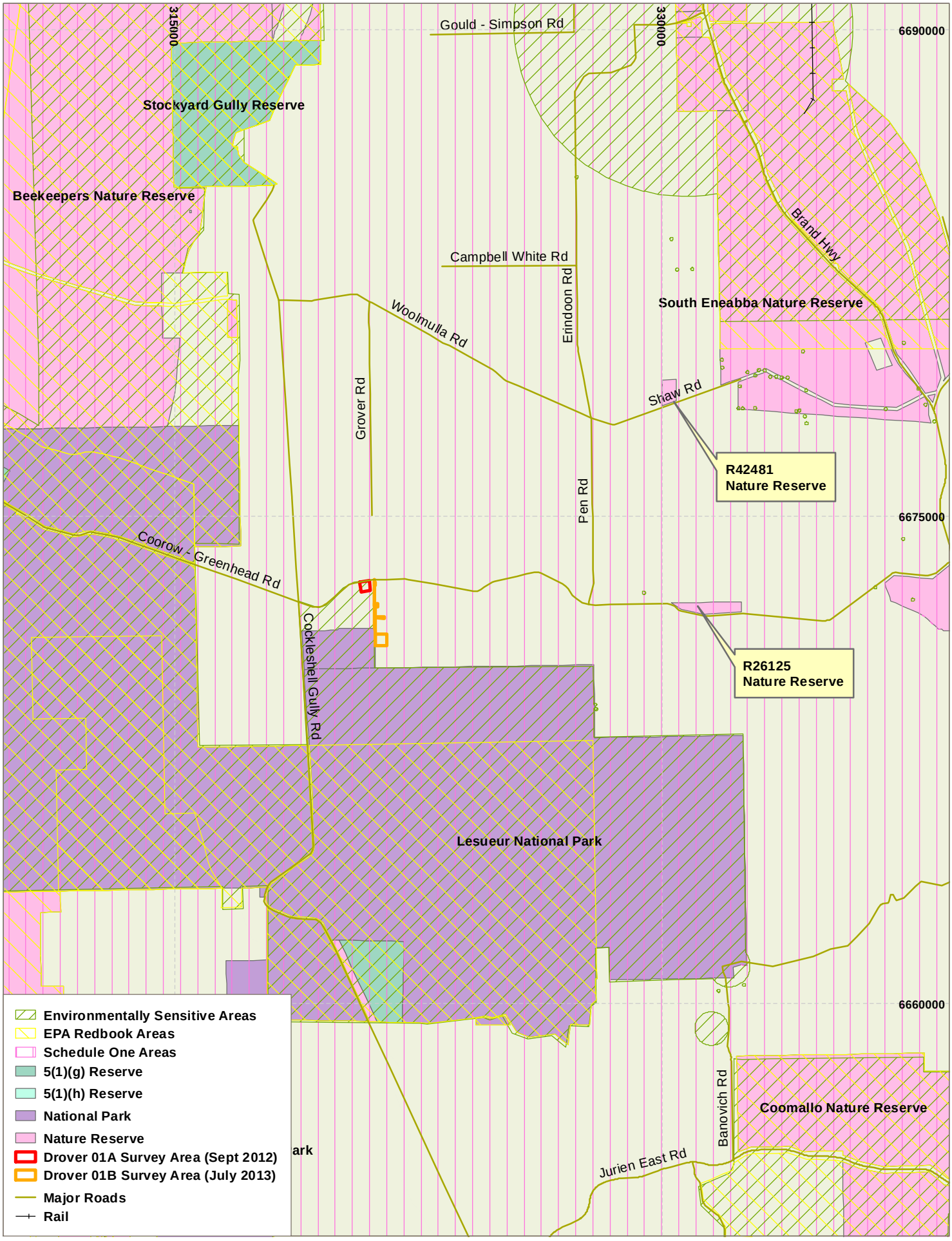

maia

Location Map

Environmentally Sensitive Areas, Conservation Estates, Schedule One Areas and EPA Redbook Areas

N

0 2

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.11

Prepared for: AWE Ltd

Drawn by: RH

Date: 9/07/2013

Version: 1

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- *Acacia carens* (P2)
- *Acacia lasiocarpa* var. *lasiocarpa* Cockleshell Gully variant (P2)
- *Phlebocarya pilosissima* subsp. *teretifolia* (P2)
- *Desmocladus biformis* (P3)
- *Diuris recurva* (P4)
- *Xanthosia tomentosa* (P4)
- *Leucopogon* aff. *oldfieldii* (TOI)
- Drover 01A Survey Area (Sept 2012)
- Major Roads

maia

Location Map

Priority Flora and Taxa of Interest Locations - Drover 01A

N

0 0.03

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.12
Prepared for: AWE Ltd
Drawn by: RH
Date: 12/06/2013
Version: 1

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Location Map

Priority Flora and Potential Significant Taxon - Drover 01B

N

0 0.1

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.13

Prepared for: AWE Ltd

Drawn by: RH

Date: 10/07/2013

Version: 1

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Location Map

Environmental Weeds - Drover 01A

N

0 0.03

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.14

Prepared for: AWE Ltd

Drawn by: RH

Date: 12/06/2013

Version: 1

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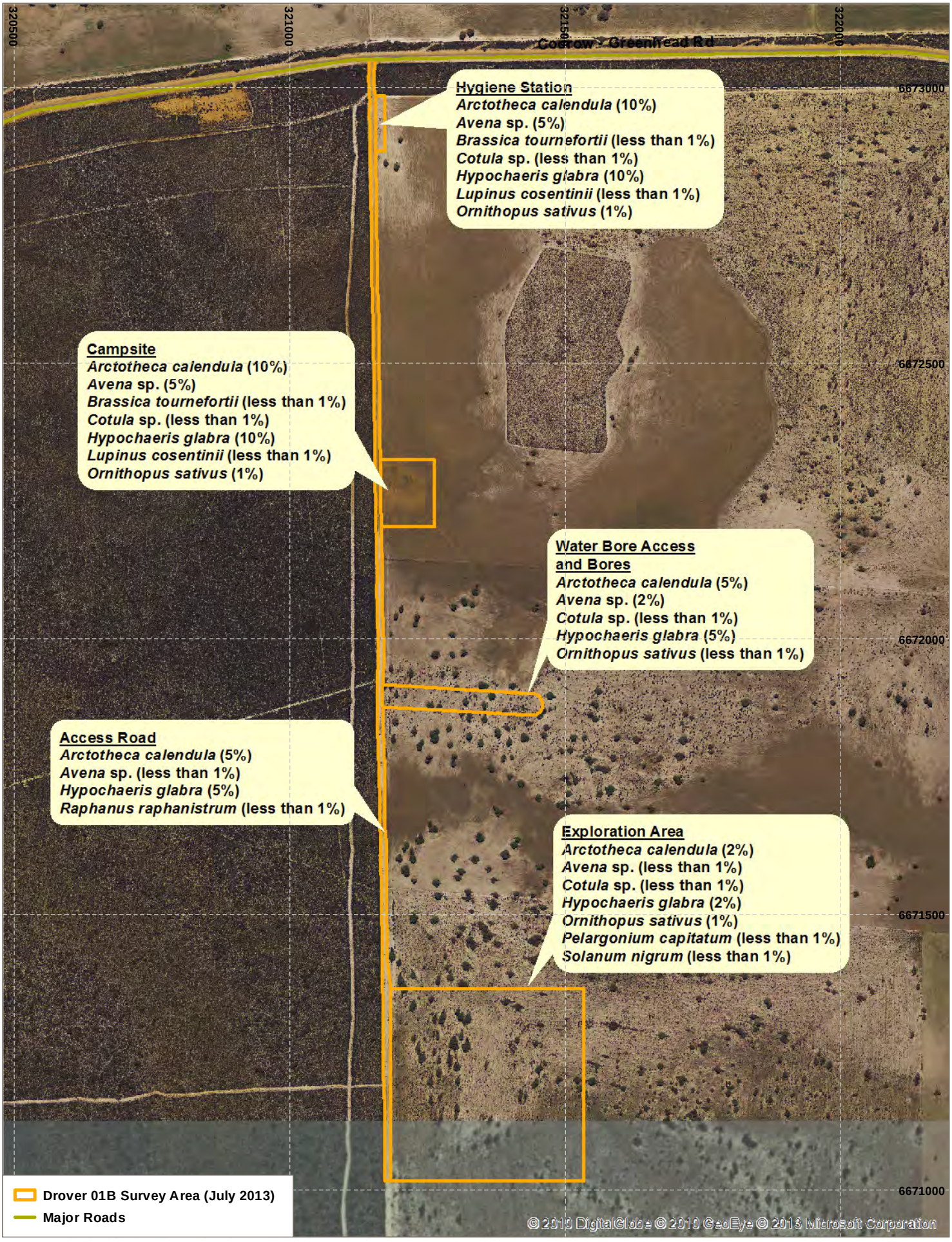

maia

Location Map

Environmental Weed Cover - Drover 01B

N

0 0.1

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.15

Prepared for: AWE Ltd

Drawn by: RH

Date: 4/07/2013

Version: 1

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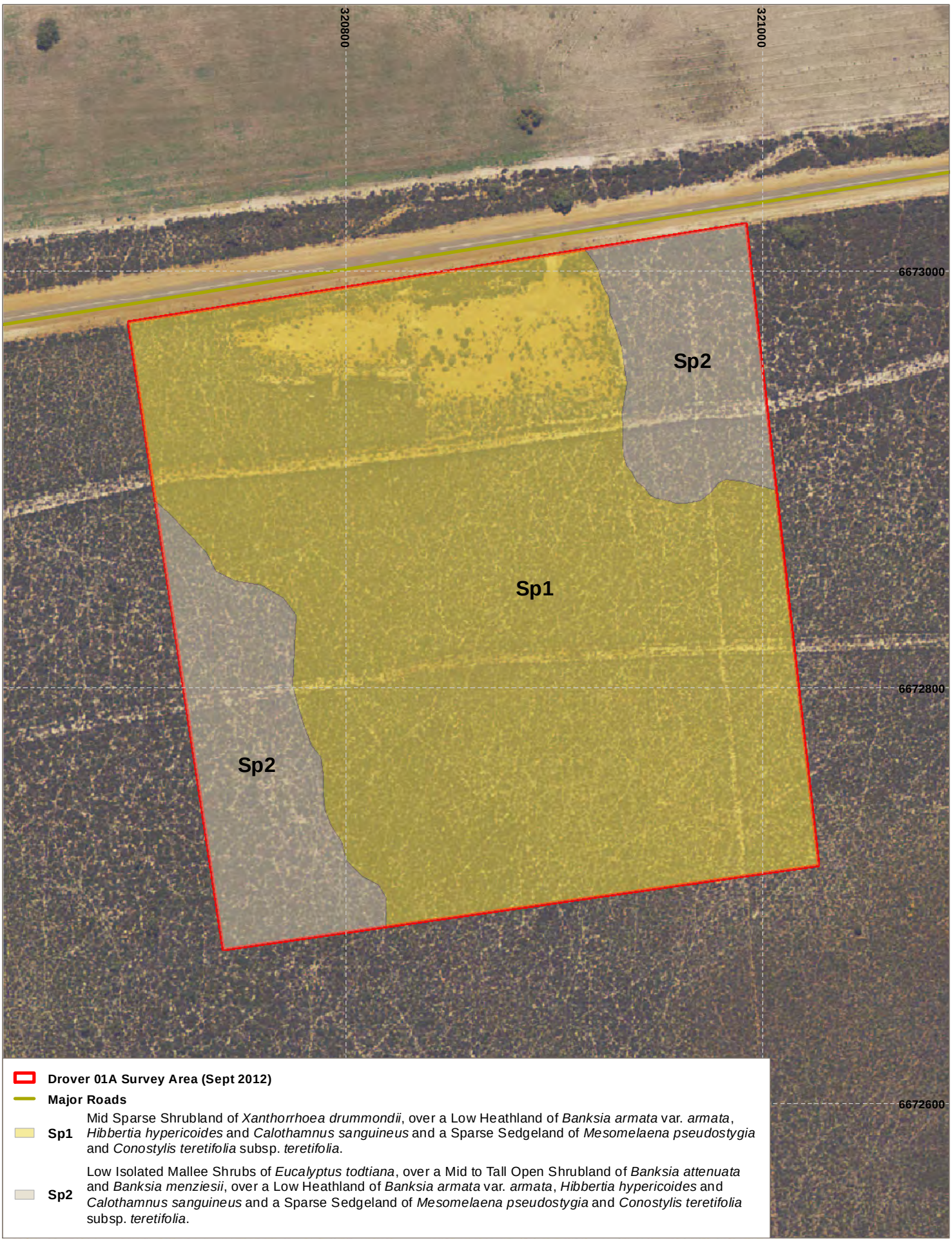

Drover 01A Survey Area (Sept 2012)

Major Roads

Sp1 Mid Sparse Shrubland of *Xanthorrhoea drummondii*, over a Low Heathland of *Banksia armata* var. *armata*, *Hibbertia hypericoides* and *Calothamnus sanguineus* and a Sparse Sedgeland of *Mesomelaena pseudostygia* and *Conostylis teretifolia* subsp. *teretifolia*.

Sp2 Low Isolated Mallee Shrubs of *Eucalyptus todtiana*, over a Mid to Tall Open Shrubland of *Banksia attenuata* and *Banksia menziesii*, over a Low Heathland of *Banksia armata* var. *armata*, *Hibbertia hypericoides* and *Calothamnus sanguineus* and a Sparse Sedgeland of *Mesomelaena pseudostygia* and *Conostylis teretifolia* subsp. *teretifolia*.

maia

Location Map

Vegetation Mapping - Drover 01A

N

0 0.03

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.16

Prepared for: AWE Ltd

Drawn by: RH

Date: 11/07/2013

Version: 1

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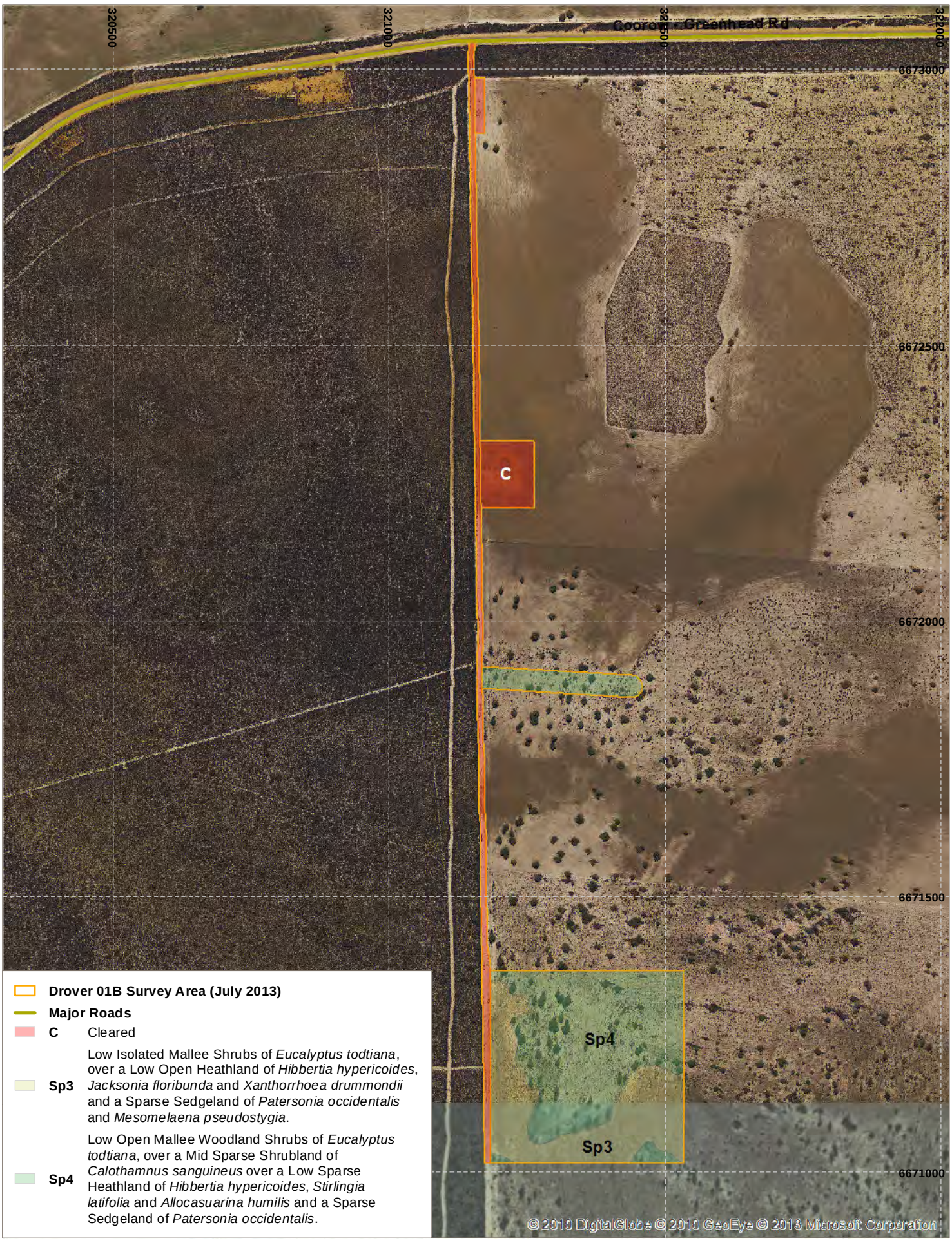

Drover 01B Survey Area (July 2013)

Major Roads

C Cleared

Sp3 Low Isolated Mallee Shrubs of *Eucalyptus todtiana*, over a Low Open Heathland of *Hibbertia hypericoides*, *Jacksonia floribunda* and *Xanthorrhoea drummondii* and a Sparse Sedgeland of *Patersonia occidentalis* and *Mesomelaena pseudostygia*.

Sp4 Low Open Mallee Woodland Shrubs of *Eucalyptus todtiana*, over a Mid Sparse Shrubland of *Calothamnus sanguineus* over a Low Sparse Heathland of *Hibbertia hypericoides*, *Stirlingia latifolia* and *Allocasuarina humilis* and a Sparse Sedgeland of *Patersonia occidentalis*.

maia

Location Map

Vegetation Mapping - Drover 01B

N

0 0.1

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.17

Prepared for: AWE Ltd

Drawn by: RH

Date: 11/07/2013

Version: 1

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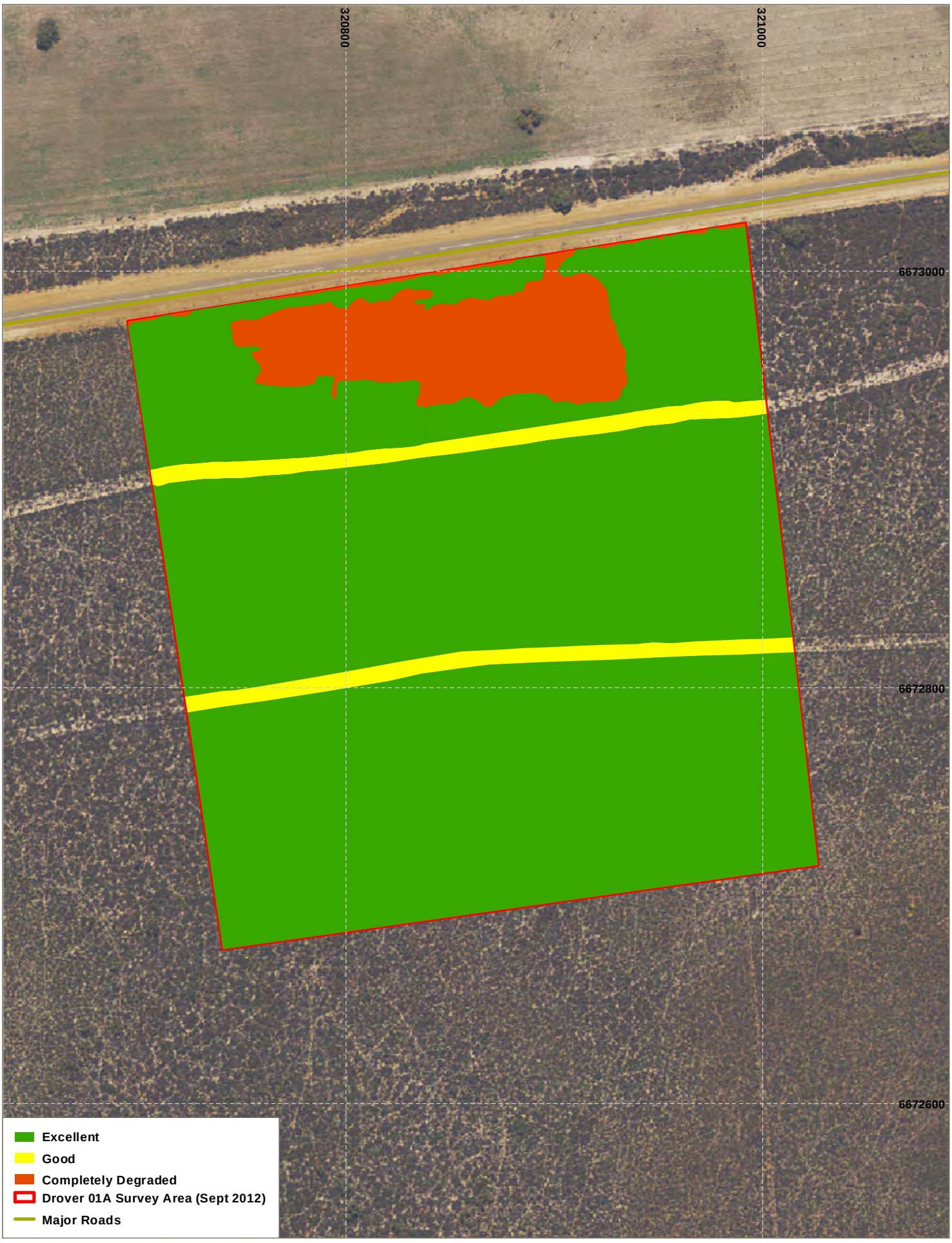

maia

Location Map

Vegetation Condition - Drover 01A

N

0 0.03

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.18

Prepared for: AWE Ltd

Drawn by: RH

Date: 4/07/2013

Version: 1

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Location Map

Vegetation Condition - Drover 01B

N

0 0.1

Kilometres

Datum: GDA 1994, MGA 50

Map: 9.19

Prepared for: AWE Ltd

Drawn by: RH

Date: 4/07/2013

Version: 1

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APPENDIX 1: NATIONAL VEGETATION INFORMATION SYSTEM VEGETATION CLASSIFICATION

able A1.1: NVIS Methodology used to Describe Vegetation Associations

Height Range (m)	Tree	Shrub	Mallee	Grass
>30	tall			
10-30	mid		tall	
<10	low		mid	
<3			low	
>2		tall		tall
1-2		mid		tall
0.5-1		low		mid
<0.5		low		low

		Structural Formation Classes					
		Foliage cover % (cover #)					
Growth Form	**Height (m)**	**70-100% (5)**	**30-70% (4)**	**10-30% (3)**	**<10% (2)**	**0-5% (1)**	**≈0% (N)**
Tree	**<10,10-30, >30**	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees
Tree mallee	**<3, <10, 10-30**	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees
Shrub	**<1,1-2,>2**	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs
Mallee shrub	**<3, <10, 10-30**	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs
Heath shrub	**<1,1-2,>2**	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs
Chenopod shrub	**<1,1-2,>2**	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs
Samphire shrub	**<0.5,>0.5**	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs
Hummock grass	**<2,>2**	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses
Tussock grass	**<0.5,>0.5**	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses
Sedge	**<0.5,>0.5**	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges
Rush	**<0.5,>0.5**	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes

APPENDIX 2: DATABASE SEARCH RESULTS

Table A2.1: Database Search Results – Conservation Significant Flora

Species	Rank	Flowering	Habitat	FloraBase Nearest Named Locations	Likelihood of Occurrence	Database Search
Acacia forrestiana	T (EPBC Act – Vulnerable, WC Act – Vulnerable)	Nov-Dec	Lateritic gravelly soils, clay loam over sandstone. Gullies, hills, breakaways.	Bidgerabbie Hill Reserve, east of Mount Peron, Lesueur National Park, Mount Misery, north of Mount Benia, Dandaragan, Jurien Bay.	Unlikely	NM, TPFL, WA Herb
Eleocharis keigheryi	T (EPBC Act – Endangered, WC Act – Vulnerable)	Aug-Nov	Clay, sandy loam. Emergent in freshwater, creeks and claypans.	Kodjee Nature Reserve, Upper Swan, Oxbow Lake, Pearce Airbase, Gingin, Kenwick.	Unlikely	NM
Eucalyptus suberea	T (EPBC Act – Vulnerable, WC Act – Vulnerable)	Nov-Dec or Mar	Grey sand. Near or on lateritic breakaways.	Jurien Bay, Hi Vallee, Badgingarra, Mt Lesueur National Park, Eneabba, Gairdner Range, Mount Benia, Mount Michaud, Mount Lesueur, Mount Peron.	Unlikely	NM, TPFL
Paracaleana dixonii	T (EPBC Act – Vulnerable, WC Act – Vulnerable)	Oct-Dec or Jan	Grey sand over granite	Jurien, Dongara, Cockleshell Gully.	Possible but unlikely	NM
Thelymitra stellata	T (EPBC Act – Endangered, WC Act – Endangered)	Oct-Nov	Sand, gravel, lateritic loam	Lesueur National Park, Jurien, Mount Peron, Eneabba, Forrestfield, Cockleshell Gully, Kukerin.	Unlikely	NM
Acacia lasiocarpa var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039)	P2	Aug	Grey-yellow sand with laterite. Low open heath.	Eneabba, Cockleshell Gully, Mt Lesueur.	Possible	NM, WA Herb
Acacia retrorsa	P2	Aug-Sep	Grey sand & lateritic gravel, sandy loam.	Lesueur National Park, Jurien Bay, Gazetted Reserve 24276, Mount Lesueur, Coorow, Hill River, Cockleshell Gully.	Possible	NM, WA Herb
Andersonia longifolia	P2	Mar-May	Sandy loam over sandstone, laterite gravel. Breakaways, ridges.	Sues Bridge, Whicher Range, Rosa Stream, Gairdner Range, Mt Lesueur.	Unlikely	NM, TPFL
Andersonia sp. Mt Lesueur (E.A. Griffin 5536)	P2	n/a	Sandy-clay with laterite.	Mount Peron, Mount Lesueur.	Possible	NM
Arnocrinum gracillimum	P2	Oct-Nov	White, grey, yellow or lateritic sand.	Moora, Coorow, south of Eneabba, Badgingarra, Lesueur.	Possible	NM, TPFL, WA Herb

Species	Rank	Flowering	Habitat	FloraBase Nearest Named Locations	Likelihood of Occurrence	Database Search
Beyeria similis	P2	Aug-Sep	Yellow or red clayey sand. Sandplains.	Eneabba, Mt Lesueur, Mount Peron, Jurien Bay.	Unlikely	NM, WA Herb
Grevillea delta	P2	Jun-Jul, Sep-Oct	Sandy clay, loam, gravelly soils, often over sandstone. Sandstone outcrops, creek beds.	Mt Lesueur, Lesueur National Park, Cockleshell Gully, Gazetted Reserve 15018, Mount Peron.	Unlikely	NM, WA Herb
Leucopogon plumuliflorus	P2	Apr, Jul-Nov	Lateritic sandy soils. Amongst lateritic boulders, hillslopes.	Gairdner Range, Mt Lesueur, Lesueur National Park, Gazetted Reserve 15018, Mount Peron, Cockleshell Gully, Jurien Bay, Hill River.	Unlikely	NM, WA Herb
Persoonia filiformis	P2	Nov-Dec	Yellow or white sand over laterite.	Eneabba, Mt Lesueur, Dongara, Jurien Bay, Mount Peron.	Possible	WA Herb
Phlebocarya pilosissima subsp. *teretifolia*	P2	Aug-Oct	White or grey sand, lateritic gravel	Eneabba, Badgingarra, Bibby Creek, Jandakot, Hill River.	Possible	NM
Stylidium diplotrichum	P2	Sep-Nov	Clayey sand or clay loam over laterite. Hillslopes and gullies.	Jurien Bay.	Unlikely	NM
Banksia kippistiana var. *paenepeccata*	P3	Oct-Nov	Lateritic gravelly soils.	Fynes Nature Reserve, Martin, Cataby, Boonanarring Nature Reserve, Gillingarra, Warradarge Hill, Lesueur National Park, Eneabba, Wongan Hills, Regans Ford, Gingin, Mount Peron.	Possible	WA Herb
Haemodorum loratum	P3	Nov	Grey or yellow sand, gravel.	Eneabba, Regans Ford.	Possible	NM
Persoonia rudis	P3	Sep-Dec, Jan	White, grey or yellow sand, often over laterite.	Boonanarring Nature Reserve, Wannamal, Eneabba, Dongara, Bullsbrook Nature Reserve, Regans Ford, Mt Lesueur, Cockleshell Gully, Muchea, Three Springs, Mount Peron, Jurien Bay, Gillingarra, Hill River, Mogumber.	Possible	WA Herb
Verticordia insignis subsp. *eomagis*	P3	Aug-Nov	Sandy soils over laterite. Sandplains, rocky rises.	Boothendarra Nature Reserve, Moora, Coorow, Green Head, New Norcia, Watheroo National Park, Hill River, Geraldton.	Possible	NM

Species	Rank	Flowering	Habitat	FloraBase Nearest Named Locations	Likelihood of Occurrence	Database Search
Verticordia muelleriana subsp. *muelleriana*	P3	Sep-Dec, Jan	White/grey or yellow sand. Sandplains.	Carnamah, Marchagee, Alexander Morrison National Park, Greenhead, Eneabba, Three Springs, Watheroo National Park, Coorow, Green Head, Dalwallinu.	Possible	NM, WA Herb
Verticordia rutilastra	P3	Sep-Nov	Sand and lateritic gravel. Hills.	Jurien Bay, Lesueur National Park, Coorow, Moora, Warradarge Hill, Gairdner Range, Mt Lesueur, Badgingarra.	Possible	NM
Asterolasia drummondii	P4	July-Sept	Lateritic gravel and sand or loam. Lateritic hills and sandplains, breakaways.	Green Head, Yandin Hill, Mt Misery, Cataby, Mt Lesueur, Mt Peron.	Unlikely	NM
Banksia sclerophylla	P4	Sep-Oct	White or grey sand over laterite, gravel.	Marchagee, Alexander Morrison National Park, Lesueur National Park, Cervantes, Green Head, Cataby, Badgingarra National Park, Mt Lesueur, Coomallo.	Possible	WA Herb
Banksia tricuspis	P4	May-Jul	Lateritic rocky soils. Sides & hilltops, breakaway edges.	Gairdner Range, Lesueur National Park, Mt Lesueur, Watheroo, Jurien Bay.	Unlikely	NM, TPFL
Stylidium inversiflorum	P4	Sep-Nov	White or grey sand over laterite. Sandplains, hillslopes and gullies. Heath, open woodland.	Gairdner Range, Eneabba, Badgingarra National Park, Green Head, Moora, Lesueur National Park, Cockleshell Gully, Reserve 31030, Gingin, Mt Lesueur.	Possible	NM, WA Herb
Thysanotus glaucus	P4	Oct-Dec or Jan-Mar	White, grey or yellow sand, sandy gravel.	Fynes Nature Reserve, Busselton, Lake King, Regans Ford, Herschel Range, Acton Park, Forrestfield, West Mount Barren.	Possible	NM
Xanthosia tomentosa	P4	Sep-Dec	Lateritic gravelly soils.	Gairdner Range, Lesueur National Park, Eneabba, Cockleshell Gully, Green Head, Jurien Bay, Gravel Reserve 42031, Badgingarra National Park, Mt Lesueur, Diamond Springs, Mount Peron, Hill River.	Possible	NM, WA Herb

Note: T = Threatened species, P2-P4 = Priority Two to Priority Four species; N/A = not available; NM = NatureMap database result (5 km buffer); TPFL = Threatened and Priority Flora database; WA Herb = WA Herbarium database. DEC's search reference number = 75-0812FL.

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Table A2.2: Conservation Significant Flora Produced by the TP List Search

Taxon	Rank	Distribution	Flowering Period
Eleocharis keigheryi	T (EPBC Act – Vulnerable, WC Act – Vulnerable)	Kenwick, Lesueur, Cataby, Wannamal, Ellenbrook, Boyanup, Waterloo, Julimar, Lesueur, Bolgart, Beverley, Woodanilling	Aug-Nov
Grevillea batrachioides	T (EPBC Act – Endangered, WC Act – Critically Endangered)	Mt Lesueur	Unknown
Thelymitra stellata	T (EPBC Act – Endangered, WC Act – Endangered)	Perth-Three Springs, Pinjarra, Dumbleyung, Corrigin, Bungendore Park, Unnamed Shire Reserve 34155, Hartfield Rd, Mt Peron, Jurien Bay, Mt Lesueur NP, Arthur River, Coomallo NR, Julimar, Chittering, Armadale	Oct-Nov
Tetratheca remota	P1	Mt Lesueur	Aug
Acacia lasiocarpa var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039)	P2	Cockleshell Gully, Lesueur NP	Unknown
Acacia retrorsa	P2	Mt Lesueur area	Aug-Sep
Andersonia longifolia	P2	Gairdner Range, Mt Lesueur	Mar-May
Arnocrinum gracillimum	P2	S of Eneabba, Badgingarra, Lesueur	Unknown
Banksia fraseri var. effusa	P2	Mt Lesueur	Jul-Aug
Beyeria similis	P2	Badgingarra, Ajana, Eneabba, Mt Lesueur	Aug-Sep
Boronia ramosa subsp. lesueurana	P2	Mt Lesueur	Jul-Aug
Daviesia debilior subsp. debilior	P2	Eneabba, Lesueur	Unknown
Eucalyptus angularis	P2	Mt Lesueur, Mt Benia	Unknown
Goodenia xanthotricha	P2	Hill River, Mt Lesueur	Jan-Feb
Grevillea delta	P2	Mt Lesueur	Oct
Hypocalymma sp. Gairdner Range (C.A. Gardner 9091)	P2	Mt Lesueur	Aug
Hypocalymma tenuatum	P2	Mt Lesueur	Jul
Lepyrodia curvescens	P2	Hazelmere, Regans Ford, Mt Lesueur, Jurien	Unknown
Leucopogon plumuliflorus	P2	Gairdner Range, Mt Lesueur	Aug-Oct
Persoonia filiformis	P2	Eneabba, Mt Lesueur	Nov
Stenanthemum limitatum	P2	Mt Lesueur	Oct-Nov
Stylidium cornuatum	P2	Eneabba, Wotto N.R., Lesueur N.P.	Sep
Stylidium diplotrichum	P2	Lesueur NP, Coorow, Alexander Morrison NP	Oct
Synaphea endothrix	P2	Badgingarra, Mt Lesueur	Aug-Sep
Synaphea lesueurensis	P2	Mt Lesueur	Aug-Oct
Synaphea xela	P2	Eneabba, Lesueur	Jul-Sep
Thelymitra pulcherrima	P2	Watheroo, Lake Logue N.R., Lesueur N.P.	Aug-Sep

Taxon	Rank	Distribution	Flowering Period
Verticordia argentea	P2	Eneabba, Hill River, Mt Lesueur	Jan
Acacia epacantha	P3	Dandaragan, Badgingarra, Eneabba, Lesueur	Unknown
Acacia plicata	P3	Hill River, Cataby, Lesueur	Aug-Oct
Allocasuarina ramosissima	P3	Badgingarra, Mt Lesueur, Hay Flat, Dandaragan, Alexander Morrison NP	Sep-Nov
Banksia kippistiana var. *paenepeccata*	P3	Warradarge Hill, Lesueur NP, Eneabba, Wannamal, Regans Ford, Gingin	Sep-Oct
Beaufortia eriocephala	P3	Mt Lesueur, Cataby, Coorow, Mogumber, York, St Ronans N.R.	Sep-Oct
Calytrix ecalycata subsp. *ecalycata*	P3	Port Gregory, Morawa, Three Springs, Mt Lesueur	Aug-Sep
Daviesia pteroclada	P3	Gairdner Ra., Warradarge Hill, Mt Lesueur	Jul-Aug
Gompholobium gairdnerianum	P3	Gairdner Range, Mt Lesueur, Badgingarra, Hill River, Jurien Bay, Minyulo NR, Mt Peron	Sep-Nov
Grevillea uniformis	P3	Mt Lesueur, Eneabba	Sep-Nov
Guichenotia alba	P3	Cockleshell Gully, Eneabba, Cataby, Badgingarra, Three Springs, Lesueur	Jul-Aug
Hakea longiflora	P3	Warradarge Hill, Coomallo Creek, Mt Lesueur, Badgingarra	Jul-Sep
Hensmania stoniella	P3	Eneabba, Watheroo, Cervantes, Nambung, Lesueur, Badgingarra, Mt Adams	Sep-Nov
Hypocalymma gardneri	P3	Gairdner Range, Cockleshell Gully, Lesueur NP, Eneabba	Aug-Oct
Isopogon drummondii	P3	Cockleshell Gully, Mt Lesueur, Mogumber, Orange Grove, Forrestfield, Moora, Midland	Jun
Jacksonia anthoclada	P3	East of Mt Lesueur	Mar-Apr, Dec
Melaleuca clavifolia	P3	Moore River, Coorow, Green Head, Cataby	
Patersonia argyrea	P3	Mt Lesueur	Sep-Oct
Persoonia rudis	P3	Gairdner Range, Muchea, Jurien, Alexander Morrison NP, Lesueur N.P., Eneabba	Sep-Nov
Stylidium nonscandens	P3	Alexander Morrison N.P., Coomallo Creek, Mogumber, Lesueur NP, Moore River	Sep-Nov
Stylidium periscelianthum	P3	Wongan Hills, Bolgart, Moora, Lesueur N.P., Watheroo	Sep-Oct
Stylidium torticarpum	P3	Lesueur, Herschell Range, Arrowsmith River	Oct
Tetratheca angulata	P3	Boothendarra Hill, Alexander Morrison NP, Mt Lesueur, Badgingarra	Aug-Oct
Thysanotus anceps	P3	John Forrest, Brookton Highway, Coomallo Creek, Mt Lesueur	Dec
Banksia sclerophylla	P4	Eneabba, Moore River, Alexander Morrison N.P., Lesueur, Coomallo	Sep-Oct

Taxon	Rank	Distribution	Flowering Period
Banksia tricuspis	P4	Lesueur	May-Sep
Desmocladus elongatus	P4	Eneabba, Cooljarloo, Coomallo, Badgingarra, Mt Lesueur	Aug-Nov
Eucalyptus exilis	P4	Mt Lesueur, Coorow, Boyagin Rock, Wandering, Bindoon, Gunapin, Coomallo NR, Beverley	Dec-Apr
Hakea neurophylla	P4	Gairdner Range, Coomallo Creek, Mt Lesueur	Jun-Aug
Stylidium aeonioides	P4	Mt Lesueur, Badgingarra, Dandaragan, Cataby	Sep-Nov
Thysanotus glaucus	P4	Regans Ford, Forrestdale, Busselton, Lake King, West Mt Barren, Lesueur NPk	Nov-Feb

TP = Threatened and Priority Flora List. DEC search reference number 75-0812FL.

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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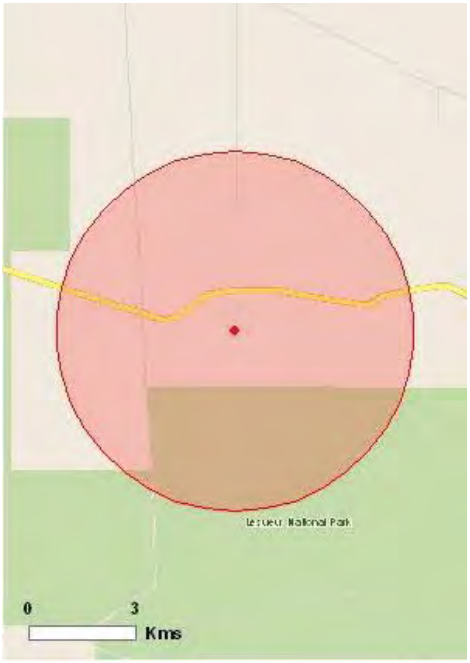

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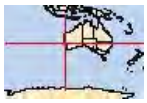

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	20
Listed Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	6
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	2
State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Natural		
Beekeepers-Lesueur-Coomallo Area and Nambung National Park	WA	Nominated place

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calyptorhynchus latirostris		
Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat likely to occur within area
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Other		
Idiosoma nigrum		
Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Acacia forrestiana		
Forest's Wattle [17235]	Vulnerable	Species or species habitat likely to occur within area
Andersonia gracilis		
Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Caladenia hoffmanii		
Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat may occur within area
Caladenia huegelii		
King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat may occur within area
Eleocharis keigheryi		
Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Eucalyptus balanites		
Cadda Road Mallee, Cadda Mallee [24264]	Endangered	Species or species habitat may occur within area
Eucalyptus impensa		
Eneabba Mallee [56711]	Endangered	Species or species habitat likely to occur within area
Eucalyptus leprophloia		
Scaly Butt Mallee, Scaly-butt Mallee [56712]	Endangered	Species or species habitat likely to occur within area
Eucalyptus suberea		
Cork Mallee, Mount Lesueur Mallee [5529]	Vulnerable	Species or species habitat likely to occur within area
Grevillea batrachioides		
Mt Lesueur Grevillea [21735]	Endangered	Species or species habitat likely to occur within area
Grevillea humifusa		
Spreading Grevillea [61182]	Endangered	Species or species habitat likely to occur within area
Hakea megalosperma		
Lesueur Hakea [10505]	Vulnerable	Species or species habitat likely to occur within area
Hemiandra gardneri		
Red Snakebush [7945]	Endangered	Species or species habitat likely to occur within area
Leucopogon obtectus		
Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Paracaleana dixonii Hopper & A.P.Br. nom. inval.		
Sandplain Duck Orchid [82050]	Endangered	Species or species habitat likely to occur within area
Tetratheca nephelioides		
[83217]	Critically Endangered	Species or species habitat likely to occur within area
Thelymitra stellata		
Star Sun-orchid [7060]	Endangered	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Mount Lesueur Area	WA	Registered
Mount Lesueur Proposed Reserve	WA	Registered

State and Territory Reserves [Resource Information]

Name	State
Lesueur	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk,		Species or species

Name	Status	Type of Presence
Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		habitat likely to occur within area

Coordinates

-30.07083 115.14389

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX 3: CONSERVATION SIGNIFICANCE – FLORA AND ECOLOGICAL COMMUNITIES

Commonwealth *Environment Protection and Biodiversity Act 1999*

Table A3.1: *EPBC Act* Categories and Definitions for Rare Flora

Category	Definition
Extinct*	A native species is eligible to be included in the extinct category if there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category if: a) it is only known to survive in cultivation, in captivity or as a naturalized population well outside its past range; or b) if it has not been recorded in its known and/ or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically endangered	A native species is eligible to be included in the critically endangered category if it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	A native species is eligible to be included in the endangered category if: a) if it is not critically endangered; and b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the vulnerable category if: a) if it is not critically endangered or endangered; and b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation dependent*	A native species is eligible to be included in the conservation dependent category if: a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or b) the following subparagraphs are satisfied; (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.
*Note: Species listed as 'conservation dependent' and 'extinct' are not matters of national environmental significance and therefore do not trigger the *EPBC Act*.	

Source: DSEWPaC (2013c).

Western Australian *Wildlife Conservation Act 1950*

Table A3.2: *WC Act* Categories and Definitions for Rare Flora

Category	Definition
T: Threatened Flora (Declared Rare Flora – Extant)	Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the Wildlife Conservation Act 1950). Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria: • CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild • EN: Endangered – considered to be facing a very high risk of extinction in the wild • VU: Vulnerable – considered to be facing a high risk of extinction in the wild.
X: Presumed Extinct Taxa (Declared Rare Flora – Extinct)	Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the Wildlife Conservation Act 1950).

Source: DEC (2013b).

Table A3.3: Categories and Definitions for Priority Flora

Category	Definition
1: Priority One: Poorly-known species	Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
2: Priority Two: Poorly-known species	Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
3: Priority Three: Poorly-known species	Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
4: Priority Four: Rare, Near Threatened and other species in need of monitoring	a. Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. b. Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
5: Priority Five: Conservation Dependent species	Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Source: DEC (2013b).

Table A3.4: Categories, Definitions and Criteria for Threatened Ecological Communities (TECs)

Category	Definition and Criteria
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats; or B) All occurrences recorded within the last 50 years have since been destroyed.
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): c) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (© or ii): • (i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); • (ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and one or more of the following apply (I, ii or iii): • (i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); • (ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; • (iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Category	Definition and Criteria
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): c) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (© or ii): • (i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); • (ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B) Current distribution is limited, and one or more of the following apply (©, ii or iii): • (i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); • (ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; • (iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

Category	Definition and Criteria
	C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Table A3.5: Categories, Definitions and Criteria for Priority Ecological Communities (PECs)

Category	Definition and Criteria
Priority One: Poorly-known ecological communities	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two: Poorly-known ecological communities	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority Three: Poorly-known ecological communities	(c) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Category	Definition and Criteria
Priority Four: Adequately known ecological communities	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened or that have been recently removed from the threatened list. These communities require regular monitoring. (a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five: Conservation Dependent ecological communities	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Source for Table A3.4 and Table A3.5: DEC (2010c).

APPENDIX 4: DECLARED PESTS CATEGORIES AND CONTROLS

Table A4.1: Categories and Controls for Declared Pests

Category	Controls
C1 Category (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 Category (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 Category (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Source: DAFWA (2013b).

APPENDIX 5: LANDGATE RESERVE ENQUIRY DETAIL

Reserve Enquiry Detail [5100L]

Screen Friendly Print Page

Reserve	42031	**Legal Area (ha)**	236.7552
Name		**Status**	Current
Type		**Current Purpose**	SAND AND GRAVEL
Notes			
File Number	499/92		
Additional Reserve Information	RESERVE COMPRISES LOT 12521 ON DP195118 (I970402)		

Class	Responsible Agency	Date of Last Change
C	EXECUTIVE DIRECTOR OF THE DEPARTMENT OF CONSERVATION & LAND MANAGEMENT	13/01/2005

Management Orders	Document	Land Use	Local Government Authority
SHIRE OF COOROW	I970403	GRAVEL	COOROW, SHIRE OF

Add Item	CLT Number	Parcel Identifier	Street Address	Suburb	File Number	PIN	Area (sqm)	Map Viewer
☐	LR3118-988	Lot 12521 On Plan 195118			00499-1992-01RO	1333505	2367657.0	

Reserve Number 42031

Previous Certificates of Title	Historic Crown Allotments
	VICTORIA Location 11926

Gaz Page/Document	Date	Type	Text
I970401	30/07/2004	Vesting	Revoked
I970402	30/07/2004	Current	Area
I970403	30/07/2004	Current	Vesting
I970404	30/07/2004	Current	Purpose
375	24/01/1992	Historical	Vesting
380	24/01/1992	Class	
380	24/01/1992	Correspondence File Number	
380	24/01/1992	Historical	Area
380	24/01/1992	Historical	Purposes
380	24/01/1992	Location	
380	24/01/1992	Original Gazettal and page	
380	24/01/1992	Public	Plan
380	24/01/1992	Street	Name
380	24/01/1992	Survey	Number

	REVOKED		
	236.7552		
	MANAGEMENT ORDER SHIRE OF COOROW		
	SAND AND GRAVEL		
	VEST NATIONAL PARKS & NATURE CONSERVATION AUTHORITY		
	C		
	499/92		
	505.9477		
	GRAVEL RESOURCE MANAGEMENT,RESTORATION & CONSERVATION		
	VICTORIA LOC 11926		
	ORIGINAL GAZETTE		
	LESUEUR & PT GREEN HEAD 1:50 000 (1937-IV & PT 1837-1)		
	COOROW-GREEN HEAD RD		
	P:16474		

This product is for information purposes only. A search of the original documentation is required for all legal purposes

Western Australian Land Information Authority (Landgate)

https://www.landgate.wa.gov.au/lia/au/gov/wa/dli/len/web/p132/flow/view5100.jsp 18/12/2012


R 37133
P214964
11419
65.459 ha
701.75
497.65
212.37
655.85
COOROW-GREEN HEAD RD
1074.98
439.44
186.47
183.37
484.95
237.68
219.01
COOROW-GREEN HEAD RD
1609.34
634.53
1563.4
61.44
1228.98
HW 1
441.31
419.01
145.2
133.08
169.33
152.25
144.6
98.43
180.45
R 42031
P195118
DP 195118
12521
FB 82794
230.77 ha
1423.12
850.48
COOROW, SHIRE OF
VICTORIA
WARRADARGE
537.84
186.21
183.53
205.29
178.75
247.05
197.82
199.85
R 42032
P195117
DP 195117
12520
FB 82794
269.18 ha
1232.5
3053.19
1171.2
COCKLESHELL GULLY RD
1005.68
2203.73.
6718.15

APPENDIX 6: FLORA TAXA RECORDED

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Table A5.1: Vascular Flora Species List

Family	Taxa	Drover 01A	Drover 01B	FlFr Drover 01A	FlFr Drover 01B
Aizoaceae	Aizoaceae sp. indet		•		
Amaranthaceae	*Ptilotus polystachyus*	•	•		
Amaranthaceae	*Ptilotus villosiflorus*	•			
Anarthriaceae	*Lyginia imberbis*	•	•		
Apiaceae	***Xanthosia tomentosa* (P4)**	•		Fl	
Araliaceae	*Trachymene ornata*	•		Fl	
Araliaceae	*Trachymene pilosa*	•			
Asparagaceae	*Chamaescilla versicolor*	•		Fl	
Asparagaceae	*Laxmannia omnifertilis*	•		Fl	
Asparagaceae	*Lomandra hastilis*	•	•	Fl	Fl
Asparagaceae	*Lomandra sericea*		•		
Asparagaceae	*Lomandra* sp. indet		•		
Asteraceae	****Arctotheca calendula***	•	•	Fl	
Asteraceae	*Cotula* sp. indet		•		
Asteraceae	****Hypochaeris glabra***	•	•	Fl	
Asteraceae	*Podolepis* sp. indet		•		
Asteraceae	*Podotheca gnaphalioides*	•		Fl	
Asteraceae	****Ursinia anthemoides* subsp. *anthemoides***	•		Fl	
Brassicaceae	****Brassica tournefortii***		•		Fl
Brassicaceae	****Raphanus raphanistrum***		•		Fl
Casuarinaceae	*Allocasuarina humilis*	•	•	Fl	
Celastraceae	*Tripterococcus brunonis*	•		Fl	
Colchicaceae	*Burchardia congesta*	•		Fl	
Cupressaceae	*Callitris acuminata*	•	•		Fr
Cyperaceae	*Caustis dioica*	•	•		
Cyperaceae	*Lepidosperma carphoides*	•	•	Fl	
Cyperaceae	*Lepidosperma* sp. P1 small head (M.D. Tindale 166A)	•		Fl	
Cyperaceae	*Mesomelaena pseudostygia*	•	•	Fl	
Cyperaceae	*Mesomelaena tetragona*	•		Fl	
Cyperaceae	*Monotaxis grandiflora* var. *grandiflora*	•		Fl	

Family	Taxa	Drover 01A	Drover 01B	FlFr Drover 01A	FlFr Drover 01B
Cyperaceae	*Schoenus brevisetis*	•		Fl	
Cyperaceae	*Schoenus grandiflorus*	•		Fl	
Cyperaceae	*Schoenus* sp. indet 1	•			
Cyperaceae	*Schoenus* sp. indet 2	•			
Cyperaceae	*Schoenus unispiculatus*	•		Fl	
Cyperaceae	*Tetraria octandra*		•		Fl
Dasypogonaceae	*Calectasia narragara*	•		Fl	
Dasypogonaceae	*Dasypogon obliquifolius*	•		Fl	
Dasypogonaceae	*Kingia australis*	•			
Dilleniaceae	*Hibbertia huegelii*	•	•	Fl	Fl
Dilleniaceae	*Hibbertia hypericoides*	•	•	Fl	Fl
Dilleniaceae	*Hibbertia leucocrossa*	•		Fl	
Dilleniaceae	*Hibbertia mylnei*	•	•		Fl
Dilleniaceae	*Hibbertia stenophylla*		•		Fl
Dilleniaceae	*Hibbertia subvaginata*	•		Fl	
Droseraceae	*Drosera echinoblastus*	•	•		
Droseraceae	*Drosera erythrorhiza* subsp. *magna*	•	•		
Droseraceae	*Drosera gigantea* subsp. *gigantea*	•			
Droseraceae	*Drosera macrantha*	•	•	Fl	
Droseraceae	*Drosera subhirtella*	•		Fl	
Elaeocarpaceae	*Tetratheca confertifolia*	•		Fl	
Ericaceae	*Andersonia heterophylla*	•	•	Fl	Fl
Ericaceae	*Andersonia lehmanniana* subsp. *lehmanniana*	•		Fl	
Ericaceae	*Astroloma microdonta*		•		Fl
Ericaceae	*Astroloma oblongifolium*		•		Fl
Ericaceae	*Astroloma stomarrhena*	•	•		Fl
Ericaceae	*Astroloma xerophyllum*	•	•	Fl	Fl
Ericaceae	*Conostephium pendulum*	•	•		Fl
Ericaceae	***Leucopogon* aff. *oldfieldii* (TOI)**	•	•	Fl	Fl
Ericaceae	*Leucopogon crassiflorus*	•	•	Fl	Fl
Ericaceae	*Leucopogon* sp. Cockleshell Gully (J.M. Powell 1749)		•		Fl

Family	Taxa	Drover 01A	Drover 01B	FlFr Drover 01A	FlFr Drover 01B
Ericaceae	*Leucopogon* sp. Lesueur (B. Evans 530)	•		Fl	
Ericaceae	*Lysinema pentapetalum*	•	•	Fl	Fl
Fabaceae	*Acacia acuaria*	•	•		Fl
Fabaceae	*Acacia auronitens*	•		Fr	
Fabaceae	***Acacia carens* (P2)**	•	•	Fr	Fl
Fabaceae	*Acacia cyclops*		•		
Fabaceae	***Acacia lasiocarpa var. lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039) (P2)**	•	•	Fr	Fl
Fabaceae	*Acacia pulchella* var. *glaberrima*		•		Fl
Fabaceae	*Acacia spathulifolia*	•		Fl	
Fabaceae	*Bossiaea eriocarpa*	•	•	Fl	
Fabaceae	*Cristonia biloba* subsp. *biloba*	•		Fl	
Fabaceae	*Daviesia angulata*	•	•	Fr	FlFr
Fabaceae	*Daviesia chapmanii*	•		Fr	
Fabaceae	*Daviesia decurrens* subsp. *decurrens*		•		Fl
Fabaceae	*Daviesia epiphyllum*	•	•	Fr	Fl
Fabaceae	*Daviesia nudiflora* subsp. *nudiflora*	•	•	Fr	
Fabaceae	*Daviesia triflora*		•		Fl
Fabaceae	*Gastrolobium oxylobioides*		•		
Fabaceae	*Gastrolobium polystachyum*	•		Fl	
Fabaceae	*Gompholobium knightianum*	•	•		
Fabaceae	*Gompholobium preissii*	•		Fl	
Fabaceae	*Gompholobium tomentosum*		•		
Fabaceae	*Hovea stricta*	•		Fl	
Fabaceae	*Jacksonia floribunda*	•	•		FlFr
Fabaceae	****Lupinus cosentinii***		•		
Fabaceae	****Ornithopus sativus***	•	•	Fl	
Fabaceae	*Sphaerolobium medium*	•		Fl	
Geraniaceae	****Pelargonium capitatum***		•		Fl
Goodeniaceae	*Dampiera carinata*	•			
Goodeniaceae	*Lechenaultia biloba*	•	•	Fl	
Goodeniaceae	*Scaevola canescens*	•	•	Fl	Fl

Family	Taxa	Drover 01A	Drover 01B	FlFr Drover 01A	FlFr Drover 01B
Goodeniaceae	*Scaevola repens* subsp. Northern Sandplains (R.J. Cranfield & P.J. Spencer 8445)	•		Fl	
Goodeniaceae	*Scaevola repens* var. *repens*		•		
Goodeniaceae	*Scaevola* sp. indet	•			
Haemodoraceae	*Anigozanthos manglesii* subsp. *manglesii*	•		Fl	
Haemodoraceae	*Anigozanthos manglesii* subsp. *quadrans*	•		Fl	
Haemodoraceae	*Anigozanthos* sp. indet	•			
Haemodoraceae	*Blancoa canescens*	•	•	Fl	Fl
Haemodoraceae	*Conostylis aculeata*		•		Fl
Haemodoraceae	*Conostylis crassinervia* subsp. *crassinervia*	•		Fl	
Haemodoraceae	*Conostylis teretifolia* subsp. *teretifolia*	•		Fl	
Haemodoraceae	*Haemodorum* ?*venosum*	•			
Haemodoraceae	*Haemodorum venosum*	•			
Haemodoraceae	***Phlebocarya pilosissima* subsp. *teretifolia* (P2)**	•		Fl	
Hemerocallidaceae	*Dianella revoluta* var. *divaricata*		•		
Hemerocallidaceae	*Johnsonia pubescens* subsp. *pubescens*	•		Fl	
Iridaceae	*Patersonia occidentalis* var. *occidentalis*		•		Fl
Lamiaceae	*Hemiphora bartlingii*	•	•	Fl	Fl
Lauraceae	*Cassytha nodiflora*	•	•		
Loranthaceae	*Nuytsia floribunda*	•	•		
Malvaceae	*Lasiopetalum drummondii*	•	•	Fl	Fl
Marsileaceae	*Marsilea drummondii*		•		
Marsileaceae	*Marsilea hirsuta*		•		
Myrtaceae	*Baeckea grandiflora*	•		Fl	
Myrtaceae	*Calothamnus sanguineus*	•	•	Fl	FlFr
Myrtaceae	*Calytrix brevifolia*	•		Fl	
Myrtaceae	*Calytrix fraseri*	•	•		Fl
Myrtaceae	*Conothamnus trinervis*	•		FlFr	
Myrtaceae	*Darwinia sanguinea*	•	•	Fl	Fl
Myrtaceae	*Eremaea asterocarpa* subsp. *asterocarpa*	•	•	Fr	Fr
Myrtaceae	*Eremaea violacea* subsp. *raphiophylla*	•	•	Fr	Fr
Myrtaceae	*Eucalyptus todtiana*	•	•	Fr	Fr

Family	Taxa	Drover 01A	Drover 01B	FlFr Drover 01A	FlFr Drover 01B
Myrtaceae	*Hypocalymma hirsutum*	•	•	Fl	Fl
Myrtaceae	*Leptospermum oligandrum*	•	•		Fr
Myrtaceae	*Leptospermum spinescens*	•	•		Fl
Myrtaceae	*Melaleuca aspalathoides*		•		Fr
Myrtaceae	*Melaleuca platycalyx*	•	•	Fr	Fr
Myrtaceae	*Melaleuca trichophylla*	•		Fr	
Myrtaceae	*Melaleuca urceolaris*	•		Fr	
Myrtaceae	*Melaleuca zonalis*		•		Fr
Myrtaceae	*Verticordia densiflora* var. *densiflora*		•		Fl
Myrtaceae	*Verticordia grandis*	•	•	Fl	Fl
Myrtaceae	*Verticordia ovalifolia*	•		Fl	
Orchidaceae	*Caladenia flava* subsp. *flava*	•		Fl	
Orchidaceae	***Diuris recurva* (P4)**	•		Fl	
Poaceae	*Amphipogon turbinatus*	•		Fl	
Poaceae	*Austrostipa flavescens*	•		Fl	
Poaceae	*Austrostipa scabra*		•		Fl
Poaceae	*Austrostipa scabra* subsp. *scabra*	•		Fl	
Poaceae	*Austrostipa* sp. indet		•		
Poaceae	*Avena* sp. indet		•		
Poaceae	*Neurachne alopecuroidea*	•		Fl	
Poaceae	Poaceae sp. indet		•		
Poaceae	****Vulpia myuros* forma *myuros***	•		Fl	
Portulacaceae	*Calandrinia corrigioloides*		•		Fl
Proteaceae	*Adenanthos cygnorum* subsp. *cygnorum*	•			
Proteaceae	*Banksia ?nobilis*		•		
Proteaceae	*Banksia armata* var. *armata*	•	•	Fl	
Proteaceae	*Banksia attenuata*	•	•	Fl	Fl
Proteaceae	*Banksia bipinnatifida* subsp. *multifida*	•			
Proteaceae	*Banksia dallanneyi* subsp. *media*	•	•	Fl	Fl
Proteaceae	*Banksia fraseri*		•		
Proteaceae	*Banksia lanata*		•		Fl

Family	Taxa	Drover 01A	Drover 01B	FlFr Drover 01A	FlFr Drover 01B
Proteaceae	*Banksia menziesii*	•	•	Fl	Fl
Proteaceae	*Banksia micrantha*	•	•	Fl	Fl
Proteaceae	*Banksia sessilis* var. *sessilis*	•		Fl	
Proteaceae	*Banksia shuttleworthiana*	•	•	Fl	Fl
Proteaceae	*Conospermum boreale* subsp. *ascendens*		•		
Proteaceae	*Conospermum boreale* subsp. *boreale*	•	•	Fr	
Proteaceae	*Conospermum canaliculatum*		•		Fl
Proteaceae	*Conospermum triplinervium*	•		Fl	
Proteaceae	*Grevillea excelsior*	•		Fl	
Proteaceae	*Grevillea synapheae* subsp. *pachyphylla*	•	•	Fl	Fl
Proteaceae	*Hakea anadenia*		•		
Proteaceae	*Hakea auriculata*	•		Fl	
Proteaceae	*Hakea conchifolia*	•	•		Fr
Proteaceae	*Hakea flabellifolia*	•	•		
Proteaceae	*Hakea incrassata*	•	•		FlFr
Proteaceae	*Hakea lissocarpha*		•		Fr
Proteaceae	*Hakea obliqua* subsp. *parviflora*	•		Fl	
Proteaceae	*Hakea preissii*	•			
Proteaceae	*Hakea prostrata*		•		
Proteaceae	*Hakea* sp. indet	•			
Proteaceae	*Hakea stenocarpa*	•			
Proteaceae	*Hakea trifurcata*	•	•	Fr	Fr
Proteaceae	*Isopogon adenanthoides*	•			
Proteaceae	*Isopogon inconspicuus*	•		Fl	
Proteaceae	*Isopogon linearis*	•	•	Fl	Fl
Proteaceae	*Isopogon panduratus* subsp. *panduratus*		•		Fl
Proteaceae	*Lambertia multiflora* var. *multiflora*	•	•	Fl	Fl
Proteaceae	*Petrophile brevifolia*		•		Fr
Proteaceae	*Petrophile linearis*	•		Fl	
Proteaceae	*Petrophile macrostachya*	•	•	Fl	Fr
Proteaceae	*Petrophile rigida*		•		Fr

Family	Taxa	Drover 01A	Drover 01B	FlFr Drover 01A	FlFr Drover 01B
Proteaceae	*Petrophile shuttleworthiana*	•		Fr	
Proteaceae	*Petrophile striata*	•		Fl	
Proteaceae	*Stirlingia latifolia*	•	•	Fl	Fl
Proteaceae	*Synaphea spinulosa* subsp. *spinulosa*	•	•	Fl	Fl
Restionaceae	*Alexgeorgea subterranea*	•		Fl	
Restionaceae	***Chordifex ?reseminans* (PST – potential P1)**		•		
Restionaceae	*Chordifex sinuosus*	•	•		Fl
Restionaceae	***Desmocladus biformis* (P3)**	•		Fl	
Rhamnaceae	*Cryptandra multispina*	•	•	Fl	Fl
Rubiaceae	*Opercularia vaginata*	•		Fl	
Rutaceae	*Boronia ramosa* subsp. *ramosa*		•		Fl
Rutaceae	*Philotheca spicata*	•		Fl	
Santalaceae	*Anthobolus foveolatus*	•			
Santalaceae	*Leptomeria preissiana*	•			
Solanaceae	****Solanum nigrum***	•	•		Fl
Stylidiaceae	*Stylidium diuroides* subsp. *diuroides*	•			
Stylidiaceae	*Stylidium repens*	•	•		Fl
Stylidiaceae	*Stylidium* sp. indet	•			
Thymelaeaceae	*Pimelea microcephala* subsp. *microcephala*	•			
Xanthorrhoeaceae	*Xanthorrhoea drummondii*	•	•		

P2-P4 = Priority Two to Priority Four species, * = environmental weed, PST = potentially significant taxon, TOI = taxon of interest.

Nomenclature based on current Western Australian Herbarium terminology and confirmed on FloraBase (WAH, 1998 -).

Green shading indicates species susceptible to Dieback.

Appendix 4
Drover-01 Biosecurity Procedure

AWE	**DROVER-01 BIO-SECURITY PROCEDURE**	**DOCUMENT NO:** HSE-PR-050
		REVISION: 0
	DROVER-01 ONSHORE DRILLING OPERATIONS	**ISSUE DATE:** 31/07/2013
		ADMINISTRATOR: Document Control
		ORIGINATOR: Environmental Advisor
		CUSTODIAN: Environmental Advisor
		APPROVER: Regional Manager - WA

1.0 PURPOSE

This document contains instructions on the bio-security procedures in place for the Drover-01 onshore drilling operations, with the aim of:

- Minimising the risk of *Phytophthora cinnamomi* and/or exotic flora species (weeds) being introduced into the Drover-01 project area via any drilling activity or AWE personnel, contractor or visitor access associated with the Drover-01 drilling operation;

2.0 SCOPE

This document applies to the following Drover-01 drilling operations, within the EP455 permit areas:

- All AWE personnel, contractor and visitor access to the Drover-01 drill site
- All site preparation activities relating to any Drover-01 drilling operation
- All site closures and rehabilitation activities relating to the Drover-01 drilling operations

3.0 REFERENCES

This document shall be read in conjunction with:

Document	Name
HSE-E-077	Drover-01 Exploration Well Environment Plan (EP)
Attachment 1	Drover-01 Bio-Security Register (attached)
Attachment 2	Drover-01 Site Layout Plan

4.0 SAFETY AND / OR ENVIRONMENTAL REQUIREMENT

Item	Activity Description	Responsibility
4.1	The dieback disease, *P. cinnamomi*, and/or exotic flora species (weeds) can be easily transported in organic material, soil or mud.	
4.2	All visitors to the Drover-01 drill site are required to arrive with vehicles and machinery in a clean state and free of all organic material, soil or mud.	All AWE personnel, contractors and visitors
4.3	Only authorised service vehicles are to be allowed past the Drover-01 camp site. All other vehicles are to be left at the camp site and site visitors are to use the camp bus to be transported to the drill site.	All AWE personnel, contractors and visitors
4.4	All visitors to the Drover-01 drill site are to report to the hygiene station on arrival, using only the established road network and following the road signs provided.	All AWE personnel, contractors and visitors
4.5	All personnel and contractors are to receive an induction prior to entering the site that includes the bio-security procedures for the Drover-01 drill site.	Field Supervisor or his/her delegate
4.6	All vehicles and machinery are to be inspected for the presence of organic material, soil or mud on arrival at the Drover-01 quarantine station prior to accessing any other part of the Drover-01 road network. Vehicles or machinery not meeting site bio-security requirements must be cleaned.	Field Supervisor or his/her delegate
4.7	All inspections and clean-downs will be recorded on the Drover-01 Bio-security Register (attached to this procedure).	Field Supervisor or his/her delegate
4.8	Vehicle and machinery movement will be restricted to only authorised service vehicles and the Drover-01 road network. The use of other tracks through the property will not be permitted, except in an emergency or unless directed to do so by AWE Environmental personnel.	All AWE personnel, contractors and visitors

Item	Activity Description	Responsibility
4.9	During dry conditions, the quarantine station must be equipped with brooms, brushes, dust pans and secure collection bins. During wet conditions, the camp site must have the same equipment as for dry conditions. However, the station must be upgraded to include high-pressure water equipment. The high-pressure water will be used to remove any wet soil, mud or organic material from the vehicle.	Field Supervisor or his/her delegate
4.10	Any gravel or limestone material utilised from imported or on-site sources for drill and/or camp site preparation and/or road maintenance, must be certified free of *P. cinnamomi* prior to being bought into the site.	Field Supervisor or his/her delegate
4.11	The quarantine station will be maintained in a clean condition and in good working order at all times. The quarantine station is to be checked daily as part of routine activities and thoroughly cleaned down at least once each week. Full service and maintenance work is completed monthly.	Field Supervisor or his/her delegate

5.0 BIO-SECURITY INSTRUCTIONS

Item	Action / Instruction	Responsibility
5.1	Only authorised service vehicles will be allowed past the Drover-01 quarantine station. All other vehicles are to be left at the camp site. All personnel, contractors and visitors to the Drover-01 drill site will proceed through the quarantine station where their footwear will be examined for signs of organic material, soil or mud. They will then board the camp bus which will transport them to the drill site.	All AWE personnel, contractors and visitors Field Supervisor or his/her delegate
5.2	All authorised vehicles must be inspected and cleaned down to remove any organic material, soil or mud prior to entering the Drover-01 drilling area.	Vehicle Operator
5.3	During dry conditions, use the brooms, brushes, dust pans provided to thoroughly clean the vehicle to remove any organic material, soil or mud. Pay particular attention to the tyres, wheel arches and any flat surfaces on the underside of the vehicle that could hold organic material. If the vehicle is a utility, the open tray area should be inspected for organic material. The interior of the vehicle should also be checked, especially the driver and passenger foot wells.	Field Supervisor or his/her delegate
5.4	During wet conditions, use the high-pressure water equipment provided to thoroughly clean the vehicle to remove any organic material, soil or mud. Again, check the tyres, wheel arches and any flat surfaces on the underside of the vehicle. The interior of the vehicle should also be checked. ***NOTE: There is no need to wash the paintwork on any vehicle unless there is evidence of wet soil, mud or organic material on the panels. If there is a need to wash wet soil, mud or organic material off paintwork it is best to use a broad spray rather than a high-pressure jet. Spraying paintwork with a high-pressure jet at close range can damage the painted surface.***	Vehicle Operator

Item	Action / Instruction	Responsibility
5.5	Once all organic material, soil or mud has been removed from the vehicle, it is to be collected and placed into the sealed plastic bins provided at the quarantine station.	Vehicle Operator
5.6	After all organic material, soil or mud has been collected, it is important to clean down all cleaning equipment and the clean-down area. This is especially important under the vehicle, so that the vehicle does not drive through wet soil or mud whilst leaving the quarantine station. All wet effluent is to be directed to the installed sump from the clean-down area. Dry effluent is to be placed in bins.	Vehicle Operator Field Supervisor or his/her delegate
5.7	The Drover-01 Bio-Security Register (Attachment 1) is to be filled out by the vehicle operator to record vehicle inspections and clean-downs. A copy of this register will be maintained at the quarantine station. Completed logs will be filed in the "Data for annual report" file located in the "Environmental Management" folder in the site office filing system. The "Data for annual report" file is then sent to the Environmental Advisor.	Vehicle Operator
5.8	The quarantine station is to be left neat and tidy. All cleaning equipment is to be kept clean. Any problems with the facility are to be addressed immediately (if possible) or reported to the field supervisor (or his delegate).	Vehicle Operator

ATTACHMENTS

Attachment 1
Drover-01 Bio-Security Register

DROVER-01 BIO-SECURITY REGISTER

The Inspector's signature on this form is confirmation that the vehicle was inspected and cleaned down in accordance with the requirements of the Drover-01 Bio-Security Procedure (HSE-PR-050)

Date	**Vehicle ID**	**Driver**	**Inspector**	**Action taken** (Inspected/cleaned)	**Inspector's Signature**

Attachment 2
Drover-01 Site Layout Plan

DROVER-01 SITE LAYOUT PLAN