



REVIEW OF ENVIRONMENTAL FACTORS FOR EXPLORATION BOREHOLES

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Submission of Environmental Assessment

Prepared under the Environmental Planning and Assessment Act 1979,
Part 5, Section 111.

Environmental assessment

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In respect of:

**Project to which Part 5
applies**

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31/979859; 202/771173; 2/590357; 27/979859; 28/979859;
372/832477

Proposed development

Coal Seam Methane Exploration Drilling

Environmental assessment

A review of environmental factors is attached.

Certificate

I certify that I have prepared the contents of this document and to the best of my knowledge:

It is in accordance with the requirements of Part 5;
It contains all available information that is relevant to the environmental impact assessment of the development to which it relates; and
The information contained in the document is neither false nor misleading.

Signature



Name

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Date

19/03/07

24/07/08

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1.0 INTRODUCTION

1.1 OBJECTIVES AND PURPOSE OF THE DOCUMENT

This Review of Environmental Factors (REF) addresses the proposed drilling and testing activities of 13 coal seam methane (CSM) stratigraphic boreholes by the Gloucester Joint Venture comprising both Lucas Coal Seam Gas Pty Ltd (Lucas) and Molopo Australia Limited (Molopo). Originally submitted in March 2007, this amended version of the REF has been prepared in July 2008 to include fracking activities.

The REF has been prepared by officers of Lucas to comply with Condition No. 1 (Environmental Assessment) of Petroleum Exploration Licence (PEL) No. 285.

Condition No. 1 states that a Category 3 activity ("in this case the drilling exploration boreholes") requires:

"...a Review of Environmental Factors in accord with Clause 228 of the Environmental Planning and Assessment Regulation 2000 must be submitted to the Environment Unit, Department of Mineral Resources to enable a determination under Part 5 of the Environmental Planning and Assessment Act to be made..."

Consultation with the New South Wales Department of Primary Industries - Mineral Resources (DPI) has confirmed that preparation of a REF is a suitable level of environmental assessment for the proposed works, and this REF has been prepared in accordance with the DPI *Guidelines for Review of Environmental Factors June 2006*.

1.2 PROJECT LOCATION

The location of the PEL area is approximately centred on the township of Stratford, approximately 70 kilometres (km) north of Newcastle in New South Wales (NSW). The area extends approximately 60 km north to south and approximately 20 km east to west comprising some 18 graticular blocks and about 1,308 square kilometres (km²) (Figure 1). The area completely contains the Gloucester Geological Basin.

The PEL area excludes existing mining leases (except Stratford Colliery), National Parks, state forest or nature reserves, Aboriginal areas and land vested in the Commonwealth of Australia. There are no World Heritage Areas or Ramsar Wetlands within the PEL.

The PEL overlays the Local Government Areas of the Gloucester Shire and Great Lakes Council.

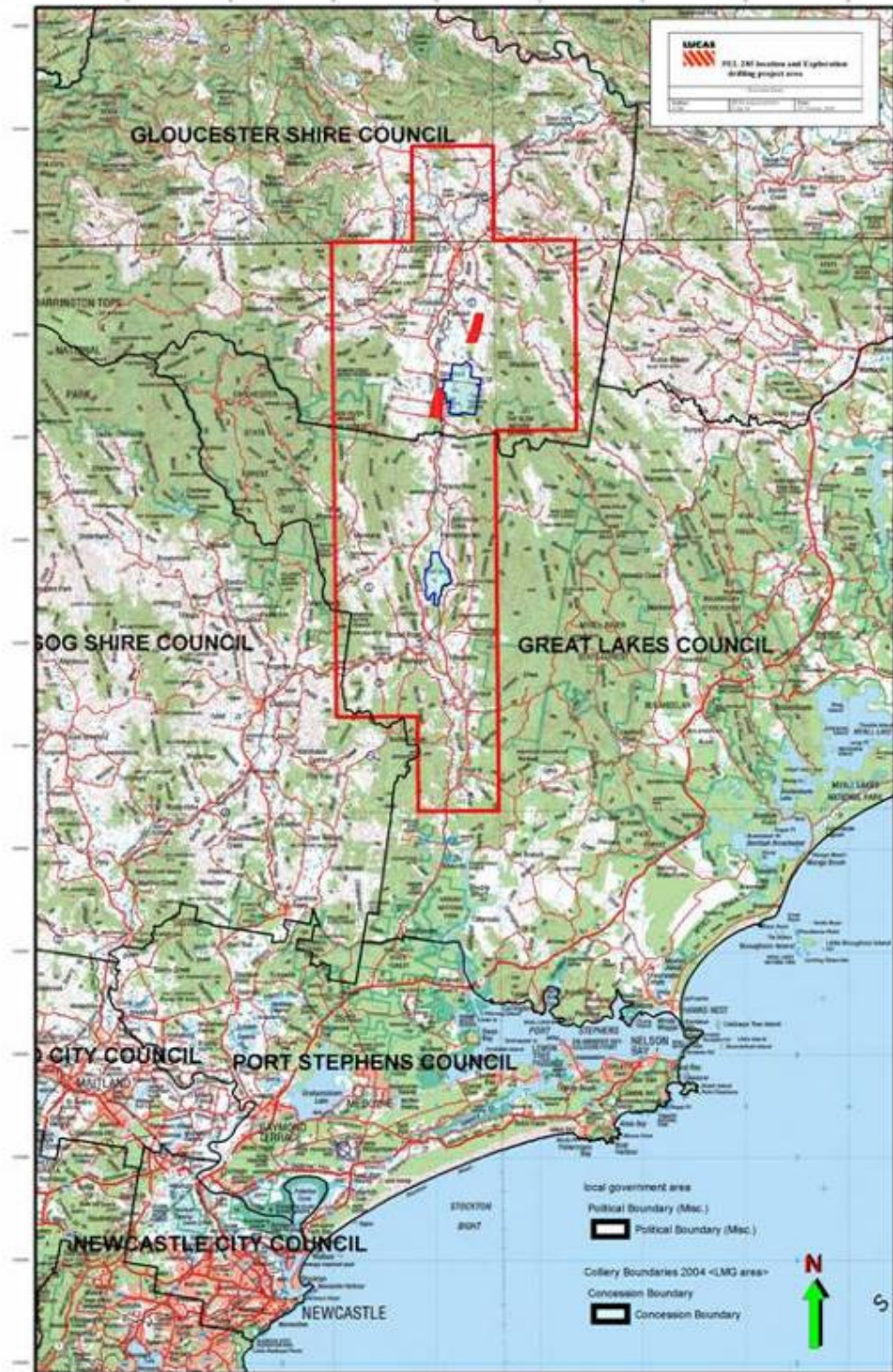


Figure 1: Project Location Map

1.3 BACKGROUND

PEL 285 was granted in 1992 under the *Petroleum (Onshore) Act, 1991*. It is jointly held by Lucas (75% interest) and Molopo (25% interest). Lucas is the Operator.

All exploration works are to be undertaken in accordance with Licence conditions that are imposed by the Minister for Primary Industries and to the works program agreed with DPI.

1.3.1 Overview of Historical Exploration Activities

In 1970-71, Noranda Australia Ltd, in search of open cut coal deposits, drilled in excess of 300 shallow holes in the Gloucester Basin. From 1977-83, BMI Mining Pty Ltd and Esso Australia Ltd drilled 990 open cut coal exploration holes, mostly shallow and non cored, in the basin. In addition, some 256 line km of Mini-SOSIE seismic reflection surveys was completed.

From a coal seam methane viewpoint, Esso-BMI drilled four deep fully cored stratigraphic holes in the north of the basin, and these have provided useful information on geology and coal development. The holes are named BMI SD 20, 22, 23, and 24, and vary in depth from 401-512 m. Hole BMI SD 20 is located in the centre of the present Stratford Coal Seam Methane (CSM) Prospect.

Three separate dedicated coal seam methane drilling programs were undertaken by Pacific Power at the Stratford Prospect in 1993, 1997, and 1999. A total of 5,590 m of cored 96 mm diameter drilling was completed in nine holes, named PGSD 1 - 9, ranging in depth from 444 m to 895 m.

The 1993 program consisted of boreholes PGSD 1 and 1A. Holes PGSD 2-5 comprised the 1997 program. In 1999, holes PGSD 2, 3 and 5 were deepened, and holes PGSD 6-9 were drilled. The purpose of the drilling was to evaluate the potential for commercial coal seam methane recovery at the Stratford Prospect.

In 2004 the Lucas-Molopo Joint Venture drilled the first dedicated production evaluation wells within the Stratford Prospect (namely LMG01, LMG02 and LMG03). LMG03 was subsequently hydraulic fracture stimulated and placed on production test. LMG01 and LMG02 are a surface to in-seam completion pair currently capped and suspended.

In 2005 the Joint Venture drilled the second set of dedicated CSM evaluation holes in the vicinity of Stratford Prospect (namely LMGW01 and LMGC01). These holes were fully cored, with the main seams tested for CSM properties.

In 2006 the Joint Venture lodged a Review of Environmental Factors to drill four exploration boreholes in the Stratford Prospect (namely LMG04, LMGW02, LMGC02 and LMGC03). ~~To date these wells have not been drilled.~~

In 2007 the Joint Venture drilled 5 exploration boreholes throughout the Gloucester basin. These were Weismantel 1 (LMGWL03), Weismantel 2 (LMGWL02), Craven 1 (LMGC10), Waukivory 1 (LMGW03) (cored), and Faulkland 1 (LMG10) (chipped). Several other wells were permitted, but not drilled during this period.

In 2008 the Joint Venture established a pilot project for production evaluation testing from several wells in the Stratford area (including LMG04, LMG08, LMG05, LMG06 and Stratford 9). Drilling, hydraulic fracture stimulation and production testing activities are ongoing at these wells.

1.4 OVERVIEW OF PROPOSED ACTIVITY

The proposed exploration activity involves the drilling of 13 coal seam methane stratigraphic and fully cored boreholes over an 18 month period.

Proposed core boreholes are:

- Lucas Molopo Gloucester Weisemantel 02 (LMGWL02)

- Lucas Molopo Gloucester Waukivory 1 03 (~~LMGW03~~)
- Lucas Molopo Gloucester Craven 1 10 (~~LMGC10~~)
- Lucas Molopo Gloucester [Faulkland 1A 10](#) (~~LMG10~~)

Proposed stratigraphic boreholes are:

- Lucas Molopo Gloucester Craven 3A 09 (~~LMGC09~~)
- Lucas Molopo Gloucester Weismantel 1 03 (~~LMGWL03~~)
- Lucas Molopo Gloucester Waukivory 02 (LMGW02)
- Lucas Molopo Gloucester [Craven 5 09](#) (~~LMG09~~)
- Lucas Molopo Gloucester [Faulkland 2 11](#) (~~LMG11~~)
- Lucas Molopo Gloucester Weismantel 3 01 (~~LMGWL01~~)
- Lucas Molopo Gloucester Craven 4 11 (~~LMGC11~~)
- Lucas Molopo Gloucester Craven 2 04 (~~LMGC04~~)
- Lucas Molopo Gloucester [Faulkland 3 12](#) (~~LMG12~~)

[A letter to the DPI of 15 May 2007 advised of the above borehole name changes. These revised names will be used in the remainder of this document.]

As at July 2008, the status of these wells is as follows:

| Well (current name) | Status | Future Activity Proposed |
|------------------------------|--------------------|----------------------------------|
| Weismantel 2 | Core hole, drilled | None |
| Waukivory 1 | Core hole, drilled | None |
| Craven 1 | Core hole, drilled | None |
| Faulkland 1A | Drilling underway | Potentially fracking and testing |
| Craven 3A | Core hole, drilled | None |
| Weismantel 1 | Core hole, drilled | None |
| Waukivory 2 | Not drilled | No plans at present |
| Craven 5 | Not drilled | No plans at present |
| Faulkland 2 | Revised location | New REF to be produced |
| Weismantel 3 | Drilled | Fracking and testing |
| Craven 4 | Not drilled | No plans at present |
| Craven 2 | Not drilled | No plans at present |
| Faulkland 3 | Not drilled | Drilling, fracking and testing |

All proposed activities are located on privately owned (freehold) land in cleared grazing paddocks (See Appendix 1).

The proposed drilling and subsequent test work aims to further test coal seam and gas characteristics and to define methane resources of the area, with a view to the development of a trial production field in the future. Hydraulic fracture stimulation ("fracking") is also proposed at the Weismantel 3 and Faulkland 3 sites, and may potentially be undertaken at Faulkland 1A in the future. Once these wells are established as production test wells, evaluation testing would involve pumping of water and then gas for a period of about six to twelve months. Pumping would take place on a seven days a week, 24 hour basis.

The activity would involve establishment of a single, moderate size truck mounted drilling rig and ancillary equipment on a small sites within cleared grazing land.

Access to most of the works area is available from the existing farm tracks. If required, some minor works may be undertaken to upgrade existing tracks. No clearing of vegetation or work across a drainage line, stream or creek for access tracks is required. Details of the activity and general environmental control measures that would be employed during the works are provided in the following sub-sections.

It is proposed that these activities would commence in April 2007 and be completed in late 2008.

1.5 SITE LAYOUT

The drilling, [fracking](#) and testing activities on each borehole site would involve temporary ground surface disturbance within a fenced area of some [65-90](#) m by [65-90](#) m. A typical site layout for the proposed drilling [and fracking](#) activity is shown in Appendix 2.

Provision would be made for storage of drilling water for circulation within each borehole. The drilling fluid performs the function of both lubricating the bit as well as transporting cuttings back to the surface. This water would be stored in sumps and/or tanks. If sumps are used, then about three or four sumps would be excavated and would each have dimensions of approximately 3 to 5 m and a depth of up to 2 m. Sumps would include safety ramps and fencing.

[Production testing involves the extraction of water from the coal seam aquifers, so "turkey's nest" storages are proposed to contain the produced water. These storages are to be located adjacent to the wells and would be sized according to the anticipated water production. A storage of about 4 ML capacity with approximate dimensions of 40m x 40m x 4.5m deep may be considered typical.](#)

[The location of each pond would be determined after environmental consideration and consultation with land owners. They would be located more than 40m from the bank of any drainage line or watercourse.](#)

Stock proof site fencing would be employed to delineate the works area and to limit the extent of disturbance. Transportable laboratory/office (2.4 m x 3.6 m) would be installed on-site during the drilling and initial downhole logging operations.

Access to all drilling sites will be via existing tracks where possible, heavy vehicle movements will be minimised or ceased during periods of heavy rain. Tracks will be ungraded if necessary to minimise damage and vehicle speeds restricted in dry conditions to minimise dust generation.

1.6 ACTIVITY DURATION AND WORKING TIMES

The drilling activity for each well would occur over a period of about 2 to 5 weeks. Work would be scheduled to take place seven days per week between the hours of 7.00 am and 6.00 pm. [Drilling may very occasionally be undertaken on a 24-hour basis, but only when geology and borehole conditions demand. Hydraulic fracture stimulation work would take several days at each site and would be undertaken during daylight hours.](#)

Downhole geophysical logging would be undertaken over a two day period on each borehole on completion of drilling. If required permeability testing which will take approximately 5 days on each site will be carried out after geophysical logging.

[Once the wells are established as production test wells, evaluation testing would involve pumping of water and then gas for a period of about six to twelve months. Pumping would take place on a seven days a week, 24 hour basis.](#)

With the completion of hydraulic fracture stimulations and the commencement of production testing, the site footprint of each well would be reduced back to an area of approximately 10m x 10m, plus the area of the adjacent water storage. The drilling sites and temporary storage turkey's nest ponds would be rehabilitated after all evaluation activities have ceased.

1.7 DRILLING METHODS

1.7.1 General

Drilling of the vertical boreholes would be undertaken with a truck mounted drilling rig. The type of rig to be used would depend on the outcome of the tendering process but would be typical of rigs used for mineral exploration. It would include equipment to raise and lower rods in the borehole, drive gear for rotary drilling, wireline equipment for recovery of core tubes and downhole devices such as magnets for recovery of any broken bits, Blow Out Prevention (BOP) equipment and pumps for circulation of drilling fluids.

The results from recent deep drilling in the Stratford Prospect indicate that blowout conditions are not present. Notwithstanding, blowout preventers would be installed as standard safety equipment at the proposed borehole sites. All boreholes would have grouted casing installed to a depth which is 10% of the total expected vertical depth, providing secure anchorage for the BOP equipment. A flare line, not less than 30 m in length, with an earthen bund at its end would be installed and additional casing may also be inserted, if required.

1.7.2 Circulation Fluids

The boreholes would be drilled either utilising a circulation fluid of water with up to containing 3 percent of potassium chloride (KCl) or high pressure air. No petroleum based drilling fluids or additives would be used at any stage in the drilling or testing of the boreholes.

All water based drilling fluids would be contained in a series of tanks and/or ground sumps on each site. Air circulation returns (namely drill cuttings and ground water) would be directed to the ground sumps via a bloopie line. Any drilling fluids containing excessive amounts of polymer or other additives would be removed from site and disposed of in a licensed facility. On completion of drilling, water remaining in the sumps would be allowed to evaporate or transported to an approved disposal site. Remaining cuttings would be buried under 1 m of soil. The surface would then be fully restored to its current status.

If required, sumps would be lined with plastic to reduce the potential for leakage to the environment and to minimise the requirement for additional water.

The start-up water required for the drilling would be obtained by truck cartage from the existing Stratford water storage. Approximately 80,000 litres (L) per borehole would be required to initially fill the sumps and a similar additional amount may be required during the drilling to maintain circulation fluid levels.

As a precaution for periods of heavy rain, upslope surface water flow would be directed around the sites in accordance with the surface water management measures presented in Section 4.2. A reserve sump will be constructed to capture any overflow from the drilling sumps. Sediment traps (e.g. silt fences) will also be used where necessary to prevent soil loss.

No drilling circulation water would be discharged to drainage lines or creeks.

1.8 BOREHOLE GEOPHYSICAL LOGGING AFTER COMPLETION OF DRILLING

Once the vertical boreholes have reached the target depth, downhole wireline geophysical logging would be undertaken for the full depth over a period of about two days on each borehole. The logging would involve the lowering of special purpose probes into the boreholes to record strata characteristics as the probe is slowly raised in the boreholes. One or more of these probes would contain small radioactive sources and only operators that are licensed to use and transport these devices would be considered for the project. The drilling rig would remain in standby during this time. Geophysical logging is expected to 2 days per borehole.

1.9 COAL SEAM PERMEABILITY TESTING

Once downhole wireline geophysical logging has been completed a program of coal seam permeability testing may be conducted on selected holes over a period of 5 days on each borehole. The testing would involve the lowering of special purpose packers on slim rods into the boreholes. The packer would isolate specific target coal seams for small scale downhole

water production and injection tests to determine permeability characteristics. Only experienced contractors/operators would be considered for this testing. The drilling rig would remain in standby during this time.

1.10 PERFORATING AND FRACTURE STIMULATION OPERATIONS

Based on the interpretation of results from openhole logging undertaken during the exploration phase, selected target coal seams will be perforated in each well. The perforating operations will be carried out by specialised wireline service companies using wireline operated guns and charges.

Each new well would then be stimulated using hydraulic fracturing ('fracking') techniques. Well stimulation through fracking opens up these paths in coal seams so they are wide enough to allow gas flow. An injectivity test would generally be carried out prior to fracturing, followed by fracture treatment by pumping water, frac sand and some additives into the selected zones at high rates.

Fracture stimulation operations would be carried out by specialised oilfield service companies over 2 to 3 days per well depending on the number of stages to be perforated and fractured in each new well.

A gravel stabilised area of 90m x 70m would provide adequate space for frac units and storage areas.

1.11 PRODUCTION TESTING

On completion of fracking, the wells would be installed with a Progressive Cavity Pump (PCP) to enable the pumping of water and methane gas to the surface from the target coal seams for evaluation and appraisal. During this period the surface facilities would include: an electric pump installed at the well head; a small diesel generator along with an associated diesel fuel tank; and metering equipment. The temporary fuel tank will either be banded or double-shelled in accordance with Australian Standard (AS) 1940.

Gas produced over the evaluation period would be disposed of by flaring at each site using an enclosed flare assembly. Waters would be pumped to the turkey's nest ponds.

Historical data from LMG03 provides an indication of methane production from the proposed wells. LMG03 produces approximately 1000 Mscf/day, which over a twelve month period equates to a production of approximately 16,400 tonnes of CO₂ equivalents by flaring the gas¹.

1.12 PRODUCTION WATER MANAGEMENT

The options for beneficial use or alternative disposal of water extracted during well production testing would be assessed once indicative flows and quality are available. All disposal options would be discussed with the relevant authorities and any necessary approvals sought, such as for on-site irrigation or even environmental discharge.

Ongoing production testing at the Stratford Pilot area provides an indication of the range of water flows and quality that might be expected at the new production wells proposed at Weismantel 3 and Faulkland 3.

Production water flows from Stratford 3 (LMG03) in the Stratford Pilot remained steady at 500bpd (79,500L/day) during initial de-watering. By contrast, recent flows from Stratford 8 (LMG08) and Stratford 4 (LMG04) have been substantially less at between 30bpd (4,750 L/day) and 140bpd (22,250 L/day). Typically, flows from dewatering can be expected to reach a maximum within the early stages of production and fall away over time.

¹ Note: greenhouse gas emissions are significantly reduced by flaring the methane gas. The same amount of methane being vented would equate to some 120,500 tonnes of CO₂.

Recent analysis by ACIRL on groundwater samples from the Craven 1 corehole show conductivity of between 3220 $\mu\text{S}/\text{cm}$ and 6240 $\mu\text{S}/\text{cm}$, while LMG03 samples have an average EC of about 3000 $\mu\text{S}/\text{cm}$. Sampling at Stratford 8 and 4 shows an average EC of 7000 $\mu\text{S}/\text{cm}$ and 9000 $\mu\text{S}/\text{cm}$ respectively.

There is significant variation in both production water quality and quantity from existing production wells in the Stratford Pilot area, suggesting variability within the targeted coal seam aquifers.

Initially, all water produced would be stored in turkey's nest storages specifically constructed adjacent to the wells for this purpose. The storages are to be sized for the anticipated flows and water that collects in these ponds would be evaporated and/or disposed of by alternative methods (discussed below).

Water quality analyses will be undertaken monthly during the first 3 months of evaluation testing to determine actual production water quality. Water quality will determine what disposal option(s) would be most appropriate.

The following subsections provide a description of the proposed water management system.

1.12.1 Turkey's Nest Ponds

Temporary turkey's nest ponds are proposed and would be located adjacent to each well to contain water produced over the production evaluation period. The ponds will be cut and fill type constructed with in-situ materials and will be lined with a geomembrane in accordance with the requirements of DPI. A storage of about 4 ML capacity with approximate dimensions of 40m x 40m x 4.5m deep may be considered typical.

The temporary turkey's nest ponds will be constructed to provide approximately 12 months storage capacity. An operational freeboard of 450 mm (equivalent to a 1 in 100 year, 72 hour duration event –Appendix B) will be maintained at all times. Once this freeboard level is reached, no further pumping of water to the ponds will be permitted.

Once water quality testing has determined the actual production water quality, disposal options for the production water will be developed during the initial evaluation period in consultation with regulatory authorities.

1.12.2 Water Disposal Options

During the initial evaluation period the Joint Venture partners would undertake consultation with the relevant authorities to evaluate and agree a suitable disposal option for the waters produced during the evaluation period. Options to be discussed and considered include:

- controlled discharge to land in the form of irrigation;
- allowing stored water to evaporate;
- discharge to a local waterway;
- disposal in a licensed liquid disposal facility; or
- controlled aquifer re-injection to groundwater.

The DPI has approved on-site irrigation using produced water at the nearby Stratford project area. As this option has the benefit of utilising the water for local agriculture rather than simply disposing of it, this is a preferable option that will be investigated and pursued at each new well. Appropriate irrigation procedures would be put in place to ensure that the water quality is suitable and there is no risk to the local environment.

The available disposal options will depend on eventual water quality and quantity. Should the water be particularly poor, some form of treatment would also be considered. In all instances, a suitable environmental assessment will be completed and licensing or approvals will be sought prior to release or disposal of any contained waters. This will include application for a groundwater extraction licence at each site.

1.13 SEALING OF BOREHOLES AND RESTORATION OF THE SITE

After completion of drilling and testing activities, the boreholes will be securely capped with a valve arrangement and pressure gauge, to allow future access. The valving would be located in a cement cellar approximately 1 m deep and flush with the ground surface. Water remaining in the drilling sumps would be allowed to evaporate and the sumps backfilled. Remaining cuttings would be buried under 1 m of soil. The surface of the drilling area would then be restored to its current status.

Once the stage is reached where no further testing is required, the wells will either be suspended as future producers or plugged. ~~boreholes would be cement sealed to the satisfaction of the DPI.~~

Turkeys Nest Ponds

The rehabilitation of the turkeys nest pond sites would be conducted in accordance with the requirements of the DPI. It is proposed that the ponds would be cleaned out, the liners removed, the embankments would be pushed in and the surface levelled, topsoiled and planted to pasture. The liner would be disposed of in a licensed facility.

2.0 PLANNING CONTEXT

2.1 LICENCES AND APPROVALS REQUIRED

The Second Schedule of PEL 285 outlines approval requirements for different types of exploration activity. The DPI recognises three categories of exploration activity. The establishment of petroleum exploration boreholes as proposed are considered Category 3 activities. Category 3 activities require a REF to be submitted to the DPI for approval.

The DPI has advised Lucas that the Minister Primary Industry is the determining authority with respect to exploration activities of this nature and will assess the REF under Part 5 of the *Environmental Planning and Assessment Act, 1979*. Clause 228 of the *Environmental Planning and Assessment Regulation, 2000* outlines the factors that the DPI must take into account when assessing the REF.

Legislative requirements for petroleum exploration in NSW such as the *Petroleum (Onshore) Act, 1991*, *Threatened Species Conservation Act, 1995*, *Fisheries Management Act 1994*, *National Parks and Wildlife Act, 1974*, *Native Vegetation Act 2003*, and *Protection of the Environment Operations Act, 1997* have been considered in the preparation of the REF.

Permits will not be obtained under the *Rivers and Foreshores Improvement Act, 1948* as no earthworks activity will be carried out within 40 metres of a designated stream.

2.1.1 Matters of National Environmental Significance EPBC Act

Under the *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth) the Joint Venture is obliged to consider matters of National Environmental Significance (NES) as part of its environmental impact assessment process. A search was conducted of the Department of Environment and Heritage online database for NES matters covering the proposed activity area.

The results of this database search are shown in Table 1.

Table 1: NES Matters for the Proposed Sites

| Factor | Impacts |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| (a) Any environmental impact on a World Heritage property? <i>Comments:</i> No world heritage property in the vicinity of the proposed work sites. | NA |
| (b) Any environmental impact on a National Heritage place? <i>Comments:</i> No national heritage place in the vicinity of the proposed work sites. | NA |
| (c) Any environmental impact on wetlands of international importance? | NA |

| Factor | Impacts |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| <i>Comments:</i> No wetlands of international importance in the vicinity of the proposed work site. | |
| (d) Any environmental impact on Commonwealth listed threatened species or ecological communities? <i>Comments:</i> No listed threatened species or ecological communities are likely to be impacted by the proposed work. | NIL |
| (e) Any environmental impact on Commonwealth listed migratory species? <i>Comments:</i> No listed migratory species are likely to be impacted by the proposed work. | NIL |
| (f) Does any part of the proposal involve a nuclear action? <i>Comments:</i> Not a nuclear action. | NO |
| (g) Any environmental impact on a Commonwealth marine area? <i>Comments:</i> Not in a Commonwealth marine area. | NA |
| (h) Any direct or indirect effect on Commonwealth land? <i>Comments:</i> Not on Commonwealth Land. | NA |

2.2 ZONING

All boreholes sites are located on privately owned lands used for grazing cattle.

Craven 5 LMG09, Faulkland 1 LMG10, Faulkland 2 LMG11, Faulkland 3 LMG12, Craven 2 LMGC04, Craven 3 LMGC09, Craven 1 LMGC10, Craven 4 LMGC11, Waukivory 2 LMGW02 and Waukivory 1 LMGW03 are located on land zoned General Rural 1A the *Gloucester Local Environmental Plan 2000*. An assessment of the *Gloucester Local Environmental Plan 2000* shows that the activities to be carried out are permissible within this land zone.

Weismantel 3 LMGWLO1, Weismantel 2 LMGWLO2 and Weismantel 1 LMGWLO3 are located on land zoned General Rural 1A within the *Great Lakes Local Environmental Plan 1996*. An assessment of the *Great Lakes Local Environmental Plan 1996* shows that the activities to be carried out are permissible within this land zone.

2.3 STAKEHOLDER CONSULTATION

Stakeholder consultation has been undertaken by Lucas with DPI, Gloucester Shire Council, Great Lakes Council, Forster Local Aboriginal Land Council, Karauh Land Council and landowners in regard to appropriate licensing, zoning and access arrangements in preparation of this REF.

Additional consultation with adjacent landholders and residents will be conducted prior to the commencement of works.

Formal access agreements are in place with the affected landowners permitting access for the drilling and testing activities proposed.

3.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 LAND RESOURCES

3.1.1 Land Use and Physiography

The borehole sites are situated in the Gloucester Valley, NSW. The landforms of the Gloucester Valley are characterised by north-south oriented linear ridges with intervening undulating lowlands and floodplains.

The topography in the vicinity of the borehole sites varies from 110 m to 130 m AHD. The topography consists of grassy flats and gentle rises. Relief on the sites is generally less than 10 m.

All borehole sites are located on improved pasture land used for cattle grazing.

3.1.2 Geology

The PEL area contains the geological domain known as the Gloucester Basin or Stroud-Gloucester Syncline. This is a canoe shaped trough containing some 4,000 m of Permian volcanics and sedimentary rocks. The basin contains the Gloucester Coal Measures and Dewrang group which are the targets for the drilling programme.

The basin sequence is summarised in Table 2.

Table 2: Summary of Relevant Stratigraphy

| Stratigraphic Unit | Approx. Age | Approx. Thickness (m) |
|--------------------------|---------------|-----------------------|
| Craven Sub Group | Late Permian | 800 |
| Speldon Formation | Late Permian | 100 |
| Avon Sub Group | Late Permian | 500 |
| Mammy Johnsons Formation | Late Permian | 300 |
| Weismantel Formation | Late Permian | 20 |
| Duralie Road Formation | Late Permian | 250 |
| Alum Mountain Volcanics | Early Permian | 2040 |

Igneous rocks in the form of two thin dykes of presumed tertiary age have been reported in the south of the Basin. In the Stratford Prospect, an irregular dolerite intrusion, 5 m thick, and two thin dolerite dykes were intersected in one previous exploration borehole (PGSD 1) where the intrusion was at the level of the Avon seams. LMGW01 also intersected approximately 5m of dolerite intrusive at the level of the Avon seams.

The strata that outcrops at the surface in the vicinity of the borehole sites is the Craven Sub Group which varies in thickness from approximately 240 m to 520 m. The Craven Sub Group consists of a sequence of delta plain sand and mud deposits, major alluvial channels, minor tuffs and numerous coal seams.

3.1.3 Soil Landscape

Faulkland 3 LMG12, Craven 2 LMG04, Craven 3 LMG09, Craven 1 LMG10, Craven 4 LMG11, Waukivory 2 LMGW02 and Waukivory 1 LMGW03 borehole sites are located within the Gloucester soil landscape. The Gloucester group was described by Henderson, 2000 and is summarised in Table 3.

Table 3: Gloucester Group Soil Landscape Attributes

| Attribute | Comment |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Landscape | Undulating low hills on Permian sediments in the Stroud-Gloucester Basin region. Relief <50 m, Elevation <200 m and Slopes <10%. |
| Soils | Moderate to deep, moderately well-drained Brown Sodosols (Yellow Soloths) and moderately well-drained Grey Kurosols (Yellow Soloths) on imperfectly to moderately well drained sideslopes and crests shallow to deep. |
| Vegetation | The original open-forest which covered most of this landscape has been cleared and replaced with improved pasture. Mature trees of Forest Red Gum (<i>Eucalyptus tereticornis</i>), Grey Box (<i>E. moluccana</i>) are common but isolated. |
| Land use | Improved and semi-improved pasture. Agricultural activities including dairying, beef cattle production, orchards, horse stud, turf farming and some cultivation. |

Craven 3 LMG09, Faulkland 1 LMG10, Faulkland 2 LMG11, Weismantel 3 LMGWLO1, Weismantel 2 LMGWLO2 and Weismantel 1 LMGWLO3 sites are located within the Wards River soil landscape. The Wards River group was described by Henderson, 2000 and is summarised in Table 4.

Table 4: Wards River Group Soil Landscape Attributes

| Attribute | Comment |
|-----------|---------|
|-----------|---------|

| Attribute | Comment |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Landscape | Rolling hills on sediments of the Gloucester Coal Measures in the Stoud-Gloucester Basin region. Relief 30-100 m, Elevation 100-240 m and Slopes <25%. |
| Soils | Moderately deep, imperfectly drained Brown Kurosolos (Yellow Soloths) on well to imperfectly drained sideslopes. |
| Vegetation | Cleared tall open-forest with semi-improved pasture. Mature trees are isolated but commonly include the Spotted Gum (<i>Corymbia maculate</i>), Red Ironbark (<i>Eucalyptus siderphloia</i>) and Broad Leaf Ironbark (<i>E. fibrosa</i>) species. |
| Land use | Beef cattle grazing on semi-improved pasture. |

3.2 CLIMATE

The climate is warm temperate (warm to hot summers, mild to cool winters) with the rainfall pattern having a summer maximum. Meteorological records indicate average annual rainfall is about 990 mm (Bureau of Meteorology [BOM], 2007). The months of July to October are the driest period and represent the period of least risk for erosion associated with earthworks. December to March is generally the wettest months and accordingly earthworks during this period must be undertaken with suitable care.

Temperatures recorded at the Stratford Coal Mine indicate that January to February is the hottest months and June is the coldest. Temperatures have been recorded varying from 38.6 to -3.8°C (BOM, 2007).

3.3 WATER RESOURCES

3.3.1 Surface Water

Craven 5 LMG09, Faulkland 1 LMG10, Faulkland 2 LMG11, Faulkland 3 LMG12, Craven 2 LMG04, Craven 3 LMG09, Craven 4 LMG11, Waukivory 2 LMGW02 and Waukivory 1 LMGW03 are situated within catchment of the Avon River. The Avon River has a catchment area of some 290 km² and is one of approximately 30 rivers that contribute to the greater Manning River system (SCPL, 2001). Groundwater seepage contributes to flows in the local tributaries and creeks during periods of elevated groundwater levels that follow rainfall events (SCPL, 2001).

Surface water quality assessments undertaken for the Bowens Road North EIS (SCPL, 2001) indicate that water quality in the area is generally in compliance with the ANZECC (1992) livestock watering and aquatic ecosystem guidelines, however, with considerable variability in pH and salinity during periods of low stream flow.

Weismantel 3 LMGW01, Weismantel 2 LMGW02 and Weismantel 1 LMGW03 are situated within an unnamed catchment of Mammy Johnsons River, a tributary of the Karuah River. The Karuah River, which rises in the Chichester State Forest, drains to Port Stephens some 40km south of Duralie.

Surface water quality assessments of Mammy Johnsons River undertaken for the Duralie Coal Mine EIS (DCPL, 1996) indicate that water quality is near neutral with high buffering capacity and high dissolved oxygen. Electrical conductivity ranged from 300 - 400 uS/cm which is indicative of medium salinity with respect to aquatic and irrigation standards.

Section 4.2.1 describes potential impacts and mitigation measures that relate to surface water.

3.3.2 Groundwater

Stratford Area - Craven 5 LMG09, Faulkland 1 LMG10, Faulkland 2 LMG11, Faulkland 3 LMG12, Craven 2 LMG04, Craven 3 LMG09, Craven 4 LMG11, Waukivory 2 LMGW02 and Waukivory 1 LMGW03

A series of assessments of the local and regional hydrogeological regime and local groundwater quality have been undertaken for the Stratford Coal Mine, Bowens Road North Coal Mine. These are summarised in the Bowens Road North EIS (SCPL, 2001).

Previous investigations have identified that the coal seams are the main continuous aquifers in the Gloucester Basin. The conductivity of coal seams may vary over several orders of magnitude and the low hydraulic conductivity of overburden and structural faults compartmentalises groundwater flows.

Groundwaters in the Bowens Road North Mine area are generally saline, highly mineralised, hard waters with slightly alkaline to acidic pH, unsuitable for domestic consumption and in some cases livestock consumption (SCPL, 2001). Shallow groundwaters tend to be more acidic than groundwaters from deeper aquifers (*ibid.*).

CSIRO water quality testing of groundwater samples from previously conducted coal seam methane exploration boreholes in the Stratford Prospect have confirmed that the groundwaters in the evaluation area are generally neutral to slightly basic (7.0-8.7 pH) and generally saline (conductivity 5,220 - 21,700 $\mu\text{S}/\text{cm}$). The results of the CSIRO groundwater testing may overstate the salinity, as a KCl based drilling fluid was utilised for completion of these boreholes to maintain hole stability.

Lucas carried out water quality testing of groundwater in samples from their coal seam methane exploration borehole (LMG03) with the Stratford Prospect area and the results of these tests confirmed that the groundwaters properties for pH are between 7.5 - 9.3 and electrical conductivity between 3,300 and 5,400 $\mu\text{S}/\text{cm}$. The water testing results and ongoing assessments have now allowed the approval of the produced water from LMG03 to be utilised for pasture irrigation.

Weisemantle Area - Weismantel 3 LMGWLO1, Weismantel 2 LMGWLO2 and Weismantel 1 LMGWLO3

Assessment of the local hydrogeological regime and local groundwater quality was undertaken for the Duralie Coal Mine Environmental Impact Study in 1996.

The coal seam is the main continuous aquifer across the area. The sandstone which overlies and underlies the coal seam has a variable hydraulic conductivity. Groundwaters were characterised in the Duralie Coal EIS as having a mean Total Dissolved Salt (TDS) of 1500 mg/l and a pH of 5.5 to 6.7. The water was described as a sodium-bicarbonate-chloride type. More recent monitoring has shown shallow groundwaters to be less saline with respect to deeper aquifers (EC 300 $\mu\text{S}/\text{cm}$).

3.4 FLORA AND FAUNA

Gloucester Local Government Area - Stratford Area - Craven 5 LMG09, Faulkland 1 LMG10, Faulkland 2 LMG11, Faulkland 3 LMG12, Craven 2 LMGC04, Craven 3 LMGC09, Craven 1 LMGC10, Craven 4 LMGC11, Waukivory 2 LMGW02 and Waukivory 1 LMGW03

Gloucester Local Government Area (LGA) contains significant biodiversity values including the world heritage listed Central Eastern Rainforest Reserves (Barrington Tops Area) NSW (Barrington Tops National Park) as well as the Woko National Park, six nature reserves and four state conservation areas located throughout the area. In all, 51,090 ha are dedicated to species and ecosystem conservation, around 17% of the entire LGA (Gloucester Shire Council 2005). Nonetheless, the LGA continues to lose biodiversity through:

- Land clearing;
- Habitat alteration through weed invasion;
- Domestic and feral animal activity; and
- Poor land management techniques.

With such significant conservation areas the LGA provides habitat for a number of species and endangered ecological communities listed on the schedules of the NSW *Threatened Species Conservation, 1995* (TSC Act), NSW *Fisheries Management Act, 1994* (FM Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) and these are listed in Gloucester Shire Council *Supplementary State of the Environment Report 2005*. A review of these lists indicate that the majority of species and ecological communities would be confined to the vegetated areas within conservation areas, within remnant vegetation in private ownership and in riparian areas and along coastal waterways.

Great Lakes Local Government Area - Weismantel Area - Weismantel 3 LMGWLO1, Weismantel 2 LMGWLO2 and Weismantel 1 LMGWLO3

Great Lakes Local Government Area (LGA) contains extensive biodiversity values including an extensive lake system, coastal zones and mountain ranges. The LGA features five national parks, nine nature reserves, two state conservation areas and other lands acquired for conservation. In total approximately 70,000 ha are held in public conservation estates which is around 20% of the LGA. Additional land totaling 878 ha is also conserved under private land covenants (Great Lakes Council, 2005). However, a rapidly expanding population continues to place pressures on terrestrial, marine and aquatic ecosystems.

With such significant conservation areas the LGA provides habitat for a number of species and endangered ecological communities listed on the schedules of the NSW *Threatened Species Conservation, 1995* (TSC Act), NSW *Fisheries Management Act, 1994* (FM Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act). The numbers of known and threatened groups within the LGA include (Great Lakes Council, 2005):

- Nine endangered ecological communities;
- Two endangered populations;
- 21 species of threatened flora;
- 25 species of threatened mammals;
- six species of threatened frogs;
- one threatened reptile; and
- 36 threatened bird species.

The majority of species, populations and ecological communities would be confined to the vegetated areas within conservation areas, within remnant vegetation in private ownership and in riparian areas and along coastal waterways.

Assessment

The National Parks and Wildlife Service (NPWS) 'Atlas of NSW Wildlife' database was reviewed for any threatened species that have been recorded within the locality (in this instance a 20 km by 20 km zone around the evaluation area) and these data are listed in Table 5.

Table 5: Atlas of NSW Wildlife Flora and Fauna Species Records of the Locality

| Scientific Name | Common Name | TSC Act Legal Status | Preferred Habitat |
|-------------------------------------------|------------------------|----------------------|----------------------------------------------|
| FLORA | | | |
| <i>Asperula asthenes</i> | | Vulnerable | Damp sites along river beds |
| FAUNA | | | |
| <i>Ephippiorhynchus asiaticus</i> | Black-necked Stork | Endangered | Permanent freshwater wetlands |
| <i>Hoplocephalus stephensi</i> | Stephens' Banded Snake | Vulnerable | Eucalypt forests and rocky areas |
| <i>Ninox strenua</i> | Powerful Owl | Vulnerable | Large tracts of forest |
| <i>Pomatostomus temporalis temporalis</i> | Grey-crowned Babbler | Vulnerable | Open woodlands |
| <i>Dasyurus maculatus</i> | Spotted-tailed Quoll | Vulnerable | Forests and heathlands |
| <i>Pyrholaemus sagittatus</i> | Speckled Warbler | Vulnerable | Eucalypt communities with grassy understorey |
| <i>Tyto tenebricosa</i> | Sooty Owl | Vulnerable | Rainforest and moist Eucalypt forests |
| <i>Tyto novaehollandiae</i> | Masked Owl | Vulnerable | Eucalypt forests and woodlands |
| <i>Calyptorhynchus lathamii</i> | Glossy Black-Cockatoo | Vulnerable | Open woodlands with stands of She-oak |

| Scientific Name | Common Name | TSC Act Legal Status | Preferred Habitat |
|--------------------------------------------|-------------------------|----------------------|-------------------------------------------------------------------------|
| <i>Phascolarctos cinereus</i> | Koala | Vulnerable | Eucalypt forests and woodlands |
| <i>Petaurus norfolcensis</i> | Squirrel Glider | Vulnerable | Eucalypt forests and woodlands |
| <i>Miniopterus australis</i> | Little Bentwing-bat | Vulnerable | Moist Eucalypt forests whilst roosting in caves and man-made structures |
| <i>Miniopterus schreibersii oceanensis</i> | Eastern Bent-wing Bat | Vulnerable | Caves and man-made structures |
| <i>Scoteanax rueppellii</i> | Greater Broad-nosed Bat | Vulnerable | Woodland areas with tree hollows |

TSC Act = NSW *Threatened Species Conservation Act 1995*; Locality = 20 km x 20 km evaluation area; Preferred habitat = sourced from DEC Threatened Species Profiles.

An assessment of all borehole sites and access ways was conducted utilising aerial photographs and a site visit. The disturbed nature of the proposed sites indicated that detailed surveys would not be required to characterise the ecology of the sites, their conservation value and the potential impacts of the proposals. The locations of the proposed boreholes are all within highly modified environments that have been cleared of native vegetation, largely revegetated with introduced pasture species and used for grazing of stock over a considerable number of years. None of the proposed borehole sites contain remnant vegetation in the form of shrubs or trees and none would be located in riparian areas or within seepage zones. No endangered ecological communities listed under the EPBC Act or TSC Act occur within or adjacent to the proposed borehole sites and there is little potential for any threatened plant to be resident on any of the proposed sites.

Habitat suitable for fauna would be limited to those common species of native and introduced fauna including bird species such as Black-faced Cuckoo Shrike (*Coracina novaehollandiae*), Crimson Rosella (*Platycercus elegans*) and Magpie (*Gymnorhina tibicen*), all of which were recorded during the brief site visit. Other species that potentially use the area may include the Eastern Grey Kangaroo (*Macropus giganteus*) and the introduced European Red Fox (*Vulpes vulpes*). There is little or no potential for any threatened species listed under the TSC Act, FM Act or EPBC Act to rely on any of the proposed borehole sites for breeding or foraging habitat although some may overfly the area or occasionally forage within the pasturelands.

An assessment under *State Environment Planning Policy No. 44 - Koala Habitat Protection* (SEPP 44) is required as Great Lakes LGA is listed under Schedule 1 of SEPP 44. This SEPP requires the identification and protection of core koala habitat within both LGAs. The proposed borehole sites could not be considered core koala habitat or potential koala habitat as the sites lack any trees and in particular those species listed under Schedule 2 of this SEPP. Consequently no further provisions of SEPP 44 need apply to this application.

Overall outcomes from this assessment include the following:

- the borehole sites are located on cleared pasture land away from native shrubs, trees or ecological communities;
- there are no rocky outcrops which could provide habitat for reptiles or small mammals; and
- the proposed areas are clear of creeks or seepages that could act as habitat for amphibians or other water dependant species.

Section 4.5 describes potential impacts and mitigation measures that relate to flora and fauna.

3.5 HERITAGE

3.5.1 Aboriginal Heritage

The borehole sites fall within the Biripi and Worimi Aboriginal Peoples traditional lands and the Aboriginal organisation that are responsible for providing advice on Aboriginal heritage management is the Forster Local Aboriginal Land Council and Karauh Local Aboriginal Land

Council respectively. Disturbance due to European occupation and grazing severely limits the likelihood of identifying significant Aboriginal sites in the area.

A search of the NPWS Aboriginal sites register for the evaluation area identified no registered sites or places were located within the proposed borehole site area or surrounds. The closest registered site is an isolated artefact near the centre of the Bowens Road North Mine area that was identified in previous assessments that were undertaken for the Bowens Road North Project (SCPL, 2001).

3.5.2 European Heritage

The evaluation area is located within cleared grazing lands and no European heritage items are known or are likely to be located in the borehole sites.

Section 4.7 describes potential impacts and mitigation measures that relate to heritage aspects.

3.6 AIR QUALITY AND NOISE

The air and noise environment in the vicinity of the proposed well site locations is influenced by typical rural activities such as ploughing, harvesting, and trucking of rural products, together with the noise of stock, insects and birds. There are existing coal operations that dominate the local noise environment.

Section 4.1 and 4.4 describe potential impacts and mitigation measures that relate to air quality and noise aspects.

3.7 SOCIO-ECONOMIC AND COMMUNITY ASPECTS

The borehole sites are located within the Gloucester and Great Lakes Local Government Area. Employment is dominated by agriculture, forestry and mining. There are well established community services and a range of hotels and other accommodation facilities available.

Section 4.10 describes potential impacts and mitigation measures that relate to socio-economic and community aspects.

4.0 ASSESSMENT OF THE POTENTIAL IMPACTS AND PROPOSED MITIGATION STRATEGIES

The following section outlines the potential impacts of the exploration borehole work that have been identified and measures to minimise these impacts. In addition a Project Environmental Management Plan (EMP) will be implemented for the project (Appendix 3). The EMP sets out the project specific procedures to manage each of the issues identified in this REF. A copy of the EMP will be kept in the site office together with the Emergency Response Procedure (ERP) and Safety Management Plan (SMP). The contractor(s) will be required to conform to the requirements of the EMP.

The EMP will include:

- A statement of objectives;
- The measures to be taken to manage the environmental issues described in this REF;
- The responsibilities of the site supervisor, contractor(s) and any sub-contractors;
- Site induction requirements;
- Reporting requirements; and
- Environmental emergency response plan.

4.1 AIR QUALITY

The potential for dust generation from the proposed drilling is minimal. Access to the majority of the proposed drill sites is expected to be via the existing farm tracks. Dust generation by vehicles moving along these tracks would be minor and similar to existing farm uses.

The drill pads and sumps require minimal earthworks and would occupy a limited area. As a result, dust generation from the operating drill rig would be negligible. Once drilling has been completed at each pad, the area would be rehabilitated and sown to pasture.

4.1.1 Produced Gas

The flares at each site would be designed to achieve a minimum of 99% destruction of methane gas and other hydrocarbons. This will be confirmed by testing after completion of the installation to ensure facilities meet or exceed design standards. There will be no venting of gas into atmosphere other than depressurising very short section of pipework at the wellhead for maintenance purposes (namely under "no flow" conditions and maximum amount of gas released 0.3 m³). This is expected to take place twice a year.

4.2 WATER RESOURCES

Potential surface water quality impacts include general migration of sediments, oils, grease or dissolved salts from disturbed areas to downstream watercourses.

4.2.1 Surface Water

Erosion and sediment control measures would be utilised to minimise the potential for sediment migration to downstream surface water catchments from disturbance areas such as drill sites, topsoil/subsoil stockpiles and access tracks. Erosion and sediment control structures may include, but would not necessarily be limited to, silt fences, diversion drains and maintenance of down slope grassed buffer zones.

Water required for commencement of drilling will be supplied from the existing project water storage. Drilling fluid waters would be stored in steel tanks or ground sumps located beside the drill pad. On completion of drilling, water and fluids collected in the sumps would be evaporated or removed to a licensed disposal facility.

The following general measures would be implemented to protect surface waters:

- Prohibition of petroleum based drilling fluids and additives in the drilling and testing of the boreholes;
- Containment of contaminated waters in sumps and where necessary removal and disposal at appropriate facilities;
- Use of liners in sumps, if required;
- The prevention of discharge of drilling fluids to creeks;
- Use of sediment fences/traps to prevent soil loss;
- The storage of fuel and lubricants on-site would be minimised;
- Bunding of oil and fuel storages and maintenance of a spill control kit on-site;
- Provision and maintenance of spare drilling sumps with capacity to contain overflow from the main sump in the event of heavy rain or flow from boreholes; and
- Restoration of all disturbed ground immediately following completion of the works to minimise sediment erosion.

4.2.2 Groundwater

Due to the short duration of the proposed production evaluation test work and the depth of the target seams it is not anticipated that any significant groundwater impacts on other groundwater users or the environment would be expected. Notwithstanding, any intersections of the boreholes with alluvial aquifers will be solid cased (typically to depths of 70 m) to minimise any potential affect on other groundwater users that access shallow alluvial aquifers in the local area (typically 20-50 m deep) or the environment surrounding the boreholes.

Following drilling and testing a decision will be made to either abandon operations or suspend operations pending further appraisal activities. The decision will determine if the boreholes are either capped with a three way valve arrangement to allow for future access or fully

cement cemented and the drill sites completely rehabilitated. The boreholes sites would be rehabilitated to the satisfaction of the landowner and DPI.

4.3 LAND RESOURCES

Site preparation will involve minor earthworks for the construction of drill pads and in-ground water management sumps. This disturbance creates the potential for increased erosion and sedimentation at the evaluation area. Potential impacts to land resources from the drilling operations predominantly relate to the potential for land contamination resulting from contact with, or absorption of, chemicals used and stored on site (namely fuels, lubricants and drilling fluids/agents). This could result from leakages from operating plant, infiltration of drilling water/fluids from temporary in-ground sumps or uncontrolled spills onto surface soils.

The Erosion and Sediment Control Plan would include the following requirements:

- Extent of disturbance to be minimised;
- Topsoil from excavations of sumps and ponds to be stockpiled for use in restoration;
- Upslope drains will divert upslope runoff water around disturbance areas;
- Sediment fences to be erected around the downslope sides of topsoil stockpiles and disturbance areas; and
- The sites would be restored immediately after drilling and testing activities have been completed and it has been determined no further work is required.

On completion of the proposed exploration activities, all surface infrastructure and waste (such as litter, used materials and any contaminated soil) will be removed from the site. Where earthworks have been conducted, the stockpiled soil would be returned (topsoil and subsoil) and the area re-contoured to its original or near-original landform. Sediment and erosion control structures would be left in place until the potential for erosion and sedimentation is sufficiently reduced by site restoration. Given that no native vegetation clearance is required, site restoration is expected to predominantly involve the sowing of suitable pasture species.

4.4 NOISE

Potential sources of noise associated with the proposed drilling activities include earthmoving equipment (namely excavator/backhoe/bobcat), drill rig, [fracking](#) and generator operation, vehicles travelling to and from the drill site, and [flaring of gas during production evaluation testing](#).

The nearest occupied residence that could be affected by the noise is approximately 180 m to the south of the [Craven 5-LMGC09](#) well site (Appendix 1 - Figure 1). [Fracking at the Faulkland 3 and Weismantel 3 sites is likely to create the greatest noise impact, albeit for a very short period.](#) The nearest occupied residences that could be affected by this particular noise are approximately 250 m to the north-east and south-west of the Weismantel 3 well site. There are several residences surrounding the Faulkland 3 site, the closest of which are approximately 270m to the north-west and 300m to the east.

Each well is generally located in a sparsely populated rural area, though noise impact modeling for each activity phase identified numerous residences as being potentially impacted by the proposed works, particularly [fracking](#). However, the following factors indicate that significant noise impacts are manageable and prolonged noise impacts unlikely:

- [Drilling and fracking activities would be of short duration \(about 2 to 5 weeks and up to 1 week per hole, respectively\);](#)
- [Operational flaring will utilise tall, enclosed structures that significantly reduce point-source noise during production testing;](#)
- [All other earthmoving, drilling and vehicle movements would be conducted over a short period of time in the site preparation, drilling and restoration phases.](#)
- [Landowners will be informed of activity durations and timing.](#)

In the event that any complaints are received in respect to noise, consultation and investigation would be undertaken to assess the nature of the concerns and identify options to mitigate the noise in consultation with the DPI.

The NSW Department of Energy and Climate Change (DECC) Industrial Noise Policy's (INP, January 2000) minimum rural background noise level of 30dB(A) was chosen as a conservative basis for noise criteria. Where construction is limited to 4 weeks at any one site, this translates to a construction noise limit of 50 db(A) (or background noise plus 20 dB(A)). For ongoing noise from production operation, a noise limit of 35 dB(A) was adopted.

The potential sources of noise associated with the proposed activities can be broken up into activities related to well preparation (namely earthmoving machinery for the construction of storage ponds, installation of gathering systems, generator operation, vehicles travelling to and from the site, and drilling), fracking, and production testing operations (namely flaring and monitoring).

Noise levels from each activity phase will impact different residents to differing degrees depending on their location relative to the sites and the activities being conducted. Construction, fracking and operational noise was modelled using ENM software and included atmospheric, wind and temperature inversion effects.

4.4.1 Construction Noise Impact

The modeling predicts the possibility of minor exceedances from construction activities (pad establishment and drilling) at three properties. The maximum exceedance is estimated as 6 dB(A) above the 50 dB(A) criteria limit.

The implementation of reasonable mitigation measures and open communication with the community, coupled with the short term duration of the activities, should work towards minimising the impact of noise on residents where these exceedances do occur. Mitigation measures to be employed include:

- Informing potentially affected residences in advance as to the extent and timing of activities and responsibly advising when noise levels during such works may be relatively high;
- Scheduling activities such that the concurrent operation of plant is limited;
- Properly maintaining plant to ensure related noise emission levels are not exceeded;
- Operations only within designated hours; and
- Providing a contact telephone number via which the public may seek information or make a complaint.

In the event that any complaints are received in respect to noise, consultation and investigation would be undertaken to assess the nature of the concerns and identify options to mitigate the noise in consultation with the DPI.

4.4.2 Fracking Noise Impact

Calculations predict that the noise related to fracking of the wells has the potential to exceed project specific criteria at numerous residences. Up to five properties may be impacted by fracking undertaken at Weismantel 3, while as many as 14 properties may be impacted by fracking at Faulkland 3. Some of the potential exceedances are quite significant, with the maximum predicted noise impact an estimated 20 dB(A) above the criteria level at the closest property.

All of the above mitigation measures will be stringently observed during fracking operations. In particular, close consultation with local landholders will be a fundamental part of managing impacts from fracking activities undertaken during designated hours. While noise levels during fracking are likely to cause some disturbance, every effort will be made to ensure these operations are of as short a duration as possible.

4.4.3 Operational Noise Impact

Noise impact modeling also identified the potential for minor exceedances from flaring during the production testing phase, although this was predicted at just three properties during maximum wind (two exceedances of an estimated 1 dB(A) and 4 dB(A) respectively) and inversion conditions (one exceedance of 1 dB(A)). However, the likelihood and extent of these impacts will be mitigated by the following:

- Modelling was based on noise measurements taken from Lucas' existing flare units at the Stratford Pilot Project, which essentially consist of rows of burners contained within a 'roofless' shipping container. However, it is proposed to use similarly enclosed flares where the height of the structure is approximately double that of existing units. This will substantially reduce the sound level from the actual point source.
- Exceedances are predicted during conditions of maximum wind and inversion, which are likely to be relatively infrequent. In the case of maximum wind conditions, background noise levels are likely to be elevated anyway.
- The sound levels modelled at each respective property represent an estimate of noise outdoors. Marginal exceedances are therefore unlikely to constitute a nuisance at night time when people are generally indoors.

As during construction phases, a contact phone number will be made available via which affected landholders may seek information or make a complaint. In the event of a complaint, consultation and investigation will be undertaken to mitigate the noise impact.

~~Unmodified drilling rigs for boreholes less than 1,000 m deep typically create noise emissions of about 85 dB(A) at a distance of 5 m reducing to about 57 dB(A) at a distance of 145 m (based on drilling rig noise measurements undertaken by Pacific Power). This data is also consistent with information obtained from Universal Drilling Systems Australia Pty Ltd, for such rigs (eg. UDR 1000) is 87 dB(A) at the operator's panel without a sound box, and 82 dB(A) with a sound box.~~

~~The following factors indicate that significant noise impacts are unlikely:~~

- ~~• All drilling activities would be of short duration (about 2 to 5 weeks per hole);~~
- ~~• All other noise (earthmoving, drilling and vehicle movements) would be conducted over a short period of time in the site preparation, drilling and restoration phases.~~
- ~~• In the event that any complaints are received in respect to noise, consultation and investigation would be undertaken to assess the nature of the concerns and identify options to mitigate the noise in consultation with the DPI.~~

4.5 FLORA AND FAUNA

The borehole sites are characterised by cleared land and improved pasture which is used for stock grazing. The borehole sites and access ways have been located to avoid areas of native vegetation and riparian or seepage areas and consequently no native vegetation would be cleared or drainage patterns altered as a consequence of this proposal.

In addition the impact area is relatively small at each of the sites and impacts would be temporary (in the range of 2 - 5 weeks for drilling). After this time the sites would be restored to their current condition.

There is the potential for threatening processes to be exacerbated by this proposal which could adversely impact on the ecology of the locality and these include:

- Weed invasion (EPBC Act and TSC Act);
- Land clearance (EPBC Act); and
- Competition and land degradation/grazing by feral Rabbits (EPBC Act & TSC Act).

However, as only small areas of improved pastureland would be cleared at each site and changes would be temporary it is considered that no long or medium term increases in threatening processes would occur as a consequence of this proposal.

Additionally, it is considered that no matters listed under the TSC Act, FM Act or EPBC Act is likely to be significantly impacted as:

- None, or little, potential habitat exists for any species listed under the TSC Act, FM ACT and EPBC Act at any of the proposed sites;
- No endangered populations are present at any of the proposed sites;
- The proposal is unlikely to disrupt important movement corridors for fauna;
- No endangered ecological communities are present, or occur adjacent to any of the proposed sites; and
- Threatening processes would not be exacerbated.

Consequently, no further consideration under the TSC Act, FM Act and EPBC Act need apply to this application.

To ensure that impacts are temporary and that there are no off-site impacts a number of general flora and fauna management strategies would be incorporated into the drilling specification and the Project EMP with the aim of protecting local flora and fauna:

- The drilling sites would be fenced with temporary stockproof fencing and bunded where appropriate;
- All drilling fluid would be contained on site and no discharge of drilling fluid to waterways, aquatic and riparian environments;
- Weeds would be controlled on all restored sites;
- On going monitoring and, if necessary, restoration maintenance would be undertaken until grass cover has re-established; and
- Vehicle speeds would be limited to reduce the risk of fauna injuries.

4.6 VISUAL AMENITY

The local landscape accommodates a number of different land use activities, including large coal mines, small rural landholdings and agricultural land, all of which necessitate the need for broad-scale vegetation clearance. This provides a typically 'rural' visual setting largely void of stands of native vegetation and the vegetation varies from cleared and heavily grazed pasture to disturbed open forest, except for remnant river/creek and roadside vegetation stands.

The proposed drilling program would result in minimal visual intrusion on the surrounding countryside given:

- The limited extent of the drilling rig assembly;
- The distance from any vantage point or residence, the flat topography and screening potential provided by remnant vegetation; and
- That disturbed surfaces will be restored to the pre-existing condition following the completion of the drilling program.

Consequently changes to the visual amenity of the area are not considered to be of significance.

4.7 HERITAGE

There are no known Aboriginal heritage sites in close proximity to the exploration area. The past disturbance to the borehole sites due to European occupation and grazing limits the likelihood of identifying significant Aboriginal sites in the area.

During site preparation, personnel will monitor for artefacts and should any relics be encountered during the course of the works, work will cease in the vicinity of the relic/artefact and the site supervisor will seek advice from DEC or Heritage Office personnel so that it can be assessed in accordance with the requirements of the *National Parks and Wildlife Act, 1974* or *Heritage Act, 1977*.

4.8 SAFETY AND RISK MANAGEMENT

4.8.1 Drilling

The drilling specification(s) would require that contractors ensure that all persons employed by them on the drilling sites are familiar with and comply with the Safety Management Plan and the Manual of Emergency Response Procedures for the drilling program. A site induction would be undertaken prior to all personnel entering or working on the sites.

The principal potential safety issues identified in connection with the proposed works relate to occupational health and safety aspects that are of a temporary nature as follows:

- Physical safety associated with the drilling and testing;
- Gas blowout;
- Mechanical failures, work related accidents and inclement conditions such as wet weather and electrical storm;
- Bushfire risk; and
- Road safety on access tracks.

The longer term safety issue arising from this activity relates to the safe sealing of the boreholes. This would be addressed by either the installation of valving to allow future downhole testing or cement sealing of the boreholes.

4.8.2 Physical Safety

- Suitable protective clothing, headgear and footwear would be worn by all staff on site in accordance with workcover requirements;
- A comprehensive first aid kit, including a snake bite kit would be maintained on site during all activities;
- A reliable system of communication would be maintained on site to enable accidents to be reported and medical assistance to be obtained if required;
- Appropriate signage for safety requirements would be placed at or near all gates; and
- No public access would be allowed to drilling sites.

4.8.3 Night Operations

No night operations are proposed. However, 24-hour drilling may be required where geological and borehole conditions demand. This is not expected to occur frequently and night-time operations will only be undertaken when borehole integrity or safety would be jeopardised by halting drilling.

4.8.4 Gas Blowout

In accordance with the exploration licence conditions, the risk of a gas blow out has been assessed based on experience from previous drilling in the immediate surrounding area, including nine deep coal seam methane exploration boreholes drilled by Pacific Power. As no blow outs were encountered in any of these boreholes the risk of blow out in the boreholes proposed is considered to be unlikely. Nevertheless blowout prevention equipment would be installed on all boreholes.

The equipment, its installation and operation would meet the requirements of the *Petroleum (Onshore) Act, 1991* and the *Petroleum (Onshore) Regulations, 2000*. In addition, a flare line, not less than 30 m in length, with an earthen bund and securely built fence at its discharge end would be installed.

4.8.5 Mechanical Safety and Work in Adverse Conditions

Drillers would be required to maintain all equipment in safe operating condition. All contractors would exercise their own discretion as to whether working conditions are safe in the case of heavy rain, strong winds or electrical storms.

4.8.6 Bushfire Risks

The main bushfire risks arise during hot dry periods and could arise from proximity to surrounding bushland or large areas of pastureland.

To minimise bushfire risks, the contractor would be required to:

- During periods of moderate to high fire danger, slash and maintain any grass in excess of 100 mm at the work site;
- Minimise the on site storage of fuel and ensure that it is safely stored at all times;
- Ensure that the flare line and pit are kept free of grass and build up of leaves;
- Maintain facilities for fighting fires on site, particularly a water pump and hoses;
- Prohibit the lighting of fires on site during periods of bushfire risk or any other time; and
- Smoking prohibited and cease activities which could cause sparks on days of extreme fire danger.

4.8.7 Road Safety

The following measures would assist the mitigation of road safety risks:

- The drilling specification would require all vehicles to comply with all statutory and licence requirements;
- Access to the sites from the local road is at a location that has adequate visibility in both directions. Speeds on local access tracks would be limited to less than 45 kph to ensure safety for stock, native fauna and other users of the tracks; and
- Any locations used for obtaining water for drilling would be assessed for road safety for access by truck and during filling.

4.8.8 Stock Injury and Loss

There are stock present at these locations. All sumps would be fenced off to prevent any stock or native animals falling into them. This would prevent access by larger animals such as the Eastern Grey Kangaroo. Other smaller animals would be discouraged from entering the compound by ensuring all rubbish is correctly disposed.

4.9 TRAFFIC

The project will involve a short term (2 - 5 weeks) on each of the borehole sites for the drilling operation and include the coming and going of drilling contractors for each shift and for the delivery of materials. The drilling contractor will have several heavy vehicles including the drilling rig and ancillary vehicles and equipment. These vehicles will mostly remain located on the drilling sites. Contractors will be required to maintain all vehicles in a roadworthy condition and obtain all necessary approvals and licences.

There will also be less frequent visits by Lucas CSG supervisors, geologists and technicians and contractors.

4.10 SOCIO-ECONOMIC AND COMMUNITY ASPECTS

Due to the limited scale and duration of the proposed evaluation works, no significant socio-economic or community impacts would result from the proposal. Notwithstanding, there would be positive economic effects associated with the short term employment of drilling and evaluation testwork employees associated with the proposal and expenditure for accommodation, food and entertainment in Gloucester.

5.0 CONSIDERATION OF ALTERNATIVES AND JUSTIFICATION FOR THE PROPOSAL

The drilling, [fracking](#) and testing is being conducted at these sites to evaluate the coal seam and gas characteristics in the PEL, with a view to the future development of a trial production field. The works are being conducted in accordance with the requirements of the Third Schedule, Work Program of PEL 285. The PEL 285 licence holders are required, as a licence condition to be committed to a minimum work program as agreed by the NSW DPI - MR, for the period of the licence term.

6.0 CONCLUSION

The proposed drilling and testing will involve minor disturbance to areas of cleared grazing lands and will be conducted for a period of 2 - 5 weeks at each site. Following completion all disturbance areas would be rehabilitated to the satisfaction of the landowner and DPI.

The drilling [and fracking](#) activities will be conducted in accordance with suitable environmental management procedures, and in consideration of the potential impacts associated with the activity. Accordingly, the proposed drilling [and fracking](#) activities at the proposed drill sites can be undertaken with minimal impact to the environment.

[Production testing is a short term activity that will be used to assess the potential gas reserves in the basin. All gas and water will be gathered in pipelines and separated. Following separation the gas will be flared and the water stored in a hold pond prior to an appropriate means of disposal agreed with the relevant authorities. No adverse impact on the environment is likely from production testing activities.](#)

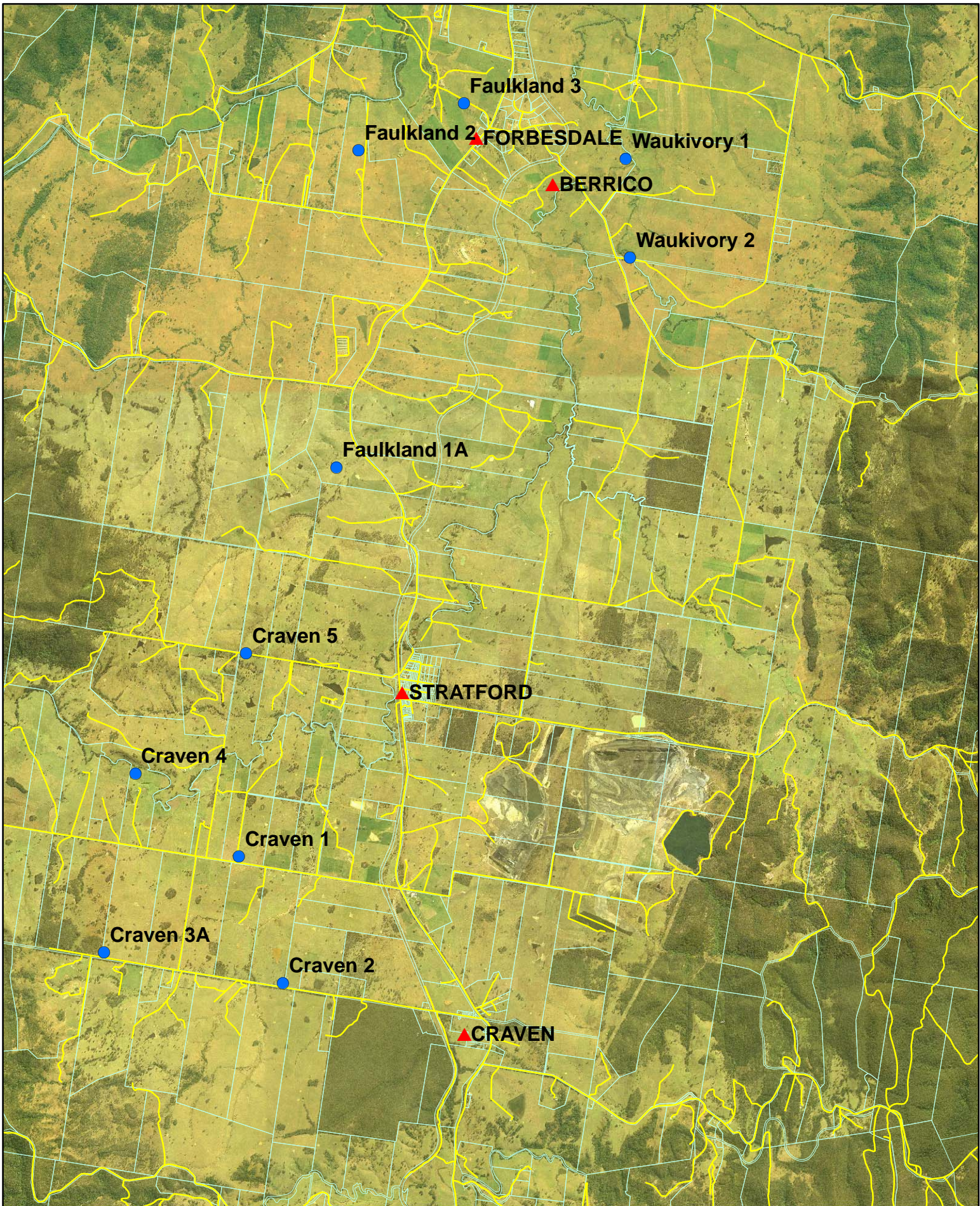
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APPENDIX 1

ACTIVITY LOCATION MAPS

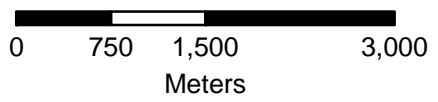


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 DATE: 23/07/08

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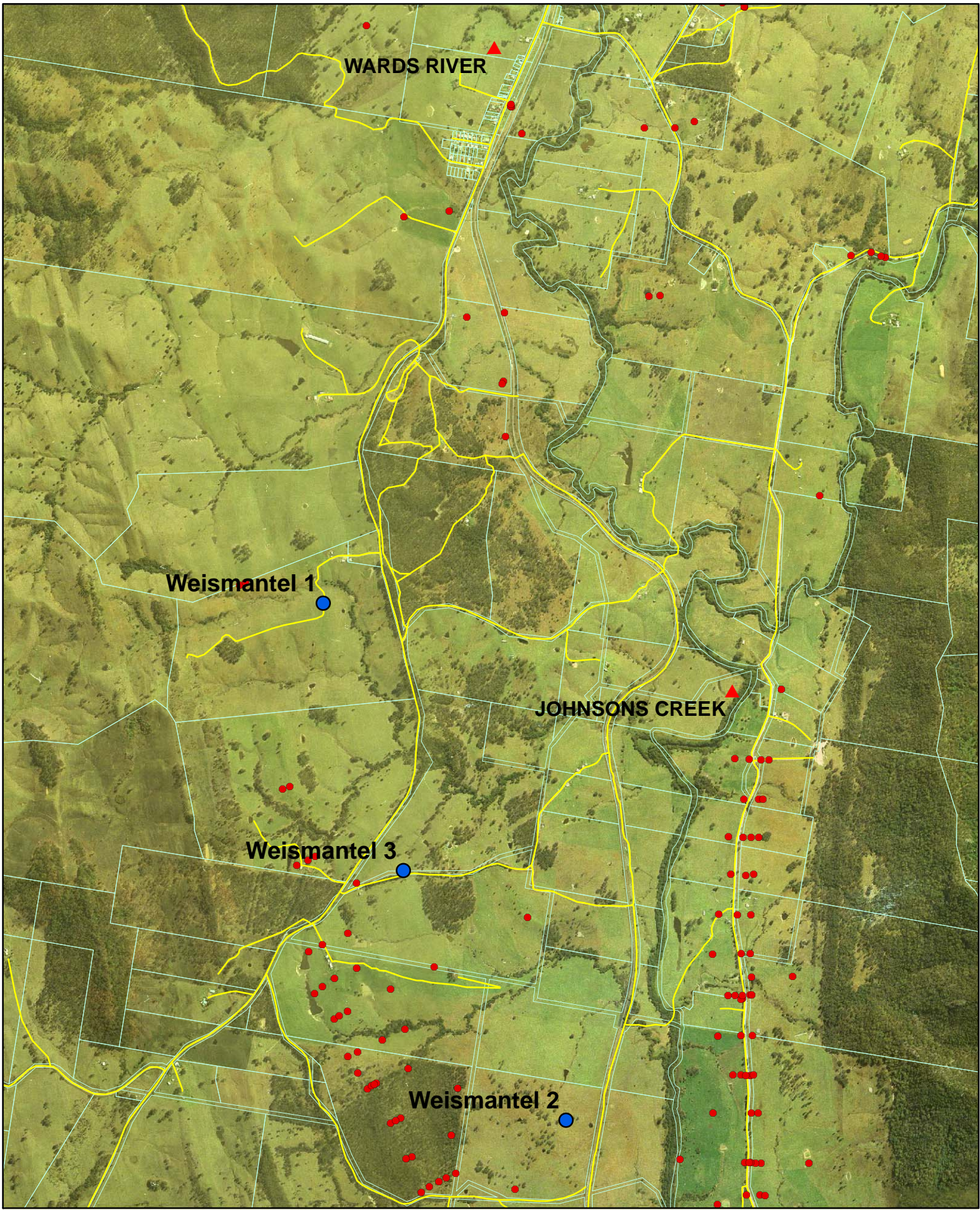
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Northern Well Sites



Legend

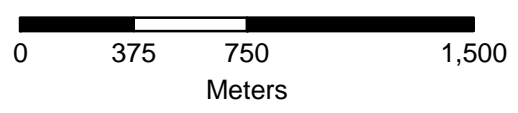
- Lucas well site
- Roads
- Lots
- ▲ Localities



AUTHOR: Kate Harper
 DATE: 23/07/08

SCALE: 1:25,000
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Weismantel Wells



- Legend**
- Lucas Exploration Well
 - Coal Exploration Well
 - Roads
 - Lots
 - ▲ Localities

APPENDIX 2

PROJECT ENVIRONMENTAL MANAGEMENT PLAN



DRILLING AND TESTING
ENVIRONMENTAL MANAGEMENT PLAN
PEL 285

G-H-LMG-PR-0-080717

July 2008

Confidential
Lucas Energy Pty Ltd
Level 8 / 160 Queen St
Melbourne VIC 3000
Ph 03 8615 7800
Fax 03 8615 7888

| REV | DATE | DESCRIPTION | PREPARED | CHECKED | APPROVED |
|-----|--------|---------------------|----------|---------|----------|
| 0 | 070515 | Issued for drilling | CB | JR | PB |
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Revisions

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1. INTRODUCTION

The Gloucester Basin coal seam gas project is located in New South Wales, approximately 100 km north of Newcastle (Figure 1). The project is a joint venture between Lucas Energy Pty Ltd (Lucas) and Molopo Australia Limited (Molopo) (together referred to as Lucas-Molopo).

The location of the PEL area is approximately centred on the township of Stratford, approximately 70 kilometres (km) north of Newcastle in New South Wales (NSW). The area extends approximately 60 km north to south and approximately 20 km east to west comprising some 18 graticular blocks and about 1,308 square kilometres (km²) (Figure 1). The area completely contains the Gloucester Geological Basin.

The project is a conventional coal seam gas project. The project involves petroleum exploration activities including drilling and production testing.

1.1 Scope

This Environmental Management Plan (EMP) applies to the drilling, fracking and production testing of coal seam gas wells and the restoration of any disturbed areas.

1.2 Purpose

The purpose of this EMP is to identify the project environmental issues, management roles, procedures and reporting methods to be used that relate to the drilling, fracking and production evaluation testing of coal seam methane wells and facilitate achievement of project environmental responsibilities.

1.3 Abbreviations

CSM – Coal Seam Methane

EMP – Environmental Management Plan

REF – Review of Environmental Factors

PEL – Petroleum Exploration Licence

OH&S – Occupational Health and Safety

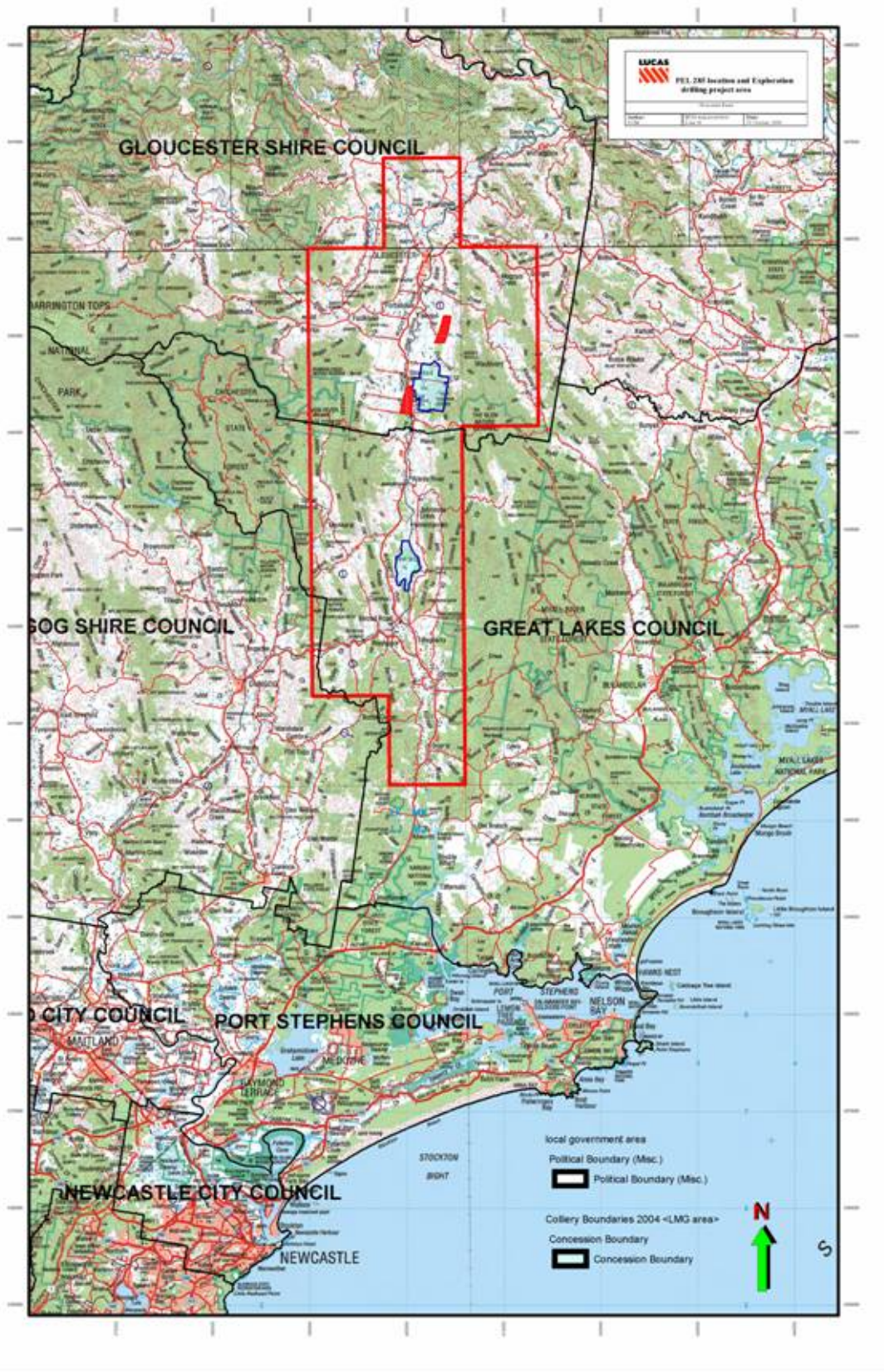


Figure 1: Project Location

2. PROJECT DETAILS

2.1 Aim of Project

The proposed drilling and production testing aims to further test coal seam methane characteristics and to define the potential resources of the area, with a view to the development of a production lease in the future.

2.2 Description of Proposed Activity

The proposed activity involves the drilling of multiple vertical coal seam methane appraisal holes, followed by downhole logging, hydraulic fracture stimulation and testing operations.

The drilling and production testing activities will involve the temporary ground surface disturbance within fenced area of approximately 90 metres by 90 metres. To provide sufficient area for safe operation well locations have been selected within cleared grazing paddocks.

The drilling activity involves the establishment of a single, moderate size truck mounted drilling rig and ancillary equipment within the fenced well area.

Access to most of the works area is available from existing farm tracks. If required, some minor works may be undertaken to upgrade existing track or provide improved access. No clearing of vegetation for access tracks is required.

Hydraulic fracture stimulation ("fracking") activities involve the mobilisation of vehicles and machinery (including frac pumps and sumps, transport of water and frac sand) for specialised oilfield service companies to carry out the fracking over a period of several days to a week. An injectivity test is generally carried out, followed by fracture treatment by pumping water, frac sand and some additives into selected zones at high rates.

Production testing follows for a period of 12-18 months, with all gas flared and water collected in a nearby "turkey's nest" storage for appropriate disposal.

2.3 Location of Wells and Access

All borehole sites are located within PEL 285. Detailed location data including land ownership is available in the Review of Environmental Factors.

2.4 Environmental Acts, Guidelines and Licenses

The works will be conducted in compliance with the *Petroleum (Onshore) Act 1991*, *Petroleum (Onshore) Regulations, 1997* and other Acts, Guidelines and Licences, as listed below:

- *Environmental Planning and Assessment Act, 1979*
- *Schedule of Onshore Petroleum Exploration and Production Safety Requirements, August, 1992*
- *Protection of Environmental Operations Act, 1997*

-
- *National Parks and Wildlife Act, 1974*
 - *Threatened Species Conservation Act, 1995*
 - *Heritage Act, 1977*
 - *Environmental Protection and Biodiversity Conservation Act, 1999*
 - *NSW Radiation Control Act, 1990 and Regulations*

▶ APPEA (1996) Code of Environmental Practice

In accordance with the above, a number of documents have been created that address policy, objectives and response procedures relating to health, safety and environmental practices and impacts, as listed below:

- ▶ Lucas and Molopo Review of Environmental Factors - Prepared for this project for submission to the Minister for Mineral Resources for a determination under Part 5 of the *Environmental Planning and Assessment Act, 1979*.
- ▶ Lucas and Molopo Safety Management Plan for Coal seam Methane Production Evaluation in NSW – Sets out corporate policy pertaining to occupational health and safety aspects of operations in the exploration for coal seam methane in NSW.
- ▶ Lucas and Molopo Manual of Emergency Response Procedures - A site specific guide to action in the event of an emergency situation occurring at the drill site.
- ▶ Lucas Occupational Health and Safety Management System - Sets out corporate policy pertaining to all works conducted or managed by Molopo Australia, as the Project Manager.
- ▶ Lucas Environmental Policy - Sets out corporate policy pertaining to all works conducted as the Project Manager.
- ▶ Lucas Health and Safety Rules – Drilling Sites - Site safety document used in Site Inductions of staff, contractors and visitors.

2.5 Site Inductions

All persons visiting the site will undergo induction to explain site environmental requirements in accordance with the EMP.

2.6 Project Team Structure

The project team structure is shown in Figure 2.

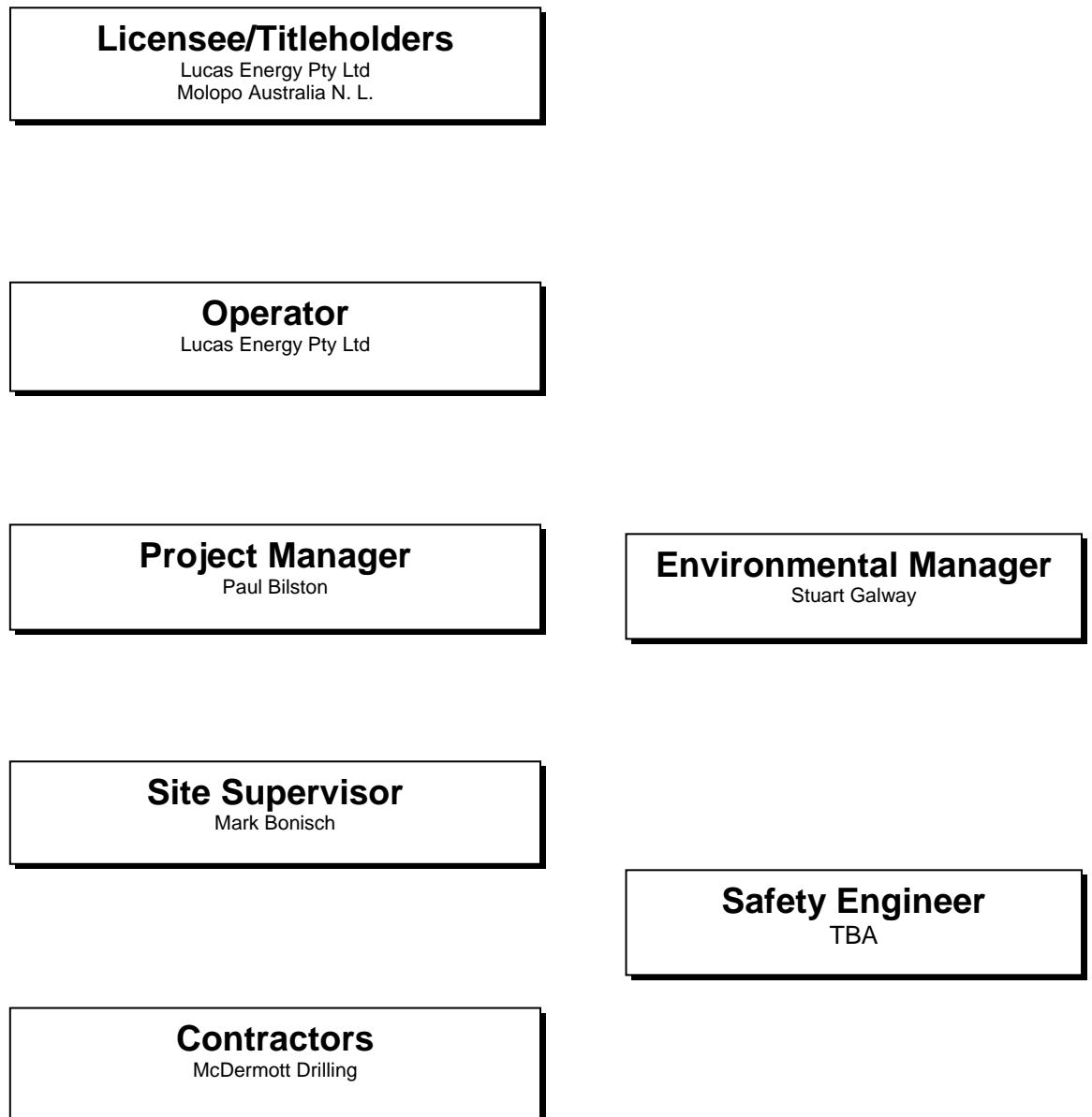


Figure 2: Project Team Structure

2.7 Procedures, Forms and Reporting

Lucas will undertake inspection of the drilling and storage pond sites and equipment to ensure that the environmental performance of Joint Venture and its contractors is satisfactory. These checks and relevant observations will be recorded in accordance with the AJ LUCAS GROUP Limited OH&S Management System (Document CO_HS_201) and Environmental Management System (Document CO_EV_201).

Site inductions will be recorded on the Health and Safety Induction Attendance Sheet – Drilling Sites. All inductees will be required to sign a Site Safety form indicating they have received instruction and understand the requirements of the Site Health and Safety Rules and agree to abide by them.

Drill site rehabilitation will be recorded on the CSM Drill Site Rehabilitation Audit Checklist.

When errors and deficiencies, either actual or potential are considered to have an adverse effect on the quality of test results, affect the safety of personnel, or impact on the environment, the person detecting the problem is required to initiate an Adverse Condition Report (ACR).

All complaints or occurrences of non-compliance to the environmental practices stated in the EMP are to be reported to the active Site Supervisor/s, as listed above in Figure 2.

3. ENVIRONMENTAL MANAGEMENT

Table 1 sets out the management processes to be implemented to control the potential impacts arising from the proposed activities.

Table1 Potential Environmental Impacts And Management

| Aspects | Potential Impact | Management Process |
|-------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Soils Site clearing and earthworks | Soil erosion and sedimentation | <p>Erosion and Sediment Control Plan</p> <ul style="list-style-type: none"> Clearly delineate disturbance areas to minimise the disturbance area and erosion and sediment migration potential. Construct table drains upslope of disturbance areas where necessary. Where possible retain grassed areas downslope to reduce overland flow velocities. Inspect the performance of all erosion and sediment controls (after rainfall events). Maintain and/or improve sediment or erosion controls where inspection indicates the need. <p>General Measures</p> <ul style="list-style-type: none"> Stockpile stripped topsoil and stabilise. Divert stormwater around all stockpiles. Rehabilitate site after completion of works. Seed topsoil with appropriate seed mix if required. |
| Surface Waters Management of drilling fluids | Adverse impact on local water quality and associated ecosystems | <ul style="list-style-type: none"> Store drilling fluids in sumps or storage tanks. Line sumps and/or use tanks to store drilling fluids. Always provide a spare sump to contain overflow from main sumps in event of heavy rain or flow from bore. If necessary, dispose of drilling fluids at appropriate off-site facilities. No discharge of drilling fluids to waterways. Prohibit use of petroleum based drilling fluids or additives in the drilling and testing of hole. |
| Management of production water | Adverse impact on local water quality and associated ecosystems | <p>Production Water Management Plan</p> <ul style="list-style-type: none"> All production water to be pumped to the turkeys nest ponds. Turkeys nest ponds to be lined with a geo-membrane liner to minimise seepage. Maintain an operational freeboard of 450mm to provide containment of a 1 in 100 year 72 hour rainfall event. Regularly inspect turkeys nest ponds to confirm an operational freeboard of 450mm is available. Immediately cease pumping to the pond if the operational freeboard level is reached. Disposal of contained waters will be agreed with relevant authorities and will preferably be via controlled discharge to land via irrigation. Water quality testing will carried out prior to discharge. |

| Aspects | Potential Impact | Management Process |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Handling of fuel, oil drilling fluids and control of spills and leakage. | Contamination of soils, water or ecosystems | <ul style="list-style-type: none"> • Maintain inventory of all fuels and chemicals stored on-site. • Maintain MSDS for all fuels and/or chemicals. • Minimise storage of fuels and oil on-site. • Maintain spill control kits on-site. • Train all staff including contractors in spill response and cleanup procedures. • All contaminated material to be removed to a licensed disposal facility. |
| Groundwater | Potential adverse impacts on groundwater quality or levels. | <ul style="list-style-type: none"> • Solid case well intersections with alluvial aquifers. • Cement grout wells at completion of works. • Use fresh water trucked to site for initial drilling fluids and hydraulic fracture stimulation. • Monitor production water quality monthly during the first 3 months of testwork. • Monitor groundwater levels and quality at the nearest water supply bore (dependent on landholder agreement and suitable bore configuration and usage). |
| Flora, fauna and weed management | <p>Harm to existing native vegetation or wildlife</p> <p>Introduction and spreading of noxious weeds through vehicle traffic movements</p> | <ul style="list-style-type: none"> • No clearance of remnant vegetation areas. • Restrict vehicle speeds on property tracks to less than 45 kph in day and night. • No discharge of drilling fluids to waterways or land. • Erect temporary stock fence around drill sites and turkeys nest ponds. • Clean equipment prior to delivery to site. • Regular weed control inspections. • Clean equipment prior to leaving site. |
| Aboriginal heritage | Harm to historical or Aboriginal artefacts or objects | <ul style="list-style-type: none"> • If Aboriginal relic(s) are found, cease works in vicinity of relic(s) and advise National Parks and Wildlife Service personnel and the Local Aboriginal Land Council. • Obtain appropriate licensing for temporary removal of the artefact prior to removal. • If historical relics (>50 years old) are identified, notify the NSW Heritage Office and cease works in the vicinity of the relic. |
| Noise | Excess noise from drilling, fracking and production equipment affects residences | <ul style="list-style-type: none"> • Consultation to be undertaken with potentially affected residents prior to drilling commencing. • Drilling operations to be conducted for only 2-5 weeks in total, the majority of these works restricted to daytime only. • Fracking operations to be limited to several days' duration in total, during daylight hours. Local residents to be informed of operational times. • Additional noise controls on drilling rigs can be applied, if required. |
| Waste disposal Recycle & waste | Waste inappropriately disposed | <ul style="list-style-type: none"> • No waste or rubbish to be discarded at sites. • Covered rubbish bins to be utilised for domestic waste. |

| Aspects | Potential Impact | Management Process |
|------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| management | Improved environmental aspect in support of sustainability goals for waste minimisation. | <ul style="list-style-type: none"> • If necessary, dispose of drilling fluids and cuttings at appropriate facilities. • Portable toilet to be provided at site • All sites to be rehabilitated and cleaned up following works. • Sort waste on site for recycling. • Record products delivered on site and record product be removed from site. |
| Dust | Dust generated from disturbed areas and tracks affects surrounding area | <ul style="list-style-type: none"> • Limit vehicle speeds on property tracks to less than 45 kph during the day and night. • Minimise land disturbance areas. • Cover or stabilise any stockpiles. • Water dusty trafficked areas if required. |
| Bushfire | Damage to fauna, flora and equipment. Danger to staff. | <ul style="list-style-type: none"> • Ensure flare line pit are kept free of grass and build up of leaves. • Maintain fire control water pump and hoses on sites. • Do not light fires in or around sites. • If required, maintain fire break around sites, and slash grasses longer than 100 mm in firebreak and compound. • Minimise storage of fuel and oil on-site. • Liaise with the local officer of the Rural Fire Service. |

4. RESTORATION

Under a formal access for exploration activities agreement currently in place with the landowner, the Joint Venture will fully restore land affected by the site works.

After completion of drilling and testing activities, the borehole will be securely capped with a valve arrangement and pressure gauge, to allow future access. The valving would be located in a cement cellar approximately 1 m deep and flush with the ground surface. Water remaining in the drilling sumps would be allowed to evaporate and the sumps backfilled. Remaining cuttings would be buried under 1m of soil. The surface of the drilling area would then be rehabilitated. Once the stage is reached where no further testing is required, the boreholes would be cement sealed to the satisfaction of the DPI and the landowner.

Specific rehabilitation practices shall include but not be limited to:

- ▶ All waste materials and equipment shall be removed from the area.
- ▶ All flagging and bunting installed for environmental or safety reasons shall be removed.
- ▶ Compacted areas shall be deep ripped or scarified for relief as required.
- ▶ Disturbed areas shall be graded to reinstate pre-existing surface contours and natural drainage patterns.
- ▶ Stockpiled topsoil and seed stock shall be re-spread across the work areas from which it was removed.
- ▶ Surface roughness shall be encouraged when re-spreading topsoil to assist water retention and seed trapping.
- ▶ Private roads and tracks used shall be returned to their pre-construction state, or to a condition agreed by the landholder.
- ▶ Any infrastructure disturbed during construction shall be restored to the landholder's satisfaction.

5. REFERENCE DOCUMENTS

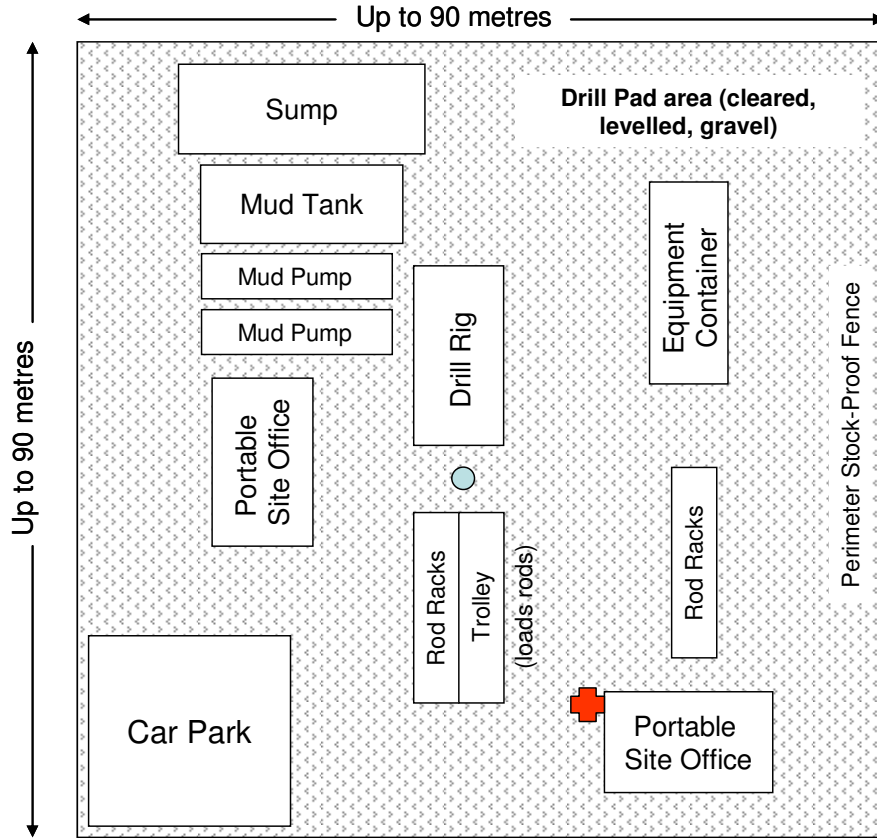
Lucas reference documents relevant to this activity include:

- ▶ CO_QA_201 Quality Management System
- ▶ CO_HS_201 OH&S Management System
- ▶ CO_HS_307 Fire Fighting
- ▶ CO_EV_201 Environmental Management System
- ▶ CO_EV_202 Waste Minimisation and Disposal
- ▶ CO_EV_501 Daily Site Inspection Environmental Controls (develop site specific)
- ▶ CO_EV_502 Waste Management Checklist (develop site specific)
- ▶ CO_EV_513 Weed Control Check List
- ▶ CS-HS-02-0001 Safety Management Plan
- ▶ CS-HS-02-0002 Emergency Response Plan
- ▶ CS_HS_03-0001 H&S Rules Drill Site
- ▶ CS-HS-03-0002 H&S Rules Project
- ▶ CS-HS-04-0001 H&S Induction Attendance
- ▶ CS-HS-04-0002 Adverse Condition Report
- ▶ CS-HS-04-0003 Work Place Injury Record
- ▶ CS-HS-04-0004 Blow out Preventer Test Record
- ▶ CS-HS-05-0001 CSMD Site Rehabilitation Check List



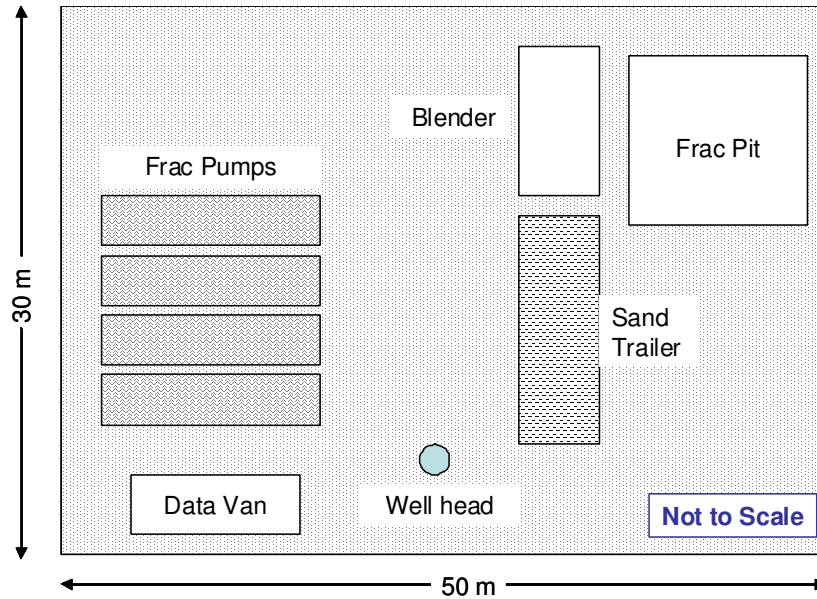
APPENDIX 3

DRILL SITE LAYOUT



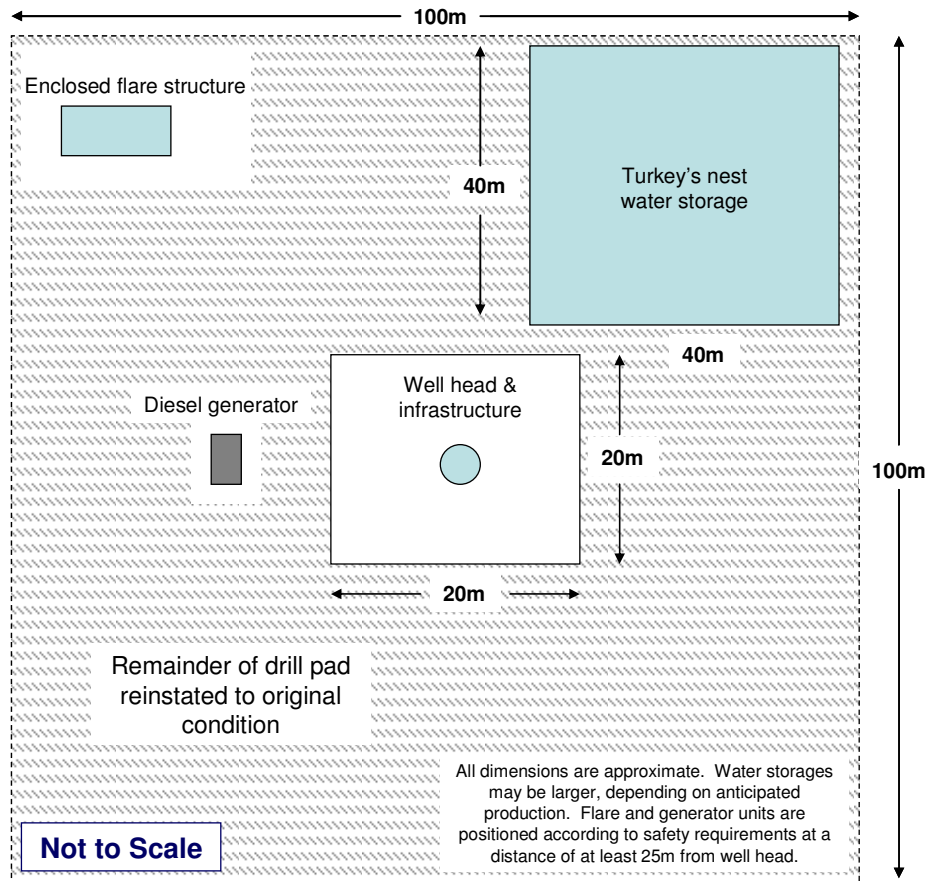
Approximate Drill Site Layout

Not to Scale



Approximate Site Layout during Fracing

Not to Scale



Approximate Site Layout during Production Testing