REVIEW OF ENVIRONMENTAL FACTORS FOR STRATFORD PILOT PROJECT

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REV	**DATE**	**DESCRIPTION**	**PREPARED**	**CHECKED**	**APPROVED**

Submission of Environmental Assessment

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

Environmental assessment prepared by:	
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In respect of:	
Project to which Part 5 applies	
Applicant name	Lucas Energy Pty Ltd
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Land to be developed	Lot 85 DP 979859; Lot 84 DP 979859; Lot 83 DP 979859; Lot 1 DP 883487; Lot 1 DP718347; Lot 80 DP 979859; Lot 82 DP 979859; Lot 1 DP 198031
Proposed development	Coal Seam Methane Exploration Drilling and Testing - Stratford Pilot
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 or misleading.
Signature	
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Date	12 June 2007

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1. INTRODUCTION

1.1 Objectives and Purpose of the Document

This Review of Environmental Factors (REF) addresses the proposed Stratford Pilot Project which consists of (i) drilling of four new coal seam methane (CSM) wells and/or one optional well, and (ii) testing activities of five coal seam methane pilot production wells by the Gloucester Joint Venture. Lucas Energy Pty Ltd (Lucas) and Molopo Australia Limited (Molopo) make up the Gloucester Joint Venture.

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 drilling pilot production wells") 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, 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 (km^2) (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.

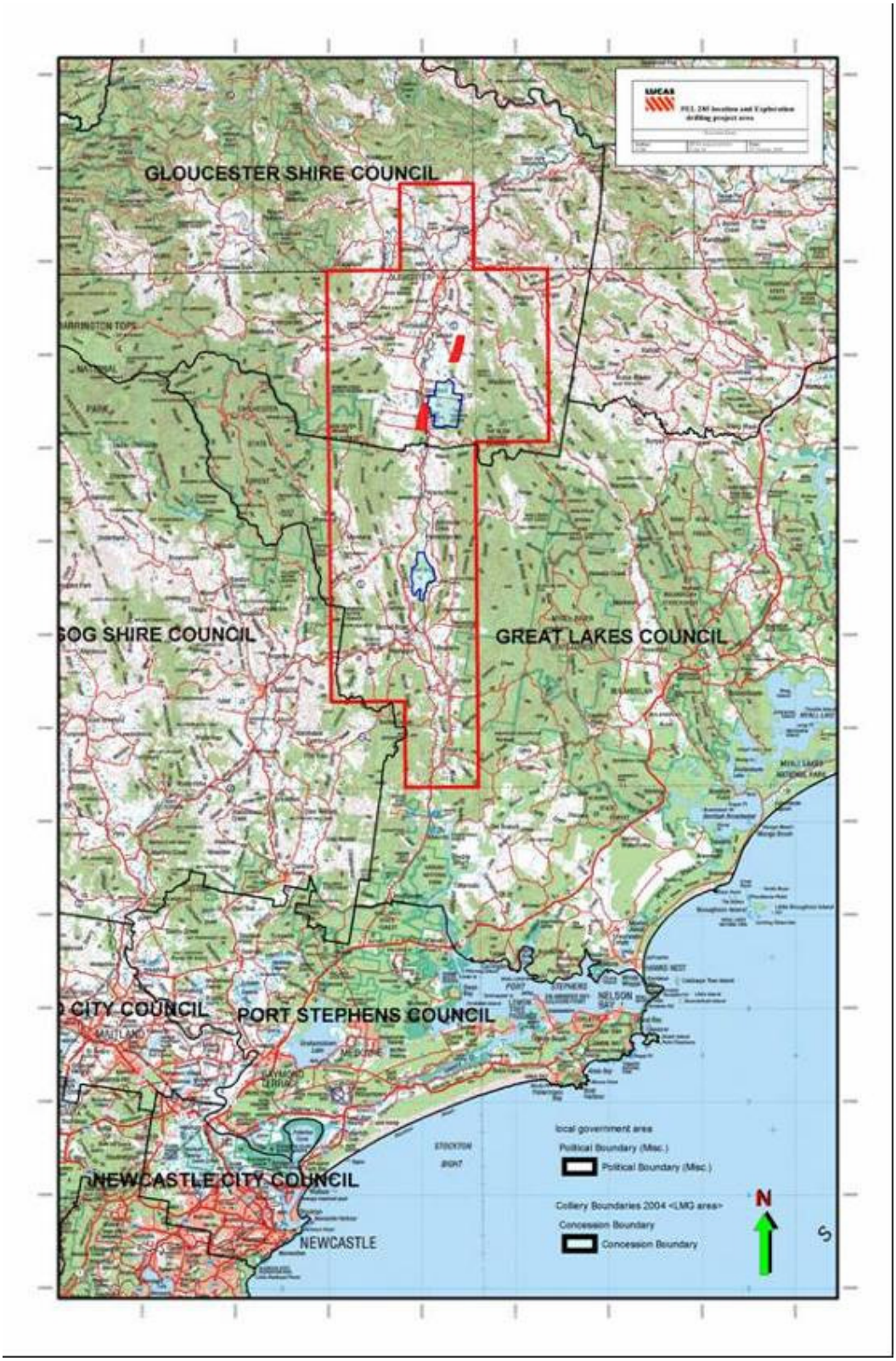

Figure 1: Project Location Map

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.

The licence enables investigation of the potential for coal seam methane resources in the Gloucester Basin with a view to possible development of a coal seam methane production field in the near future.

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 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 March 2007 the Joint Venture lodged a Review of Environmental Factors to drill thirteen stratigraphic exploration boreholes in the three target location of PEL285 area.

1.4 Overview of Proposed Activity

The proposed exploration activity involves the drilling of four new coal seam methane pilot production boreholes followed by downhole logging, running and cementing production casings in place, over a 6 week period. These wells will, then, be perforated at selected seams and hydraulic fracturing stimulation work will be performed in stages. This work is expected to be completed over a period of approximately 4 to 6 weeks. The wells will be installed with dewatering pumps and connected to surface facilities. Final stage of the work will involve production testing of these wells for an approximately 12-15 months.

The pilot production wells are identified as Lucas Molopo Gloucester new wells (LMG-04), (LMG-05), (LMG-06) (LMG-08), and/or an optional well and existing LMG-03 well, all located in cleared grazing lands at the Stratford area (Figure 2).

The proposed drilling and subsequent evaluation 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.

As part of the evaluation program, three locations have been selected to install bottomhole gauges for coal seam pressure monitoring purposes. Two of the locations would be existing boreholes, PGSD02 and PGSD03 drilled by Pacific Gas approximately 780 and 570 meters respectively. The third observation well would be a new borehole to be drilled to the west of the area at approximately 650 meters. All three wells will be installed with multiple pressure gauges (piezometers) and will be cemented to surface. Pressure reading/recording connections will be installed at the surface. The locations of these boreholes, APW01, APW02 and APW03 are shown on Figure 2.

The drilling activity would involve establishment of a single, moderate size truck mounted drilling rig and ancillary equipment on 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.

It is proposed that these activities would commence in August 2007 and be completed by the end of 2008.

1.5 General Location

All proposed activities are located on privately owned (freehold) land in cleared grazing paddocks (Figure 2).

DP116336
DP1040412
DP859902
DP732508
3087R
LMG04
3027R
3085R
3086R
DP979859
LMG05
Flare
DP979859
APW01
Storage Dams
APW03
PGSD 3
PGSD 6
PGSD 7
DP822601
Optional Well
DP979859
DP1015343
Contingent Storage Dam
7106R
LMG08
LMG06
DP979859
7114R
7073R
LMG01
7022R
PGSD 8
DDH20C
7016R
LMG02
PGSD 1
PGSD 4
DP883487
LMG03
7054R
7077R
DP979859
DP198031
7037R
DP718347
7015R
DP979859
DP1069458
DP979859
APW02
PGSD 2
7024R
7065R
PGSD5
7051R
PGSD 9
DP979859
DP826955
DP979859

LUCAS ENERGY

AUTHOR : Andrew Farley

DATE: 12/06/07

SCALE: 1:8,000

Strictly Confidential

Figure 2

0 100 200 400 600

Meters

N

Legend

- Stratford Pilot Production Holes
- Monitoring Hole
- PGSD Wells
- Holes to be cemented
- Existing roads
- New Access Road
- Existing Powerlines
- Substations
- New Power Lines (HV)
- New Trenched Power (LV)
- Gas Trunk Line
- Gas Gathering Line
- Water Gathering Line
- Dams
- Contingent Dam
- Current Irrigation
- New Irrigation Area
- Atkins Boundary
- Gloucester Coal Boundary
- Tiedman Boundary
- Contours

1.6 Site Layout

The drilling and testing activities on each well site would involve temporary ground surface disturbance within a fenced area of some 70 m by 60 m. A typical site layout for the proposed drilling activity is shown in Figure 3.

Provision would be made for storage of drilling fluid 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. The water would be stored in sumps and/or tanks on site. If sumps are used, then about three or four sumps would be excavated and would each have dimensions of about 3 to 5 m and a depth of up to 2 m. Sumps would include safety ramps and fencing.

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, wireline logging, perforation and stimulation 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. New access tracks will be graded and vehicle speeds restricted in dry conditions to minimise dust generation.

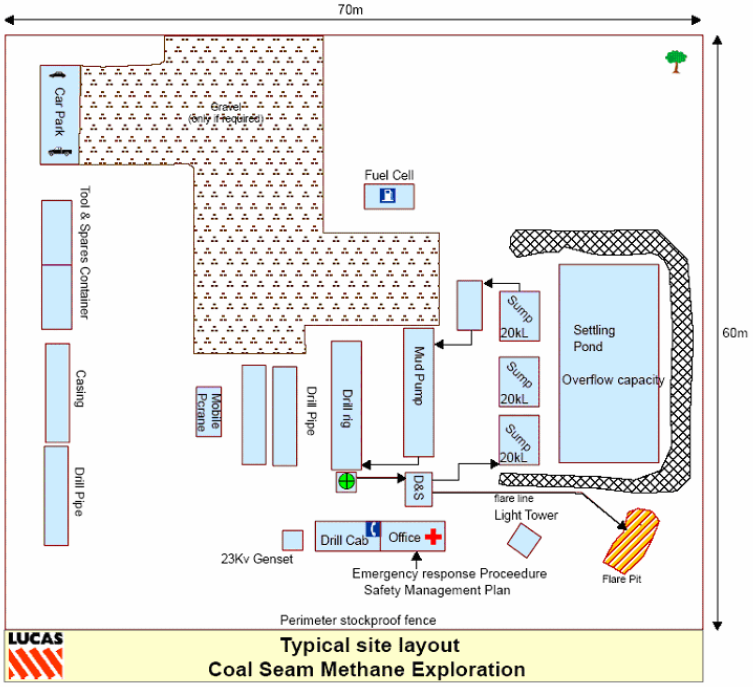

Figure 3: Typical Drill Site Layout

1.7 Activity Duration and Working Times

The drilling activity for each new well would occur over a period of about 6 weeks and is scheduled to take place in daylight hours between 7.00 am and 6.00 pm.

Openhole wireline logging will be undertaken over a two day period on each well once drilling has been completed. The production casing will then be run to TD and cemented to surface. When all wells are drilled, completed and cemented, selected coal seams in each well will be perforated and hydraulic fracture stimulated and the dewatering pumps run in hole ready for testing. These operations are expected to take approximately 4 to 6 weeks. These operations are scheduled to take place between 7.00 am and 6.00 pm

Pilot production testing operations would occur over 12 to 15 months during which time both water and gas will be produced from all five wells. Testing will take place 24 hours per day seven days per week.

1.8 Drilling Methods

1.8.1 General

Drilling of the vertical boreholes would be undertaken with a truck mounted drilling rig. The type of rig to be used will depend on the outcome of the tendering process but will 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, Blow Out Prevention (BOP) equipment and pumps for circulation of drilling fluids.

The results from recent deep drilling in the Stratford Prospect indicate that blow out conditions are not present. Notwithstanding, BOP's will be installed as standard safety equipment at the proposed borehole sites. All wells will have the surface casing installed to a depth of at least 10% of the expected vertical depth of the hole. The surface casing will be cemented to surface providing secure anchorage for the BOP equipment. The production casings will be installed from surface to TD and will be cemented to surface. 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.

1.8.2 Circulation Fluids

The boreholes will be drilled either utilising a circulation fluid of water with up to 3 percent potassium chloride (KCl) or high pressure air. No oil 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 material (i.e. drill cuttings and ground water) would be directed to the ground sumps via a blooie line. Any drilling fluids containing excessive amounts of polymer or other additives would be removed from site and disposed off 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 liquid-based drilling would be obtained by truck cartage from the existing Stratford water storage. Approximately 60-80,000 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 local drainage lines or creeks.

1.9 Borehole Geophysical Logging After Completion Of Drilling

Once the vertical boreholes have reached the target depth, openhole wireline geophysical logging will be undertaken to TD. The logging would involve the lowering of special purpose probes into the boreholes to record strata characteristics. 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.

1.10 Production Casing Running and Cementing

Once downhole wireline geophysical logging has been completed a production casing string, with centralisers, would be run in hole from surface to the final depth. The production casing will be fully cemented in place from the casing shoe to surface. The cementing work will be designed and carried out by specialised oilfield service company.

Following completion of the cementing work, casings will be pressure tested and a cement bond log (CBL –CCL) will be run in each well to confirm the integrity of cement bond behind the production casing prior to fracturing operations.

1.11 Perforating and Fracture Stimulation Operations

Based on the interpretation results of the openhole logs, target coal seams will be perforated on all new (four) wells. 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 technique. Well stimulation through a 'fracture treatment' 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 on the Stratford Pilot project.

It is anticipated that the location prepared for drilling operations would need to be modified temporarily for frac equipment/package on these locations by just expanding the gravel stabilised area. An extension area of 20m x 70m in addition to existing drilling pad would provide adequate space for frac units and storage area.

1.12 Production Testing

On completion of stimulation operations, each well would be installed with a Progressive Cavity Pump (PCP) to enable the pumping of water through tubing, and thus allowing production of gas from coal seams for evaluation and appraisal. PCP pump installation would include an electric powered top drive fitted at the wellhead. Short term production testing will be conducted at the Stratford pilot for an approximate period of 12 to 15 months.

Three observation boreholes, fully cemented to surface, would be used for pressure monitoring of selected coal seams. The piezometers would be installed during cementing operations with data cables extended to surface for pressure data reading and recording purposes.

1.12.1 Gas and Water Gathering

Gas and water produced during testing will be gathered and disposed of in central facilities within the boundary of the pilot program, as can be seen in the Stratford Pilot layout (Figure 2). Gas and water gathering lines will be buried and have surface markers/signage.

Gas gathering lines would be constructed using polyethylene pipe with appropriate valving from wellheads to central flare location. Wellhead facilities will be equipped with a slam-shut valve in order to isolate the individual wellhead from rest of the system in the event of emergency.

Water gathering lines would be constructed using poly pipes and would be configured to be able to divert the flow from one pond to another storage pond should water quality change over time.

1.12.2 Production Testing and Flaring

The centralized flare will be located in the north of the pilot area with gathering lines from LMG-03 (existing well), LMG-04, LMG-05, LMG-06 & LMG-08.

Using historical data from LMG03 an estimation of methane production for the pilot programme is approximately 900 Mscf/day per well. For a twelve month period this

equates to a production of approximately 14,800 tonne's of CO_2 equivalents by flaring the gas1.

1.12.3 Produced Water Management and Disposal

The produced water management plan for the Stratford Pilot would involve an expansion of existing site water management infrastructure and increasing the area under irrigation. The proposed layout is shown in Figure 2. The expanded water infrastructure would involve installing additional water gathering pipelines linking all five of the evaluation wells to two (2) new turkey's nest storage dams. The existing irrigation system would be further developed to cover additional areas with improved and more flexible transfer and irrigation facilities. Irrigation delivery pipelines would supply water on an as required basis to travelling irrigators operating in each area. Water monitoring will be set up to mange water over the testing period to ensure that the irrigation water remains within approved limits.

1.13 Sealing of Wells and restoration of the Site

After completion of the testing activities, the wells will be securely capped with a wellhead assembly and a pressure gauge, to allow future access.

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.

Based on the results of the pilot testing of Stratford pilot wells, once the stage is reached where no further testing and/or production is required, the wells would be cement sealed to the satisfaction of the DPI. The well pads and other areas used would be rehabilitated to the satisfaction of the DPI and land owners.

1 Note: the green house gas emissions from flaring the methane gas is significantly reduced compared to the same amount of methane being vented which would equate to 120,500 tonne's of CO_2.

2. 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 AJ Lucas that the Minister of 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,* and *Protection of the Environment Operations Act, 1997* have been considered in the preparation of the REF.

Permits will be obtained under the *Rivers and Foreshores Improvement Act, 1948* for the two designated stream crossings. No other 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? *Comments:* No world heritage property in the vicinity of the proposed work sites.	NA
(b) Any environmental impact on a National Heritage place? *Comments:* No national heritage place in the vicinity of the proposed work sites.	NA
(c) Any environmental impact on wetlands of international importance? *Comments:* No wetlands of international importance in the vicinity of the proposed work site.	NA
(d) Any environmental impact on Commonwealth listed threatened species or ecological	NIL

Factor	Impacts
communities? *Comments:* No listed threatened species or ecological communities are likely to be impacted by the proposed work.	
(e) Any environmental impact on Commonwealth listed migratory species? *Comments:* 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? *Comments:* Not a nuclear action.	NO
(g) Any environmental impact on a Commonwealth marine area? *Comments:* Not in a Commonwealth marine area.	NA
(h) Any direct or indirect effect on Commonwealth land? *Comments:* Not on Commonwealth Land.	NA

2.2 Zoning

The boreholes sites are located on privately owned lands used for grazing cattle. All sites are located on land zoned General Rural 1A the Gloucester Local Environmental Plan. An assessment of the Gloucester *Local Environmental Plan 2000* shows that the activities to be carried out are permissible.

2.3 Stakeholder Consultation

Stakeholder consultation has been undertaken by Lucas with DPI, Natural Resources, Gloucester Shire Council, Forster Local Aboriginal 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 will be in place with the affected landowners permitting access for the drilling and testing activities proposed.

3. 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 Pilot 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.

The nearest occupied residence to the Pilot activities is approximately 250m south from LMG03 (See Figure 2).

3.1.2 Geology

The Licence 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 stratigraphy of the Basin contains the Gloucester Coal Measures sequence which is the target for the drilling to depths of approximately 700 m.

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

The proposed well 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 (*Eucalyptus tereticornis*), Grey Box (*E. moluccana*) 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.

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^{o}C (BOM, 2007).

3.3 Water Resources

3.3.1 Surface Water

The evaluation area is situated within unnamed tributary catchments of the Avon River. The Avon River has a catchment area of some 290 km^2 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.

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

3.3.2 Groundwater

A series of assessments of the local and regional hydrogeological regime and local groundwater quality have been undertaken for the Stratford Coal Mine and 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 µS/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 µS/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.

Section 4.2.2 describes potential impacts and mitigation measures that relate to groundwater.

3.3.3 Produced Formation Water Management

Lucas has a produced formation water management plan in place that will involve gathering water into a central holding pond system, testing and disposing through an irrigation system.

Section 4.2.2 describes potential impacts and mitigation measures that relate to produced formation water.

3.4 Flora and Fauna

The proposed Stratford Pilot site has been modified for agriculture over many years and retains few natural values. The majority of the site is comprised of three gently sloping fenced paddocks of pasture improved grass. A number of scattered trees are present within some of the paddocks although all shrub species are absent. The nearest remnant vegetation is a woodland on the eastern boundary of the proposed site. Areas of degraded riparian vegetation occurs along some stretches of the two drainage lines flowing through or adjacent to the site.

The location of the proposed activities 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 drill sites contain remnant vegetation in the form of shrubs or trees and none would be located in riparian areas or within seepage zones. The footprint of the proposal has been designed so that no trees would need to be removed. Paspalum (*Paspalum dilatatum)* was the dominant plant species across the site and all paddocks had at least moderate levels of invasion by Fireweed (*Senecio madagascariensis)*.

A gas gathering line would be located adjacent to the boundary of the woodland area. The woodland has been mapped as a combination of a number of vegetation communities, including Ironbark, Escarpment Redgum, South Coast Shrubby Grey Gum and Stringybark – Apple (Forest Ecosystem Lower North East NPWS). The woodland adjacent to the cleared paddock areas has been grazed and selectively logged in the past. Narrow-leaved Ironbark (*Eucalyptus crebra*) was the dominant tree species with the understorey dominated by Blackthorn (*Bursaria spinosa*). Other tree species present included Broad-leaved Apple (*Eucalyptus subvelutina*), White Stringybark (*Eucalyptus globoidea*) Blackbutt (*Eucalyptus pilularis*), Cherry Ballart (*Exocarpos cupressiformis*). Shrubs and groundcover species included Cassytha glabella, Dusky Coral Pea (*Kennedia rubicunda*), Ivy Goodenia (*Goodenia hederacea*), *Glycine tabacina* and Wattle Mat-rush (*Lomandra filiformis*). Tracks traversed the area and there had been dumping of various items including vehicles and the carcases of cattle.

A gas gathering line, water gathering line and trenched power line would cross one drainage lines, one near the south-west corner of the woodland. The crossing of the drainage line near the woodland is below a small dammed area which appears to receive very little water except during storm events. Rather than containing a riparian zone this area is a shallow depression with very little riparian vegetation.

Several soaks occurred in a number of locations across the broader site and these were vegetated with pure stands of Flax-leaved Paperbark (*Melaleuca linariifolia*). The understorey was largely devoid of vegetation although in places some introduced grasses were present. The proposal does not include any works within these areas.

The access road contained very narrow linear woodland vegetation approximately 2 m wide between the gravel road and fenced paddocks. This comprised a combination of weed species and small shrubs and trees including Narrow-leaved Ironbark and Prickly-leaved Paperbark *(Melaleuca stypheloides*).

3.4.1 Fauna habitat

The site lacks habitat complexity due to the lack of trees, shrubs, rocky areas and fallen timber. Therefore, habitat suitable for fauna would generally be limited to those common species of native and introduced fauna. The Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) is listed as Vulnerable under the TSC Act and was recorded along the roadside reserve of the access road and within the adjacent woodland.

3.4.2 Threatened Species

The Department of Environment and Conservation's (DEC) Threatened Species Database and Department of Environment and Heritage's (DEH) online protected matters search tool for Matters of NES were reviewed for species and populations that have been recorded within the locality (10 km radius) or with the potential to occur. The site lacks the complexity required to provide habitat for a range of threatened species as pasturelands generally have few refuge areas or foraging resources, especially for mammals and reptiles. The farm dams and retention basins also lack habitat complexity and therefore provide few resources for waterbirds or amphibians. However, the remnant woodland vegetation and roadside reserve would provide some habitat for native species including the threatened Grey-crowned Babbler. There is also the potential for the Barred Cuckoo-shrike (*Coracina lineata*) and Turquoise Parrot (*Neophema pulchella*) to potentially forage along the margins of the woodlands and drainage lines and these two species are also listed as threatened under the *Threatened Species Conservation Act 1995* (TSC Act). Those species for which potential habitat is present at the site, their conservation status and preferred habitat are listed below in Table 4. An assessment of significance under Section 5a of the EP&A Act has been completed for these species and the results provided in Appendix A.

Table 4: Threatened species for which habitat occurs across the site

Species	Conservation Status	Habitat	Likelihood of occurrence on site
Grey-crowned Babbler *Pomatostomus temporalis temporalis*	V - TSC	Open woodlands.	Occurs.
Barred Cuckoo-shrike *Coracina lineata*	V-TSC	Rainforest, eucalypt forests and woodlands, clearings in secondary growth, swamp woodlands and timber along watercourses.	Has potential to forage into cleared areas of site and along drainage lines
Turquoise Parrot *Neophema pulchella*	V-TSC	Lives on edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	Has potential to forage into cleared areas of site.
Note: TSC = NSW *Threatened Species Conservation Act 1995*. V = Vulnerable			

3.4.3 Endangered Ecological Communities

The Pilot site is highly modified with the majority of the area comprising paddocks of improved pasture and consequently none of the endangered ecological communities known from the locality occur across the work site.

3.4.4 SEPP 44 – Koala Habitat Protection

An assessment under *State Environment Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44) is required as the Gloucester LGA is listed under Schedule 1 of SEPP 44. The proposed works areas 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. It is possible that the woodland area could provide habitat for the Koala as in sections it contains Eucalypts listed as Feed Tree Species under Schedule 2. However, all site works would be undertaken outside this woodland area. Consequently no further provisions of SEPP 44 need apply to this application.

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

3.5 Heritage

3.5.1 Aboriginal Heritage

The evaluation area falls within the Worimi Aboriginal Peoples traditional lands and the Aboriginal organisation that is responsible for providing advice on Aboriginal heritage management is the Forster Local Aboriginal Land Council.

Forster Local Aboriginal Land Council representatives conducted a comprehensive site clearance, with the assistance of an archaeologist. Evidence of Aboriginal cultural heritage was sought; various management options were considered when cultural heritage items were found; and decisions on the appropriate management were agreed upon.

A search of the Department of Environment and Conservation Aboriginal Heritage Information Management System (AHIMS) database was undertaken for the project area and surrounding district. This search revealed small numbers of previously recorded sites, but none in the project area. The nearest recorded heritage location to the proposed development is an isolated stone artefact (AHIMS Site 38-1-31), found 1.3km to the southwest of the LMG03 well. A small stone artefact scatter (AHIMS Site 38-1-8), found to the south of the Gloucester coal mine and 5.2km to the south of the LMG03 well, is the nearest site.

Despite poor ground surface visibility, several isolated stone artefacts were found, indicating locations where further occupation material might occur. Two of the stone artefacts were found outside areas where any impacts will occur. The third artefact is found on a track to the south of a proposed bore hole site (LMG04).

3.5.2 European Heritage

The project area is located within cleared grazing lands and no European heritage items were detected during the heritage site clearance. There is a low likelihood of European cultural heritage items being located in the project area.

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 is also the 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 Noise

The 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 is also the existing coal operations that dominate the local noise environment.

Section 4.4 describes potential impacts and mitigation measures that relate to noise aspects.

3.8 Socio-economic and Community Aspects

The Stratfrod Pilot site is located within the Gloucester Shire, some 7.5 to 9 km south-south east of the Gloucester and 4 km east north east of the township of Stratford. Employment within the shire is dominated by agriculture, forestry and mining. The shire has 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. ASSESSMENT OF THE POTENTIAL IMPACTS AND PROPOSED MITIGATION STRATEGIES

The following section outlines the potential impacts of the production evaluation test 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. 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 and completion programme 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 of surface disturbance. Once drilling has been completed at each pad, the area would be rehabilitated and sown to pasture.

Drill pads will be utilised for stimulation operations with some minor modifications to site layout depending on location of wellhead and access roads. There would be some supply truck and pumping unit movements mobilising equipment into the area. During operations, the equipment would be mobilised from one location to next one using access roads. After completion of the stimulation operations all units and equipment will be transported back out of the area.

The construction of two central water storage ponds and central flare location would also be a short term activity with minor surface disturbance.

4.1.1 Produced Gas

The central flare 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 m^3). 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 downslope grassed buffer zones.

Water required for commencement of drilling will be supplied from the existing project water storage or town water supply (local contractor). Drilling fluid waters would be stored in ground sumps or steel tanks 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 (12 – 15 months) 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 (minimum depth 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.

Due to the minor volumes of water extracted (section 3.6), the limited duration of the test work (notionally 12 – 15 months) and deep nature of the target seams (200 to 700 m in depth) no impacts on groundwater sources of surface water flows are anticipated from the activities.

Water depth monitoring will occur within a number of existing water wells around the production wells. This monitoring aims to measure the impacts if any on the level of water availability for local users. During previous production testing of LMG03, no water depth impacts were identified in the monitoring of the existing water extraction bores.

Following 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 grouted to surface and the drill sites completely rehabilitated. The boreholes sites would be rehabilitated to the satisfaction of the landowner and DPI.

4.2.3 Produced Formation Water

Production water management, volumes and options for disposal are detailed in section 1.12.3. The likely impacts of extracting the produced formation water are discussed in section 4.2.2.

4.3 Land Resources

Site preparation will involve earthworks for the construction of drill pads, access roads, gathering lines and water management ponds. 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 (ie. fuels, lubricants and drilling fluids/agents). This could result from leakages from operating plant (eg. drill rig), infiltration of drilling water/fluids from temporary in-ground sumps or uncontrolled spills onto surface soils.

The erosion and sediment control plan for the activities would include:

- 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 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

Stratford is a sparsely populated rural area with six residences identified as being potentially impacted by the proposed works. There is an operating open cut mine (Bowens Road North) that comes to within 1.3 km south of the project area however mining operations are not expected to influence project specific noise levels.

The NSW Department of Energy and Conservation (DEC) Industrial Noise Policy's (INP, January 2000) minimum rural background noise level of 30dB(A) was chosen as a conservative estimate and will be used as the project Rated Background Level (RBL) for all residences across the day, evening and night periods.

The potential sources of noise associated with the Pilot can be broken up into activities related to construction (namely drilling pad and access road construction, installation of gathering systems, drill rig and generator, vehicles travelling to and from the drill site and fraccing operations) and operations (namely flaring and monitoring).

Both construction and operational noise will impact different residents to differing degrees depending on their location relative to the sites and activities being conducted. Construction and operational noise was modelled using the ENM software and included atmospheric, wind and temperature inversion affects.

Calculations predicted that that noise related to construction of the wells has the potential to exceed project specific criteria at all residences identified at some point. Specifically, this exceedance is related to fraccing works.

Generally operational noise from the pilot project is predicted to meet compliance with the project specific noise criteria under all considered weather condition at all residences as determined from the NSW INP.

While there exist the potential for noise to exceed the recommended criterion for nearby residents during some activities (namely fraccing), 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 if exceedance does occur. The mitigation measures to be employed to minimise the impacts of noise, include:

- Informing potentially affected residences in advance as to the extent and timing of drilling and fraccing activities and responsibly advising when noise levels during such works may be relatively high;
- Scheduling drilling related activities such that the concurrent operation of plant is limited;
- Properly maintaining plan to ensure related noise emission levels are not exceeded;
- Operations only within designated hours; and
- Provide 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.

4.5 Flora and Fauna

Potential Impacts

A number of direct, indirect and operational impacts have the potential to occur as a consequence of the proposal and may have negative impacts on flora and fauna at the site. Potential impacts include:

Direct Impacts

- Vegetation clearance – however, the works are situated within paddocks and / or adjacent to vegetated areas and the majority of vegetation cleared would be improved pasture species and pasture weeds;
- Hydrological changes – leading to:
  - Alteration of the ecology of an area including the vegetational composition and loss of fauna habitat;
  - Increased runoff rates and hence erosion;
  - Changes in soil moisture content; and
  - May create conditions conducive to invasion by exotic species.
- Loss of fauna habitat - the proposal has been designed to avoid the removal of trees and consequently there are not expected to be any additional direct losses of fauna habitat other than of some foraging habitat for grazing species.

Indirect Impacts

- Runoff and sedimentation through earthworks and the removal of pasture - provided appropriate stormwater and sediment trapping systems are implemented and that revegetation of the area is undertaken as soon as is practical after construction, then indirect impacts are not anticipated; and
- Disturbance of fauna - through an increase in noise and activity levels across the site. However, most of the noise and activity would be created in paddock areas and would be temporary and / or could be managed with appropriate management plans.

Key Threatening Processes

It is unlikely that any key threatening processes listed under the TSC Act or EPBC Act would be exacerbated by this proposal as the sites of the boreholes 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 natural drainage patterns altered as a consequence of this proposal.

NSW Legislative Assessments

Assessments of the likely impacts on species, populations and communities listed under the TSC Act were undertaken. Assessments of Significance for those species with the potential to be impacted by this proposal have been undertaken (Appendix A). Those species considered were:

- Grey-crowned Babbler;
- Barred Cuckoo-shrike; and
- Turquoise Parrot.

It was concluded that with stringent management measures it is unlikely that any of these species would be significantly impacted by this proposal and therefore a Species Impact Statement is not necessary.

Commonwealth Legislative Assessments

There were no matters of NES listed under the EPBC Act that would be likely to have any potential to be impacted by this proposal. The highly modified nature of the proposed works areas are such that they do not provide habitat for species, populations or communities listed under the Act. Consequently, a Referral to DEW is not required as this proposal is unlikely to be considered a controlled action.

Cumulative Impacts

Cumulative impacts are those that add to the deterioration of the ecological values of a site or locality and generally occur when remaining native vegetation is removed or altered, fauna habitat is removed or altered and / or the natural hydrology of the area is altered. There are unlikely to be cumulative impacts associated with this proposal as native vegetation would not be removed, fauna habitat would not be altered and the hydrology of the site would not be changed.

Management Measures

To ensure that impacts on the site are managed and that there are no off-site impacts a number of general flora and fauna management strategies would be implemented for the project with the aim of protecting local flora and fauna and in particular the Grey-crowned Babbler. These include:

- Vehicle numbers and speed would be strictly limited to reduce the risk of fauna injuries;
- The drilling sites would be fenced with temporary stock-proof 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 would be permitted;
- 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;
- Diversion of stormwater to direct run-off to sediment control mechanisms;
- Rubbish should be collected and removed off site to prevent it entering the waterway and causing harm to fauna; and
- No chemicals, fuels and / or wastes should be stored within or near any natural or stormwater drainage lines. All such substances are to be contained in sealed vessels of appropriate volumes and, where necessary, stored within bunded areas.

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 or testing 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.
- Flaring is designed to be of low visual impact with the use of enclosed flaring systems and aesthetically pleasing monitoring facilities.

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

4.7 Heritage

Construction impacts will be minor and localised, with narrow trenches to contain gathering lines, water pipelines and power lines.

The stone artefacts that were found are located in areas that will not be affected by construction, or can be avoided by minor modification of proposed construction plans.

Isolated stone artefact 1 – is found in an area of forest to the east of the development area, and will not be affected by construction.

To ensure that construction impacts do not result in the lost of this artefact, construction activities will be excluded from the forest remnant at the eastern edge of the project area.

Isolated stone artefacts 2 and 3 – are located on a vehicle track running along the fence to the south of the proposed LMG04 lease and will not be affected by construction or vehicle movement.

Isolated artefact 3 is found well to the west of the proposed development and will not be affected by construction or vehicle movement.

The representatives of the Forster Local Aboriginal Land Council have requested ongoing involvement in the protection of cultural heritage items identified in the project area. The nature of this involvement will be decided through ongoing consultation with the joint venture partners. A cultural heritage management plan will be prepared to formalise the agreement between the parties.

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*.

Although no items of historical heritage were identified during the field survey, there is a slight possibility that early pastoral sites may occur. Should this be the case, it would be necessary for work to cease and the NSW Heritage Office contacted for advice on the most appropriate impact mitigation measures.

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 and issues such as snake bite;
- Gas blowout;
- Mechanical failures, work related accidents and inclement conditions such as wet weather and electrical storm;
- Bushfire risk;

- Road safety on access tracks; and
- Stock injury or loss of temporary sumps and pits.

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 Production Testing

- At all times during production testing company representatives will be easily contactable and at most times present on site.
- Stratford pilot production testing safety plan will be put into action and followed through out all production testing.
- The site will be fenced and appropriate signage erected to inform the general public about the operations.

4.8.3 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; and
- A reliable system of communication would be maintained on site to enable accidents to be reported and medical assistance to be obtained if required.

4.8.4 Night Operations

No night operations are proposed accept for the continuous flaring activity during production testing.

4.8.5 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 and three by Lucas. 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.

The NSW DPI Senior Inspector of Coal Mines would also be notified within 24 hours of any over-pressure gas occurrences, which occur during drilling.

4.8.6 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.

4.8.7 Bushfire Risks

Flaring will be enclosed and hence will have nil to no risk of bush fire.

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 damager.

4.8.8 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.

4.8.9 Stock Injury and Loss

There are cattle present at these locations. All pits 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

4.9.1 Drilling and Completions

The project will involve a short term drilling and completions operations (6 – 9 weeks) 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.

During fraccing operations a number of heavy vehicle movements are required to deliver the frac pumps, tanks and sand. This equipment will relocated to each new well via internal access roads.

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

4.9.2 Production Testing

There will be daily visits to each well site by light utility vehicle.

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 the Gloucester LGA.

5. CONSIDERATION OF ALTERNATIVES AND JUSTIFICATION FOR THE PROPOSAL

The drilling 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 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 - Mineral Resources, for the period of the licence term.

6. CONCLUSION

The proposed activities will involve minor disturbance to areas of cleared grazing lands and will be conducted for a period of 12 – 15 months. Following completion all disturbance areas would be rehabilitated to the satisfaction of the landowners and DPI.

The drilling and testing 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 testing 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 (underground/aboveground) pipelines to a central location, where it will be separated. Following separation the gas will be flared and the water sent to a hold pond prior to disposal via irrigation. No adverse impact on the environment is likely from production testing activities.

7. REFERENCES

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APPENDIX 1

SPECIES IMPACT ASSESSMENT

APPENDIX 2

PROJECT ENVIRONMENTAL MANAGEMENT PLAN

DRILLING AND TESTING ENVIRONEMNTAL MANAGEMNT PLAN PEL 285

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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 (km^2) (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 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 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 Heath and Safety

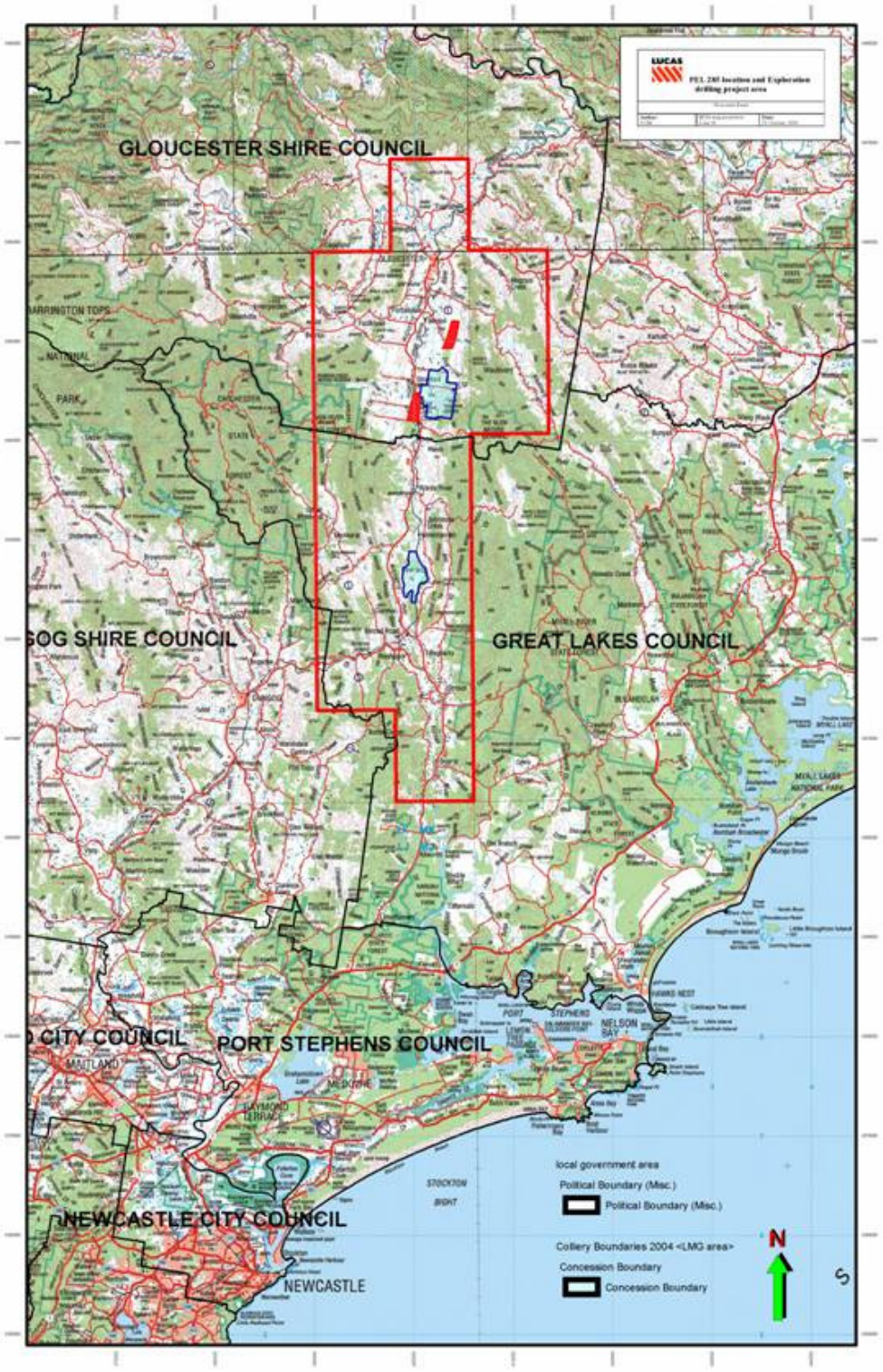

Figure 1: Project Location

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 and testing operations.

The drilling and production testing activities will involve the temporary ground surface disturbance within fenced area of approximately 60 metres by 70 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.

Production testing wells via flaring.

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.

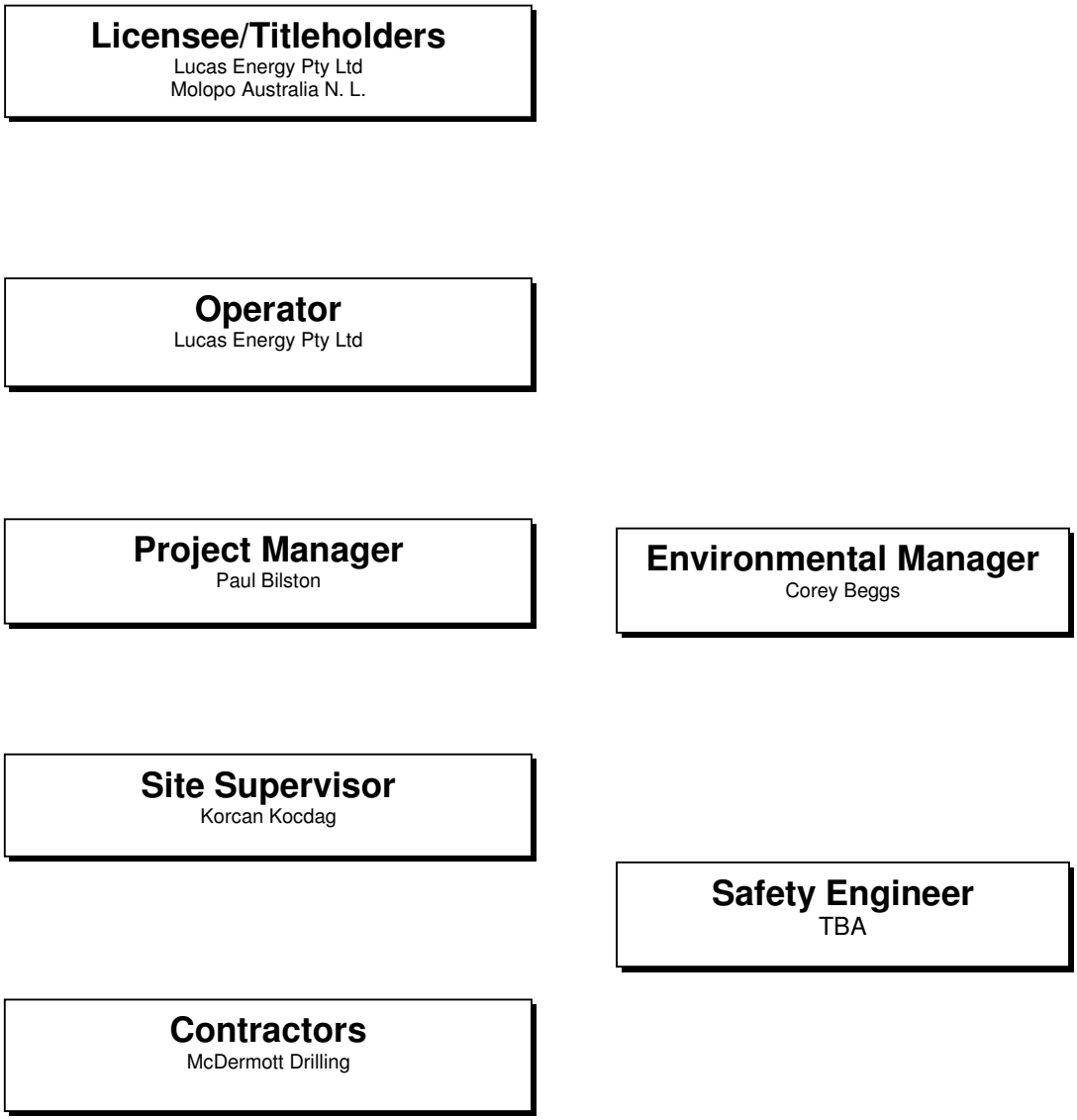

Figure 2: Project Team Structure

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	Erosion and Sediment Control Plan • 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. General Measures • 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	• 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	Production Water Management Plan • 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 via the 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	• 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.	• 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	Harm to existing native vegetation or wildlife Introduction and spreading of noxious weeds through vehicle traffic movements	• 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	• 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 and production equipment affects residences	• 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. • Additional noise controls on drilling rigs can be applied, if required.
Waste disposal Recycle & waste management	Waste inappropriately disposed Improved environmental aspect in support of sustainability	• No waste or rubbish to be discarded at sites. • Covered rubbish bins to be utilised for domestic waste. • If necessary, dispose of drilling fluids and cuttings at appropriate facilities.

Aspects	Potential Impact	Management Process
	goals for waste minimisation.	• 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	• 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.	• 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