REVIEW OF ENVIRONMENTAL FACTORS FOR EXPLORATION BOREHOLES AND PRODUCTION EVALUATION TESTING

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

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In respect of:	
Project to which Part 5 applies	
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Land to be developed	445/629097, 31/571522, 2/234517, 3/868581, 96/979859
Proposed development	Coal Seam Methane Exploration Drilling & Production Evaluation Testing
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	
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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 five coal seam methane (CSM) stratigraphic boreholes by the Gloucester Joint Venture comprising both Lucas Energy Pty Ltd (Lucas) and Molopo Australia Limited (Molopo).

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 of exploration boreholes for production evaluation testing") 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 (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.

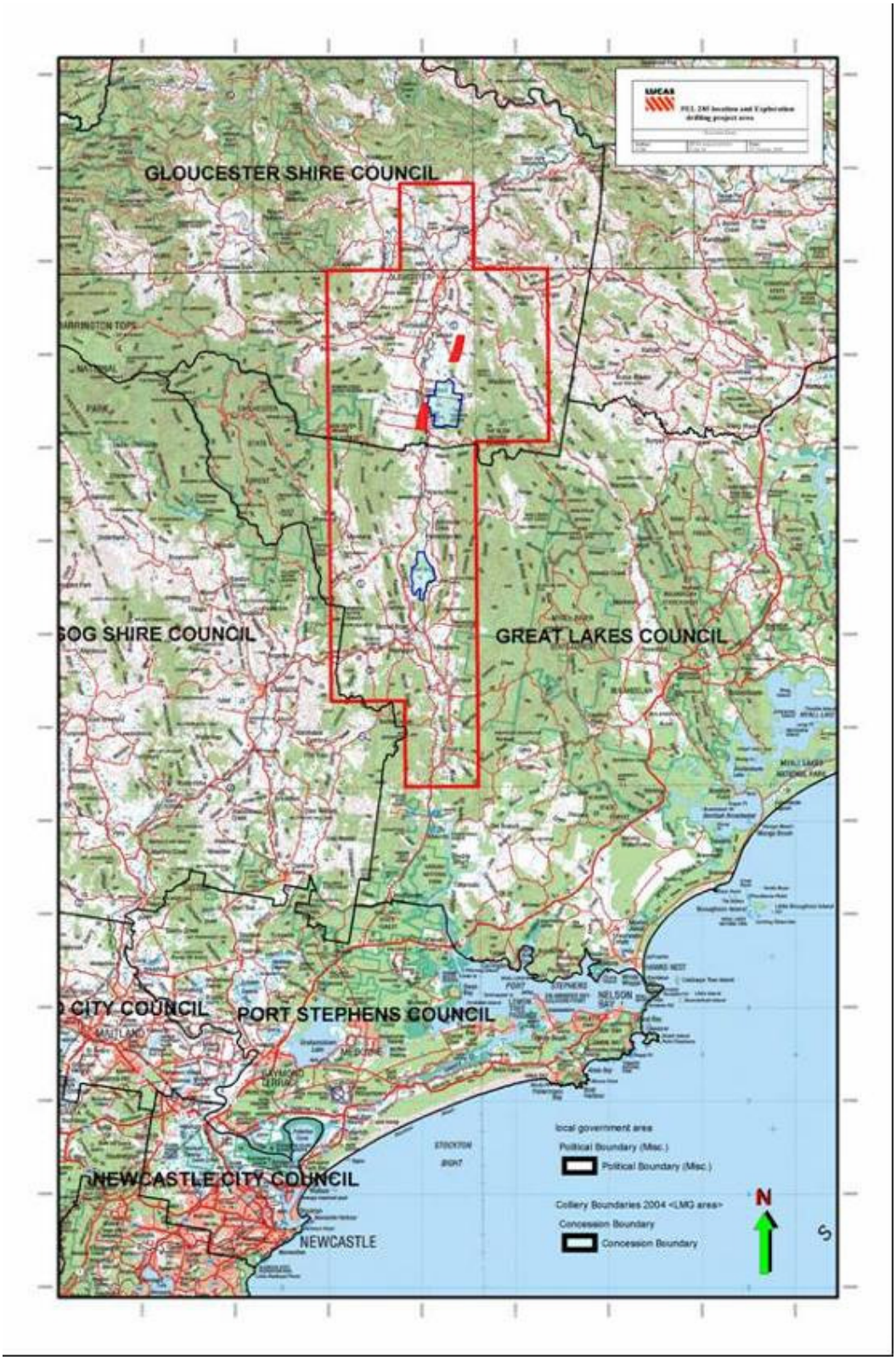


Figure 1: Project Location Map

1.3 BACKGROUND

PEL 285 was granted in 1992 under the *Petroleum (Onshore) Act, 1991*. It is jointly held by Lucas (70% interest) and Molopo (30% 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 with 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 only LMG04 has been drilled.

In 2007 the Joint Venture drilled five 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 five new coal seam gas pilot production boreholes, followed by downhole logging, running and cementing production

casings in place. These wells will then be perforated at selected seams and hydraulic fracturing stimulation work performed in stages. This work is expected to be completed over a period of approximately 4 to 6 weeks at each well. The wells will be installed with dewatering pumps and connected to surface facilities, with the final stage of the work involving production testing of the wells for up to 12-15 months.

The wells are identified as **Waukivory 3, Waukivory 4, Stratford 7, Stratford 10 and Faulkland 2.** All proposed activities are located on privately owned (freehold) land in cleared grazing paddocks (See Appendix 1).

The proposed drilling and subsequent production 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 production field in the future.

The drilling activity would involve establishment of a single, moderate size truck mounted drilling rig and ancillary equipment on a small site within cleared grazing land. Subsequent production testing would require the construction of a "turkey's nest" type pond to provide storage for water produced over the production evaluation period. Appropriate disposal of this water would be discussed and agreed with the relevant authorities and agencies.

Access to most of the works area is available from existing farm tracks. If required, some minor works may be undertaken to upgrade existing tracks. There is currently no access to the proposed Waukivory 3 site, but construction of a new access track will be on land that is currently improved pasture. 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 October 2008 and be completed by the end of 2009.

1.5 SITE LAYOUT

The drilling and fracture stimulation activities on each borehole site involve temporary ground surface disturbance within a fenced area of some 90 m by 90 m. Following completion of well preparation activities, the site would be reduced back to an area of 10 m by 10 m during production testing as well as any adjacent water storage and flaring equipment that will generally be contained within an area of 100m by 100m. A typical site layout for each of the proposed drilling and testing activities 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 tanks.

Production testing involves the extraction of water from the coal seam aquifers, so "turkey's nest" storages are proposed at each site to contain the produced water. These storages are to be located adjacent to the wells and sized according to the anticipated water production. Water produced at the Stratford 7 & 10 sites may alternatively be stored in bladder tanks (or similar) and transferred directly to existing water storages within the Stratford Pilot Project area.

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. A 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 and heavy vehicle movements will be minimised or ceased during periods of heavy rain. New tracks will be graded 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 is scheduled to take place seven days per week between the hours of 7.00 am and 6.00 pm. In some instances and only as required by the local geology and borehole conditions, it may be necessary to drill on a 24-hour basis. This is not expected to occur frequently and will only be undertaken when required to ensure borehole integrity and safe operations.

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 Target Depth (TD) and cemented to surface. Once a well is drilled, completed and cemented, selected coal seams will be perforated, hydraulic fracture stimulated and the dewatering pumps run in hole ready for testing. These operations are expected to take approximately several days to a week at each well and would be scheduled to take place between 7.00 am and 6.00 pm.

Pilot production testing operations would occur over a period of up to 12 to 15 months, during which time both water and gas would be produced. Testing will take place 24 hours per day, seven days per week.

With the completion of drilling and hydraulic fracture stimulation 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 and flaring unit. 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 is typical of rigs used for coal seam gas drilling and includes 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 utilising either a circulation fluid of water containing up to 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 on each site. Air circulation returns (namely drill cuttings and ground water) would be directed to the tanks via a blooie 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 tanks would be transported to an approved disposal site.

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 tanks 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. 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 take 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 PRODUCTION CASING RUNNING AND CEMENTING

Once permeability testing 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 a 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 the 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 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 ("fraccing") techniques. Well stimulation through a 'fracture treatment' opens up the 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.

The location prepared for drilling operations would need to be modified for frac equipment, but the gravel stabilised area of the existing drilling pad would provide adequate space for frac units and storage area (see Appendix 2).

1.12 PRODUCTION TESTING

On completion of fraccing operations, each well would be installed with a Progressive Cavity Pump (PCP) to enable the pumping of water from the borehole, 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 would be conducted for a period of up to 12 to 15 months.

1.12.1 Gas and Water Gathering

Gas and water produced during testing would be gathered and disposed of within the vicinity of each well. Water will be transferred in poly pipes to an adjacent turkey's nest storage for appropriate disposal (discussed further below). Gas extracted will be delivered directly to an enclosed flare assembly at each well site.

1.12.2 Production Testing and Flaring

As an indication of anticipated methane extraction, historical data from LMG03 within the nearby Stratford Pilot Project area shows production of approximately 1000 Mscf/day. For a twelve month period this equates to production of approximately 16,400 tonnes of CO_2 equivalents by flaring the gas[1].

1.13 PRODUCTION WATER MANAGEMENT

Boreholes developed into production evaluation wells would be dewatered to facilitate coal seam gas release from target coal seams. The target coal seams will be further defined after geophysical logging, however it is anticipated that they will be generally located at depths greater than 100 metres. Ongoing production testing at the nearby Stratford Pilot area provides some indication of the water flows and quality that might be expected at the proposed new wells.

Flows from Stratford 3 (LMG03) in the Stratford Pilot area water production 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.

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

It can be noted therefore that there is significant variation in both production water quality and quantity from existing production wells in the 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. 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 (discussed further in Section 4.2.3). All disposal options would be discussed with the relevant authorities and any necessary approvals sought, such as for on-site irrigation or environmental discharge.

Daily sampling of basic field parameters (including EC) will be undertaken, as well as more detailed monthly water quality analyses for the first 3 months of evaluation testing, to determine actual production water quality.

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 CO_2.

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

1.13.1 Turkey's Nest Ponds

Temporary turkey's nest ponds are proposed and would be located adjacent to each well to contain waters 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 sufficient storage to enable gas production to continue unhindered as far as possible. However, an operational freeboard of 450 mm (equivalent to a 1-in-100-year, 72 hour duration event) will be maintained at all times and once this freeboard level is reached, no further pumping of water to the ponds will be permitted.

The construction of on-site storages will be based on water balance modelling and an operational philosophy of minimising the risk of any spillage. An example of the design specifications and operational concept that will be observed is provided in Appendix 5, which provides the conceptual design that was undertaken for existing storages at the Stratford Pilot. A similar process will be undertaken for storages to be constructed at any of the proposed five sites, though it should be noted that the sizing is likely to be considerably smaller for the following reasons:

- Production at Stratford 3 (LMG03) appears anomalous, with most other wells at the Stratford Pilot producing significantly lower volumes – hence the LMG03 storage was sized at higher flows and modelling for future storages will likely be based on production estimates lower than 30 m^3/day; and
- Production testing is likely to be undertaken over a relatively shorter duration – possibly as short as 3 months.

Hence it is anticipated that the storages will be approximately of the dimensions indicated above, with a smaller footprint than the existing Stratford Pilot dams. Even at a rate of production of 50 m^3/day (greater than that expected), this will still provide some 80 days' storage. This period will enable disposal options to be assessed and implemented and – at the least – trucking of water from site to maintain capacity in the dam.

Daily sampling of basic field parameters (including EC) will be undertaken, as well as more detailed monthly water quality analyses for the first 3 months of evaluation testing, to determine actual production water quality.

1.13.2 Water Disposal Options

During the initial evaluation period consultation will be undertaken with the relevant authorities to evaluate and agree a suitable disposal option for the water produced. 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;
- transport of the water to the nearby Stratford Pilot Project;
- disposal in a licensed liquid disposal facility; or
- controlled aquifer re-injection.

Section 4.2.3 describes the conditions under which each of the above options might be selected as appropriate.

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 alternative 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 may 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 also include application for a groundwater extraction licence at each site.

1.14 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 stored in tanks on-site will be removed for appropriate disposal. The surface of the drilling area would then be restored to its original condition.

Once the stage is reached where no further testing is required, the wells will either be suspended as future producers or plugged.

The rehabilitation of the turkey's 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 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 for Primary Industries 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? *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 communities? *Comments:* 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? *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

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

All proposed boreholes (Waukivory 3 & 4, Stratford 7 & 10, and Faulkland 2) are located on land zoned General Rural 1A in 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.

2.3 STAKEHOLDER CONSULTATION

Stakeholder consultation has been undertaken by Lucas with the directly impacted landholders as well as Forster Local Aboriginal Land Council in regard to appropriate 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 metres.

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 some 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

All proposed 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.

Attribute	Comment
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 are 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 and February are the hottest months and June 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

The proposed borehole sites are situated within the catchment 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

Stratford Area - Stratford 7, Stratford 10, Faulkland 2, Waukivory 3, Waukivory 4,

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 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 continues to carry out water quality testing of groundwater from several coal seam methane exploration boreholes within the Stratford Prospect area. Samples from borehole LMG03 show groundwater properties for pH are between 7.5 - 9.3 and electrical conductivity is between 3,300 and 5,400 µS/cm. The water testing results and ongoing assessments have now enabled the approval of the produced water from LMG03 to be utilised for pasture irrigation.

Daily measurements of electrical conductivity at boreholes Stratford 4 and Stratford 8 average around 9,400 and 7,400 µS/cm respectively. However, the volume of water produced from these wells is significantly less than that produced historically at LMG03.

3.3.3 Produced Formation Water Management

As discussed in Section 1.13, groundwater extracted during production evaluation testing will be collected in a storage pond prior to appropriate disposal, which will be discussed and agreed with the relevant authorities. Section 4.2.3 describes further the decision process for disposal options.

All storages would be operated with sufficient freeboard to cater for a 1-in-100 year 72-hour rainfall event to minimize the probability of any spillage. Should this capacity be reached production would cease until the water could be appropriately disposed of.

3.4 FLORA AND FAUNA

Gloucester Local Government Area – Stratford Area - Stratford 7, Stratford 10, Faulkland 2, Waukivory 3, Waukivory 4,

Gloucester Local Government Area (LGA) contains significant biodiversity values, including the World Heritage listed Central Eastern Rainforest Reserves (Barrington Tops Area) and 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 loose 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 indicates 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.

Assessment

A thorough ecological assessment of each borehole site was undertaken, involving:

- A review of available literature and databases to assist with identification of site values, especially in relation to threatened species, populations and endangered ecological communities;
- Field investigations to ascertain the current site condition and the presence or likely presence of threatened or protected species;

- An impact assessment to determine the likely effects of the proposal on the ecology of the sites; and
- Preparation of preliminary recommendations to ameliorate and mitigate any impacts.

Prior to a site visit to each borehole location by a suitably qualified ecologist, the following databases were reviewed:

- Department of Environment and Climate Change (DECC) – Threatened species database records (DECC, 2008); and
- Department of Environment, Water, Heritage and the Arts (DEWHA) – Online protected matters search tool for Matters of National Environmental Significance (NES) (DEWHA, 2008).

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.

3.4.1 State and Commonwealth legislation

Given the highly modified nature of the sites, none of the Endangered Ecological Communities (EECs) listed as occurring within the Karuah and Manning CMA are present. A total of 63 species (ten plants, one reptile, four amphibians, 25 birds and 23 mammals) listed under the NSW *Threatened Species Conservation Act 1995* (TSC) have been recorded within the locality, but for the vast majority of species the proposed borehole sites lack the complexity required to provide habitat and their presence is considered unlikely. Likewise, of the 14 fauna, 13 flora and 12 migratory species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) with potential to occur within the locality of the site, the majority are considered unlikely.

Three species recognised under the TSC Act, one of which is also listed under the EPBC Act, have been identified as possibly residing or foraging within the locality of the proposed sites. These are shown in Table 4.

Although the local farm dams and creeks provide few resources for waterbirds and amphibians, it is considered there may be marginal habitat for the Green and Golden Bell Frog (*Litoria aurea*) in some adjacent areas. The Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) is known within the area and although there is no habitat at any proposed borehole site, nearby woodland areas may provide nesting and foraging habitat. Similarly, the Grass Owl (*Tyto capensis*) may occasionally forage across the study area.

Although the potential for these threatened species to be impacted by the proposed work is limited, Assessments of Significance (required under Part 5A of the NSW *Environmental Planning and Assessment Act 1979*) have been undertaken as a precautionary measure. As the Green and Golden Bell Frog is also listed as endangered under the EPBC Act, this species has also been considered using the Significant Impact Criteria for Endangered Species listed in the EPBC Act *Administrative Guidelines for Significance* (Commonwealth of Australia 2006). These assessments are included in Appendix 3.

Table 4: Threatened species for which habitat occurs within the locality

Species	Conservation Status	Habitat	Likelihood of occurrence on site
Green & Golden Bell Frog *Litoria aurea*	E - TSC V - EPBC	Marshes, dams & stream-sides, particularly those containing *Typha* or *Eleocharis.*	Unlikely - cleared paddocks. Perhaps very marginal habitat.
Grey-crowned Babbler *Pomatostomus temporalis temporalis*	V - TSC	Open woodlands.	May occur in nearby woodland areas.
Grass Owl *Tyto capensis*	V - TSC	Tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath and cane grass, or sedges on flood plains.	Cleared paddocks. Unlikely – but may occasionally forage across wetter paddock areas.
Note: TSC = NSW Threatened Species Conservation Act 1995. EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999. V = Vulnerable. E = Endangered.			

It was concluded that the proposed works would not impact on any known breeding habitat for these species and would be unlikely to have a significant impact on foraging resources. Given the highly modified nature of the works areas, the minimum impact of the proposed works and the implementation of stringent management measures, it was considered unlikely that any of these species would be significantly impacted.

A Species Impact Statement is therefore not necessary, nor a referral to DEWHA required.

An assessment under *State Environment Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44) is required as Gloucester LGA is listed under Schedule 1 of SEPP 44, which requires the identification and protection of core koala habitat. 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 the ecological 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 Worimi Aboriginal Peoples traditional lands and the Aboriginal organisation responsible for providing advice on Aboriginal heritage management is the Forster Local Aboriginal Land Council (LALC). Disturbance due to European occupation and grazing severely limits the likelihood of identifying significant Aboriginal sites in the area.

A search of the Department of Environment and Climate Change (DECC) Aboriginal Heritage Information Management System (AHIMS) database was undertaken for the project areas and surrounding district. This search did not identify any previously recorded Aboriginal heritage sites within the proximity of the proposed borehole sites.

Following a process of consultation with the local Aboriginal community (in accordance with DECC guidelines), walkover surveys of the sites were scheduled to be conducted by representatives of the Forster LALC with the assistance of an archaeologist.

Three of the five sites were inspected on 4 August 2008 – namely Waukivory 3, Stratford 7 and Faulkland 2 – and no artefacts or objects of significance were identified. Due to landowner access issues at the time, the remaining two sites – being Waukivory 4 and Stratford 10 – were not surveyed, but were intended for visits in subsequent weeks. While these surveys will be undertaken at first opportunity, the nature of the sites and the lack of findings at the other locations suggest a low likelihood of significant findings.

Lucas proposes to submit this REF on this basis, with the intention of submitting a Letter of Addendum to the DPI once the walkover surveys have been completed to provide an update of any artefact findings. This does not preclude the mitigation measures (described in Section 4.7) that will regardless be observed at all times.

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. The Buckett's Way bisects the area and carries a reasonable amount of through traffic, including heavy vehicles.

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 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 and production evaluation testing activities 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 4). 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 require minimal earthworks and would occupy a limited area. As a result, dust generation from the operating drill rig would be negligible. Drill pads will also be utilised for fraccing operations, with some minor modifications to the site layout depending on the location of the wellhead and access roads. There would be some supply truck and pumping unit movements mobilising equipment into the area. After completion of the stimulation operations all units and equipment will be transported back out of the area.

Following fraccing the drill pad will be reduced to some 10 m x 10m, further reducing the potential for any dust generation. Once production testing has been completed at each pad, the area would be rehabilitated and sown to pasture.

The construction of the small turkey's nest ponds at selected sites would be a short term construction activity involving only disturbance to a minor area (approximately 40 m x 40 m). Dust generation can be easily controlled during these works with the application of clean, dust suppression water.

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 the atmosphere other than depressurising very short sections 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 no more than 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 project water storages at the nearby Stratford Pilot Project. Drilling fluid waters would be stored in tanks located beside the drill pad. On completion of drilling, water and fluids collected in the tanks would be 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 tanks and where necessary removal and disposal at appropriate facilities;
- 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 tanks with capacity to contain overflow from the main tank in the event of increased flow from the borehole; 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.

Due to the relatively low volumes of water extracted, the limited duration of the testwork (notionally 6-12 months) and deep nature of the target seams (100 to 500 m in depth) no impacts on groundwater sources of surface water flows are anticipated from the groundwater extraction. Fraccing of target seams will be conducted with water transported to the drill site. Dewatering of the seams will remove the majority of this water, avoiding contamination of the coal seam aquifers themselves.

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

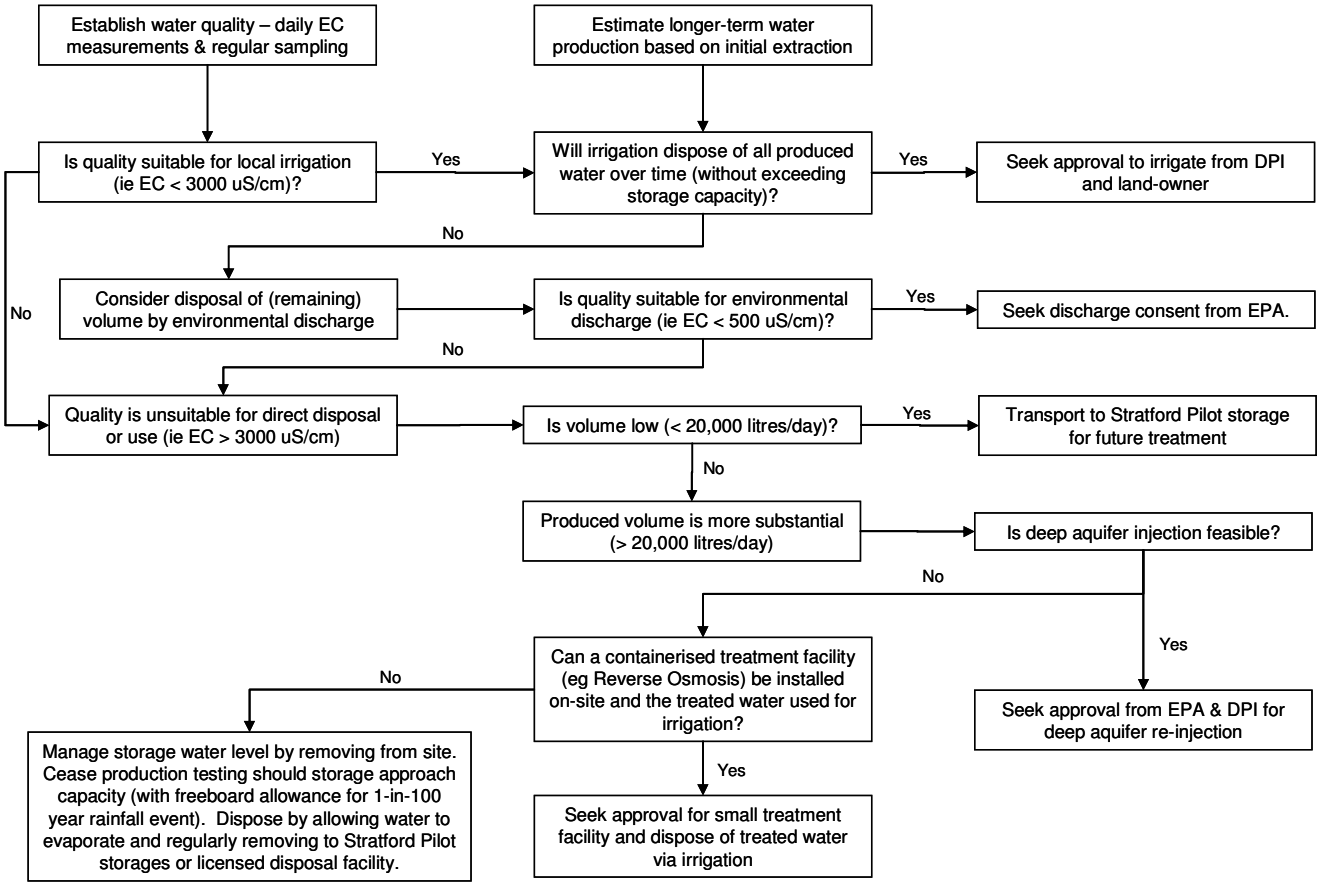
4.2.3 Production water

As described in Section 1.13 production water extracted during the evaluation period would be collected in localized storages. Sufficient freeboard to cater for a 1-in-100-year 72 hour rain event would be maintained in all storages to minimize the risk of spills to the environment. Storages would be lined with a geomembrane to prevent leaching into soils and groundwater.

The optimal disposal option for the collected water will be dependant on the quality and quantity of water produced, which can only be definitively determined once production testing commences. It is proposed to design the storage dams on the basis of assumed anticipated flows (discussed in Section 1.13.1) such that the capacity of the storage will provide a reasonable length of time in which to establish a suitable disposal option.

Figure 2 below indicates the decision process that will be undertaken once quality and quantity becomes better understood. It is intended to engage with the DPI and other relevant authorities to discuss these disposal options and ensure all necessary approvals are obtained.

Figure 2 – Decision Tree for Produced Water Management



Based on experience from the nearby Stratford Pilot Project, water production is quite variable between different locations. However, it has generally been found that where water is produced in larger volumes it is of reasonable quality (EC less than 3 dS/cm) and where quality is poor (EC greater than 3 dS/cm) it is produced in much smaller quantities. This influences the approach to produced water management.

It is anticipated that water production will therefore fall approximately within one of two scenarios:

1. Larger quantities (> 20,000 litres per day) of reasonable quality (< 3 dS/m) water that can be disposed of by carefully managed local irrigation; or
2. Lower quantities (< 20,000 litres per day) of poor quality (> 3 dS/m) water that will be removed from site to be later treated and disposed of at the Stratford Pilot area.

Should water production not conform to either of these scenarios, the above decision process describes how Lucas will manage the quantities produced. In all cases, the turkey's nest dams will provide at least several weeks' worth of storage. The operational philosophy of the storage will be to minimize the risk of accidental environmental discharge at all times. This includes ceasing production testing as necessary (if capacity is approached) so that the water can be removed and the level in the storage reduced.

Table 5 below further summarises the prioritised disposal options and the likelihood of each.

Table 5: Ranked disposal options for produced water

Ranked Option	Potential Environmental Impact	Likelihood
1. Direct irrigation	Managed to minimise risk	Dependant on water quality (considered where EC < 3 dS/m)
2. Discharge to local waterway	Managed to minimise risk	Unlikely – produced water historically too saline (< 500 uS/cm required)
3. Treatment for irrigation	Managed to minimise risk	Likely to be feasible only where volume produced is significant
4. Aquifer re-injection	Potential groundwater contamination	Unlikely – could require extensive investigation to minimise risk
5. Removal from site	Minimal	Likely where volumes are low, or to maintain sufficient capacity in the storage, and to dispose of water at completion of testing

The rationale for each disposal option is discussed further below.

Direct Irrigation

Table 5 and Figure 2 show that using the water for irrigation is preferable to other options, as it potentially has productivity benefits for the land holder. The trigger for water suitable for irrigation is tentatively indicated as 3,000 uS/cm (3 dS/m), though at each location this may depend on the local soil conditions, pasture type and preferences of the land holder. Rainfall (or other water sources) may facilitate some dilution, but in all cases irrigation would be carefully managed in accordance with an irrigation management plan. This would include water and soil quality monitoring to ensure there is no environmental impact, though generally the irrigation would be of such a temporary nature that impacts would be unlikely even if the water is considered of marginal quality.

The DPI has previously approved irrigation using produced water as part of the Stratford Pilot Project. This has been a successful means of disposing of produced water of appropriate quality, with the landholder indicating greater productivity from the irrigated areas. Wherever possible, this will therefore be the preferred option of disposal. The Stratford Pilot provides a precedent for this option, with a successful format for a suitable Irrigation Management Plan.

Discharge to a Waterway

The discharge of water to a nearby waterway could also be beneficial as environmental flows, though – based on existing production – it is unlikely that the produced water will be of appropriate quality. Local waterways typically have an EC in the range of 400 to 800 uS/cm, which is likely to be significantly lower than the water extracted from coal seam aquifers.

However, a discharge consent during high flows may remain an option, particularly if the EC of the produced water is lower than expected.

Treatment and Irrigation

It may be feasible to treat the produced water on-site, with the treated water then used for irrigation. This would be a suitable option when produced volumes are higher (such that removing the water from site requires an excessive number of tanker journeys). Portable, containerised treatment facilities are available that would be ideal for this role, though at some locations this may not be possible if there is insufficient power infrastructure available. Appropriate approvals would need to be sought.

As this is an expensive alternative, it is likely only to be considered where production testing is longer term (12 months) and daily produced volumes are high (greater than 50 m^3/day). The waste stream from the treatment process would be removed from site for disposal in a licensed facility.

Aquifer Re-injection

The re-injection of liquids into coal seam or other aquifers is a recognised means of disposal, particularly in the USA. Where geological conditions are suitable, this approach enables water to be re-injected underground to be contained within isolated aquifers.

The risk is clearly that re-injected waters escape the aquifer to contaminate other shallow aquifers that may be used. It is expected that considerable hydrogeological investigation would be required to mitigate against this risk on a case by case basis.

As a result, aquifer re-injection is not considered a likely disposal option for individual wells. However, should drilling reveal conditions suitable for disposing of produced water underground, it may be considered further. A discharge consent would have to be sought from the EPA, with appropriate justification that any environmental impacts would be prevented.

Removal of Produced Water from Site

Where quality is deemed too poor for direct disposal or use (and localized treatment or aquifer re-injection is not feasible), Lucas will transport all produced water from site in tankers. The water will then be transferred to existing storages at the Stratford Pilot area or – in the extremely unlikely event that these storages are at capacity – for disposal at a licensed facility.

The turkey's nest storages at each site would be operated with a philosophy of minimizing the risk of discharge to the environment. Therefore, levels in the dams would be managed to ensure there is sufficient capacity to enable production testing to continue unhindered. Should the dams approach capacity, production testing would simply be ceased until the water could be removed.

A typical tanker load of 20m^3 could potentially remove an entire day's production with one trip, enabling storage levels to be readily managed. In any event, a capacity of several megalitres would provide at least several weeks' storage (this is discussed further in Section 1.13.1). Produced water would therefore be removed from site as required to ensure that dam levels are well below capacity.

At the completion of testing, all water would be removed or allowed to evaporate prior to the de-construction of the storage and reinstatement of the land to its original condition.

Lucas has more than 50 ML of storage capacity at the Stratford Pilot area, with approval to irrigate on-site (with appropriate quality water). Treatment of produced water will likely be undertaken here in the future as a means of disposing of water produced from various sources. In the very unlikely event that these storages approach capacity and the water cannot be disposed of, Lucas will truck water off-site for disposal in a licensed facility.

4.3 LAND RESOURCES

Site preparation for each proposed well will involve minor earthworks for the construction of drill pads, as well as the construction of turkey's nest ponds at those sites where production testing is then undertaken. 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, spillage of drilling water/fluids from tanks 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 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;
- The drill pad area will be reduced back to an area of 10m by 10m for production testing; 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, fraccing and generator operation; vehicles travelling to and from the drill site; and flaring of gas during production evaluation testing.

Other than one residence within 250m of Faulkland 2, all properties are at least 500m from the proposed well locations. Each well is generally located in a sparsely populated rural area, though noise impact modelling for each activity phase identified some residences as being potentially impacted by the proposed works, particularly fraccing. However, the following factors indicate that significant noise impacts are manageable and prolonged noise impacts unlikely:

- Drilling and fraccing activities would be of short duration (about 2 to 5 weeks and several days 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.

Current assessment criteria for noise impact assessment are set out in the NSW Department of Environment and Climate Change's (DECC) Construction noise guide. Noise level criteria are based on existing background noise, with the guidelines specifying that construction periods of four weeks and under should not exceed the background level by more than 20 dB(A). A conservative minimum rural background noise level of 30 dB(A) was adopted during noise modelling, with the applicable criteria therefore that construction noise levels should not exceed 50 dB(A). However, in a landscape characterized in part by mine and farming operations, as well as traffic along the Buckett's Way, a daytime background noise of 40 dB(A) could be considered more reasonable, with a resulting criteria level of 60 dB(A).

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 drill pads and storage ponds, installation of gathering systems, generator operation, vehicles travelling to and from the site, and drilling), fraccing, 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, fraccing and operational noise was modelled using ENM software and included atmospheric, wind and temperature inversion effects. Appendix 6 details the results of modelling.

4.4.1 Construction Noise Impact

The modelling predicts the possibility of minor exceedances from construction activities (pad establishment and drilling) at one property near Faulkland 2, belonging to the landholder (in excess of 50 dB(A) but below 60 dB(A)). An agreement is in place with the landholder for Lucas' proposed operations on the property.

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 such an exceedance should occur. Mitigation measures to be employed may 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;
- Inclusion of noise management in the EMP so that employees understand and take responsibility for noise control at the sites (such as optimizing the location of plant in relation to sensitive receptors);
- Scheduling activities such that the concurrent operation of plant is limited;
- Where known to be available, deploying plant having lower noise emission levels;
- Routine field monitoring of noise during actual operations;
- 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 rare event that drilling operations must occur during the night, affected landholders would be informed and particular attention given to maintaining plant, employing units with lower noise levels, and limiting concurrent operation of plant.

4.4.2 Fraccing Noise Impact

Modelling predicts that the noise related to fraccing of the wells has the potential to exceed project specific criteria (50dB(A)) at some sensitive receptors within the proximity of each proposed borehole. All the sensitive receptors are residential dwellings; there are no schools, hospitals or similar establishments within the proximity of the proposed wells.

Appendix 6 shows the location of each sensitive receptor in relation to the proposed well sites, as well the predicted noise impacts at each receptor during fraccing. Fraccing is the loudest activity involved in drilling and well preparation, but it is limited to just several days' duration at the most.

It is noted that DECC has recently published draft Construction Noise Guidelines[2] to supersede the existing critiera with new guidelines focused on achieving desired environmental outcomes without setting prescribed noise controls. Rather than establishing arbitrary noise threshold levels, the new guidelines specify that all *feasible* and *reasonable* work practices be implemented to minimize noise impacts. In this context, Lucas considers that there will be limited and manageable noise impact from fraccing operations for the following reasons:

- Fraccing involves running a blender and up to five pumps, each potentially operating at high revs. Noise generation is an inevitable part of this operation, so every feasible effort is made by the operator as a matter of course to mitigate sound at the source;
- The duration of fraccing activities is relatively short. Depending on the number of seams being stimulated, the operation may take several hours or occur over several

2 *New South Wales Construction Noise Guidelines (Draft for Consultation)*, August 2008. Department of Environment and Climate Change (DECC). http://www.environment.nsw.gov.au/noise/constructnoise.htm

days. The actual operation of pumps at full capacity (when noise creation is greatest) is limited to an hour or two at a time, always during normal construction times;

- Lucas propose to inform those residences that modelling has indicated may be affected, by sending a letter advising of the potential extent and duration of noise;
- Modelling is based on a conservative background level of 30 dB(A). In reality, the background noise level is considerably higher in places, particularly within the vicinity of mining operations and along the Buckett's Way thoroughfare. Residences in this area are more likely to have a background noise level of 40-50 dB(A) (representative of heavy vehicle traffic). On this basis, the current guidelines would therefore set the construction noise level at 60-70 dB(A), which the majority of predicted noise impacts from fraccing would fall within.

All of the mitigation measures indicated in Section 4.4.1 will be stringently observed during fraccing operations. While noise levels during fraccing have the potential to exceed current criteria at some locations, every feasible and reasonable effort will be made to ensure noise impacts are mitigated as far as possible.

4.4.3 Operational Noise Impact

In its Industrial Noise Policy (INP, January 2000), the NSW DECC stipulates guidelines for assessment of noise from the operation of industrial facilities. The INP was specifically developed to provide a comprehensive assessment technique that complies with the *Protection of the Environment (Operations) Act.* The intrusiveness criterion requires that newly introduced noise levels do not exceed existing background noise levels by more than 5 db(A) at the sensitive receptor. Adopting a conservative rural background noise level of 30 dB(A) implies a noise limit of 35 dB(A) at residences closest to the proposed sites.

Noise impact modelling identified the potential for very minor exceedances – during maximum wind and inversion conditions – from flaring during the production testing phase, at two properties in the vicinity of Faulkland 2 (potential 1 dB(A) and 3 dB(A) exceedances).

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 (by an estimated 5 dB(A)).
- The minor exceedances are predicted during conditions of maximum wind at two properties (and a 1 dB(A) exceedance at one property during an 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 exceedences 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.

4.4.4 Noise Impacts and Mitigation – Conclusion

With the removal of arbitrary noise level thresholds in DECC's new draft Construction Noise Guidelines, the emphasis is on managing noise impacts by employing all feasible and reasonable work practices. Lucas endeavours at all times to employ best practice to mitigate noise impacts. Table 6 details how Lucas proposes to manage noise impacts with feasible and reasonable work practices in relation to the strategies detailed in the new draft guidelines.

Modelling shows that some activities – particularly fraccing – may have the potential to exceed criteria levels according to the current guidelines. However, the criteria levels are determined

as a surplus of 20 dB(A) above background noise levels. A conservative background noise level of 30 dB(A) was adopted for modelling, but in a landscape characterised by mining and farm operations, as well as traffic along the Buckett's Way, a background noise level of 40 dB(A) is considered reasonable. This then infers a noise criteria level of 60 dB(A), which reduces significantly the number of potential exceedances.

In almost all instances, the potential impacts are the result of fraccing activities, which occur during normal working hours over a period of several days at the most. Where residences are in close proximity to the borehole and therefore likely to be impacted more substantially, the landholders will be closely consulted. In most cases, these affected properties are those of the landholder with whom Lucas has an agreement for the construction of the borehole.

It is considered that Lucas has undertaken all feasible and reasonable efforts to mitigate against potential noise impacts from fraccing activities at the three borehole sites. In particular, the good relationship the company has with local landholders will facilitate consultation and communication of potential noise impacts, which will be of a short and temporary nature.

Table 6: Noise impact mitigation – strategies and work practices

Strategy	Work Practice employed by Lucas
1 – Universal Work Practices	• Staff and contractors trained to operate equipment in ways to minimise noise; • No stereos, public address systems or unnecessary shouting; • Noise management included in company and project Environmental Management Plans.
2 – Consultation and Notification	• Information provided to local landholders and residents in relation to anticipated construction extent and duration; • Consultation with individual landholders who may be impacted; • Regular community consultation and meetings undertaken as part of the project; • A website to be set up to provide information to the community, and a toll-free phone number made available to enable queries, complaints or feedback; • A documented complaints procedure, with senior staff readily responding to community concerns and all reasonable and feasible measures taken to address complaints.
3 – Plant & Equipment	• Recognition that controlling noise at the source is the most effective way of mitigating impacts; • Employing, wherever possible, equipment that represents the quietest alternative for the job; • Considering noise attenuation devices wherever equipment noise is excessive; • Maintaining equipment in good working order, including regular inspections.
4 – On site	• Design site set-up to ensure the greatest distance possible is placed between equipment and sensitive receptors; • Positioning of site-offices, tanks and other objects as potential barriers; • Site vehicle entrances located away from sensitive receptors.
5 – Work Scheduling	• Restrict operations to normal hours wherever possible (Monday to Friday, 7am to 6pm; Saturday 8am to 1pm); • Consideration of local events, or scheduling around business/school hours where applicable; • Optimising site deliveries and scheduling them for normal hours only; • Where night work cannot be reasonably avoided, restrict the number of successive nights and/or the number of nights in a calendar month.
6 – Transmission Path	• Reduce the line-of-sight noise transmission to residences using temporary barriers (typically for longer exposure); • If temporary barriers are to be employed, erect them before work commences.
7 – At Sensitive Receptor	• Mitigating noise impacts at the sensitive receptor is considered a last resort and is not preferred; • Temporary relocation may be considered if extended and excessive noise impacts cannot be reasonably or feasibly mitigated.

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 little or native vegetation would be cleared or drainage patterns altered as a consequence of this proposal. The potential removal of four Narrow-leaved Ironbark saplings to gain access to the Waukivory 4 site is not considered significant, as the saplings lack complexity, dense canopy and tree hollows.

Furthermore, 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 and 6-12 months for production evaluation testing if required). After this time the sites would be restored to their current condition.

Key Threatening Processes and NSW and Commonwealth Legislative Assessments

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, it is considered unlikely that any key threatening processes under the TSC Act or EPBC Act would be exacerbated by this proposal, since the borehole sites and access routes have been located to avoid native vegetation and riparian or seepage areas. Consequently no native vegetation (with the possible exception of four saplings) would be cleared or important natural drainage patterns altered.

Assessments of Significance for the Green and Golden Bell Frog, Grey-crowned Babbler and Grass Owl concluded that the proposed works were unlikely to impact on these species.

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

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, the hydrology of the site would not be changed and any impacts would be minor and temporary.

Management Measures

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:

- Vehicle numbers and speed would be strictly limited to reduce the risk of fauna injuries;
- The 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;
- Ongoing 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 waterways 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 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. No artefacts were disc overed during thorough walkover surveys of those sites visited by representatives of the Forster LALC. Two remaining sites are yet to be visited, but it is assumed that there is a similarly low likelihood of significant discoveries. The surveys are to be undertaken at first opportunity and the DPI will be advised of the survey outcome.

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 DECC 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 specifications 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.

Continuous flaring from production testing would take place within an enclosed flare assembly.

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
- Prohibit smoking 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 excavations 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 short term (2 – 5 weeks) activities 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. During fraccing operations a number of heavy vehicle movements are required to deliver the frac pumps, tanks and sand. 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 Energy supervisors, geologists, technicians and contractors.

During production evaluation pumping a contractor will initially visit each well site on a daily basis to record production data and inspect and maintain surface equipment. This will become less frequent towards the end of the production testing period. Should well blockages or pump failure occur during the production testing period a drilling rig may need to return to the site to complete necessary remediations.

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 test work 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 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, for the period of the licence term.

6.0 CONCLUSION

The proposed drilling, fraccing and testing will involve minor disturbance to areas of cleared grazing lands and will be conducted for a period of 2 - 5 weeks for initial well construction, followed by ongoing testing for 6-12 months. Following completion all disturbance areas would be rehabilitated to the satisfaction of the landowner and DPI.

The drilling 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 activities at the proposed drill sites can be undertaken with minimal impact to the environment.

7.0 REFERENCES

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DECC (2008), New South Wales Construction Noise Guidelines (Draft for Consultation), August 2008. http://www.environment.nsw.gov.au/noise/constructnoise.htm

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APPENDIX 1

ACTIVITY LOCATION MAP

LUCAS ENERGY

AUTHOR : Kate Harper

DATE: 16/05/08

SCALE: 1:30,000

Strictly Confidential

Proposed well locations

0 0.5 1 2

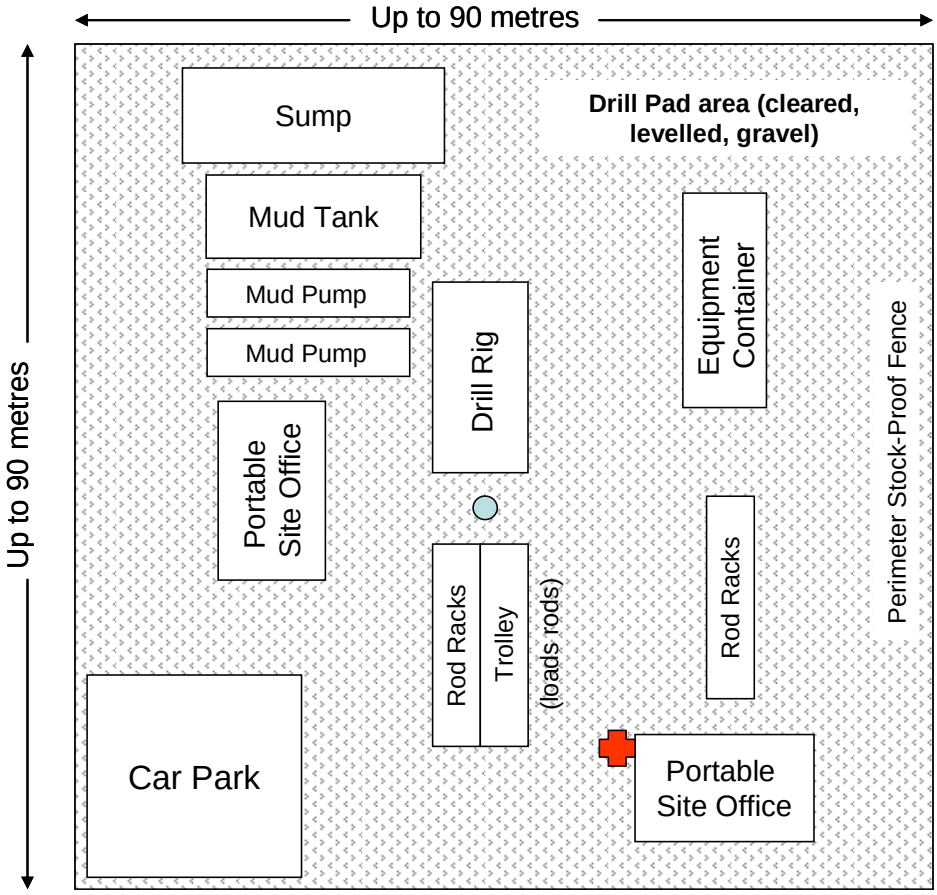
Kilometers

N

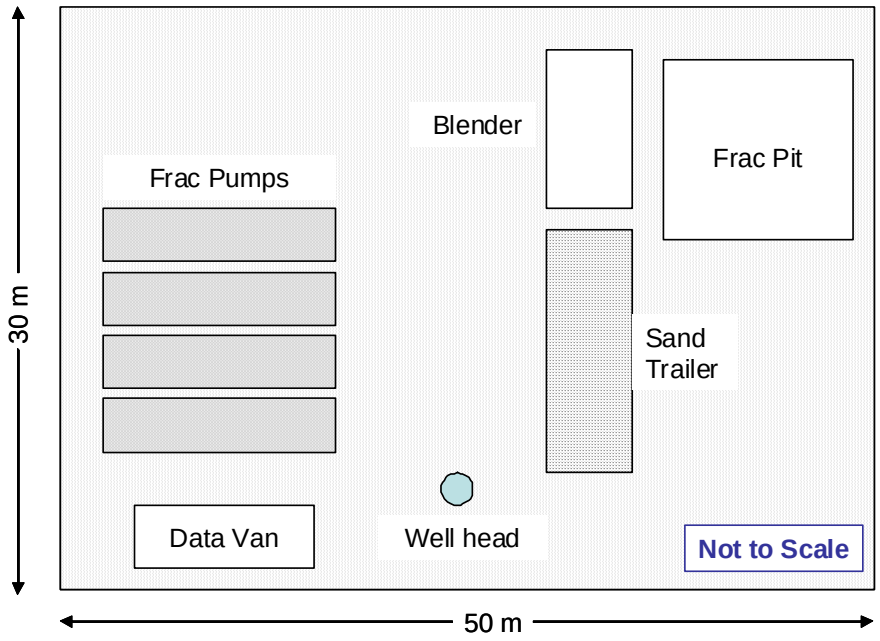
- Proposed well
- Existing Lucas well
- Roads
- Lots
- Localities

APPENDIX 2

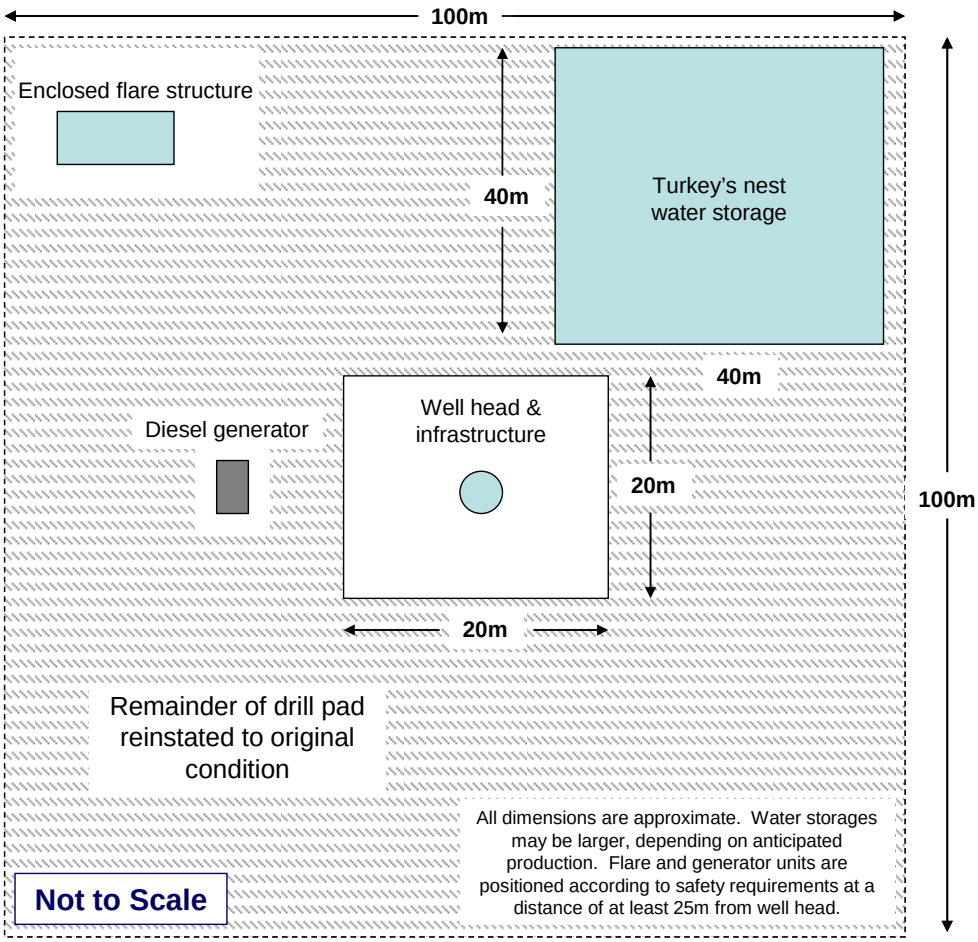
SITE LAYOUTS



Approximate Drill Site Layout **Not to Scale**



Approximate Site Layout during Fraccing



Approximate Site Layout during Production Testing

APPENDIX 3

FLORA & FAUNA ASSESSMENTS OF SIGNIFICANCE

APPENDIX B

Assessment of Significance

Background

As required under the Section 5A of the *Environmental Planning & Assessment Act 1979* (EP&A Act), Assessments of Significance were undertaken to determine the significance of impacts of the proposal on threatened species listed on Schedules of the NSW *Threatened Species Conservation Act 1995* (TSC Act). A number of threatened species were listed as occurring within the locality but habitat for only a very small percentage of these occur at the site due to the highly modified nature of the proposal area. Therefore, Assessments of Significance have been undertaken only for those species for which potential habitat occurs either across the study area or within the near locality. Those species addressed are:

- Green & Golden Bell Frog (*Litoria aurea*);
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*); and
- Grass Owl (*Tyto capensis*).

Grey-crowned Babbler

Grey-crowned Babbler (GCB) (*Pomatostomus temporalis temporalis*) (eastern subspecies) is listed as Vulnerable under the TSC Act. This species is found throughout large parts of northern Australia and in south-eastern Australia. In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Hay. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. This species is a laborious flyer so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. GCB feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal would not directly impact on any known breeding or foraging areas of this species as all works would be undertaken outside of woodland areas. However, the GCB is known extensively from the Gloucester Shire Council LGA and it is possible that this species would occur in nearby woodland or trees. No potential habitat would be removed or altered for this proposal. The Grey-crowned Babbler appears to be relatively disturbance tolerant as this bird has been observed foraging and nesting in gardens, parks and small remnants, along fence boundaries and man-made structures near major roads (Parsons Brinckerhoff 2005). However, this species is a laborious flyer and is known to feed on the ground placing it at risk of being struck by construction traffic which would increase temporarily during drilling operations. To

avoid bird strike stringent traffic management should be implemented and traffic flow, vehicle speed and vehicle numbers entering and leaving the sites should be controlled.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) in relation to the habitat of a threatened species, population or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The proposed action would not result in habitat being removed or altered and habitat would not become fragmented or isolated from other areas. All proposed works are to be undertaken within pasture improved paddocks.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There is no critical habitat listed for this species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

Although the Grey-crowned Babbler Retention Plan – Gloucester Shire Council (Parsons Brinckerhoff 2005) deals with potential family groups outside of the study area, several of the management measures are applicable to management of the GCB within the study area and these are:

- Habitat protection and maintenance: to maintain and protect woodland remnants that form part of a corridor network and other habitats that have potential for regeneration for the longer term benefit of the species; and
- Road and traffic management: prevent / reduce the incidence of collision of GCB with motor vehicles through the implementation of go slow areas and increasing public awareness through signage.

This proposal would not remove or modify current habitat for this species and a Construction Environment Management Plan would ensure that vegetated areas are protected, through fencing where appropriate and education of personnel to raise awareness of the importance of this species. Stringent traffic management would also be implemented to ensure that the incidence of collision does not increase due to the increase of traffic and it will address such matters as traffic numbers, traffic speed and traffic flow.

DEC have also identified five strategies to help recover the species (DEC 2005d) and these include community and land-holder awareness, development and implementation of protocols and guidelines, habitat rehabilitation / restoration, research and survey / mapping and habitat assessment. None of the actions of this proposal are inconsistent with any of the strategies or actions outlined in the PAS.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

It is unlikely that any key threatening processes listed under the TSC Act would be exacerbated by this proposal as the proposed work sites have been located to avoid areas of native vegetation and consequently no native vegetation would be cleared as a consequence of this proposal. Threats identified by DEC (2005) include clearing of woodland remnants, heavy grazing and removal of woody debris and nest predation by bird species. None of these threats would be increased as a consequence of this proposal.

Conclusion

No changes to GCB habitat would occur through removal or modification as all proposed works are outside of woodland and remnant vegetation and potential disturbance through an increase in traffic movement would be managed through stringent traffic controls. Therefore, it is considered unlikely that this proposal would have significant impacts on this species.

Grass Owl

The Grass Owl (*Tyto capensis*) is listed as Vulnerable under the TSC Act. Grass Owls have been recorded occasionally in all mainland states of Australia but appear to be more commonly recorded in northern and north-eastern Australia. In NSW they are more likely to be found in the north-east. Grass Owl numbers often increase when rodent numbers increase. They are found in areas of tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath, and cane grass, or sedges on flood plains. They rest by day in a 'form' - a trampled platform in a large tussock or other heavy growth. They also nest in trodden-down grass (DECC 2005).

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Disturbance to grassed and tussocky areas within paddocks would be minimal and temporary. Substantial areas of foraging and nesting habitat would remain within the locality and

consequently it is unlikely that this species would be adversely affected or placed at the risk of extinction as a consequence of this proposal.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

III. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

IV. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) in relation to the habitat of a threatened species, population or ecological community:

IV. The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

V. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

VI. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The proposal would only temporarily disrupt potential habitat for this species. Disturbance would be minimal and the borehole sites would revegetated with pasture species as soon as practicable after completion of the drilling operations.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

There is no critical habitat listed for this species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There has not been a recovery plan or threat abetment plan prepared for the Grass Owl.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

It is unlikely that any key threatening processes listed under the TSC Act would be exacerbated by this proposal as the proposed work sites have been located to avoid areas of native vegetation and consequently no native vegetation would be cleared as a consequence of this proposal. However, threatening processes listed by DECC (2005) for the Grass Owl include, loss of suitable habitat due to grazing, agriculture and development and disturbance and habitat

degradation by stock. Disturbance to any potential habitat for this species would be minimal and temporary as the sites would be returned to their current condition at the completion of testing.

Conclusion

It is considered unlikely that this proposal would result in significant impacts on this species as disturbance to any potential habitat would be minimal and temporary as the sites would be returned to their current condition at the completion of testing.

Green and Golden Bell Frog

The Green and Golden Bell Frog (GGBF) (*Litoria aurea*) is listed as Endangered under the TSC Act. This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available.

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The GGBF has not been recorded within the Gloucester Shire Council LGA (Gloucester Shire Council 2007). The closest record is approximately 50 km to the south-west of the study area near Dungog. However, marginal potential habitat is located near the access road of Waukivory 3 and along the access road at Stratford 10. This habitat consists of degraded drainage lines with emergent Cumbungi and surrounding grassed area. Environmental management of the site during construction could ensure that these areas would be protected from the affects of run-off and sedimentation during construction through the use of sedimentation fences and revegetation. Consequently, should the GGBF occur in adjacent areas it is unlikely that this species would be impacted by this proposal.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not an endangered population.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

I. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

II. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not an endangered ecological community.

d) In relation to the habitat of a threatened species, population or ecological community:

I. **The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

II. **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

III. **The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

This proposal would not remove potential habitat for this species and consequently a reduction in the area of potential occupancy would not occur. This proposal is unlikely to fragment existing populations as habitat for this species is unlikely to be removed or habitat corridors interrupted.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

This area has not been identified as critical habitat for this species.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

This proposal would not be pose a threat to the recovery of the GGBF as potential habitat of this species would be maintained and protected through environmental management during construction. Recognised threats would not be exacerbated.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Two Key Threatening Processes have potential relevance to this proposal. These are *Predation by Gambusia holbrooki (Plague Minnow)* and *Infection of frogs by amphibian chytrid causing the disease chytridiomycosis*. The adjacent potential habitat is likely to already contain the invasive Plague Minnow which is a known predator of tadpoles of the GGBF although it was not recorded on the day of assessment. If this invasive species is not currently present it is unlikely that this proposal would introduce it to the study area. The fungal pathogen, Frog Chytrid Fungus, is a known threat to the GGBF. Chytrid fungus is probably transferred by direct contact between frogs and tadpoles, or through exposure to infected water. This proposal would not involve the moving of frogs or tadpoles, exposing frogs to infected water or handling of frogs in any way.

Conclusion

The Green & Golden Bell Frog is unlikely to be impacted by this proposal due to the highly modified nature of the proposed works areas and the minimum impact this proposal is likely to have on the ecology of the study area and locality. Consequently, it is considered that a Species Impact Statement is not required.

APPENDIX C

ASSESSMENT UNDER THE EPBC ACT

Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The study area supports very limited habitat for native fauna as it is highly modified and predominately agricultural lands. However, marginal potential habitat for the Green and Golden Bell Frog (GGBF) (*Litoria aurea*), which is listed as endangered under the EPBC Act, could potentially occur in areas adjacent to the access roads at some sites and consequently this species has been considered below using the Significant Impact Criteria for Endangered Species listed in the EPBC Act *Administrative Guidelines for Significance* (Commonwealth of Australia 2006).

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population;

  The GGBF has not been recorded within the Gloucester Shire Council LGA (Gloucester Shire Council 2007). The closest record is approximately 50 km to the south-west of the study area near Dungog. However, marginal potential habitat is located near the access road of Waukivory 3 and along the access road at Stratford 10. This habitat consists of degraded drainage lines with emergent Cumbungi and surrounding grassed area. Environmental management of the site during construction could ensure that these areas would be protected from the affects of run-off and sedimentation during construction through the use of sedimentation fences and revegetation. Consequently, should the GGBF occur in adjacent areas it is unlikely that this species would be impacted by this proposal.

- Reduce the area of occupancy of the species;

  This proposal would not remove potential habitat for this species and consequently a reduction in the area of potential occupancy would not occur.

- Fragment an existing population into two or more populations;

  This proposal is unlikely to fragment existing populations as habitat for this species is unlikely to be removed or habitat corridors interrupted.

- Adversely affect habitat critical to the survival of a species;

  Potential habitat has not been identified as critical habitat within the recovery plan for this species or listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act and so is unlikely to provide habitat critical to survival of this species.

- Disrupt the breeding cycle of a population;

  This proposal is very unlikely to disrupt the breeding cycle of a population. None are known from the area and should they occur in adjacent areas environmental management of the site during drilling could ensure that these potential habitat areas would be protected from the affects of run-off and sedimentation through the use of sedimentation fences and revegetation. Consequently, should the GGBF occur it is unlikely that the breeding cycle of this species would be disrupted.

- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

  This proposal is unlikely to directly impact on potential habitat and management of environmental risks would assist in the protection of this potential habitat and consequently this species is unlikely to decline due to this proposal.

- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;

  The adjacent potential habitat is likely to already contain the invasive Plague Minnow which is a known predator of tadpoles of the GGBF although it was not recorded on the day of assessment. If this invasive species is not currently present it is unlikely that this proposal would introduce it to the study area.

- Introduce disease that may cause the species to decline; or

  The fungal pathogen, Frog Chytrid Fungus, is a known threat to the GGBF. Chytrid fungus is probably transferred by direct contact between frogs and tadpoles, or through exposure to infected water. This proposal would not involve the moving of frogs or tadpoles, exposing frogs to infected water or handling of frogs in any way.

- Interfere with the recovery of the species.

  This proposal would not pose a threat to the recovery of the GGBF as potential habitat of this species would be maintained and protected through environmental management during drilling activities. Recognised threats would not be exacerbated.

The Green & Golden Bell Frog is unlikely to be impacted by this proposal due to the highly modified nature of the proposed works areas and the minimum impact this proposal is likely to have on the ecology of the study area and locality. Consequently, it is considered that a Referral to DEWHA is not required as this proposal is unlikely to be considered a controlled action.

APPENDIX 4

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
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0	070515	Issued for drilling	CB	JR	PB
REV	**DATE**	**DESCRIPTION**	**PREPARED**	**CHECKED**	**APPROVED**

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, fraccing 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, fraccing 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

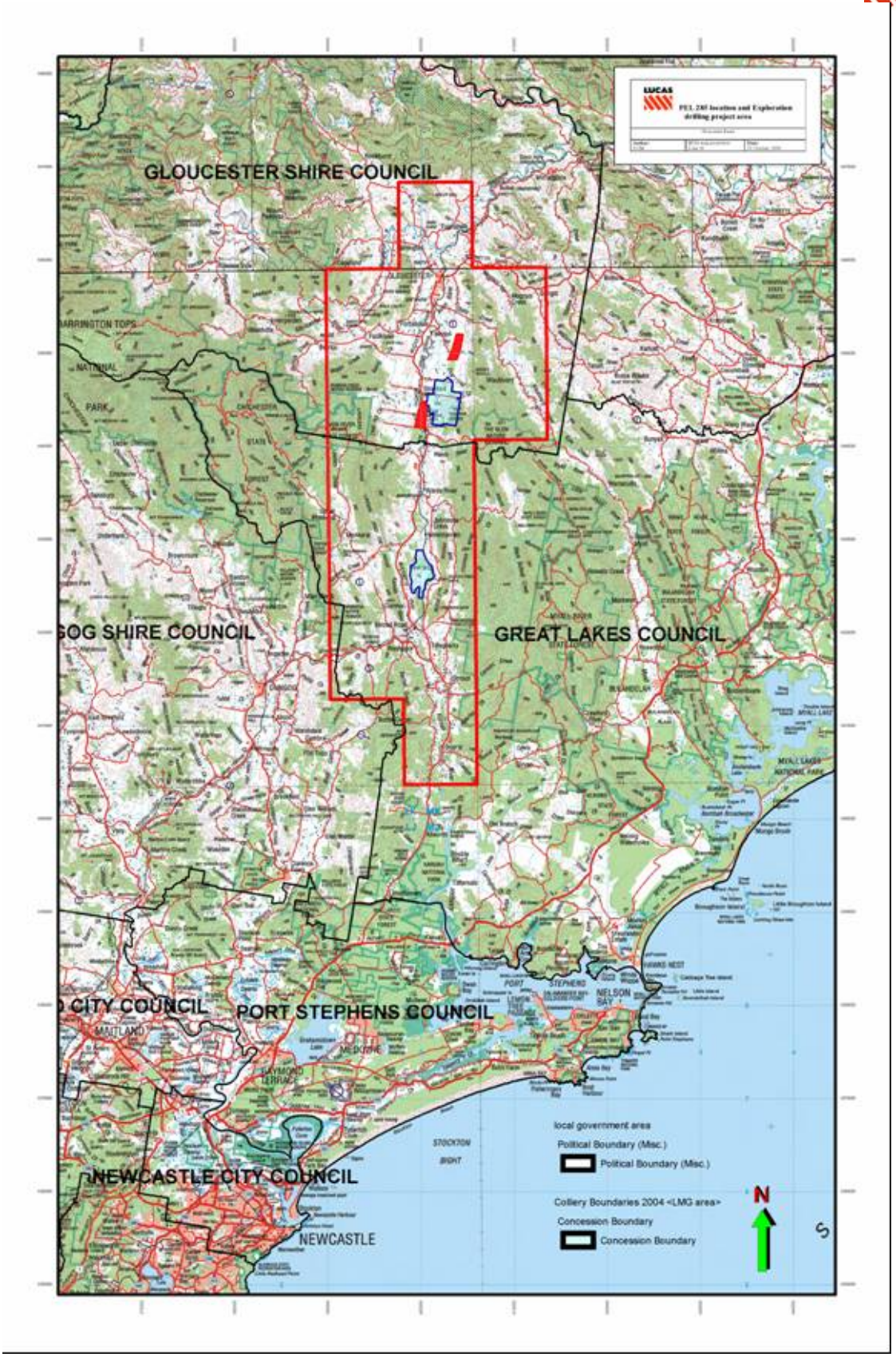

Figure 1: Project Location

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, 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 ("fraccing") 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 fraccing 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.

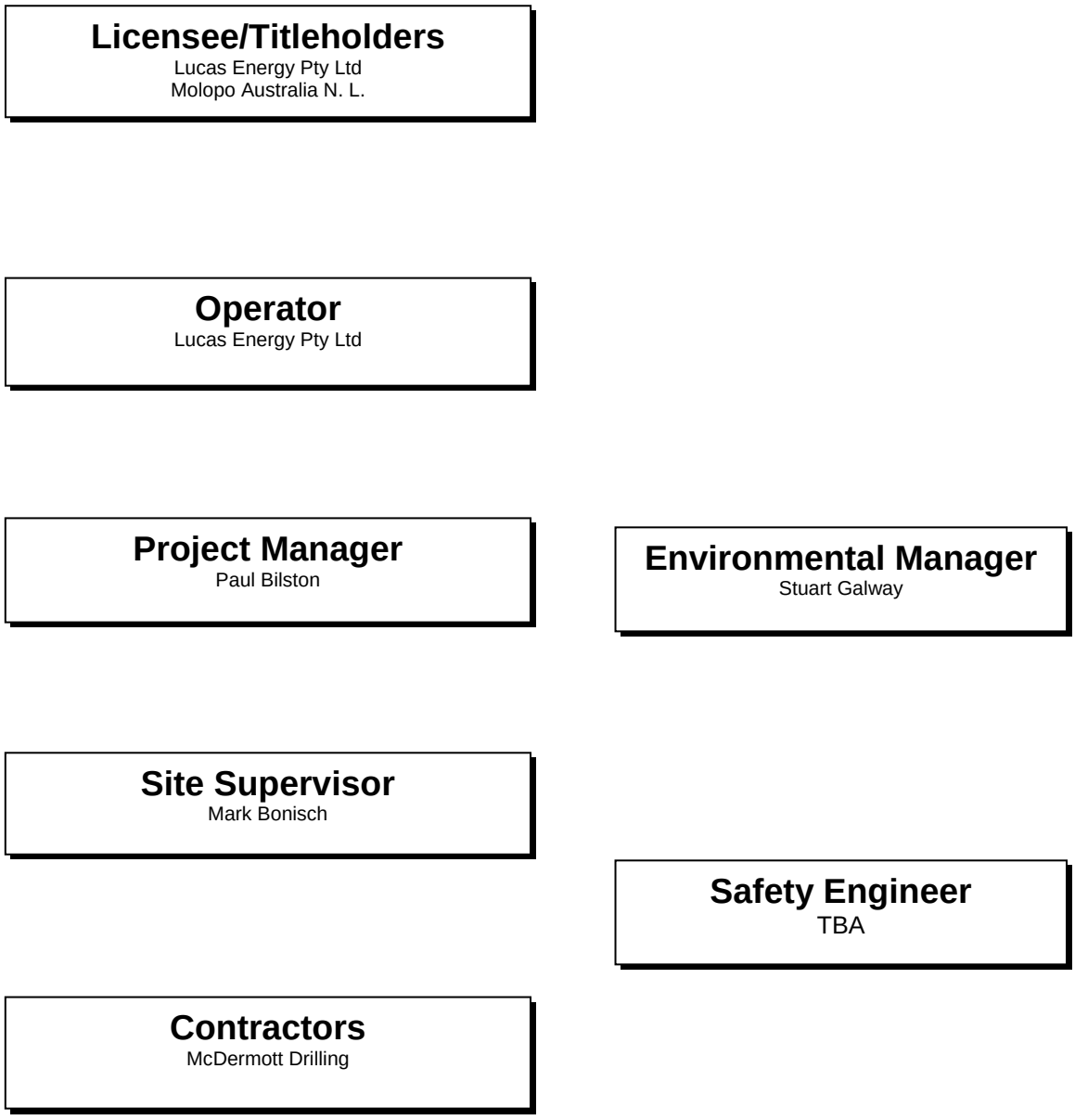

Figure 2: Project Team Structure

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	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 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	• 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, fraccing 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. • Fraccing 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	• 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.	• 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	• 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

APPENDIX 5

EXAMPLE OF CONCEPTUAL DESIGN FOR WATER STORAGES

MOLOPO AUSTRALIA NL

STRATFORD COAL SEAM METHANE PRODUCTION EVALUATION PROJECT

STORAGE PONDS CONCEPTUAL DESIGN

FINAL REPORT

August 2003
Project No. 0112-mol-001
Ref: wp/r001-b

ALLAN WATSON ASSOCIATES
Waste and Water Management Consultants

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SECTION 1.0 INTRODUCTION

1.1 BACKGROUND AND SCOPE

Molopo Australia NL (Molopo), in a joint venture with A.J Lucas Coal Technologies, proposes to carry out coal seam methane production evaluation on three wells within Petroleum Exploration Licence 285 (Gloucester). As part of the evaluation, two of the wells (LMG01 and LMG03) will be used for dewatering/pumping over the evaluation period of some 12 months. Groundwater recovered will be highly saline, and ultimately will disposed under licence. As an interim measure (i.e. during the period of production evaluation), this water will be held within a storage pond located adjacent to each well. A site layout plan showing the proposed locations of the wells and storage ponds is provided as **Figure 1**

Approvals for the coal seam methane evaluation production project is currently being sought through NSW Department of Mineral Resources (DMR). As a part of this process, a Review of Environmental Factors (REF) and an Environmental Management Plan (EMP) is to be prepared to assist in determination of the proposal.

For the purpose of preliminary planning with respect to the project, Molopo has commissioned Allan Watson Associates Pty Limited (Watson Associates) to prepare a conceptual design for the proposed storage ponds. It is understood that conceptual design details will be included as part of the REF. The specific scope of the preliminary design is as follows:

- to review climatic data for the site, relevant to the sizing of the storage ponds;
- to develop a water balance for the each pond from which risk of spill for a defined pond size can be assessed; and
- to develop operational rules/guidelines as a means of minimising the risk of spill/discharge from the ponds.

1.2 REPORT STRUCTURE

To address the scope as outlined in **Section 1.1**, this report has been structured as follows:

Section 2: summarises background data relevant to the storage ponds conceptual design,

Section 3: presents the principle basis for design of the storage ponds.

Section 4: describes the water balance/freeboard modelling undertaken and presents the results of this modelling in terms of spill risk for the defined pond size.

Section 5: outlines operating concepts relevant to the storage ponds.

Section 6: provides comment on construction related issues in relation to the ponds.

A series of figures is also attached, showing the siting and concepts for development/ construction of the storage ponds.

SECTION 2.0 BACKGROUND DATA

2.1 SITE SETTING

2.1.1 Site Location

The project site is located at Wenhams Cox Road, Eviron, approximately 4.0km east north-east of the town of Stratford.

2.1.2 Site Topography

The project site is located within the lower foothills of the Avon River valley, and comprises undulating, well drained topography. The dominant feature of the area is Dog Trap Creek, located to the south west of the site. Dog Trap Creek flows generally in a north west direction towards the Avon River. The Dog Trap Creek – Avon River confluence is located some 2.0km from LMG 01 (refer **Figure 1**).

Slopes within the site are approximately 5% for the area surrounding LMG 01 and 2.5% for the area surrounding LMG 03. Site elevation is approximately within the range RL 115m to RL 130m.

2.1.3 Climate

Rainfall

The climate of the Stratford region can be described as temperate. The average annual rainfall in the region is some 1,076 mm[1]. The distribution of this rainfall, in terms of monthly average totals is shown in **Table 1**. Rainfall is greatest during the wet season/summer months of December to March, with the highest monthly average rainfall total of 138mm in March. The driest rainfall month is August with an average monthly total of 51 mm.

Evaporation

The average annual evaporation[2] for the region is 1,076 mm. On an average monthly basis, highest evaporation occurs during the wet season/summer months, with December experiencing the highest average monthly evaporation, of 155mm. During dry season months, evaporation is significantly lower, with the lowest average monthly total of 33mm during June. **Table 1** summarises the monthly average evaporation relevant to the project site.

TABLE 1
SUMMARY OF CLIMATIC DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall (mm)													
Average Rainfall	125.1	127.3	138.7	83.1	75.7	74.2	56.3	50.5	55.1	71.7	89.3	112.3	1059.4
Evaporation (mm)													
Average Evaporation	142.6	110.2	96.1	69.0	46.5	33.0	40.3	58.9	84.0	114.7	126.0	155.0	1076.3

[1] Based on a composite record from Gloucester Post Office (Station No. 60015, period 1889 to 1962) and Craven (Longview) (Station No. 60042, period 1962 to 2002). Data from Gloucester calibrated based on comparison of annual averages between Gloucester and Craven. Data obtain from Bureau of Meteorology.
[2] Obtained from Bureau of Meteorology for Station No.61151, Chichester Dam.

2.2 EVALUATION WELLS WATER YIELDS AND QUALITY

2.2.1 Groundwater Yield

Molopo has undertaken groundwater yield modelling to estimate potential daily pumping rates. The modelling conservatively estimates the following yields:

- From commissioning of the well pumps, the yield is likely to increase rapidly, reaching a peak of some 50m^3/day after 50 days pumping.
- Between 50 days to end of evaluation period (365 days), the yield is likely to steadily reduce to a long term sustainable pumping rate of 28m^3/day.

Based on the above, a maximum total yield from each well for the 12 month evaluation period is some 13.5ML. Molopo has indicated that a more probable yield for the 12 months will be of the order of 10ML.

2.2.2 Water Quality

The quality of groundwater to be recovered from the dewatering wells (LMG01 and LMG03) is expected to be comparable to groundwater derived in the adjacent Stratford Mine pit, where it has been reported (Resource Strategies, 2001) that conductivity typically ranges between 2,400 to 12,000 micro-siemens per centimetre (µS/cm).

Further groundwater quality analyses have been undertaken by CSIRO on exploration bores within the Stratford Prospect with consistent results generally ranging from 5,200 to 11,000µS/cm, however with a single result of 21,700µS/cm. It should be noted that the water quality results from the exploration bores are likely to have been influenced by the use of drilling fluid additive potassium chloride used during construction of the bores.

The water quality as discussed above would generally necessitate disposal by evaporation and or disposed of by alternative methods (e.g. transfer to Stratford Coal Mine or disposal to a liquid disposal facility).

SECTION 3.0 STORAGE PONDS PRELIMINARY DESIGN BASIS

Based on discussions with DMR (pers.comm. DMR Officer Paul Fredericson), no specific design standards or guidelines exist in relation to the proposed storage ponds, however, there is a general expectation that the construction and operation of the ponds will be carried out in an environmentally sustainable manner using best practise techniques to minimise potential for environmental harm. Further to this input, Molopo has committed to the following conditions with respect to the storage ponds:

- Ponds are to be located within the physical confines of the site areas allocated to wells LMG01 and LMG03. The extent of these site areas is shown on **Figure 1**.
- No release of contaminated waters is to occur from the project site. Molopo proposes to manage the ponds such that the ponds do not spill during the evaluation period.
- Ponds to be lined to minimise release of saline water via seepage and to enhance stability/integrity of pond embankments.

These conditions are discussed in more detail below:

Pond Storage Capacities

Molopo has indicated that due to minimum agreed buffer distances to waterways and also the physical size of the site area allocated to each well, the maximum available footprint areas for the storage pond development are as follows:

Storage Pond for LMG 01 – 6,300 m^2 (90m x 70m)

Storage Pond for LMG 03 – 6,400 m^2 (80m x 80m)

Molopo has also indicated a desire for a minimum storage capacity for each pond of some 10ML.

Maintaining Release Conditions

To maintain a no release condition for the evaluation period, and beyond while the storage ponds remain active, a pump out/disposal mechanism will be available for excess water accumulated within the ponds. For the purpose of this concept design, it has been assumed that this mechanism will be by 20,000L tanker with a maximum of 2 loads per day removed from each pond, with this water to be disposed of at a licensed facility.

Pond Lining

Based on the expected quality of water to be contained within the storage ponds (refer **Section 2.2.2**, and to maintain/operate the pond in an environmentally responsible manner, it is considered that each storage pond comprise a low permeability liner. Based on current engineering best practices, such a liner should comprise a geomembrane of material type suitable for use under proposed conditions.

SECTION 4.0 WATER BALANCE/FREEBOARD MODELLING

4.1 MODEL DESCRIPTION

The water balance modelling has been undertaken to develop an understanding of the behaviour of the ponds subject to proposed operating conditions, as well as the prevailing climatic conditions of the site. In particular, this modelling enables an assessment of whether the ponds will operate under a net excess condition (i.e. makes water) or a net surplus conditions (i.e. loses water). Each pond has been modelled individually, based on the adopted pond configuration/geometry.

The key components of the water balance model are as follows:

- Direct precipitation onto the storage pond surface
- Seepage from the storage pond
- Evaporation from the free water surface within the pond
- Inflow of groundwater to pond as recovered from the adjacent well
- Disposal to an approved/licensed facility

The water balance model is based on the following algorithm:

$$\mathbf{Water_{in} = Water_{out} + Change\ in\ Storage}$$

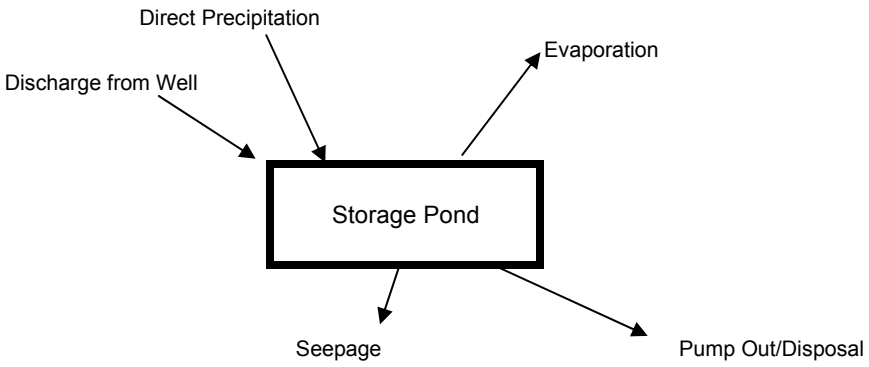


PLATE 1: WATER BALANCE PROCESS FLOW

In the context of the above components, the process diagram shown as **Plate 1** would apply. The water balance relationship that represents this process is provided below:

$$\mathbf{L + P = S + E + D + O + \Delta S}$$

where:

L = Discharge from well to storage pond

P = Direct rainfall over surface of leachate pond

S = Seepage from storage pond

E = Evaporation from pond water surface

D = Pump out/removal of pond water to an approved/licensed facility

ΔS = Change in storage within pond

4.2 MODEL ANALYSIS

The water balance model comprises a spreadsheet based, monthly time step, mass balance analysis, developed in relation to the water balance relationship as outlined in **Section 4.1.** The conditions applied within the model are described below:

Basis for Model Input

Modelling Period

The storage pond analysis is based on a finite modelling period. This period has been taken as the timeframe for well evaluation, being some 12 months.

Rainfall

No long term rainfall record for the project site is available. A long term monthly rainfall record for the site has therefore been derived as a composite of the records from nearby sites, as follows:

Station No.*	Site	Period of Record	Years of Data	Approx. Distance from Site
60015	Gloucester Post Office	1889 to 1962	73	16km
60042	Craven (Longview)	1962 to 2002	30	5.5km

* Data obtained from Bureau of Meteorology

An analysis of the derived long term record was subsequently undertaken to select data "windows" representing extreme and median conditions for the 12 month modelling period. Using a Weibull analysis (IE Aust, 1998), the following data windows were determined:

Median Condition	Year of 1921
10th Percentile Wet Condition[3]	Year of 1891
5th Percentile Wet Condition[4]	Year of 1996

For the purpose of modelling, the data sequences were assumed to commence on 1st January of the year, therefore each sequence extends from January to December.

Well Discharge

Well discharge volumes adopted for the modelling were in accordance with **Section 2.2.1**, summarised as follows:

Commissioning to Day 50	Increasing at a constant rate from $0m^3$/day to $50m^3$/day
Day 50 to Day 365 (Closure)	Decreasing at a constant rate from $50m^3$/day to $28m^3$/day.

This is equivalent to total inflow of some 13.5ML.

Evaporation

Monthly average evaporation data as presented in **Section 2.1.3** (obtained for Station No.61151, Chichester Dam) has been adopted for the analysis. Average monthly evaporation totals were utilised in the model given the limited availability of long term monthly evaporation data.

[3] Defined as the period for which 10% of equivalent duration periods within the record are wetter.
[4] Defined as the period for which 5% of equivalent duration periods within the record are wetter.

Pond Catchment Area

The pond catchment area for the pond as considered within the model was taken as the horizontal footprint projection within the embankment centreline, as follows:

Storage Pond LMG 01	3,850m^2
Storage Pond LMG 03	4,225m^2

Pond Capacity

A nominal storage capacity of 10ML for each pond has been assumed, with the pond assumed to be empty at the start of the modelling sequence. This capacity is based on containing the total expected well inflows for the 365 day evaluation period.

Seepage Losses from Pond

Based on **Section 3.0**, given that the ponds will be lined using a geomembrane, zero seepage loss is assumed for the purpose of modelling.

Pump Out/Removal of Pond Water

Pump out/removal of pond water commences by reaching a stored pond volume trigger level and then pump out occurs at a prescribed constant monthly rate. For the purpose of this model, a pump out rate for each pond of 40m^3/day (based on **Section 3.0**) has been adopted. It is noted that a trigger level has been derived as an output from the modelling for each pond, being defined as the limit at which pond overflow would occur subject to a 5th percentile wet rainfall year, whilst maintaining the defined pump out rate.

Model Outputs

The key output from the water balance analysis comprises storage pond water level over time and total pump out volume requirement (over the evaluation period). The trigger level for each pond, at which pump put would commence has also been derived as an output from the model. Model output is presented graphically as described in **Section 4.3**.

4.3 MODEL RESULTS

The storage pond analysis has been undertaken based on the conditions as outlined in **Section 4.2**. As an initial output from the modeling, a trigger level at which pump put would commence from either pond, has been determined to be equivalent to a storage volume of 7.0ML. This trigger level was adopted for all subsequent analyses.

Output from the modelling is shown on **Graphs 001** to **003** for the three rainfall sequences analysed, and based on a trigger level of 7.0ML storage, with the following data being presented:

- Rainfall adopted for the modelling period
- Total well inflow to pond
- Total rainfall to pond
- Storage pond volume (with time)
- Volume of water pumped out/removed (with time)

Summary results from the water balance analyses are presented in **Table 2**.

TABLE 2
SUMMARY RESULTS OF WATER BALANCE ANALYSES

Rainfall Sequence	Total Rainfall (mm)	Total Rainfall Inflow (ML)	Total Pump Out Volume for Modelled Period* (ML)
STORAGE POND LMG O1			
Median Condition	1,039.7	1.2	8.6
10th Percentile (Wet) Condition	1,457.9	2.8	9.8
5th Percentile (Wet) Condition	1,678.1	3.6	9.8
STORAGE POND LMG O3			
Median Condition	1,039.7	1.4	8.6
10th Percentile (Wet) Condition	1,457.9	3.1	9.8
5th Percentile (Wet) Condition	1,678.1	4.0	9.8

* Pump out volume to maintain the pond at the pond pump out trigger level, nominally 7.0ML

In summary, it is indicated that well inflow volume is the largest component of the total stored volume. On average, the contribution made by well inflow to the total pond volume is:

Median Condition	90%
10th Percentile (Wet) Condition	81%
5th Percentile (Wet) Condition	78%

The most significant outcome from the water balance modelling is that for a nominal pond volume of 10ML, the pond will operate under a net surplus condition (i.e. an excess volume of water will exist). It is noted that this is a fundamental outcome given that the nominal pond capacity is the some 3.5ML less than the assumed well inflow rate for the 12 month evaluation period. For the rainfall sequences analysed, the total excess (i.e. pump out requirement) will be of the order of 8 to 10ML. In reality, this excess confirms the need to implement a system to recover and dispose of water from the pond (as part of the pump out mechanism). Otherwise, spillage from the pond would occur.

Further to the above, it can be expected that at some stage during the 12 month duration evaluation period, the pond will reach the 7.0ML storage trigger level. Beyond that time, the mechanism for pump out and disposal will need to be maintained, providing sufficient capacity within the pond for ongoing well inflows and rainfall. The quantity of rainfall experienced over the evaluation period will define when this mechanism will need to be available. The modelling results for the 5th Percentile Wet sequence suggests that such a system should be available within a period of some 6 months following commencement of pumping.

SECTION 5.0 STORAGE PONDS OPERATION CONCEPT

The following provides broad concepts for operation of the proposed storage ponds. The basis of these concepts is to ensure the appropriate environmental performance of the ponds (related to minimising long term environmental impacts and reducing associated liabilities).

General Operating Philosophy

The general philosophy for operation of the storage ponds will be to minimise the probability of uncontrolled discharge (in the form of spill or seepage) from the ponds to the environment. The means by which this objective will be obtained are as follows:

- Implementation of effective methods for monitoring of pond water levels
- Securing an appropriate mechanism for pump out and disposal of excess water
- Defining a trigger level within the ponds at which pump out must commence (confirmed as output from the model)
- Providing for ongoing pump out and disposal in the event that the evaluation period extends beyond 12 months.

Pond Sizing

Notwithstanding the modelling outcomes as outlined in **Section 4.3**, Molopo has indicated a preference for a capacity of each pond of 10ML, with the maximum pond capacity being constrained by the limits of the available site area, the geometry of the structure to achieve a geotechnically stable configuration and an appropriate earthworks balance (in terms of excavation to filling). Based on the 10ML capacity, it is expected that the pond will operate for a minimum of six months before commencement of extraction will be required.

Monitoring Systems

Monitoring of the storage ponds is a key operating requirement, in order to identify:

(i) timing requirements for availability of a pump out and disposal system; and

(ii) timing for commencement of the pump out and disposal system.

Monitoring will be required in relation to the following:

(i) well extraction rates, with a need to undertake ongoing reviews of the water balance model to enable forward prediction with respect to the requirements for availability of the pump out and disposal system; and

(ii) pond water levels, to indicate the need for commencement of the pump out system.

Monitoring in relation to the above should be carried out on a daily basis, with review of the status of the system being undertaken weekly.

Pond Trigger Levels

Pond trigger levels, relevant to operation of the ponds can be defined as follows. The basis of these trigger levels is to identify storage water levels within which the pond must operate as a means of substantially reducing the risk of spill:

<u>Pump out Trigger Level</u>

The pump out trigger level is the level at which pump out/removal of pond water would need to commence. The pump out trigger level will ultimately be subject to the method of pump out, the rate of pump out and reliability of the system. Assuming the pump out system as proposed in the above modelling is implemented (minimum pump out rate of 40m^3/day, i.e. 2

by 20,000L tanker loads removed each day), model output results indicate that a storage trigger level of 7.0ML would apply to maintain the risk of spill at less than 5%.

Shutdown Trigger Level/Operational Freeboard

The shutdown trigger level is provided as a level at which well extraction would need to cease until such time as the water level is lowered to below the pump out trigger level. As a best practice, it is suggested that the trigger level correspond to a significant rainfall event. For the purpose of conceptual design, a 100 year Average Recurrence Interval, 72 hour duration storm has been selected as the basis for defining this level. A shutdown trigger level equivalent to a depth of 450mm below the spillway invert level has therefore been selected.

SECTION 6.0 POND CONSTRUCTION AND DECOMMISSIONING RELATED ISSUES

6.1 CONSTRUCTION ISSUES

In addition to the operational concepts as outlined in **Section 5.0**, appropriate construction of the ponds and associated works will be required to maintain the integrity of the structure. Key construction issues are as follows:

- Detailed design, supported by ground survey and geotechnical assessment of the proposed pond sites would need to be completed to confirm embankment configurations, foundation preparation requirements, and construction materials types and earthworks specifications.
- Prior to commencement of the works, sediment and erosion controls are to be installed in accordance with regulatory/best practice requirements. These works will also likely include permanent diversion of upslope clean water around the site.
- Clearing, topsoil stripping and removal of weak/compressible material should be undertaken, as a minimum, within embankment footprint areas as part of foundation preparation.
- It is proposed to construct the pond using cut to fill construction techniques. Subject to the suitability of excavated materials from within the storage area, these materials would therefore be used as embankment fill materials.
- Trimming and surface preparation will be required prior to the placement of the geomembrane liner in accordance with liner manufacturer's requirements.
- Armouring of downstream embankment batters, using rock fill or other available treatment will be required to minimise batter erosion.
- Access ramps and all-weather site access is to be maintained. This is particularly important if tankers are to be used to pump out water for removal from the ponds.
- An emergency spillway is to be provided in the event that overtopping occurs. Spillway discharge would need to directed via a controlled structure into an adjacent watercourse. It is noted that spill flows would only likely be tolerated from a regulatory perspective during a significant rainfall event, with dilution likely to reduce the environmental impact of such release.

Conceptual layout and details for construction of the ponds is shown on **Figure 001**.

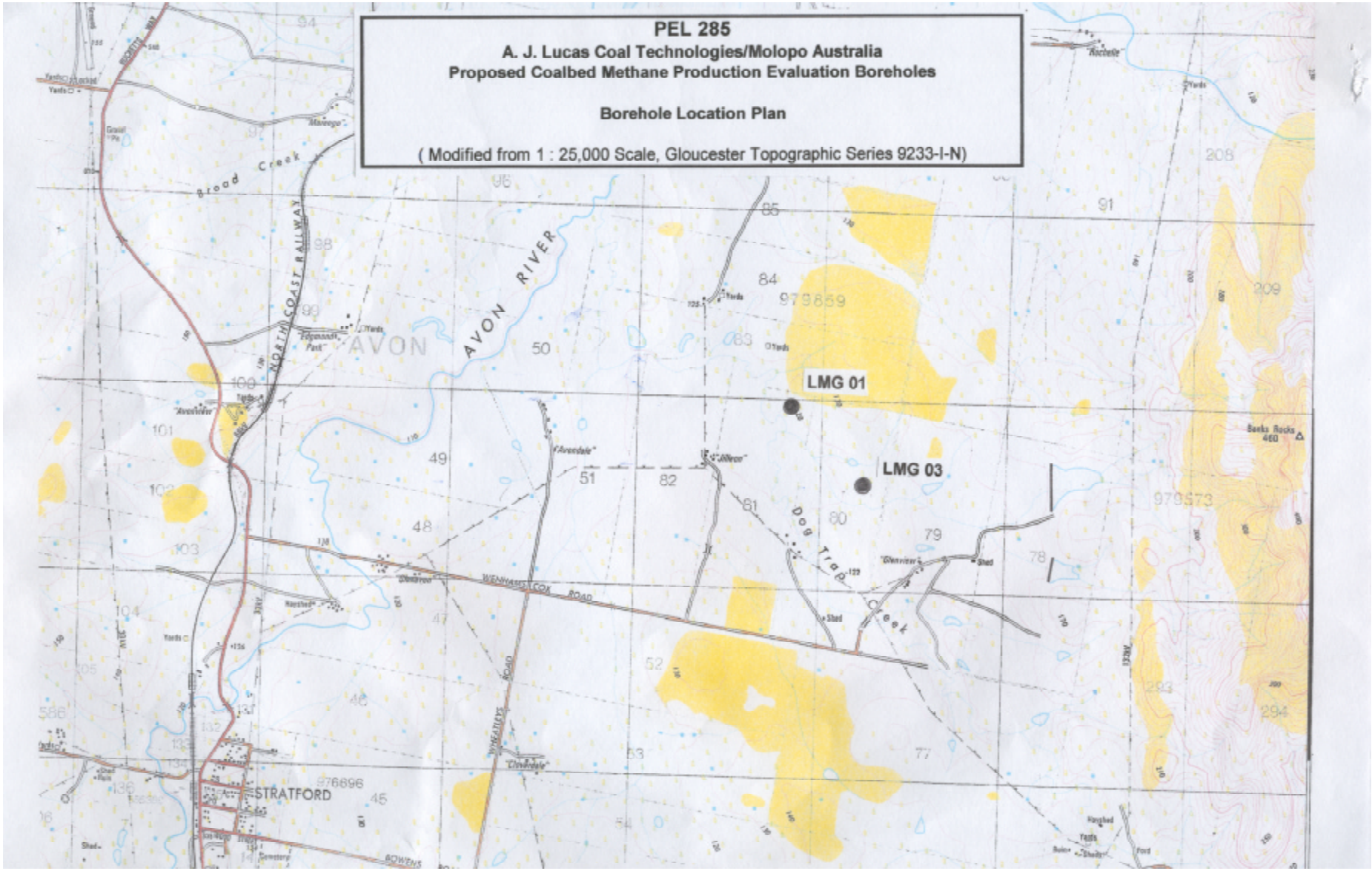
6.2 DECOMMISSIONING ISSUES

At completion of the well evaluation process, the ponds will need to be decommissioned to remove salt precipitates accumulated within the ponds. Where such solids remain, any further rainfall would mix with these precipitates, with an ongoing requirement for licensed disposal existing. Decommissioning may therefore be limited to removal and disposal of the liner.

SECTION 7.0 REFERENCES

1. CSIRO (2001), *Analytical Report Nos 03000019,02000032, 02000033, 02000034*, prepared on behalf of Pacific Power.
2. IE Aust (1998), *Australian Rainfall and Runoff - Volume 1*.
3. Resource Strategies (2001), *Bowen's Road Environmental Impact Statement*, prepared on behalf of Stratford Coal.

FIGURES



ALLAN WATSON ASSOCIATES Waste and Water Management Consultants ABN 24 081 272 406 PO Box 46 Ashgrove QLD 4060 PH (07) 3366 6588 FAX (07) 3366 2413	DESIGNED	SCALE N.T.S.	CLIENT **MOLOPO AUSTRALIA NL**	JOB NUMBER 0112–MOL–001
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	CHECKED ASW	SHEET SIZE A4		
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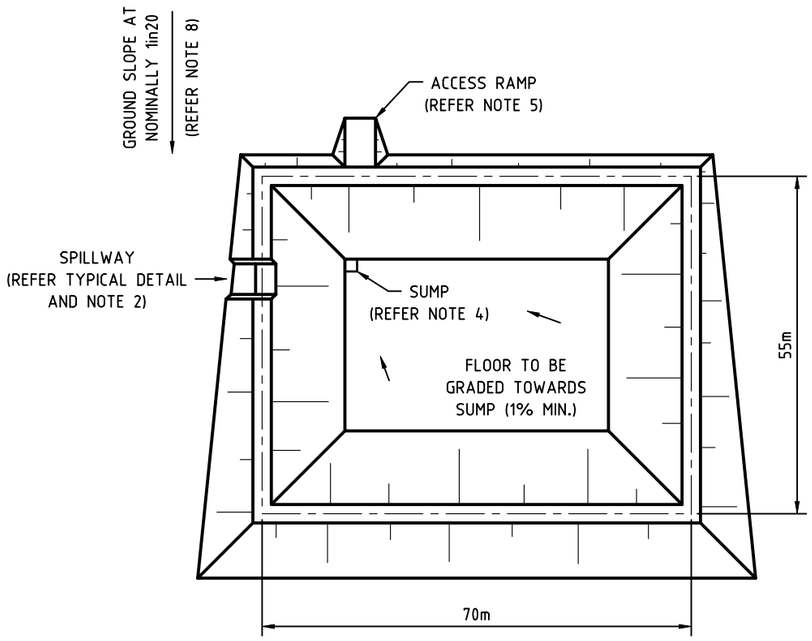
	DATE AUG. 2003	ISSUE REVIEW		REV



PLAN - STORAGE POND (LMG01)

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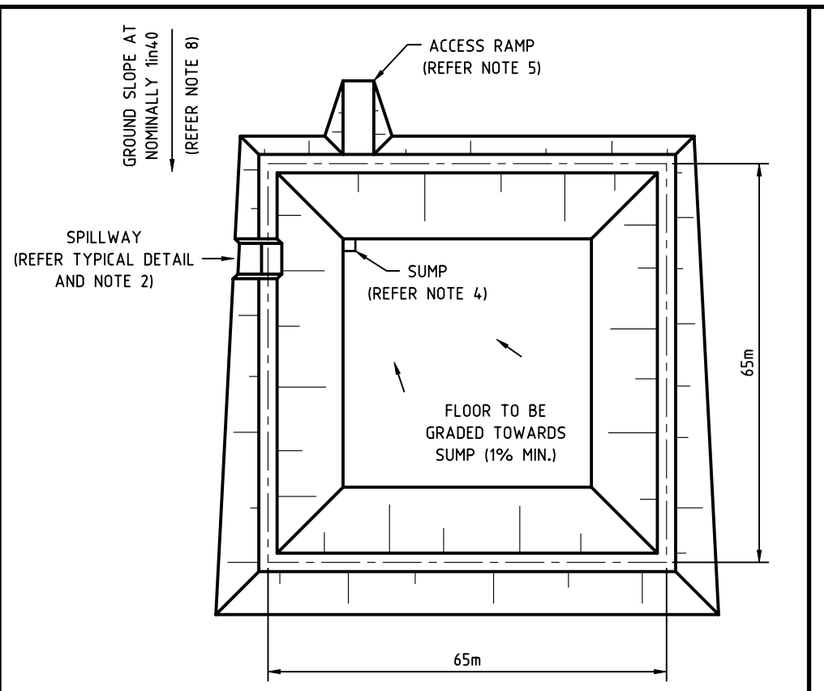
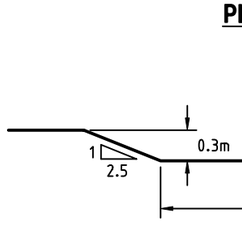


PLAN - STORAGE POND (LMG03)

SCALE 1:1000

NOTES:

1. EARTHWORKS CONSTRUCTION TO BE BY CUT TO FILL METHODS. GROUND SURFACE LEVELS WITHIN POND ARE TO BE DETERMINED IN CONJUNCTION WITH DETAILED DESIGN TO CONFIRM EMBANKMENT CREST AND POND FLOOR LEVELS TO ACHIEVE MINIMUM POND CAPACITY OF 10ML.
2. SPILLWAY TO BE ARMOURED USING SELECT ROCK FILL PLACED OVER GEOFABRIC.
3. SURFACE PREPARATION TO BE IN ACCORDANCE WITH MANUFACTURERS REQUIREMENTS FOR THE PLACEMENT OF GEOMEMBRANE LINER.
4. SUMP TO BE PROVIDED TO ALLOW PUMPING OUT OF POND. MINIMUM DIMENSIONS 0.6m DEEP x 2.0m x 2.0m.
5. ACCESS RAMP TO BE PROVIDED AS REQUIRED AND TO BE CONSTRUCTED USING CLAYFILL WITH ROCK ARMOURING (MAXIMUM SLOPE 10h to 1v).
6. EROSION AND SEDIMENT CONTROL FOR CONSTRUCTION TO BE IN ACCORDANCE WITH REGULATORY REQUIREMENTS.
7. SECURITY / SAFETY FENCING AROUND POND PERIMETER TO BE PROVIDED IN ACCORDANCE WITH REGULATORY REQUIREMENTS.
8. APPROXIMATE SLOPE INTERPRETED FROM 1:25000 GLOUCESTER TOPOGRAPHIC SERIES.
9. MATERIALS DEFINITIONS AND SOURCES:
   CLAY FILL - TO COMPRISE A FINE GRAINED COHESIVE MATERIAL WITH LESS THAN 25% BY VOLUME OF PARTICLES GREATER THAN 25mm. CLAY FILL TO BE SOURCED FROM WITHIN THE POND STORAGE AREA.
   ROCK ARMOURING - TO COMPRISE STRONG ROCK MATERIAL, WELL GRADED WITH A MAXIMUM PARTICLE SIZE OF 300mm.



TYPICAL SPILLWAY CROSS SECTION

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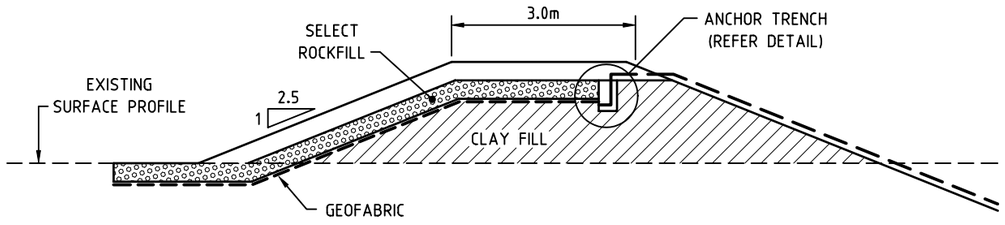

TYPICAL SPILLWAY LONG SECTION

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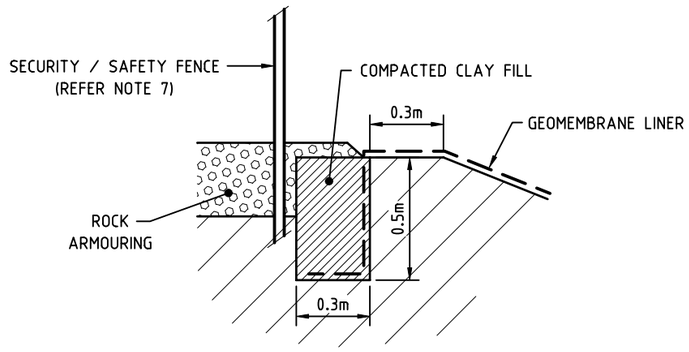

TYPICAL ANCHOR TRENCH

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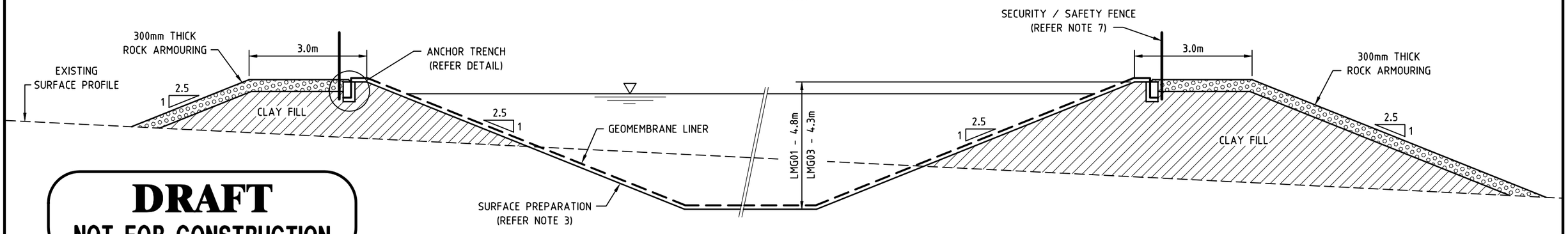

TYPICAL STORAGE POND SECTION

N.T.S.

DRAFT
NOT FOR CONSTRUCTION

REV	DESCRIPTION	DATE	APPROVED
A	REVIEW	14-08-03	ASW

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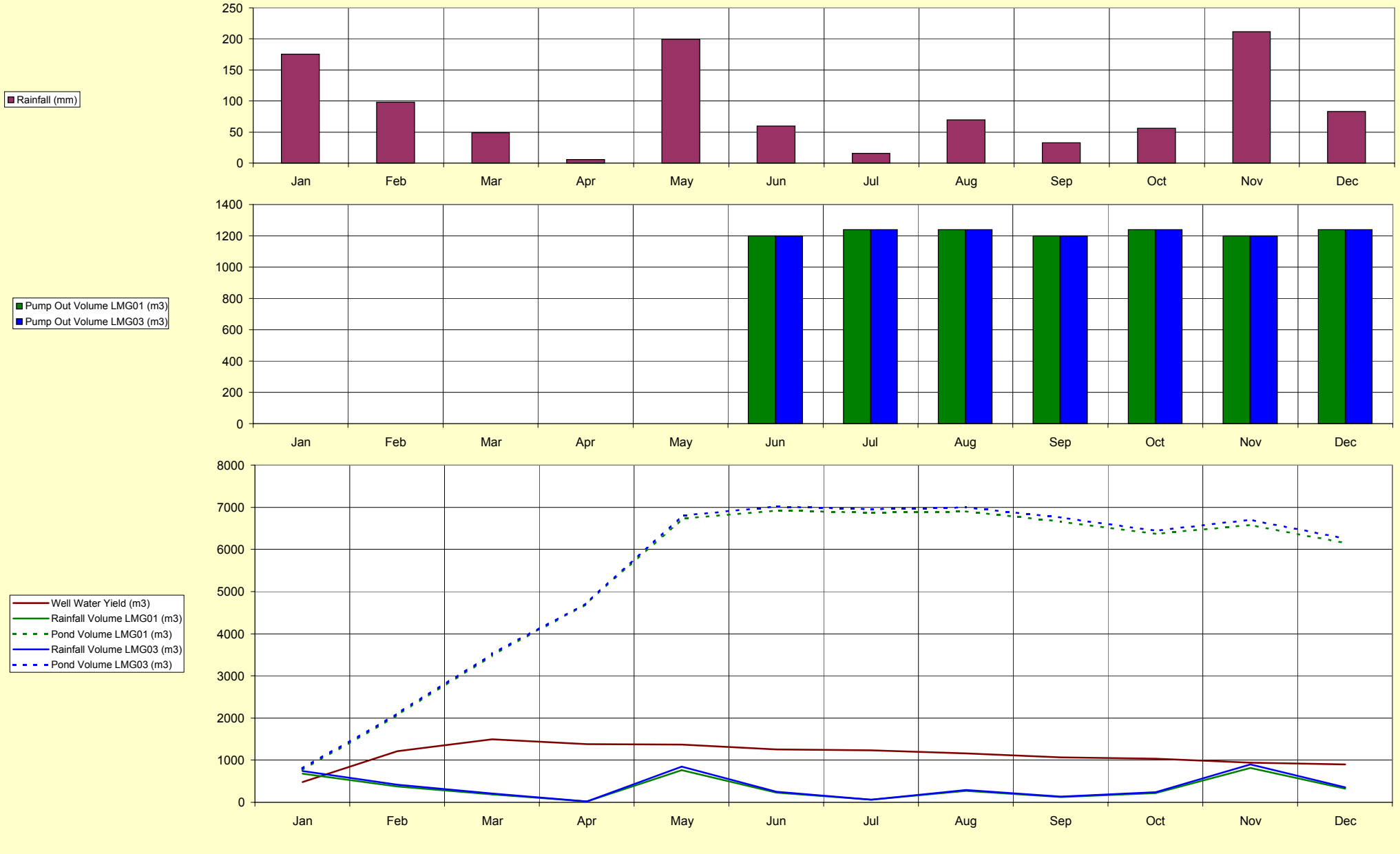
DRAWN: RJS	LEVEL DATUM:	PROJECT: STRATFORD COAL SEAM METHANE EVALUATION WELLS	DRAWING: 002
CHECKED: ASW	SHEET SIZE: A3		
APPROVED:	CAD FILE: 0112-MOL-001-002A	TITLE: STORAGE PONDS - CONCEPT LAYOUTS AND TYPICAL DETAILS	REV: A
DATE: AUG. 2003	ISSUE: REVIEW		

GRAPHS



REV	DESCRIPTION	DATE	APPROVED

ALLAN WATSON ASSOCIATES
Waste and Water Management Consultants
ACN 081 272 407

PREPARED BY: RJH	CHECKED BY: ASW
PROJECT NO: 0112-MOL-001	
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CLIENT: MOLOPO AUSTRALIA NL	
PROJECT: STRATFORD COAL SEAM METHANE EVALUATION WELLS	
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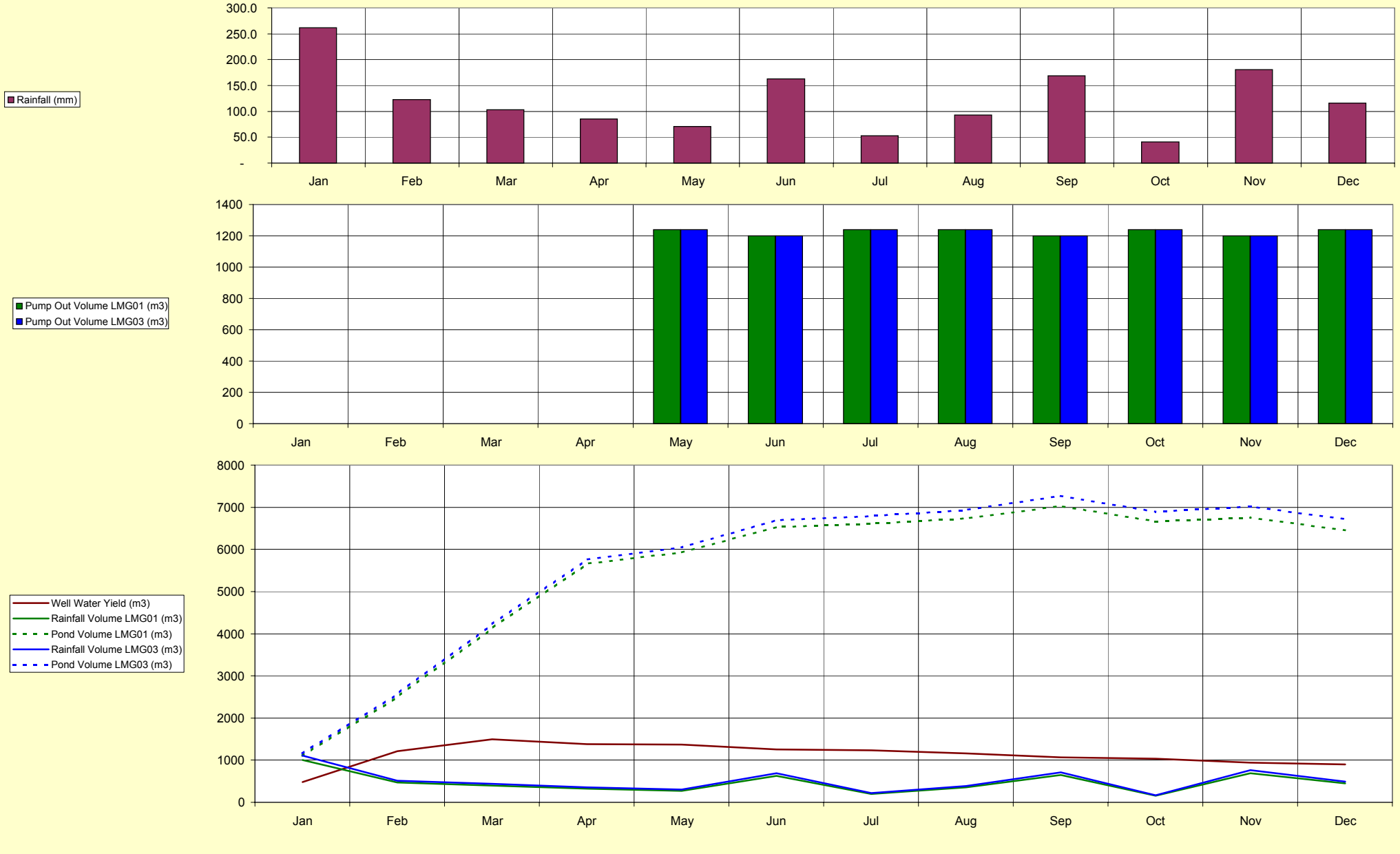
REV:	DATE: Jul-03



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ALLAN WATSON ASSOCIATES
Waste and Water Management Consultants
ACN 081 272 407

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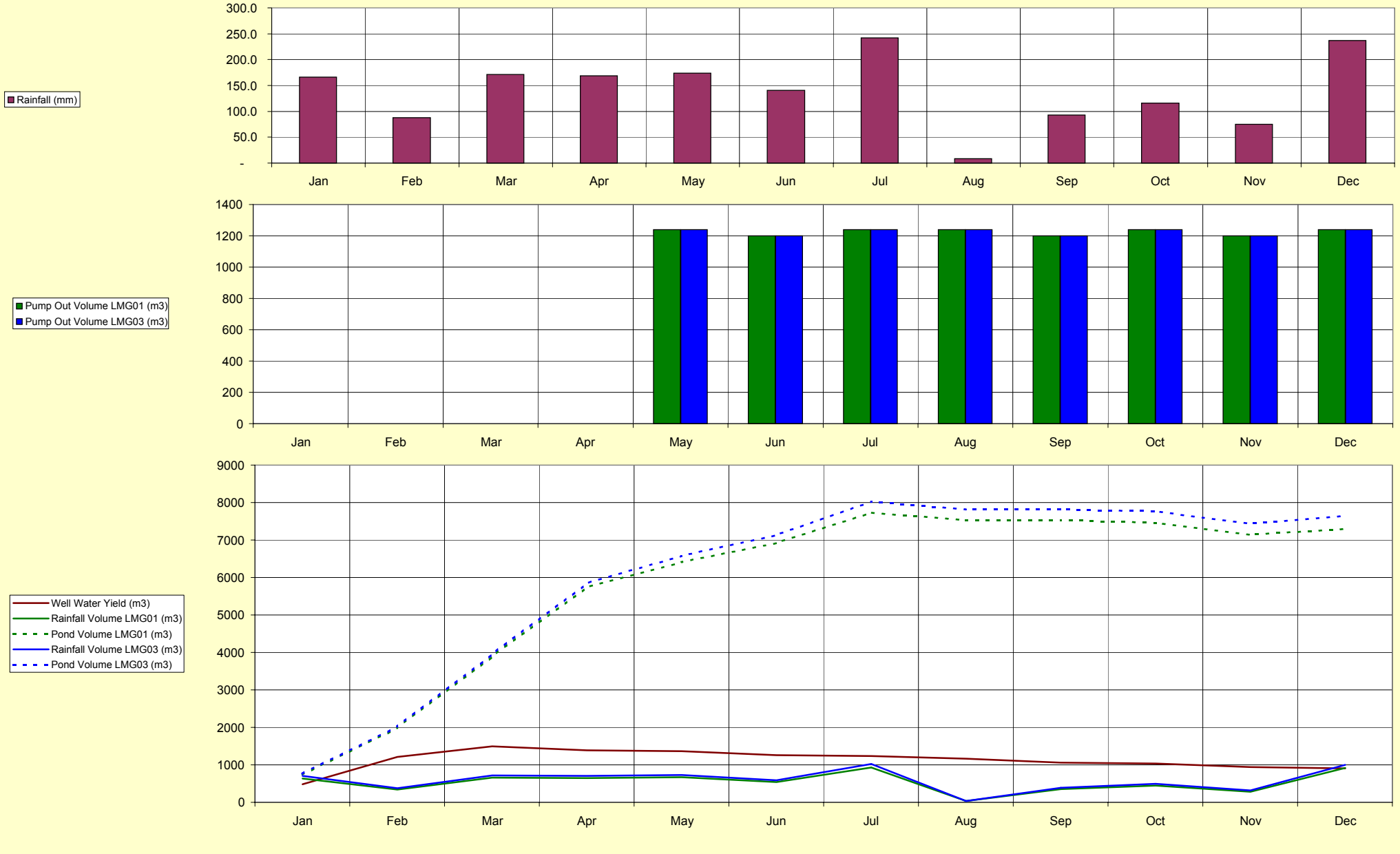
FILE/SOURCE: D:\2002 Jobs\0102-mOL\001\excel\WATER_BALANCE.xls		TITLE: WATER BALANCE RESULTS - 10 PERCENTILE (WET) RAINFALL SEQUENCE	REV: / DATE: Jul-03



REV	DESCRIPTION	DATE	APPROVED

ALLAN WATSON ASSOCIATES
Waste and Water Management Consultants
ACN 081 272 407

PREPARED BY: RJH	CHECKED BY: ASW	CLIENT: MOLOPO AUSTRALIA NL	GRAPH NO: 03
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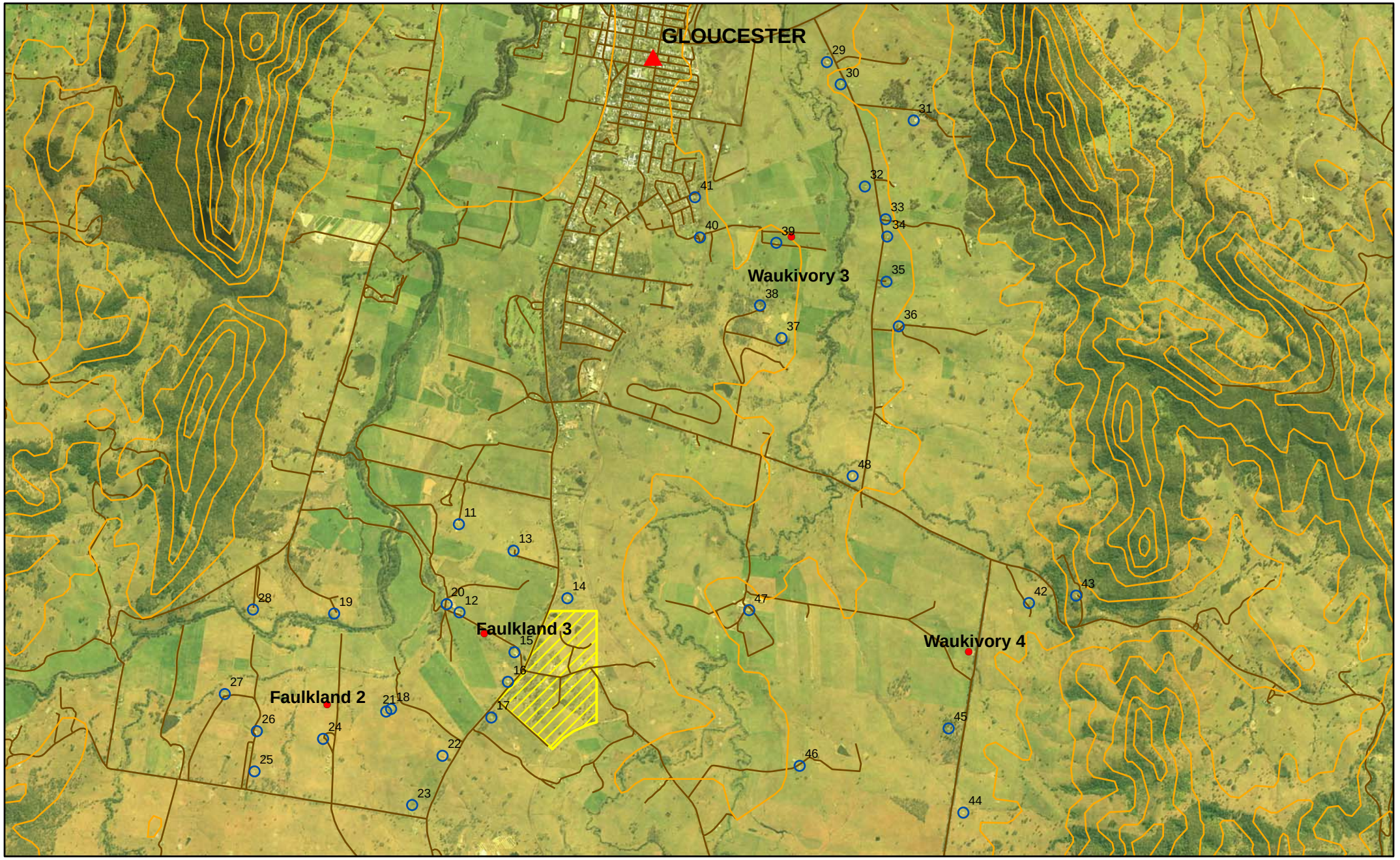
APPENDIX 6

SENSITIVE RECEPTOR LOCATIONS & POTENTIAL NOISE IMPACTS



LUCAS ENERGY

Proposed Well Locations and Sensitive Receptors

0 0.5 1 2

Kilometers

N

- Proposed Borholes
- Sensitive Receptors
- Localities
- Contours_50m
- Roads
- Rural 1C Sub-Division

LUCAS ENERGY

Proposed Well Locations and Sensitive Receptors

0 0.5 1 2

Kilometers

N

- Proposed Borholes
- Sensitive Receptors
- Localities
- Contours_50m
- Roads

As noted in Section 4.4, a criteria level of 50 dB(A) – applied during modelling – is considered overly conservative, with daytime background noise (in an environment characterised by mine and farming operations and through traffic) considered closer to 40 dB(A). Almost all potential exceedances predicted by modelling fall below the resulting criteria level of 60 dB(A).

The following legend applies to tables in this Appendix:

Noise potentially greater than conservative 50 dB(A) criteria	Noise potentially greater than 60 dB(A)

New draft construction noise guidelines have recently been published by DECC[1], which remove arbitrary noise threshold criteria levels, focusing instead on achieving desired environmental outcomes by undertaking all reasonable and feasible work practices.

As these guidelines remain in draft form, this Appendix details the results of modelling in relation to the current Construction Noise Guidelines (formerly Chapter 171 of the Environmental Noise Control Manual (ENCM, EPA 1994)). However, Lucas aims to conduct its operations in accordance with international best practice, and as such endeavours to address potential noise impacts by employing all reasonable and feasible means of prevention and mitigation. Community consultation continues to be an important aspect of all Lucas' activities.

A6.1 FAULKLAND 2

The residence potentially most severely impacted by temporary fraccing noise at Faulkland 2 is number 24. This property is owned by the landholder with whom Lucas has an agreement for the construction of the borehole on the property. Lucas also propose to consult directly with landholders of properties 21 and 26 regarding the potential noise during short-duration fraccing activities.

Table A6-1: Sensitive receptors and modeled noise levels – Faulkland 2

Residence[1]	Distance[2] (m)	Construction		Fraccing		Operation[3]	
		Estimated	Criteria[4]	Estimated	Criteria[4]	Estimated	Criteria[4]
19	740	45	50	59	50	25	35
20	1300	Hayshed – not a sensitive receptor					
21	490	49	50	62	50	36	35
22	1040	42	50	56	50	27	35
23	1090	42	50	56	50	26	35
24	250	55	50	69	50	38	35
25	810	46	50	59	50	28	35
26	620	47	50	61	50	32	35
27	830	43	50	57	50	26	35
28	990	42	50	55	50	19	35

1. See maps
2. Distance between sensitive receptor and borehole
3. Maximum wind - represents loudest operational conditions
4. Adopting a conservative background noise level of 30 dB(A)
5. All values dB(A)

1 *New South Wales Construction Noise Guidelines (Draft for Consultation)*, August 2008. Department of Environment and Climate Change (DECC). http://www.environment.nsw.gov.au/noise/constructnoise.htm

A6.2 WAUKIVORY 3

Table A6-2 shows that there are no significant noise exceedances expected at Waukivory 3 during construction or operation of the proposed borehole. All but one of the potential noise exceedances from fraccing are within the threshold of 60 dB(A). There is the possibility of a very minor exceedance of this threshold at one property (number 38), with whom Lucas propose to consult directly.

Table A6-2: Sensitive receptors and modelled noise levels – Waukivory 3

Residence[1]	Distance[2] (m)	Construction		Fraccing		Operation[3]	
		Estimated	Criteria[4]	Estimated	Criteria[4]	Estimated	Criteria[4]
29	1470	38	50	52	50	20	35
30	1320	39	50	53	50	20	35
31	1390	38	50	52	50	21	35
32	730	46	50	59	50	29	35
33	790	45	50	59	50	30	35
34	780	45	50	59	50	30	35
35	870	44	50	58	50	29	35
36	1150	40	50	54	50	24	35
37	840	45	50	59	50	31	35
38	630	47	50	61	50	29	35
39	Hayshed – not a sensitive receptor						
40	760	45	50	59	50	23	35
41	850	45	50	59	50	18	35

1. See maps
2. Distance between sensitive receptor and borehole
3. Maximum wind - represents loudest operational conditions
4. Adopting a conservative background noise level of 30 dB(A)
5. All values dB(A)

A6.3 WAUKIVORY 4

Table A6-3: Sensitive receptors and modelled noise levels – Waukivory 4

Residence[1]	Distance[2] (m)	Construction		Fraccing		Operation[3]	
		Estimated	Criteria[4]	Estimated	Criteria[4]	Estimated	Criteria[4]
42	650	38	50	52	50	27	35
43	1000	37	50	51	50	25	35
44	1330	34	50	48	50	23	35
45	660	46	50	60	50	34	35
46	1700	36	50	50	50	20	35
47	1850	35	50	49	50	19	35
48	1760	34	50	48	50	14	35

1. See maps
2. Distance between sensitive receptor and borehole
3. Maximum wind - represents loudest operational conditions
4. Adopting a conservative background noise level of 30 dB(A)
5. All values dB(A)

A6.4 STRATFORD 7

Table A6-4: Sensitive receptors and modelled noise levels – Stratford 7

Residence[1]	Distance[2] (m)	Construction		Fraccing		Operation[3]	
		Estimated	Criteria[4]	Estimated	Criteria[4]	Estimated	Criteria[4]
49	1670	34	50	48	50	18	35
50	1060	40	50	53	50	24	35
51	1170	33	50	47	50	23	35
52	1690	32	50	46	50	19	35
53	1880	32	50	46	50	19	35
54	1770	34	50	47	50	22	35
55	1000	40	50	54	50	20	35

1. See maps
2. Distance between sensitive receptor and borehole
3. Maximum wind - represents loudest operational conditions
4. Adopting a conservative background noise level of 30 dB(A)
5. All values dB(A)

A6.5 STRATFORD 10

Table A6-5: Sensitive receptors and modelled noise levels – Stratford 10

Residence[1]	Distance[2] (m)	Construction		Fraccing		Operation[3]	
		Estimated	Criteria[4]	Estimated	Criteria[4]	Estimated	Criteria[4]
56	950	40	50	54	50	19	35
57	1200	38	50	52	50	20	35
58	1820	33	50	47	50	16	35
59	1300	37	50	50	50	22	35
60	1260	38	50	51	50	24	35
61	1120	39	50	53	50	24	35

1. See maps
2. Distance between sensitive receptor and borehole
3. Maximum wind - represents loudest operational conditions
4. Adopting a conservative background noise level of 30 dB(A)
5. All values dB(A)