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Review of Environmental Factors

Proposed Exploration Wells, Waukivory

Prepared for AGL Upstream Investments Pty Ltd | March 2011

Proposed Exploration Wells, Waukivory

Final

Prepared for AGL Upstream Investments Pty Ltd | 31 March 2011

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Table of Contents

Table of Contents *(Cont'd)*

Table of Contents

Table of Contents

Tables

Tables

Figures

Appendices

Submission of Environmental Assessment

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

Environmental Assessment prepared by:	
Name	Duncan Peake
Qualifications	BSc (Hons)
Address	EMGA Mitchell McLennan Pty Limited PO Box 21 St Leonards NSW 1590
Certification	I certify that I have prepared the contents of this document and to the best of my knowledge: It is accordance with the requirements of Part 5 of the *Environmental Planning and Assessment Act 1979*; It contains all available information that is relevant to the environmental impact assessment of the development to which it relates; and The information contained in the document is neither false nor misleading.
Signature	
Name	Duncan Peake
Date	31-03-11

In respect of:

Project to which Part 5 applies	
Applicant Name	AGL Upstream Investments Pty Ltd
Contact	Toni Laurie
Phone	02 6558 1139
Address	22 Tate Street, Gloucester, NSW 2422
Land to be developed	Lot 11 DP 841445, Lot 251 DP 785579
Proposed development	Coal seam gas exploration drilling
Environmental assessment	A review of environmental factors is attached
Signature	
Name	Toni Laurie
Date	31-03-11

1 Introduction

1.1 Purpose of the REF

This Review of Environmental Factors (REF) has been prepared by EMGA Mitchell McLennan Pty Ltd (EMM) on behalf of AGL Upstream Investments Pty Ltd (hereafter AGL) for four proposed exploration wells and one groundwater deep monitoring piezometer near Gloucester in the Hunter Valley. The proposed four exploration wells would be drilled on two properties to the south-east of Gloucester to investigate the potential for coal seam gas (CSG) resource in accordance with the requirements of Petroleum Exploration Licence No. 285 (PEL 285). PEL 285 is shown in Figure 1.1.

For the purposes of the REF the four proposed exploration wells are identified as:

- Waukivory 11 (WK 11);
- Waukivory 12 (WK 12);
- Waukivory 13 (WK 13); and
- Waukivory 14 (WK 14).

WK 11 and 13 and the monitoring piezometer would be located on one property, while WK 12 and 14 would be on the other property. The monitoring piezometer is identified as WMB05 (this would be the fifth dedicated monitoring bore in this area). A map of the location of the four proposed exploration wells and approximate location of the monitoring piezometer is presented in Figure 1.2.

PEL 285 is located within the local government areas of Great Lakes, Dungog and Gloucester as identified in Figure 1.1. In accordance with the licence conditions issued for PEL 285 under Part 3 of the NSW *Petroleum (Onshore) Act 1991*, exploration wells are classified as a Category 3 activity. A Category 3 activity requires the licence holder to notify the NSW Department of Industry and Investment (DII) of that activity, and in most circumstances, submit an assessment of the activity in accordance with Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The REF describes the proposal, documents the potential impacts, and details protective measures to be implemented. It has been prepared pursuant to section 111 of the EP&A Act and clause 228 of the NSW *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). Other relevant legislation has also been considered, including but not limited to the NSW *Threatened Species Conservation Act 1995* (TSC Act), NSW *National Parks and Wildlife Act 1974* (NPW Act), NSW *Protection of the Environment Operations Act 1997* (POEO Act) and the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In doing so, the REF fulfils the requirements of section 111 of the EP&A Act, so that the responsible consent authority, in this case the DII can examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity in determining the proposal.

1.2 Site description

As described above, the proposed four exploration wells and monitoring piezometer would be located on two properties. The proposed exploration wells WK 11 and WK 13 are proposed on Lot 11 DP 841445, 20 Grantham Road, in the locality of Forbesdale, while WK 12 and WK 14 are on Lot 251 DP 785579, 197 Fairbairns Road in the locality of Forbesdale. The monitoring piezometer is located on Lot 11 DP 841445.

The proposed exploration wells are all located to the east of Fairbairns Road, which is approximately six kilometres (km) south of Gloucester town centre.

1.3 Zoning

Within the Gloucester Local Environmental Plan (LEP) 2010 the subject lots are zone E3 Environmental Management. The objectives of the E3 zone are:

- to protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values;
- to provide for a limited range of development that does not have an adverse effect on those values; and
- to conserve biological diversity and native vegetation corridors, and their scenic qualities, in a rural setting.

An assessment of the ecological and biodiversity impacts is presented in Section 5 which identifies that the proposed exploration wells and monitoring piezometer would not have a long term significant impact on the environment. It is considered that the subject sites are zoned E3 Environmental Management due to the environmental as well as the scenic qualities of the location. There is a significant ridgeline to the east of the subject lots. The proposed works are not expected to have any significant impact upon the scenic qualities of the area. All works are for exploration purposes and are short term in nature.

Under the provisions of the Gloucester LEP extractive industry is technically prohibited in the E3 zone, however, the provisions of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (hereafter Mining SEPP) for petroleum exploration override the LEP provisions. Under the Mining SEPP the proposed exploration wells are permitted without consent, although an REF is required due to the proposed activity being subject to Part 5 of the EP&A Act, in accordance with the requirements of the PEL.

1.4 Ownership

The eastern parcel, Lot 251 DP 785579 is currently owned by Waukivory Road Pty Ltd a subsidiary of Gloucester Resources Ltd, while the western parcel Lot 11 DP 841445 is owned by an individual landholder. Access to the lots and landholders permission to undertake the proposed works has been negotiated by AGL.

1.5 Overview of PEL 285

PEL 285 was granted in 1992 under the NSW *Petroleum (Onshore) Act 1991*. In 2008, AGL Energy acquired PEL 285 from the Lucas Energy and Molopo Joint Venture to become the sole operator. The licence enables investigation of the exploration of petroleum within the licence area (refer to Figure 1.1.). The Lucas-Molopo Joint Venture conducted a number of exploration activities which provide important background material to the present activities within the PEL.

1.6 Previous exploration activities

Exploration activities within the Gloucester Basin have been occurring since the early 1970s, when Noranda Australia Ltd drilled over 300 wells in the Gloucester Basin in search of open cut coal deposits. From 1977 to 1983, BMI Mining Pty Ltd (BMI) and Esso Australia Pty Ltd (Esso) drilled approximately 990 open cut coal exploration holes in the basin. BMI and Esso also drilled four deep fully cored stratigraphic

holes in the north of the basin in relation to CSG exploration activities. Three separate dedicated CSG drilling programs were also undertaken nearby by Pacific Power near Stratford in 1993, 1997 and 1999.

In 2004, the Lucas-Molopo Joint Venture drilled the first dedicated production evaluation wells within PEL 285 near Stratford (LMG 01-03). LMG03 was subsequently hydraulic fracture stimulated and production tested. LMG 01 and LMG02 are a surface to in-seam (SIS) completion pair currently capped and suspended.

In 2005, the Lucas-Molopo Joint Venture drilled a second set of dedicated CSG evaluation wells in the vicinity of Stratford (LMGW01 and LMGC01). These holes were fully cored and tested. In 2006 the Joint Venture lodged an REF to drill a further four exploration wells near Stratford (LMG04, LMGW02, LMGC02 and LMGC03).

In 2007, the Lucas-Molopo Joint Venture drilled five exploration wells throughout the Gloucester Basin. These were Weismantel (LMGWL03), Weismantel 2 (LMGWL02), Craven 1 (LMGC10), Waukivory (LMGW03), and Faulkland 1 (LMG10). Waukivory 1, located in the vicinity to the proposed WK 11, was cored.

The Lucas-Molopo Joint Venture established a pilot project for production evaluation testing in 2008 from several wells in the Stratford area, including LMG04, LMG08, LMG05, LMG06 and Stratford 9. The pilot included drilling, hydraulic fracture stimulation and production testing activities. In late 2008 the Joint Venture drilled additional pilot production wells Stratford 7, Stratford 10, Waukivory 3, Craven 6 and Faulkland 3. All wells were subsequently perforated and hydraulically fracture stimulated.

In relation to the proposed activities, Waukivory 1 and Faulkland 3 are in close proximity to the four proposed exploration wells as identified in Figure 1.2. Information from the REFs prepared as part of these wells has been used in this assessment. It should also be noted that these exploration wells are still used for testing purposes, and some are currently at the production testing stage.

1.7 Gloucester Gas Project

Planning approval of the Gloucester Gas Project[1] (GGP) was approved by the Planning Assessment Commission (PAC) in February 2011 under Part 3A of the EP&A Act. A number of environmental investigations were undertaken as part of this project and have been used as background material for this REF. In addition, exploration wells within the GGP are not covered by the Part 3A approval and as such are required to be considered under Part 5 of the EP&A Act.

The GGP is approximately 100 km north of Newcastle and is situated within PEL 285. The GGP primarily involves four integrated components:

- Gas Field Development Area (GFDA) – development of producing wells and associated infrastructure within the Concept Area and Stage 1 GFDA;
- Central Processing Facility (CPF) – compression of gas up to 30PJ per year with an 80 TJ/day average, water treatment facility including associated storage and evaporation ponds, small scale ancillary power generation facility, and other ancillary infrastructure;

[1] The Gloucester Gas Project is also the common name given to PEL 285.

- Gas Transmission Pipeline (GTP) – high pressure gas pipeline from Stratford to Hexham; and
- Hexham Delivery Station (HDS) - custody transfer point for CSG from the pipeline to the Sydney Newcastle trunk pipeline.

Approval has been granted by the NSW PAC for:

- up to 110 well site locations within the Stage 1 GFDA of the Concept Area, including access roads, gas and water gathering system and other associated infrastructure;
- construction and operation of the CPF (up to 30 PJ per year with an average of 80 TJ per day) including a water treatment facility, storage ponds and an evaporation pond, 15 MW ancillary power generation facility and associated infrastructure within the Stage 1 GFDA;
- construction and operation of the gas pipeline from the CPF at Stratford to Hexham; and
- Hexham Delivery Station to transfer gas to market.

Gas from the GGP would produce at 20 to 30 PJ per annum, which is more than 10% of the existing NSW market. This represents the additional gas demand growth projected for the underlying NSW gas market over the next three to four years (excluding fuel for power generation). CSG from the GGP would be delivered into the existing NSW gas market through the pipeline connection into the existing Newcastle/Sydney gas network at Hexham.

1.8 Overview of proposed exploration activities

The proposed exploration activity involves the drilling of four new exploration wells with regard to CSG testing and exploration activities in accordance with the requirements of PEL 285. As previously mentioned the exploration wells have been identified as WK 11, WK 12, WK 13 and WK 14.

The proposed groundwater monitoring piezometer would be drilled under a water bore licence but this REF addresses the environmental assessment of the disturbed area in the vicinity of the proposed drill site.

All proposed activities are located on privately owned (freehold) land in cleared grazing paddocks. Landholder consent has been obtained for the two lots identified for the four exploration wells and monitoring piezometer. It is proposed that drilling would be conducted on a 24 hour basis for all five wells. The work is expected to be completed over a period of approximately one to three weeks at each well location.

The drilling activity would be conducted on a constructed pad with an area of approximately 70 m x 60 m. With ancillary equipment the pad could be an area of up to 100 m x 100 m, dependent upon identified site constraints. A mounted drilling rig and associated ancillary equipment would be required to access the site and would be used within the pad. The depth of the four exploration wells is expected to up to approximately 1 km, while the depth of the monitoring piezometer may be up to 300 m.

Access to the constructed pads would be via council maintained roads and existing private access tracks within the subject properties where possible. Some new access tracks are likely to be required for WK 12, WK 13 and WK 14 to enable equipment to be moved across the existing grazing paddocks between well surface locations. An access track is required for WK 11 off the council maintained road (Fairbairns Road) as identified in Figure 1.2. A previous exploration well (Waukivory 1) was located to the immediate east of WK 11. The access track previously used for Waukivory 1 would be used to access WK 11. There is

expected to be negligible impact from the construction of the access tracks, which is assessed in more detail in Section 4.

If the results of the proposed exploration activities prove a viable resource, the proponent may seek further planning and environmental approvals to convert the proposed exploration wells to production wells. The exploration wells would be cased and suspended whilst the relevant approvals/agreements are sought. If further investigation of the exploration wells is not required, the well would be plugged in accordance with the Borehole Sealing Requirements (Department of Primary Industries, now DII), and the site rehabilitated.

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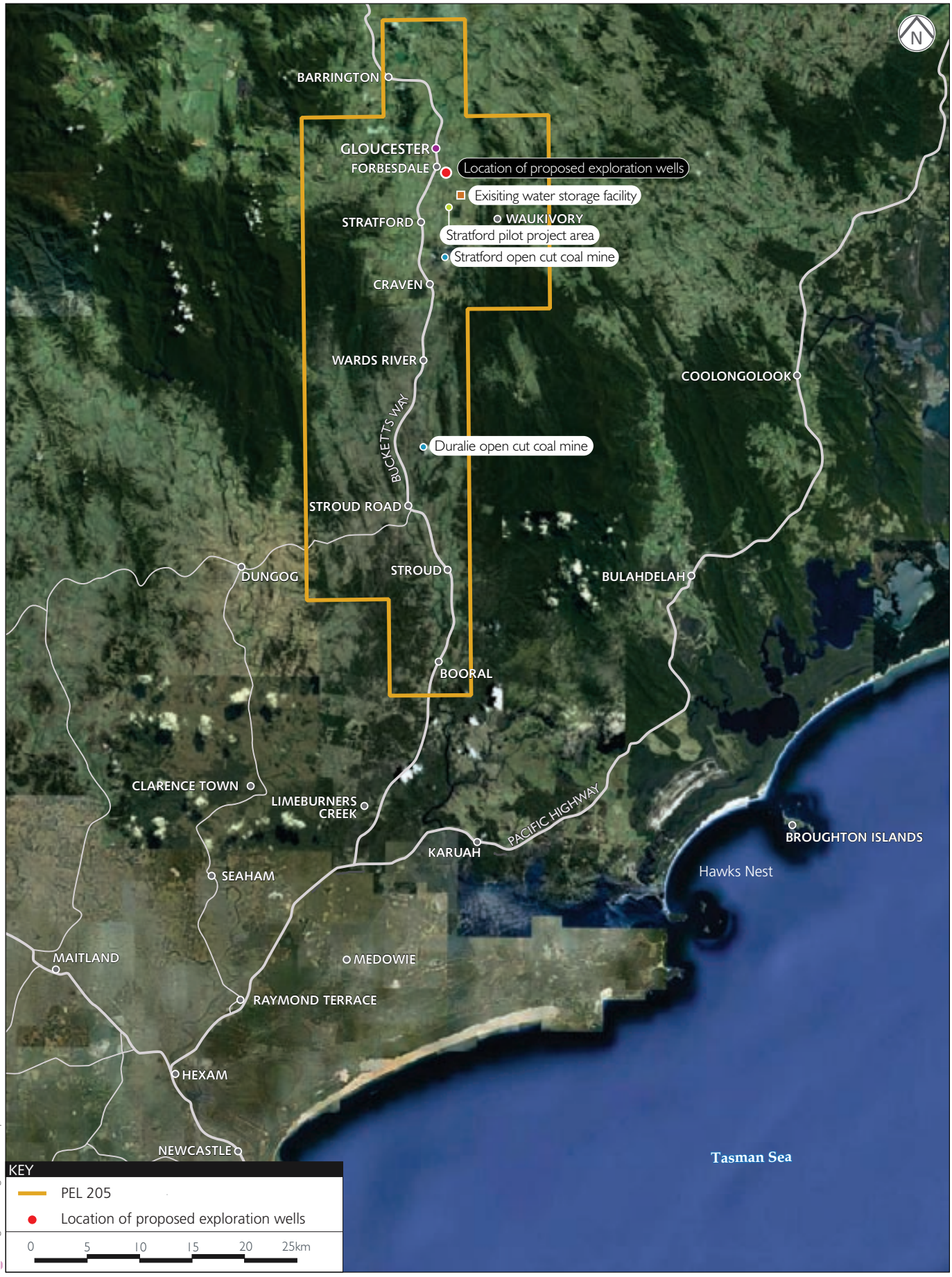

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Regional context

Proposed exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 1.1

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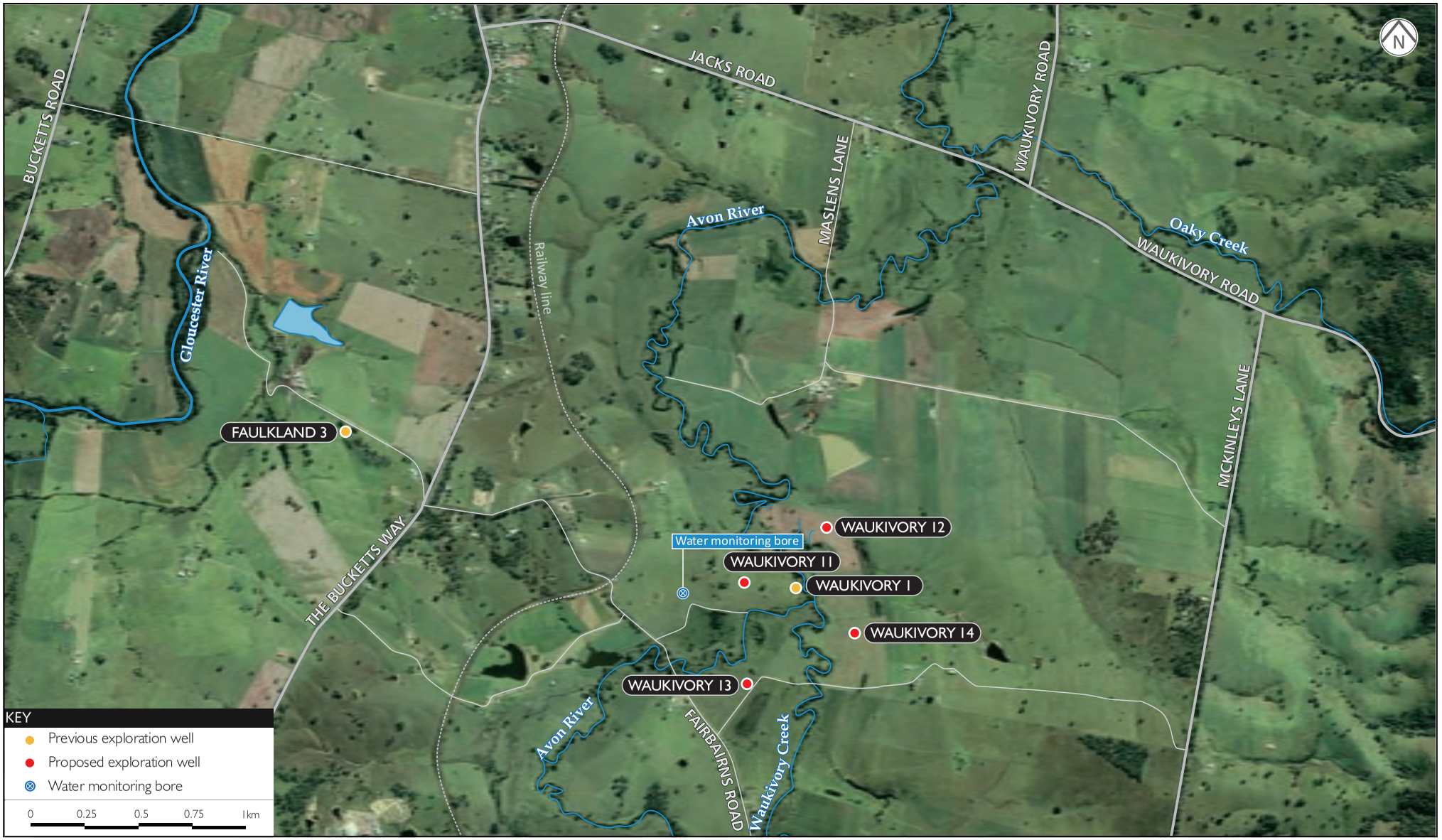

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Proposed locations of exploration wells

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 1.2

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2 Proposed activities

2.1 Site layout

The drilling activities on each exploration well site would involve temporary ground surface disturbance of an area approximately 70 m x 60 m. Water storage and flaring equipment during production testing would require a potential site disturbance area of up to 100 m x 100 m. A typical site layout for each of the proposed drilling activities is shown in Figure 2.1 to 2.3.

Provision would be made for storage of drilling water for circulation within each of the assessed areas. This water is stored on site and would be disposed at an appropriate facility. Disposal of the water would be via water carts (e.g. trucks). The traffic movements associated with water disposal from the proposed exploration sites is discussed in Section 5.

Stock proof fencing would be employed to delineate the works area and to limit the extent of disturbance. Transportable laboratories/office's (approximately 2.4 m x 3.6 m) would be installed on-site during the drilling operations. Information regarding the layout for the monitoring piezometer is discussed in Section 2.9.

2.2 Activity duration and working times

The drill activity for each well would occur over a period of about one to three weeks. It is proposed to undertake 24 hour drilling operations at each of the exploration wells due to the local geology and well conditions. Based on the local geology it is recommended that for well integrity and safe operations that drilling is conducted over a 24 hour period. Openhole wireline logging would be undertaken over a two day period on each well once drilling has been completed. The casing would then be run to a target depth and cemented to surface. Once a well is drilled, completed and cemented, selected coal seams would be perforated, hydraulically fracture stimulated or under-reamed, and the dewatering pumps run in the proposed exploration well ready for testing. The use of fracture stimulation or under-reaming would be determined upon the results of the openhole logging.

The drilling sites and temporary water storage ponds would be rehabilitated after all exploration activities have ceased.

2.3 Pre drilling construction activities

Prior to the commencement of drilling activities, the designated access tracks (refer to Figure 5.5 and 5.6) would be prepared and upgraded to enable access for the drilling equipment. These tracks would be upgraded in consultation with the landholder. Access objectives are to:

- minimise disturbance to soils, native vegetation and fauna;
- minimise impacts to natural drainage patterns;
- minimise disruption to landholders; and
- avoid adverse impacts to existing cultural and heritage amenity.

Generally, the proposed upgrades would involve a maximum disturbance width of 4 m along the upgraded length, 3 m of which would be actual track. The surface would be levelled and maybe covered

with a compacted layer of gravel. Field trials are currently being undertaken by AGL as to the use of alternative methodologies to complete the access track and pads. This may involve the folding back of the topsoil and the installation of a load bearing plastic mesh onto the subsurface clay structure. The topsoil is then folded back onto the mesh and seeded with grasses.

2.4 Drilling methods

2.4.1 General

Drilling of the proposed exploration wells and deep monitoring piezometer would be undertaken with a trailer mounted drill rig. The type of drill rig to be used is typical of rigs used for CSG drilling. This includes equipment to raise and lower drill pipe in the borehole; drive gear for rotary drilling; wireline equipment for the recovery of core tubes; blow out prevention (BOP) equipment as a safety standard; pumps for the circulation of drilling fluids; and a mud tank system to separate cuttings from the drill fluid.

2.4.2 Conductor section of well

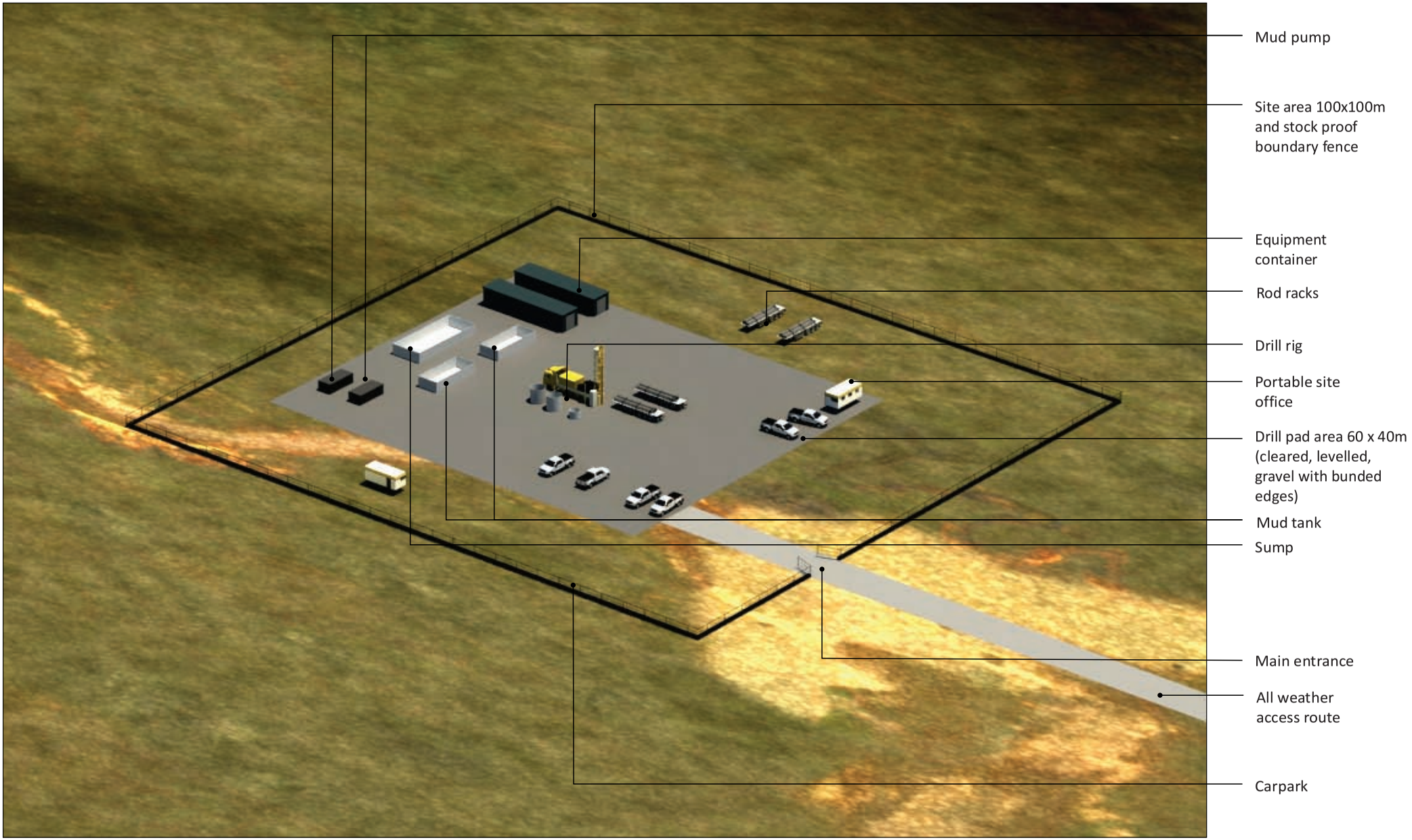
The conductor casing would be cemented in place to provide a seal and prevent washouts, whilst the surface casing is being drilled. The depth of the casing to be cemented would vary from site to site and is dependent upon the formation encountered, in accordance with standard drilling practice.

2.4.3 Surface hole section of the well

Following drilling of the surface hole section a steel surface casing would be inserted to 10% of the target depth and would be pressure cemented back to surface, as per standard industry practice. The purpose of this casing is to isolate shallow beneficial use aquifers and other formations that may be encountered during the drilling process. This also provides structural support for the remaining surface and subsurface equipment to be installed in a well.

2.4.4 Production hole section

Beyond the steel surface casing the rest of the well is referred to as the production hole section. Once drilled this hole section would also be cased and cemented. This ensures that there is no interaction between aquifers or strata and the targeted coal seams, and ensures no cross-contamination between aquifers. The open hole section is drilled to the target depth. As previously noted, logging and testing is undertaken in the open hole section prior to casing, cementing and any fracture stimulation or under-reaming.



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Indicative drill site layout

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

FIGURE 2.1

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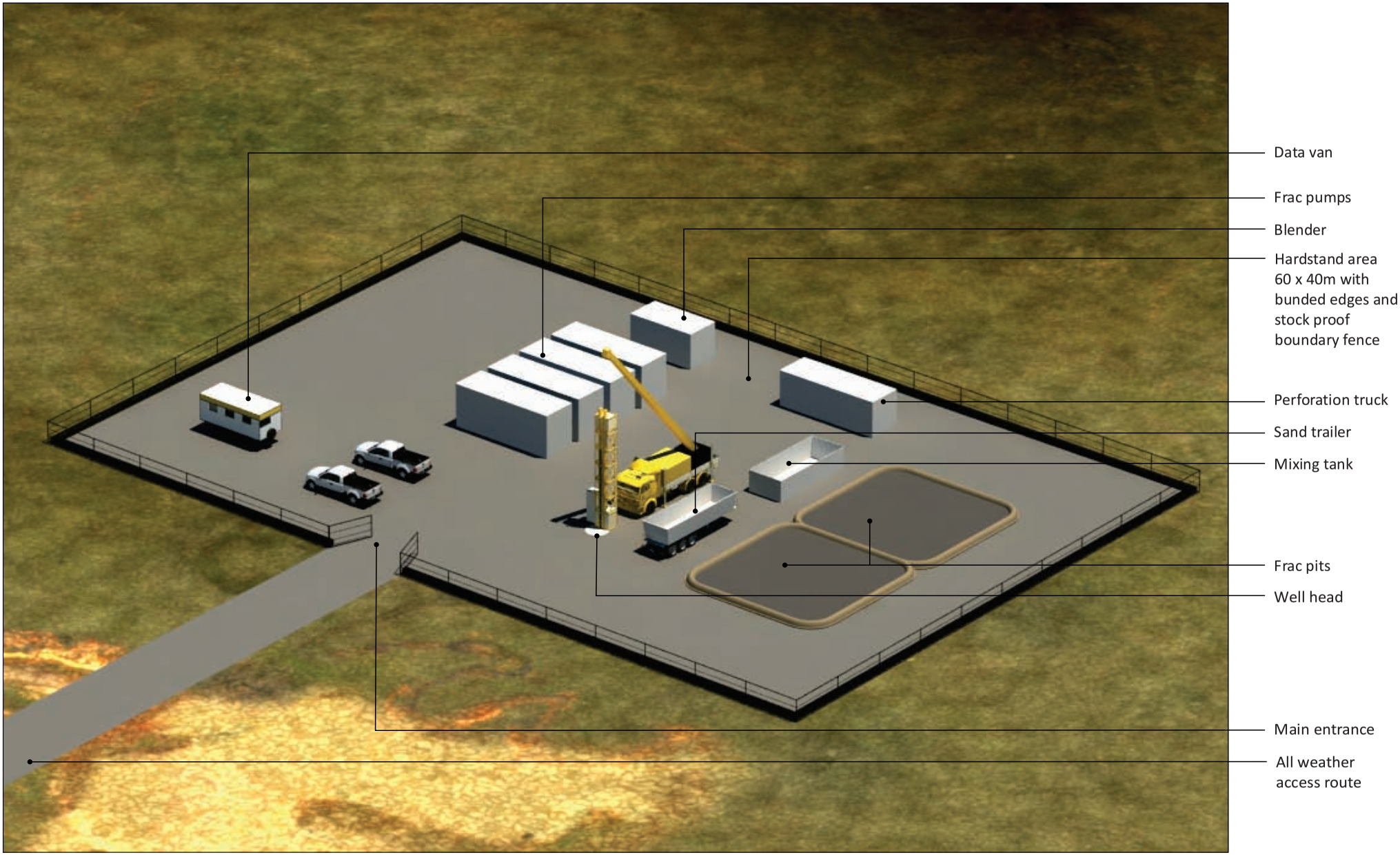

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Indicative site layout during fracture stimulation

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

FIGURE 2.2

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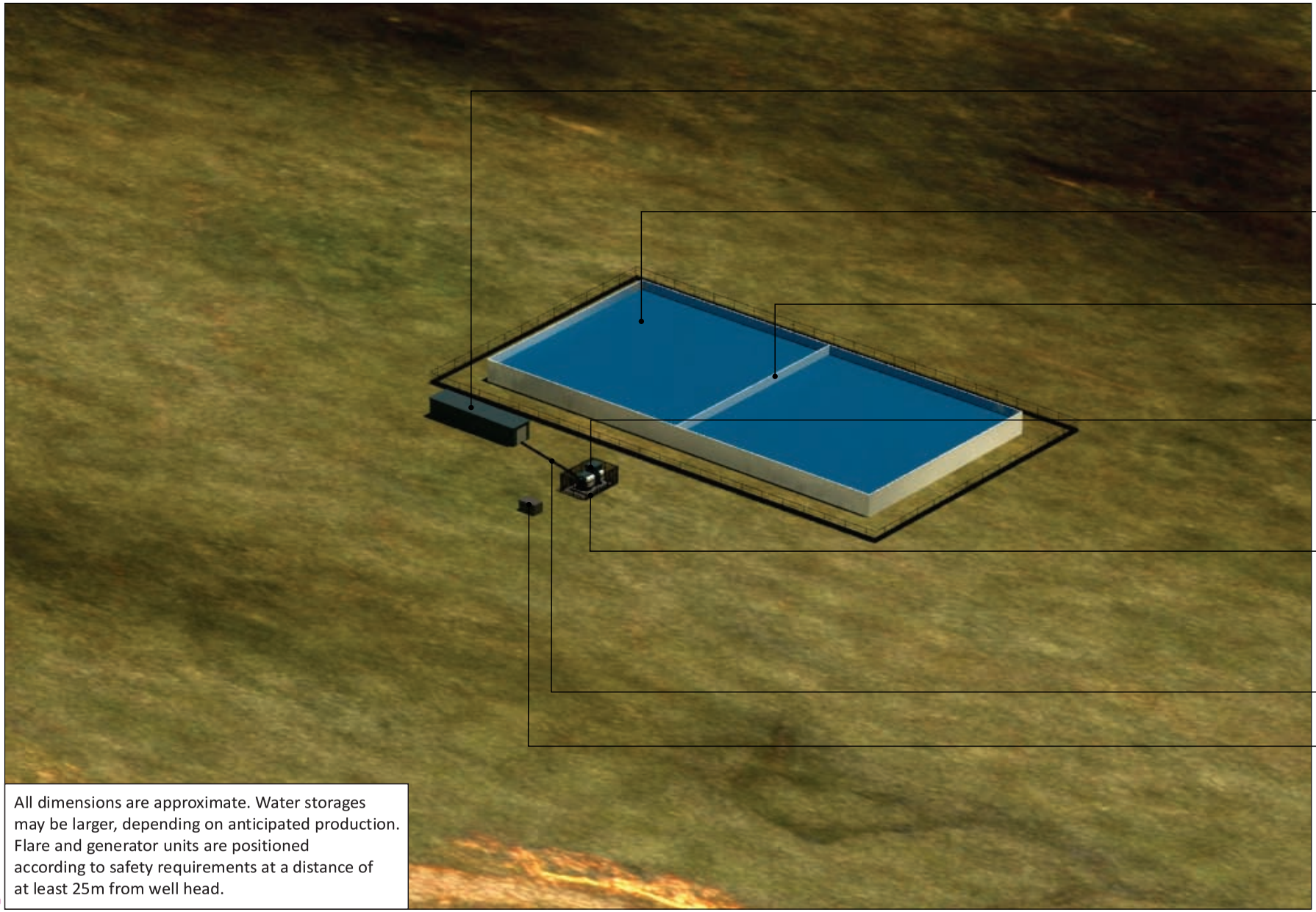

All dimensions are approximate. Water storages may be larger, depending on anticipated production. Flare and generator units are positioned according to safety requirements at a distance of at least 25m from well head.

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Indicative site layout during production testing

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

FIGURE 2.3

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2.4.5 Logging

Once the drilling of the proposed exploration wells has reached the target depth, downhole wireline geophysical logging would be undertaken for the full depth over a period of up to two days at each borehole. The geophysical logging involves the lowering of probes into the proposed exploration well which are specifically designed to record strata characteristics as the probe is slowly raised in the proposed exploration well. One or more of these probes would contain small radioactive sources and only approved licensed operators are authorised to use and transport the devices. The drilling rig would remain on standby during this testing phase.

2.4.6 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 three to five days at each proposed exploration well. The testing procedure involves the lowering of specifically designed "tools" on slim rods or a wireline into the proposed exploration wells. The tools would isolate specific target coal seams for small scale downhole water production and injection tests to determine permeability characteristics of the coal seam. Only experienced operators are used for this testing. The drilling rig would remain on standby during this time.

2.4.7 Drilling fluids

The proposed exploration wells would be drilled utilising a fresh water based fluid containing one or a combination of constituents that may include; potassium chloride, bentonite clay, ploy anionic cellulose, partially hydrolysed polyacrylamide, xanthium gum, acrylic polymer, anionic surfactants and sodium carbonate. An alternate drilling fluid medium may also include the use of high pressure air. No petroleum based fluids or additives are used in the drilling of the proposed exploration wells.

Any water based drilling fluids would be contained in a series of tanks located on each construction pad. Air circulation returns 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 the site and disposed of at an appropriate facility. Any water left in the tanks at the completion of drilling would also be disposed of at an appropriate facility. All drilling fluids would be managed within a closed system, preventing any ability for this fluid to leave the site and enter a drainage line or creek.

The start-up water required for drilling would be obtained by water trucks (approximately four trucks per well) from the existing Stratford water storage, which is located 8 km from the proposal. Approximately 80,000 litres (L) per proposed exploration well would be required to initially fill the tanks and a similar amount may be required during the drilling to maintain circulation fluid levels.

Although the sites selected for the four proposed exploration wells are relatively flat, precautions for periods of heavy rain would be employed. An upslope surface water flow would be directed around the site. Sediment traps (i.e. silt fences) would also be used to prevent soil loss from the site.

2.5 Completion techniques

2.5.1 Under-reaming

Under-reaming is a method that involves enlarging the size of a hole beneath the end of a casing (i.e. the open-hole section discussed in Section 2.4.4). If suitable geological conditions exist an additional stage to open-hole completions can be added to widen the borehole where it intersects the target coal, which is

located below the cased section of the well. After the well is cased a special reaming tool with rotating blades, jets or drill cones is used to ream out a cavity in the coal (one seam at a time). Under-reaming is a useful process where there are multiple seams with high to moderate permeability. Once the proposed exploration well has been widened at each seam, slotted casing is inserted across the coal interval and, where needed, gravel is packed between the walls of the cavity and casing to keep the cavity open. After under-reaming, the proposed exploration well is cleaned out with a fresh water flush.

It is proposed to utilise the under-reaming method for WK 12 and WK 14 if the coal seam properties are found to be suited to this type of completion. Alternatively, these proposed exploration wells may be fracture stimulated, should the under-reaming completion technique not produce sufficient flows for pilot testing purposes.

2.5.2 Hydraulic fracture stimulation

Hydraulic fracture stimulation is a common method used in CSG operations to locally increase the permeability of the target coal seam. Hydraulic fracture stimulation uses the hydraulic pressure of fluid pumped into gas wells to open coal seams and help increase gas flow to surface. The fracture stimulation fluid comprises 99.5 % fresh water and sand, while 0.5 % contains other fluids (refer to Section 5). Fluids used during fracture stimulation are flushed from the coal seam and pumped to lined containment pits or tanks and disposed of at appropriate off-site facilities.

Generally, only wells that intersect low permeability coal seams require fracture stimulation and these seams are usually very deep and beneath beneficial aquifers. CSG wells, including exploration wells, are fully lined with steel casing, which is securely cemented in place to isolate shallower (and beneficial) aquifers overlying the target coal seam(s). The well must be fully cased and is perforated at specific intervals where the fracture stimulation is to be completed. Thus, fracture stimulation operations are controlled and designed so they are limited to coal seams and do not extend either above or below the targeted seam. It should be noted that exploration wells are drilled and testing is undertaken prior to fracture stimulation occurring.

It is proposed to utilise the fracture stimulation method for WK 11 and WK 13, however, it is possible following logging and geological testing of the seams that fracture stimulation may be used at WK 12 and WK 14. As such, the REF has considered and assessed this scenario. It should be noted that fracture stimulation would be limited to daytime hours only.

2.5.3 Twinning

Twinning is a procedure in which two exploration wells are undertaken on the same drill pad site. The wells are within 6 m to 10 m apart at the surface therefore allowing both shallow and deeper coal seams to be pilot tested within the one pad in an efficient manner, should geological properties be suitable. This twinning option may be used for WK 12 and/or WK 14. If this technique is used at these sites, the twinning activity would enable direct targeting of seams at less than 700 m depth for evaluation of under-reaming stimulation techniques and also with fracture stimulation methods used on the adjacent deeper wells of WK 11, WK 12, WK 13 and WK 14

In general, the first exploration well is constructed in the same manner as described in Section 2.4. This well is drilled to the target depth of approximately 1,100 m, production casing installed and cemented, and wireline logging tools are used to evaluate the formations. As described in Section 2.5.1, should the shallower target seams (i.e. less than 700 m) comprise geological properties conducive and suitable to under reaming stimulation techniques following drilling, logging and testing of the first well , then twinning at the drill pad would be undertaken.

Once it is determined that under-reaming the shallower seams can be undertaken, the drill rig is moved over 6 m to 10 m from the first drilled exploration well and a second exploration well targeting these shallower seams is constructed. The well is drilled to the pre-determined depth (e.g. 700 m), production casing and cementing is undertaken to ensure stability and protection of beneficial groundwater, and under-reaming is undertaken. The deeper targeted seams within the first exploration well may then be fracture stimulated at a later date, if required. However, due to the difference in depths and casing of these two exploration wells, the under-reaming of one well and the fracture stimulation of another well would not create additional impacts to those assessed in this REF (refer to Section 5).

During the twinning process, production water is removed from both holes and stored in ponds located on-site and sized accordingly as discussed below. As with all exploration wells, upon completion of exploration activities wells would to be either plugged and abandoned or capped and suspended in accordance with industry best practice.

2.6 Production testing facilities

2.6.1 Dewatering

When the wells are drilled the target coal seams generally contain groundwater and, as such, the exploration well would need to be dewatered. Dewatering reduces the pressure in coal seam which enables the methane to flow. Over time the amount of water being "pumped" decreases as water in the target coal seams is removed. It should be noted that the water within coal seams is generally very saline and not suitable for beneficial use.

2.6.2 Flaring

A gas flare or flare stack is an elevated vertical stack or pipe for burning gas released during the production and processing of CSG. Commonly referred to as "flaring", the flare burns gas that needs to be released for safety reasons. Flaring of gas burns off any combustible vapours produced from the gas well. The released gases and/or hydrocarbon vapour liquids are burned as they leave the flare stacks. Flaring is also considered the most environmentally friendly method to dispose of gas. The carbon dioxide (CO_2) produced from the burning process (i.e. the burning of methane gas) has less than one-twentieth of the impact on the Earth's atmosphere than to simply release methane[2] into the atmosphere. The gas flares would also be enclosed to mitigate noise impacts.

2.6.3 Lined pits (temporary water storage ponds)

Temporary water storage ponds are proposed to be located adjacent to each of the proposed exploration wells within the construction pad (100 m x 100 m). The ponds would be constructed with in situ materials (i.e. cut and fill) and would be lined with an impermeable liner in accordance with the requirements of DII. The dimensions of the ponds would be up to 40 m x 40 m x 4.5 m deep (7,200 m^3). An operational freeboard of approximately 450 mm would be maintained at all times to allow for unexpected heavy rainfall. Nonetheless, should this freeboard level be reached, no further pumping of water to the temporary ponds would be permitted.

The construction of on-site temporary storage is based upon minimising the risk of spillage. The anticipated storage capacity of the ponds is an approximation only. The average exploration well can produce between 5 m^3 and 100 m^3 of water per day. As such, the proposed size of the ponds would

[2] *Queensland Government (2010) Flaring in the coal seam gas industry*.

provide sufficient capacity for the proposed exploration wells. Once water from the wells has reduced to manageable quantities the lined pits would be removed and rehabilitated and replaced by on-site storage tanks.

2.7 Production water management

Water produced from the proposed exploration wells would be collected in local storage facilities (e.g. lined ponds), which include a freeboard to cater for overflow and/or significant rainfall events. The ponds are lined with a geomembrane to prevent leaching of production water into the groundwater.

The optimal disposal option for the collection of production water would be dependent upon the quality and quantity of water produced, which can only be definitive determined once testing commences. Given the number of previous exploration wells drilled in the vicinity of the proposal and the Gloucester Basin in general (refer to Section 1.6), the proposed temporary water storage ponds have been designed based on the information collected from these previous exploration wells as well as investigations undertaken as part of the environmental assessment for the GGP. The temporary storage ponds are designed to hold a significant amount of water for a number of days.

Table 2.1 below indicates the disposal options available once the produced water quality and quantity become more definitively understood. It is also intended that appropriate consultation with relevant stakeholders (including DII) would be conducted to discuss the disposal options below and ensure necessary approvals are obtained. The table below summarises the disposal options, and the likelihood of each.

Table 2.1 Disposal options for produced water

Ranked Option	Potential Environmental Impact	Likelihood
1.Direct irrigation onto adjacent land	Managed/treated to minimise risk	Dependent on water quality. EC will need to be less than 3,000 µS/cm
2.Discharge to local waterway	Managed/treated to minimise risk	No, as produced water is likely to be too saline
3.Treatment for irrigation	Managed/treated to minimise risk	This option is likely to be feasible only where the volume of water produced is significant and the produced water can be blended/treated for re-use
4.Aquifer re-injection	Potential groundwater contamination	Unlikely as this would require extensive investigations 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. Preference is for storage at a central facility with possible blending and irrigation re-use at a later date.

Based on the information obtained from previous exploration and production wells in the area it is envisaged that the produced water during the proposed exploration activities would require removal from the site for disposal (i.e. Option 5) due to the expected salinity levels.

Should the produced water require removal from the site, it is proposed that to store the water in purpose built water storages on a property owned by the proponent, located near the subject site. An existing storage facility is located approximately 3 km to the east of the site which has been previously

used for water storage for produced water from exploration wells. This property is commonly referred to as "Tiedmans". Should the quality of the produced water be suitable and the appropriate licences obtained, the produced water would be blended at "Tiedmans". Following the blending process and water quality validation, the produced water may be re-used for irrigation purposes.

The "Tiedmans" property is currently zoned RU1 Primary Production. The proposed water storage facilities at "Tiedmans" have been approved by DII as part of the GGP exploration project.

This REF has examined the impact of removing produced water from the site for disposal at "Tiedmans". If other options are identified and pursued, further assessment would be required, along with proposed management options. If the produced water is identified as being beneficial for re-use in irrigation, once treated at the water storage facility on "Tiedmans", this would also be subject to further approvals/agreements.

2.8 Rehabilitation and restoration

If it is determined that any of the four exploration well sites are not required for further production testing the surface of the drilling area and any access tracks would be rehabilitated. This includes any disturbed areas of the entire construction pad. Rehabilitation of the sites would be with native species endemic to the local area, and in accordance with the current agricultural nature of the lots in which the four sites are situated. A previous exploration borehole (Waukivory 1) in the immediate vicinity was rehabilitated in this manner.

The rehabilitation of the lined pond sites would be conducted in accordance with the requirements of DII. It is proposed that the ponds would be cleaned out, the liners removed, the embankments pushed in and the surface levelled, topsoiled and rehabilitated. The liner would be disposed of at a licensed facility.

2.9 Water monitoring piezometer

As part of the proposed works a water monitoring bore with a piezometer would be installed. The monitoring piezometer would be installed and identified as WMB05 (this would be the fifth dedicated monitoring piezometer in this area). The monitoring piezometer would be located to the west of WK 11 as identified in Figure 1.2. The pad that upon which the piezometer would be developed is anticipated to be 50 m x 30 m in size. The installed logger in the monitoring piezometer would constantly measure water pressure and level. Water samples are expected to be undertaken throughout the entire project timeframes. It is also expected that this monitoring piezometer would be incorporated into the ongoing monitoring network for the GGP.

2.10 General environmental management of works

The GGP comprises an existing environmental management plan (EMP) for exploration, which acts as an overarching document managing and monitoring the GGP's environmental interactions. It is proposed that the activities associated with the proposed exploration wells would be incorporated into this existing EMP. This EMP is provided in Appendix C and comprises the following aspects:

- produced water management;
- soil and ground stability;
- vegetation management;
- bushfire protection;

- air emissions;
- noise and vibration;
- clearing and grading;
- drilling, perforation and fracture stimulation;
- pond construction;
- trenching;
- cultural heritage;
- community and social impact;
- waste management;
- fuel and chemical storage and spills;
- pipe stringing and welding;
- pipe laying and backfilling;
- hydrotesting; and
- clean up and rehabilitation.

The EMP would be implemented for the proposed works.

3 Planning and statutory context

3.1 Petroleum (Onshore) Act 1991

The NSW *Petroleum (Onshore) Act 1991* regulates the search for onshore production and extraction of petroleum (i.e. oil and gas) in NSW. It creates exploration and production titles and also addresses environmental protection, royalties and compensation. The NSW *Petroleum (Onshore) Regulation 2007* requires all exploration or other activity carried out under the authority of a petroleum title to be carried out in conformity with the schedule published by the DII.

Under this Act the definition of "petroleum" includes any naturally occurring hydrocarbon, whether in a gaseous, liquid or solid state, but specifically *does not* include coal or oil shale. Methane (the major component of CSG is a gaseous hydrocarbon, and therefore CSG is defined as a petroleum activity under this Act.

Before undertaking any activities, companies or individuals wishing to explore for coal seam gas in NSW must first apply to the Minister for Mineral Resources for a licence issued under the NSW *Petroleum (Onshore) Act*.

There are three main types of permits issued under the *Petroleum (Onshore) Act*:

- Petroleum Exploration Licence (PEL);
- Petroleum Assessment Lease (PAL); and
- Petroleum Production Lease (PPL).

As previously stated, AGL has been issued a PEL (PEL 285) under the provisions of the NSW *Petroleum (Onshore) Act 1991*. To ensure environmental protection, operators apply for permission to operate by submitting an REF to DII. The REF describes how the operator would manage identified risks relating to the environment.

3.1.1 Petroleum Exploration Licence No 285

The four proposed exploration wells would be undertaken in accordance with the provisions of PEL 285, which is held by AGL. Under the provisions of the PEL the proposed exploration wells would be classified as a Category 3 activity under the PEL. Condition 1 of the Second Schedule states that:

> *The type of activity listed in Category 3 requires notification to an Environmental Officer of the Department and will normally require an additional specific determination under Part 5 of the Environmental planning and Assessment Act, 1979. At least 4 weeks prior to the proposed commencement of any activity listed in Category 3, a Review of Environmental factors in accord with Clause 228 of the Environmental Planning and Assessment Regulation 2000 must be submitted to the Department to enable determination under Part 5 of the Environmental Planning and Assessment Act, 1979 to be made.*

3.2 Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Regulations 2000

The EP&A Act provides the legislative requirements and processes for any development (infrastructure, residential, industrial etc) in NSW. Any development in NSW is determined in accordance with the provisions of Part 3A, Part 4 or Part 5 of the EP&A Act. Under the provisions of section 76 of the EP&A Act and the Mining SEPP, Part 5 of the EP&A Act will apply to the proposed exploration wells as identified in the PEL.

Under section 111 of the EP&A Act, AGL is required to consider the potential environmental impacts of any activity before DII determine whether or not the activity can proceed. The potential environmental impacts of a proposal are, generally, identified within an REF. Under section 112, if the REF identifies that the proposed activity would have a significant environmental impact then an Environmental Impact Statement (EIS) is required to be prepared.

In addition, clause 228 of the EP&A Regulation identifies a series of 'factors' which must be considered when an REF is being prepared. These factors have been considered in preparing this REF. A summary of the aspects addressed in this REF with reference to clause 228 of the EP&A Regulation is provided in Section 7.3.

3.3 State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

The aims of this SEPP are:

a) to provide for the proper management and development of mineral, petroleum and extractive material resources for the purpose of promoting the social and economic welfare of the State, and

b) to facilitate the orderly and economic use and development of land containing mineral, petroleum and extractive material resources, and

c) to establish appropriate planning controls to encourage ecologically sustainable development through the environmental assessment, and sustainable management, of development of mineral, petroleum and extractive material resources.

Under clause 6 of the Mining SEPP development for any of the following purposes may be carried out without development consent:

a) mineral exploration and fossicking,

b) rehabilitation, by or on behalf of a public authority, of an abandoned mine site,

c) mining within a mineral claims district pursuant to a mineral claim under the NSW Mining Act 1992,

d) petroleum exploration,

e) the construction, maintenance or use (in each case, outside an environmentally sensitive area of State significance) of any pollution control works or pollution control equipment required as a result of the variation of a licence under the NSW Protection of the Environment Operations

Act 1997, being a licence that applies to an extractive industry, mine or petroleum production facility in existence immediately before the commencement of this clause.

Although petroleum exploration is identified as development which does not require consent, this does not preclude an REF or EIS from being prepared as a result of the provisions of section 76 of the EP&A Act. Section 76(2) of the EP&A Act notes that, only where an environmental planning identifies a development to be "exempt" does Part 5 of the EP&A Act not apply. As the proposed exploration wells are *not* identified as "exempt" then Part 5 of the EP&A Act will still apply.

3.4 State Environmental Planning Policy (Infrastructure) 2007

The aim of this SEPP is to facilitate the effective delivery of infrastructure across NSW. The SEPP is divided into a number of Divisions which allow works on, or on behalf, of a public authority to be carried in relation to electricity, gas, water and sewer, telecommunications, roads, airports, hospitals, railways, educational establishments, correctional centres, and the like. Division 9 applies to gas pipelines which are licensed under the NSW *Pipelines Act 1967* and NSW *Gas Supply Act 1996*, however, this SEPP does not apply to the proposed exploration wells.

3.5 State Environmental Planning Policy No. 55 (Remediation of Land) 1998

The objective of this SEPP is to provide for a State-wide planning approach to the remediation of contaminated land. In particular, this SEPP aims to promote the remediation of contaminated land:

a) by specifying when consent is required, and when it is not required, for a remediation work, and

b) by specifying certain considerations that are relevant in rezoning land and in determining development applications in general and development applications for consent to carry out a remediation work in particular, and

c) by requiring that a remediation work meet certain standards and notification requirements.

No contamination has been identified on the site. The subject sites have a history of agricultural uses. Some minor earthworks would be required to level the pad upon which the drilling would take place. It is considered that these minor works would not result in any contamination of the land as identified under this SEPP, and that the previous disturbance of the land from agricultural activities is unlikely to have resulted in any significant contamination issue. Therefore, it is considered that a Phase 1 Environmental Site Assessment is not required or warranted for any of the proposed activities.

Nonetheless, if any contaminants are found during any works it would be necessary to have the contamination assessed, remediated and the site validated by a site contamination consultant. The assessment shall be carried out by a recognised contaminated land consultant and in accordance with the NSW Department of Environment, Climate Change and Water (DECCW) guidelines and the NSW *Contaminated Land Management Act 1997*.

3.6 Protection of the Environment Operations Act 1997

The POEO Act aims to protect and reduce degradation of the environment from development activities. The POEO Act examines issues such as air and water pollution, waste management and noise. The POEO Act also prescribes "scheduled activities" in which a license must be obtained from the DECCW. These "scheduled activities" include in industrial, mining, petroleum and agricultural developments of a certain

size. Clause 5 and Schedule 1 of the POEO Act identify works that are considered to be a "scheduled activity". For petroleum works this includes activities which:

1. produce, other than in the course of exploratory activities, crude or shale oil, or

2. produce more than 5 petajoules (PJ) per year of natural gas or methane, or

3. refine crude petroleum, shale oil or natural gas, or

4. manufacture more than 100 tonnes per year of petroleum products (including aviation fuel, petrol, kerosene, mineral turpentine, fuel oils, lubricants, wax, bitumen, liquefied gas and the precursors to petrochemicals such as acetylene, ethylene, toluene and xylene), or

5. store petroleum and natural gas products with an intended storage capacity in excess of:

    a) 200 tonnes of liquefied gases, or

    b) 2,000 tonnes of any petroleum products, or

    c) dispose of oil waste or petroleum waste or process or recover more than 20 tonnes of oil waste or petroleum waste per year.

The proposed exploration wells are not identified as a "scheduled activity" and therefore do not require the proponent to obtain an environmental protection licence from DECCW.

3.7 Threatened Species Conservation Act 1995

The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The objectives of the TSC Act are:

- to conserve biological diversity and promote ecologically sustainable development, and
- to prevent the extinction and promote the recovery of threatened species, populations and ecological communities, and
- to protect the critical habitat of those threatened species, populations and ecological communities that are endangered, and
- to eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities, and
- to ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed, and
- to encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

In general, the TSC Act provides for the identification, and classification, of threatened species, populations and ecological communities. It also provides for the identification of key threatening processes that are most likely to jeopardise the survival of those species, populations and ecological communities.

The TSC Act also contains provisions about species impact statements. These statements are prepared to measure the significance of the effect of actions on threatened species, populations or ecological communities, or their habitats. A species impact statement must be lodged with an application for a licence under this Act if the Director-General determines that the action proposed is likely to significantly affect threatened species, populations or ecological communities, or their habitats.

If the action proposed to be taken by the applicant is not on land that is critical habitat and the application is not accompanied by a species impact statement, the Director-General must determine whether the action proposed is likely to significantly affect threatened species, populations or ecological communities, or their habitats.

An assessment of the impact on flora and fauna has been prepared for the proposed exploration sites as well as the proposed water monitoring piezometer site, which is discussed in Section 5. The assessment identifies that the proposed works would have no impact on any threatened flora or fauna.

3.8 National Parks and Wildlife Act 1974

The objectives of the NPW Act include:

a) the conservation of nature, including, but not limited to, the conservation of:

   i) habitat, ecosystems and ecosystem processes, and

   ii) biological diversity at the community, species and genetic levels, and

   iii) landforms of significance, including geological features and processes, and

   iv) landscapes and natural features of significance including wilderness and wild rivers,

b) the conservation of objects, places or features (including biological diversity) of cultural value within the landscape, including, but not limited to:

   i) places, objects and features of significance to Aboriginal people, and

   ii) places of social value to the people of NSW, and

   iii) places of historic, architectural or scientific significance,

c) fostering public appreciation, understanding and enjoyment of nature and cultural heritage and their conservation,

d) providing for the management of land reserved under this Act in accordance with the management principles applicable for each type of reservation.

In general the NPW Act seeks to conserve areas of significant biological diversity (e.g. National Parks, Nature reserves etc). Under the NPW Act it is an offence to harm threatened species or endangered ecological communities. In addition, the NPW Act also protects Aboriginal areas and items. It is also an offence under the NPW Act to disturb or destroy an Aboriginal object, without the consent of the Director-General.

In relation to the proposed works, a flora and fauna assessment has been prepared which identifies that no threatened species or endangered ecological communities would be disturbed by the proposed works

(Appendix A). An Aboriginal archaeological heritage assessment was also prepared for the proposed wells which concluded that the works are highly unlikely to disturb any items or areas of Aboriginal significance (Section 5). If any items are uncovered during construction, work must immediately cease and the DECCW should be notified.

3.9 Heritage Act 1977

The NSW *Heritage Act 1977* aims to maintain items and areas of European heritage significance. The objectives of the Heritage Act are:

a) to promote an understanding of the State's heritage,

b) to encourage the conservation of the State's heritage,

c) to provide for the identification and registration of items of State heritage significance,

d) to provide for the interim protection of items of State heritage significance,

e) to encourage the adaptive reuse of items of State heritage significance,

f) to constitute the Heritage Council of NSW and confer on it functions relating to the State's heritage,

g) to assist owners with the conservation of items of State heritage significance.

Under the Heritage Act a register must be maintained of all heritage items and areas of state significance. This register is called the State Heritage Register (SHR) and is administered by the Heritage Council.

Under the Heritage Act (i.e. section 139) it is an offence to disturb or excavate land that will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed unless an appropriate permit has been approved. A search of relevant heritage databases revealed that the works would not impact on any items or areas of heritage significance.

3.10 Water Management Act 2000 and Water Act 1912

The NSW *Water Management (WM) Act 2000* provides for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular:

a) to apply the principles of ecologically sustainable development, and

b) to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and

c) to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:

   i) benefits to the environment, and

   ii) benefits to urban communities, agriculture, fisheries, industry and recreation, and

   iii) benefits to culture and heritage, and

iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,

d) to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,

e) to provide for the orderly, efficient and equitable sharing of water from water sources,

f) to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,

g) to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,

h) to encourage best practice in the management and use of water.

The WM Act sets out principles for the management of water in NSW. The principles include:

a) water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and

b) habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and

c) the water quality of all water sources should be protected and, wherever possible, enhanced, and

d) the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and

e) geographical and other features of indigenous significance should be protected, and

f) geographical and other features of major cultural, heritage or spiritual significance should be protected, and

g) the social and economic benefits to the community should be maximised, and

h) the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements.

The WM Act applies to those areas in NSW which are subject to Water Sharing Plans. Those areas not covered by a Water Sharing Plan are managed in accordance with the NSW *Water Act 1912.* There is no porous rock Water Sharing Plan in place for the Gloucester Basin at this time.

It is an offence under the WM Act to take water from a water source or interfere with an aquifer without an appropriate licence issued by the relevant authority. Even when a project is being undertaken by a local council or State agency requires an approval or licence is required under the NSW *Water Act 1912* or the WM Act. The proposed exploration wells and monitoring piezometer would intercept deep groundwater on the subject sites (see Section 5). As such appropriate bore licences would need to be obtained from NSW Office of Water (NOW) prior to exploration activities under the NSW *Water Act 1912.*

It should be noted that there are no streams or rivers that would be directly impacted by the proposed works. Nonetheless, an appropriate water management plan would be prepared for the proposed works

to ensure no impacts would occur on downstream waterways. In addition, during the works appropriate erosion management controls would also need to be in place to ensure the protection of the local rivers and streams.

3.11 Environmental Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Commonwealth Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the Act as matters of national environmental significance. The EPBC Act focuses Commonwealth Government interests on the protection of matters of national environmental significance, with the states and territories having responsibility for matters of state and local significance. The objectives of the EPBC Act are to:

- provide for the protection of the environment, especially matters of national environmental significance;
- conserve Australian biodiversity;
- provide a streamlined national environmental assessment and approvals process;
- enhance the protection and management of important natural and cultural places;
- control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife; and
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.

In general, the EPBC Act lists flora and fauna, ecological communities, and heritage items and places that are deemed to be of National significance. The eight matters of national environmental significance to which the EPBC Act applies are:

- world heritage sites;
- national heritage places;
- wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed);
- nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park; and
- nuclear actions.

These matters of national environmental significance are assessed as part of the flora and fauna and heritage assessments. Matters identified on a site that are listed under the EPBC Act mean that the Commonwealth Government's Department of Sustainability, Environment, Water, Population and

Communities (DSEWPC) need to concur that the proposed development would not significantly impact upon matters identified as being of national significance. That is, DSEWPC would need to approve a development if an assessment identifies that it might impact upon a matter of national environmental significance, before the development can proceed. This approval is in addition to any State or local approval.

In relation to the proposed exploration sites and proposed water monitoring piezometer site, no matters of national environmental significance were identified in the heritage review, preliminary Aboriginal cultural heritage assessment or flora and fauna assessment. As such, the proposed development does not need a separate approval under the EPBC Act.

3.12 Native Title Act 1993

The Commonwealth *Native Title Act 1993* provides for the recognition and protection of native title. There are no known native title claims over the land within the areas proposed for works.

3.13 Ecologically sustainable development

Legislation in NSW is consistent with the principles of ecologically sustainable development (ESD). The most common definition of ESD emerged from the 1987 Brundtland Report, introduced by the World Commission on Environment and Development (WCED). The WCED define ESD as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

In NSW, Section 6(2) of the *Protection of the Environment Administration Act* notes that ecologically sustainable development requires the effective integration of economic and environmental considerations in decision-making processes. The Act goes on to note that ecologically sustainable development can be achieved through the implementation of the following principles and programs:

a) the precautionary principle—namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

b) in the application of the precautionary principle, public and private decisions should be guided by:

   i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and

   ii) an assessment of the risk-weighted consequences of various options,

c) inter-generational equity—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,

d) conservation of biological diversity and ecological integrity—namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,

e) improved valuation, pricing and incentive mechanisms—namely, that environmental factors should be included in the valuation of assets and services, such as:

i) polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The principles of ESD have been considered in the preparation of this REF. The principles would also need to be considered during the construction phase of the project.

3.14 Other legislation and guidelines

Other legislation was considered in the preparation of this REF, but was identified as not applying to the proposed exploration wells. This includes the *Fisheries Management Act 1994, Coastal Protection Act 1979, Forestry Act 1916* and the *Wilderness Act 1987*.

Other guidelines were considered in preparing this REF. This includes:

- Department of Infrastructure, Planning and Natural Resources (2004) Locational Guidelines: Development in the Vicinity of Operating Coal Seam Methane Wells;
- Mineral Resources NSW (1997) Borehole Sealing Requirements on Land; and
- Department of Primary Industries (2006) Guidelines for Review of Environmental Factors.

3.15 Environmental licences and permits

The table below identifies a number of pieces of State and Commonwealth legislation and whether a permit is required under that Act or Regulation for the proposed development. The table below excludes any requirements under the EP&A Act, or EP&A Regulation.

Table 3.1 Licence and permit requirements

Relevant legislation where a permit may be required	Permit/Concurrence required
Coastal Protection Act 1979 and Regulation 2004	No
Protection of the Environment Operations Act 1997	Unlikely, however, contractors should ensure appropriate licences are in place prior to construction, if required.
Water Act 1912	Licence(s) will be required for the proposed exploration wells and monitoring bore prior to the commencement of works as the wells would intercept groundwater
Threatened Species Conservation Act 1995	No

Relevant legislation where a permit may be required	Permit/Concurrence required
Fisheries Management Act 1994	No
National Parks and Wildlife Act 1974	No
Forestry Act 1916	No
Wilderness Act 1987	No
Heritage Act 1977	No
Native Vegetation Act 2003	No
Commonwealth Environmental Protection and Biodiversity Conservation Act 1999	No
Commonwealth Native Title Act 1993	No

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4 Stakeholder and community consultation

Stakeholder consultation has been undertaken by the proponent for the purposes of this REF. Landholders directly affected by the proposal have been consulted, and access arrangements with relevant landholders have been negotiated. The Aboriginal cultural heritage assessment also involved the Forster Local Aboriginal Land Council (LALC). Additional consultation with adjacent landholders would also be undertaken prior to the commencement of any works.

The proponent continues to maintain an open and ongoing communication with the local community about its present and future. Communications with the public are maintained through AGL's GGP website, as well as the GGP Community Consultative Committee (CCC).

Extensive community consultation has been undertaken since February 2008 to ensure community views have been captured, and these have been incorporated into the EA prepared as part of the GGP. A variety of consultation techniques that are (and would be) implemented were designed to enable information about the Project to effectively reach target audiences.

The overall objective of community consultation for the GGP is to ensure clear, effective, open, two-way communication at all times by listening, recording and responding to issues. The approach included distributing information to and interacting with the local community and landowners affected by the proposed development, and to obtain community feedback.

4.1 Community consultative committee

As part of the wider GGP a CCC was formed in September 2008 to provide a forum for discussion and exchange of information between the community, Government agencies and AGL. The CCC assists AGL in identifying project related local issues for consideration during the development, environmental, construction and operational phases of the project. It also acts as a communication link between AGL, the community and other stakeholders. The CCC includes representatives from the community, local Landcare Group, Gloucester Council, as well as representatives from AGL. Minutes from the CCC meetings are also available to individuals on the GGP web site.

4.2 Agency consultation

Mr Craig Campbell from the DII was consulted on 28 January 2011 regarding the four proposed exploration wells. Mr Campbell noted that a number of previous REFs had been completed in the area which should be considered in preparing this REF. Mr Campbell also noted that in relation to the Premier's media release on 19 December 2010 regarding new regulations for CSG exploration licences it would be appropriate to include an impact assessment of fluids used during fracture stimulation and Material Safety Data Sheets, where practical. In addition, Mr Campbell also noted that DII now refer REFs to the DoP and DECCW.

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5 Environmental Interactions

5.1 Landform and geology

The Gloucester geological basin straddles the Manning River Catchment to the north and the Karuah River Catchment to the south. The subject sites are within the Manning River Catchment which is approximately 8,200 km^2 in size. The subject sites are within the Avon River Sub-Catchment. The Avon River originates to the south west of Gloucester and joins the Gloucester River to the north of the township of Gloucester. Waukivory Creek, Dog Trap Creek and Avondale Creek are also located within the Sub-Catchment.

The landforms of the locality are guided by the geology of the Stroud-Gloucester Syncline and comprise ridges to the east and west, undulating low hills and flat land in the centre where the Avon River flows to the north. The lowest points in the area are on the Avon Rover floodplain at approximately 100 m RL.

The Gloucester Geological Basin is a synclinal structure formed by Permian consolidated sediments. The Permian Rocks display steep dips of up to 90° on the edge of the basin, dipping towards the north-south axis, and flattening towards the basin centre. They lay on a basement composed of Early and Late Carboniferous sedimentary and volcanic units that are part of the New England Fold Belt. The geology of the area comprises Quaternary sediments along the valley floor and Permian rocks along the flanks and over most of the catchment. Carboniferous volcanics form the major east and west ridgelines.

A summary of the stratigraphy of the area is presented in Table 4.1 below.

Table 5.1 Summary of relevant stratigraphy

Group	Sub-Group	Formation	Approx Thickness (m)	Coal Seams
Gloucester Coal Measures	Craven Sub-Group	Crowthers Road Conglomerate	350	
		Leloma Formation or Woods Road	585	Linden Marker M6, M7 (“JD Coals”) Bindaboo Deards
		Jilleon Formation or Bucketts Way	175	Cloverdale Roseville Marker M3, M8, M1 (“Tereel Coals” – Fairbairns Road)
		Wards River Conglomerate	Varies	
		Wenham Formation	24	Bowens Road (BR0-BR5) Bowens Road Lower (BR6)

Table 5.1 Summary of relevant stratigraphy

Group	Sub-Group	Formation	Approx Thickness (m)	Coal Seams
	Speldon Formation		77	
	Avon Sub-Group	Dog Trap Creek Formation	126	Glenview Marker 2
		Waukivory Creek Formation	326	Avon Triple Rombo Glen Road Valley View Parkers Road
Dewrang Group	Mammy Johnsons Formation		300	Mammy Johnsons
	Weismantel Formation		20	Weismantel
	Duralie Road Formation		250	
		Unconformity		
	Alum Mountain Volcanics			Clareval Basal Coal Seam

Notes: 1.Source: AECOM (2009) Gloucester Gas Project Environmental Assessment, prepared for AGL.

5.2 Climate

The regional climate in this part of the Upper Hunter is characterised by hot summers, averaging 27°C in January, with periods of humid, stormy conditions, while winters are cool to mild and dry with average temperatures of 6°C in July.

Meteorological data is collected at the Gloucester Post Office station, just north of the proposed exploration wells. The average annual rainfall in the area is 950 mm per annum, while the average evaporation rate is 1,103 mm. Evaporation exceeds precipitation from August to January.

5.3 Ecology

5.3.1 Introduction

An ecological assessment of the proposed drilling pads, monitoring piezometer and access tracks was undertaken by Alison Hunt and Associates. A copy of the assessment is provided in Appendix A. The ecological assessment was prepared in accordance with Part 5A of the EP&A Act, TSC Act and EPBC Act. In particular the ecological assessment identified:

- the potential for endangered ecological communities, threatened species and/or their habitat listed under the TSC Act to occur within the study area;
- the potential presence of any matters of National Environmental Significance (NES) listed under the EPBC Act; and

- any avoidance, management of mitigation options.

5.3.2 Methodology

The ecological assessment included:

- a review of available literature and ecological databases;
- a field investigation to ascertain existing site conditions;
- an impact assessment to determine the likely effects of the works on the ecology of the site and locality; and
- preparation of recommendations to mitigate impacts.

5.3.3 Existing environment

A site assessment was conducted by Alison Hunt and Associates on 17 November 2010. The proposed well locations, proposed water monitoring piezometer and access tracks are all within a highly modified environment that has been cleared of native vegetation, largely revegetated with introduced pasture species and used for the grazing of stock over a considerable number of years. None of the proposed sites contain remnant native shrubs or tress and none are located in riparian areas. The lack of structural diversity means that fauna habitat resources are extremely limited and in general the existing habitat would only be suitable to common species regularly found in disturbed areas.

i. Flora

The proposed locations of the wells, monitoring piezometer and access tracks are in paddocks which currently contain pasture species or exotic grasses. No native trees or shrubs were evident. Flora species present include:

- White Clover (Trifolium repens);
- Couch (Cynodon dactylon);
- Ryegrass (Lolium sp.);
- Carex sp.;
- Paspalum (Paspalum dilatatum);
- Kikuyu Grass (Pennisetum clandestinum);
- Purpletop (Verbena bonariensis); and
- Fireweed (Senecio madagascariensis);

ii. Fauna

The lack of structural diversity across the two lots means fauna habitat resources are limited. In general, habitat suitable for fauna would be limited to common species of native and introduced fauna found in disturbed areas such as:

- Eastern Grey Kangaroo (Macropus giganteus);
- European Red Fox (Vulpes vulpes);
- Black Rat (Rattus rattus);
- House Mouse (Mus musculus); and
- Domestic cats and dogs.

5.3.4 Impact assessment

A number of direct and indirect impacts associated with the construction and operation of the proposal have the potential to occur on the site and adjacent areas.

i. Endangered Ecological Communities (EECs)

The subject sites are located with the Karuah Manning Catchment Management Authority (CMA). Alison Hunt and Associates identified 12 endangered ecological communities (EECs) as being listed within this CMA. None of the 12 listed EECs were present on the subject sites.

ii. Commonwealth EPBC Act

The ecological assessment identified 14 fauna, 13 flora and 12 migratory species listed under the EPBC Act that have the potential to occur in the locality. Site investigations concluded that there are no EPBC Act listed species with real potential to occur across the sites or directly adjacent. It is considered that this proposal is highly unlikely to be a controlled action under the EPBC Act.

iii. Species listed under the TSC Act

A total of 63 threatened species listed under the TSC Act have been recorded in the locality, including 10 plans, one reptile, four amphibians, 25 birds and 23 mammals. The subject sites lack the complexity required to provide habitat for a range of threatened species as pasturelands generally have few refuge areas or foraging resources. Road reserves in the area may provide nesting and foraging habitat for the Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) which is listed as vulnerable under the TSC Act. Similarly, the Grass Owl (*Tyto capensis*) may occasionally forage across the area.

An Assessment of Significance under section 5A of the EP&A Act was undertaken on the Grey-crowned Babbler and Grass Owl by Alison Hunt and Associates (refer to Appendix A). It was concluded that the proposed works would not impact on any known breeding habitat for these species and it is unlikely to have a significant impact on foraging resources, and with appropriate management options as identified below, it is unlikely that any of these species would be significantly impacted. Therefore, a Species Impact Statement is not required.

iv. Corridors and connectivity

The proposed works are situated in an agricultural landscape and most of the adjacent lands have been previously cleared, with only isolated pockets of remnant bushland remaining with the broad valley area around Gloucester. The Avon and Gloucester Rivers would provide the strongest linkages in the area. The proposed wells and piezometer are unlikely to affect movement corridors and connectivity for any species of flora or fauna within the locality.

v. SEPP 44 – Koala Habitat Protection

An assessment under SEPP 44 was also undertaken by Alison Hunt and Associates as Gloucester is a local government area listed under Schedule 1 of SEPP 44. The assessment concluded that the proposed exploration well sites, proposed monitoring piezometer site and access tracks could not be considered core koala habitat or potential koala habitat as the proposed area lacks trees and in particular those species listed under Schedule 2 of the SEPP.

vi. Key threatening processes

It is unlikely that any key threatening processes listed under the TSC Act or EPBC Act would be exacerbated by this proposal as the proposed exploration well sites, proposed monitoring piezometer and access tracks have been located to avoid areas of native vegetation and riparian or seepage areas, and no native vegetation would be cleared or natural drainage patterns altered.

vii. Disturbance of fauna

Disturbance of fauna could occur as a result of increased noise levels from drilling or traffic. As the majority of construction activities would be within modified paddocks it is anticipated that this proposal would provide few risks to fauna.

viii. Runoff and sedimentation

There is the potential for impacts to drainage lines, downslope during the construction period of the proposed works. Provided appropriate erosion and sediment controls are implemented and that revegetation of disturbed areas occurs as soon as practical after construction there are not expected to be impacts associated with the works. It is also recommended that works not be undertaken during times of high rainfall.

ix. Priority actions

There are 90 priority actions identified as being “high priority” in the Gloucester local government area, which include actions that apply to 31 threatened species, populations and communities, and one key threatening process. None of the activities of the proposal are inconsistent with any of the strategies or actions identified for this area.

x. Cumulative impacts

The ecological assessment states that there is unlikely to be any cumulative impacts associated with the proposed works as native vegetation would not be removed, fauna habitat would not be altered and with appropriate management methods the hydrology of the site would not change and any impacts would be minor and temporary.

5.3.5 Mitigation measures

The ecological assessment identified the following mitigation measures:

- construction works be undertaken during drier periods;
- preparation and implementation of a construction environmental management plan for the works on-site, which includes:

- on site environmental management to advise machinery operators and other on-site personnel on ways of minimising ecological impacts;
- fencing of the areas where work is being carried out to ensure that machinery remains in the designated works zone and to contain the area of disturbance;
- measures to control the number of vehicles entering the sites(s);
- measures to control and strictly limit the speed of vehicles on the site to reduce the risk of fauna injuries;
- fencing the drilling sites with temporary stock proof fencing and bunded where appropriate;
- measures and requirements to ensure all drilling fluid is contained on site. No discharge of drilling fluid to waterways, aquatic and riparian environments would be permitted without suitable licences or approvals;
- measures to control weeds across all sites would be implemented;
- ongoing monitoring and, if necessary, restoration maintenance would be undertaken until grass cover has re-established;
- rubbish should be collected and removed off site to prevent it attracting pests, entering waterways and causing harm to fauna;
- no chemicals, fuels or wastes should be stored within or near any natural or stormwater drainage lines. All substances are to be contained in sealed vessels of appropriate volumes and, where necessary, stored within bunded areas;

- preparation and implementation of an erosion and sediment control plan which includes:
  - installation of sediment fences to prevent stormwater runoff and sediment entering the adjacent drainage lines and rivers;
  - stockpiling of soil that may contain seeds of exotic species away from the creeks, drainage lines and other areas of native vegetation to prevent transportation to adjacent areas during rainfall or wind events; and
  - measures to ensure that erosion and movement of sediments down slope do not occur during construction and these should include protection of bare ground with the use of jute mats or similar, weed control and revegetation of disturbed areas with pasture species.

5.4 Aboriginal cultural heritage

5.4.1 Introduction

An Aboriginal cultural heritage assessment was conducted for the proposed exploration wells WK 11, WK 12, WK 13 and WK 14 and their respective access tracks. Consideration was also provided to the site identified for the proposed groundwater monitoring piezometer.

The aim of the assessment was to identify the Aboriginal cultural heritage values pertaining to the specific areas to be impacted by the proposed exploration wells and water monitoring piezometer. Cultural

heritage values may pertain to physical sites of Aboriginal objects, particular significant historical associations with the particular areas or socio-cultural values associated with Aboriginal tradition. The most commonly identified Aboriginal heritage values in assessments of this nature relate to the presence of Aboriginal objects. The location of one or more Aboriginal objects is generally referred to as an Aboriginal site.

5.4.2 Methodology

The methods employed to identify Aboriginal cultural heritage values included background research, physical inspection and Aboriginal consultation. Background research included a review of the recent comprehensive Aboriginal heritage assessment conducted for the related Gloucester Coal Seam Gas Project. Survey for the gas pipeline related to that project included the study area. This assessment in accordance with due diligence guidelines relies on the background environmental data provided in that report as relevant to understanding the archaeological potential of the area. A search of the Aboriginal Heritage Information System (AHIMS) database for Aboriginal site records was also conducted on 14 January 2011 for the area surrounding the proposed exploration gas wells and water monitoring piezometer.

Aboriginal consultation was conducted with the Forster Local Aboriginal Land Council through its Chief Executive Officer, Tim Kelly, and Norma Fisher, a local Aboriginal elder in Gloucester who both participated in a site inspection on 21 January 2011 with Neville Baker (EMM archaeologist) and Toni Laurie (AGL Land and Approvals Manager).

5.4.3 Background

The proposed impact areas occur between 100 m and 150 m of the junction of the Avon River and Waukivory Creek (Figure 5.1). Both watercourses appear to be comparable in channel size. No rock outcrops occur and land disturbance is limited to past land clearing for cattle grazing. The land form is creek-flat open cattle paddocks on soils derived from the Gloucester Coal Measures geology within the Gloucester Vale. The exception to this is WK11 which is situated on the top of a low spur. The eastern end of the spur is likely to have good archaeological potential due to its prominent elevated position with 270° outlook over the valley and close to water. Approximately 20 m of elevated flat area back from the edge of the eastern end of the spur is likely to be archaeologically sensitive, however WK 11 is proposed to be located 140 m west of this sensitive area.

The area was initially occupied by people of the Birpai language group, also known in the various literature as Biribay, Biribi, Birippi, Birrapee, Birripai, Birripi, Bripi, Brippai and Waw-wyper. According to Tindale (1974:192) this territory covered an area of some 7,300 km^2, extending from the Manning River at Taree south to Cape Hawke (near Forster) on the coast, and inland to the dividing range around Gloucester in the south west and the head of the Hastings River in the northwest.

Archaeological investigations have been limited in the area to a few coal mine assessments and the recent AECOM assessment cited above. AECOM (2009) report that there have been few archaeological surveys conducted in the Gloucester region, with only a few open stone artefact sites comprising small numbers of flaked stone tools recorded. The thick grass cover through this well-watered country is an obstacle to identifying open stone artefact sites. Such sites typically comprise flaked stone artefacts distributed within the topsoil, and therefore are readily hidden in a grassed paddock. Typically areas of intact ground within 50 m of a creek in the greater Hunter region are considered archaeologically sensitive based on the results of archaeological test excavations. Assessment of potential impact is therefore made on a predictive basis rather than on direct observation of open stone artefact sites.

5.4.4 Results

No Aboriginal sites occur within the impact areas including proposed exploration well and water monitoring piezometer locations and access tracks. One AHIMS record, 38-1-49 (site name LEA1) listed as a possible Aboriginal scarred tree, is located on the edge of the Avon River bank. The scarred tree was originally recorded by Rick Bullers as part of the AECOM Gloucester Coal Seam Gas 2009 survey and the assessment notes the uncertainty over its status as an Aboriginal scarred tree. The tree was identified in the field and assessed as not an Aboriginal scarred tree based on the absence of Aboriginal scarred tree attributes, notably the massive scar extending to the base of the tree and widening at the base in a manner typically of corm detachment or fire damage, and uncharacteristic of any known form of Aboriginal scarring. Regardless of the tree's status as an Aboriginal object, it is located over 200 m southeast of the nearest proposed exploration well location (WK 11) would not be impacted by the development.

A single stone artefact, site WK-IF-1, was located on a disturbed gravelled track east of WK 11 at MGA coordinates 402,571E 6,452,567N. The single indurated mudstone thick blade flake occurs in a disturbed context of introduced gravel on a rehabilitated access track and may be introduced with the gravel. The flake occurs within the archaeologically sensitive area and 160 m east of the proposed WK 11 well. The isolated find site would not be affected directly or indirectly by the proposed exploration well.

During fieldwork local Aboriginal elder Norma Fisher discussed the preference for Aboriginal people in the past to move along the creeks and camp close to the creek bank areas near tea tree. The tea tree could be burned to produce smoke and discourage insects. No Aboriginal socio-cultural heritage values specific to the areas nor to the creek valley generally were identified, but this does not diminish the overall value that Aboriginal people place on the landscape generally.

5.4.5 Legislative considerations

Aboriginal objects and Aboriginal places are protected by the NPW Act. Aboriginal sites are protected because they consist of Aboriginal objects. An Aboriginal place is defined in the Act as a place declared by the Minister that is or was of special significance with respect to Aboriginal culture. The Act includes a strict liability offence for harm to an Aboriginal object and provides significant penalties for individuals and corporation. An Aboriginal heritage Impact Permit (AHIP) must be obtained prior to harming Aboriginal objects. Applications to the DECCW for an AHIP must show evidence of Aboriginal consultation in accordance with the National Parks and Wildlife Regulation 2009 and follow published guidelines. The location of Aboriginal objects must be notified to DECCW in the prescribed manner.

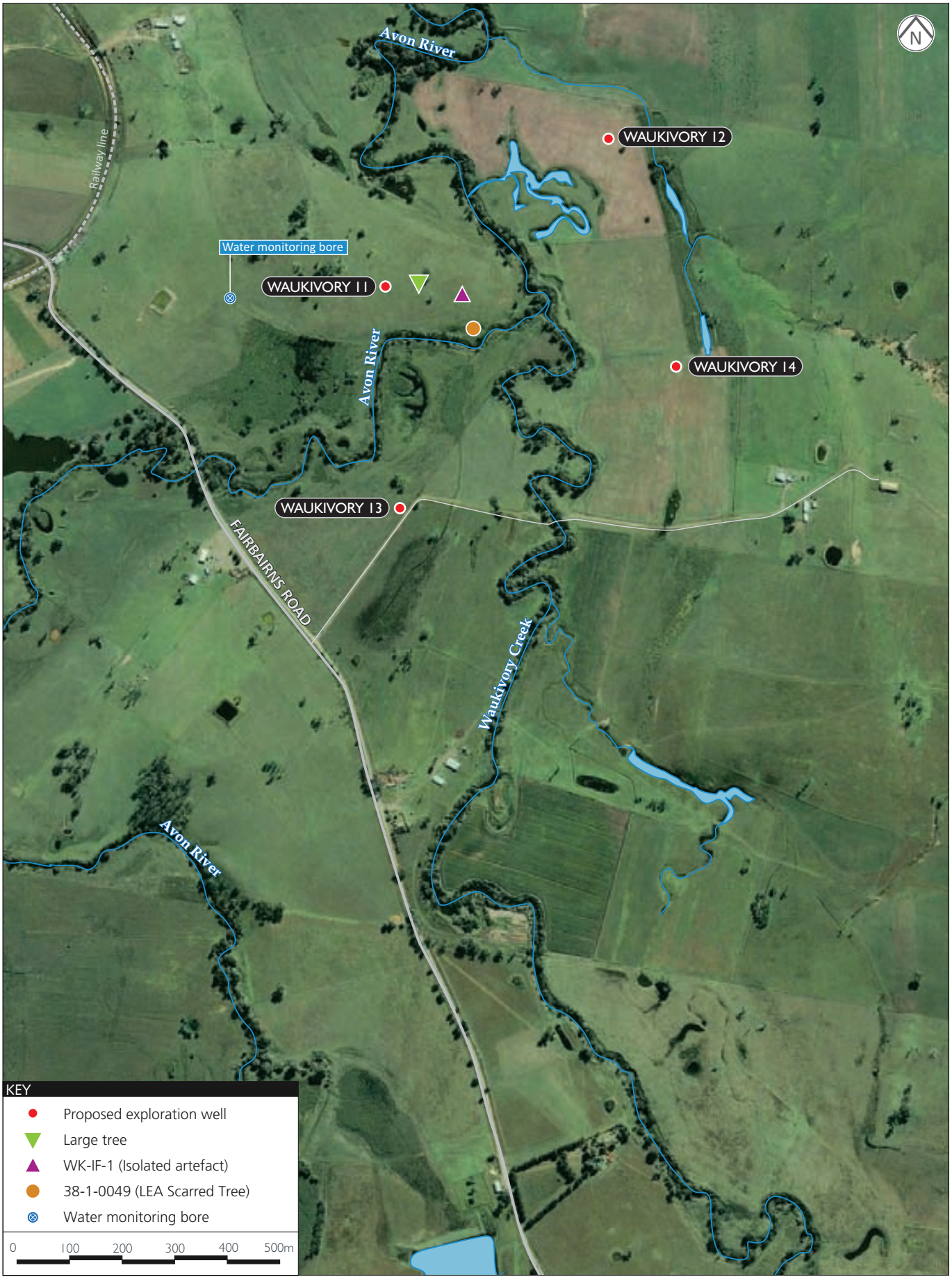
5.4.6 Mitigation measures

Although no Aboriginal heritage impacts were identified as part of the proposed works, Aboriginal heritage is still protected under the NPW Act. As such, all workers (including contractors) should be made aware that it illegal to destroy and Aboriginal item or artefact, and if it is considered that a potential Aboriginal item is uncovered during drilling works, all work is to cease and DECCW is to be contacted.

5.4.7 Conclusion

No Aboriginal heritage constraints to the proposed construction of the four exploration wells and water monitoring piezometer were identified. Furthermore, access tracks to the wells would not result in significant ground disturbance and would not pass over archaeologically sensitive landforms.

No further Aboriginal heritage investigations are considered necessary.



Aboriginal heritage items

Proposed exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 5.1

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5.5 Surface water

5.5.1 Existing environment

There are two watercourses in the vicinity of the proposed exploration wells as identified in Figure 1.2. The Avon River dissects the study area, with WK 11 located on the western side of the River while WK 12, WK 13 and WK 14 to the east. Waukivory Creek is a tributary of the Avon River which dissects WK 13 and WK 14. The intersection of Waukivory Creek and Avon River is located south of WK 11 and WK 12.

5.5.2 Impact assessment

The potential impacts on surface water of the proposed exploration wells and proposed water monitoring piezometer are from water (including stormwater) entering the drilling pad/compound or from water or sediment leaving the drilling pad and flowing into nearby watercourses. The water leaving the site may also contain oils and grease from operating machinery.

5.5.3 Mitigation measures

During the construction (i.e. drilling and fracture stimulation) of the proposed exploration wells and water monitoring piezometer, drainage and erosion control measures would be implemented to prevent potential off site surface water impacts by directing water flow around the drill pad ensuring water from adjacent areas does not flow into the pad area. These erosion and sediment control measures (see also Section 5.17) would be utilised to minimise the potential for sediment to move/migrate to nearby watercourses. Specific control measures may include silt fences, hay bales or diversion drains.

In conjunction with the management of surface water on site, appropriate waste management would be implemented on site to minimise potential for surface water interaction with and oil, grease or other fluids. Drilling fluids and cuttings, and all fracture stimulation fluids would be contained in onsite tanks to ensure no impact to surface water. Other measures would include ensuring fuel and lubricants are stored in appropriate places, degraded land is restored as soon as possible, and saline water is appropriately managed. As previously stated in Section 2, the temporary water storage ponds on site would be utilised for this purpose.

The following general measures would be implemented on the site:

- prohibition of petroleum based drilling fluids and additives in the drilling and testing of the proposed exploration wells;
- containment of contaminated water in tanks or lined ponds and where necessary removal and disposal at appropriate facilities;
- the prevention of discharge of drilling fluids and produced water to creeks;
- use of sediment fences/traps, diversion drains, hay bales etc 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 tanks/pond capacity to contain overflow from the main tank/pond in the event of increased flow from the well;

- upslope drains would divert upslope runoff water around disturbance areas; and
- restoration of all disturbed ground immediately following completion of the works.

5.6 Flooding

The subject lots are not within the "flood planning area" as identified in Gloucester LEP. A flood planning area is the area of land below the flood planning level (1 in 100 year flood plus a 0.5 m freeboard) and thus subject to flood related development controls. Thus, the site is not within a flood prone area.

5.7 Groundwater

5.7.1 Existing environment

i Groundwater depths, yields and levels

Within the Gloucester Basin, three types of aquifers have been identified during previous investigations (SRK Consulting,2010). In order of depth this includes:

- shallow alluvial aquifer;
- shallow bedrock aquifer; and
- coal seam water bearing zones.

Prior to the SRK Consulting investigations, an investigation undertaken by AECOM stated that the depth to water in the shallow alluvial aquifer in the Gloucester Basin ranges from 2 m to 20 m, while in the shallow bedrock aquifer depth to water is generally 20 m to 40 m. In addition, the groundwater within coal seams is considered a very poor aquifer, and is generally confined and sub-artesian with most water coming from higher in the stratigraphic sequence (AECOM 2009).

These results were confirmed by SRK Consulting (2010)[3] who reviewed the data available for registered groundwater bores in the Gloucester Basin. From a total of 128 registered bores/wells identified in the Gloucester Basin, the depth of the bores/wells varied from between 6 m to 66 m. Of these, four were located on an alluvial aquifer (6 m to 9 m deep) while the rest were all deeper, at up to 66 metres, and sited in the shallow fracture (bedrock) aquifer (Permian rocks). The majority of the bores and wells in the shallow bedrock aquifer had groundwater levels ranging from 1.5 m to 33.7 m below ground level (bgl). The investigation noted that studies undertaken at the Duralie Mine in the southern part of the Gloucester Basin (refer Figure 1.2) identified groundwater levels in the shallow bedrock aquifer as varying from 6.4 to 15.8 m bgl.

Many bores have been established for monitoring purposes with the remainder of bores/wells mostly being used for stock and domestic purposes. The primary aquifers across the catchment are the shallow alluvium associated with the major rivers and creek systems, and the shallow fractured bedrock to around 75 m depth.

[3] SRK Consulting (2010) *Gloucester Basin Stage 1 Gas Field Development Project Preliminary Groundwater Assessment and Initial Conceptual Hydrogeological Model*.

The maximum yield determined in alluvial bores and wells is 7.6 litres per second (L/s). The water bore yields from bores in the shallow fractured aquifer reported vary from 0.05 to 2 L/s. At depths greater than 150 m, bore yields decrease significantly and the coals seams are poor aquifers (most yields are less than 0.1 L/s).

ii Groundwater quality

The AECOM (2009) report notes that within the shallow alluvial aquifer groundwater is fresh to brackish and is suitable for domestic (non-potable) and livestock consumption and irrigation (at selected sites). Groundwater in the shallow bedrock aquifer is brackish to slightly saline while within the deep coal seam zones, groundwater is slightly to moderately saline and is unusable for most purposes. These results suggest that the groundwater gets more saline (due to longer residence times) with depth.

The water quality from the alluvial and shallow bedrock aquifers indicates salinity (EC) values between 500 μS/cm and 1,900 μS/cm, while salinity values up to 9,600 μS/cm have been recorded for the deeper coal seams.

iii Groundwater flows

The current conceptual flow model for groundwater flow within the Gloucester Basin is described within the SRK Consulting report (2010). Ridges and rock outcrops are generally considered as being zones of preferred rainfall recharge. Outcropping aquifer zones, including the alluvial sediments along the valley floor, are recharged via direct infiltration of rainfall. Shallow fractured aquifers and deeper water bearing zones (e.g. coal seams) are recharged around the margin of the basin where individual formations outcrop.

Towards the centre of the Gloucester Basin, deeper coal seams are confined and artesian conditions are suspected in the rock water bearing zones.

Rainfall recharge rates to the alluvial aquifers are considered to be high. Recharge in the coal seam aquifers (deep aquifers) is considered to be relatively low, as evidenced by the poorer groundwater quality of the coal seams.

Discharge from all the hydrogeological units occurs by seepage to springs, rivers and streams. As the Gloucester Basin is a closed geological basin, most groundwater is expected to discharge in the lower catchment areas of the Avon River and Gloucester River in the vicinity of Gloucester.

iv Permeability

Investigations by Pacific Power in 1999 on 28 coal intervals indicated that coal seam intrinsic permeability decreases sharply with depth. At 100 m depth the intrinsic permeability averages 100 milliDarcy (mD) and at 300 m depth its range is 7 mD to 27 mD. SRK Consulting converted these intrinsic permeability values to hydraulic conductivity and measurements were below 10^{-2} m per day. Generally, shallow beneficial aquifers have hydraulic conductivity values greater than 10^{-2} m per day with alluvial aquifers generally above 1 m per day.

5.7.2 Impact assessment

A change in the quality of the deeper (saline) groundwater during the drilling and fracture stimulation processes has the potential to change water quality in other adjacent zones. In particular, the potential impact of additives used in the fracture stimulation fluid and drilling fluids may enter the coal seam water

bearing zones causing potential water quality changes this deep groundwater. Notwithstanding this, this deep groundwater is too low in yield and too high in salinity to be considered a beneficial aquifer.

Groundwater contained in the upper alluvial and shallow fractured rock aquifers (the only useful groundwater sources in the Gloucester area as described in Section 5.7.1ii)) would not be impacted by drilling and fracture stimulation as these zones are cased and cemented off during the construction of the exploration wells.

The other potential source of groundwater contamination is for drilling and fracture stimulation fluids leaching through the ground from the surface into the shallow groundwater aquifer. Fluids used in the drilling and fracture stimulation process are pumped out of the exploration wells into tanks or lined ponds (refer to Section 2.5.2). Appropriate measures would be implemented to ensure there is no leakage from the lined ponds, and any drilling and fracture stimulation water is disposed of at an appropriate facility.

5.7.3 Mitigation measures

As previously discussed in Section 2.6.3, appropriately sized and lined ponds are proposed for the drilling pads to store any saline groundwater, which would be disposed of in an appropriate manner. This would prevent infiltration of saline waters from the surface to any shallow aquifers. No drilling circulation water is to be discharged to drainage lines or creeks.

The potential for contamination of shallow groundwater aquifers is also minimised through the use of a pressure rated steel casing in the production of well design. All wells would be cased off and cemented in accordance with the requirements of DII. It should be noted that wells are cased beyond the uppermost beneficial use aquifers to ensure there is no contamination of the groundwater. The proposed exploration wells would be up to 1,000 m deep with beneficial use aquifers in the area typically 20 m to 75 m bgl.

Upon completion of exploration activities wells are to be plugged or capped in accordance with industry best practice.

The four proposed exploration wells (and the one water monitoring piezometer) are within the approved GGP area. Whilst the management of the proposed exploration wells would be conducted through the EMP (see Appendix C), the proposed monitoring piezometer would be incorporated into the broader groundwater monitoring network and the Groundwater Management Plan to be prepared for the GGP to assess connectivity and to ensure there are no adverse impacts on the groundwater aquifers in this northern part of the Gloucester Basin.

5.7.4 Conclusion

It is considered that the management measures to be implemented during the drilling of the proposed exploration wells and the measures during the fracture stimulation activities would minimise the potential for groundwater resource impacts resulting from the proposed activities. However, it is possible that increased permeability may be experienced within the deep coal seam zones following fracture stimulation of the target coal seams. These coal seams are not beneficial use aquifers. As the seams are dewatered, there is potential for lowering of hydrostatic pressure and water levels within the deep coal seams but medium-long term water quality changes are unlikely.

5.8 Noise

5.8.1 Introduction

A noise assessment was under taken by EMM for the proposed exploration wells and water monitoring piezometer. The following aspects of the proposed exploration wells were assessed:

- potential environmental noise impact from the proposal including:
  - particularly noisy activities such as drilling and fracture stimulation;
  - other operational activities such as flaring; and
- predicted traffic noise from proposed increases in related road traffic.

The assessment assumes that drilling activities would occur at all times of the day, whereas fracture stimulation would occur for up to one hour per well during the daytime period.

A copy of the full noise assessment is contained in Appendix B.

5.8.2 Assessment criteria

The proposed exploration wells and water monitoring piezometer were assessed according to DECCW's Interim Construction Noise Guidelines (ICNG) which provides guidelines for the assessment and management of noise from construction works. The INCG recommended approach is a quantitative assessment, more complex approach than qualitative assessment, as the duration of the proposed exploration wells is greater than three weeks.

The ICNG recommends the following time restrictions for construction activities where resultant noise levels are audible at residential premises:

- Monday to Friday 7.00 am - 6.00 pm;
- Saturday 8.00 am - 1.00 pm; and
- no construction work to take place on Sundays or public holidays.

The ICNG noise level goals for activities during the above hours are 10dB above the existing background levels. For activities outside of the above hours the noise levels should be no more than 5dB above the existing background levels.

As there is no existing background noise level data at the surrounding sensitive residences, this assessment adopted a conservative approach of setting a background noise level typical of rural environments of 30dB(A). This approach is consistent with the guidelines of DECCW's Industrial Noise Policy. The residential construction noise criteria for the proposal are provided in Table 5.2.

Table 5.2 Residential construction noise criteria

Location	$L_{Aeq, 15min}$ Noise Criterion, dB(A)
Noise Assessment Locations (refer to Figure 1)	40, ie background plus 10dB (recommended hours)
	35, ie background plus 5dB (Out of hours)

Notes: 1. The recommended construction hours are as described earlier.

Potential noise impacts resulting from expected increases in traffic were assessed using DECCW's Environmental Criteria for Road Traffic Noise (ECRTN 1999). To determine suitable traffic noise criteria for a particular project, the road or roads must be categorised with respect to the ECRTN definitions. The current project would potentially create additional traffic on existing collector (The Bucketts Way) and local roads. The traffic noise criteria adopted for the proposal is provided in Table 5.3.

Table 5.3 NSW DECCW road traffic noise criteria

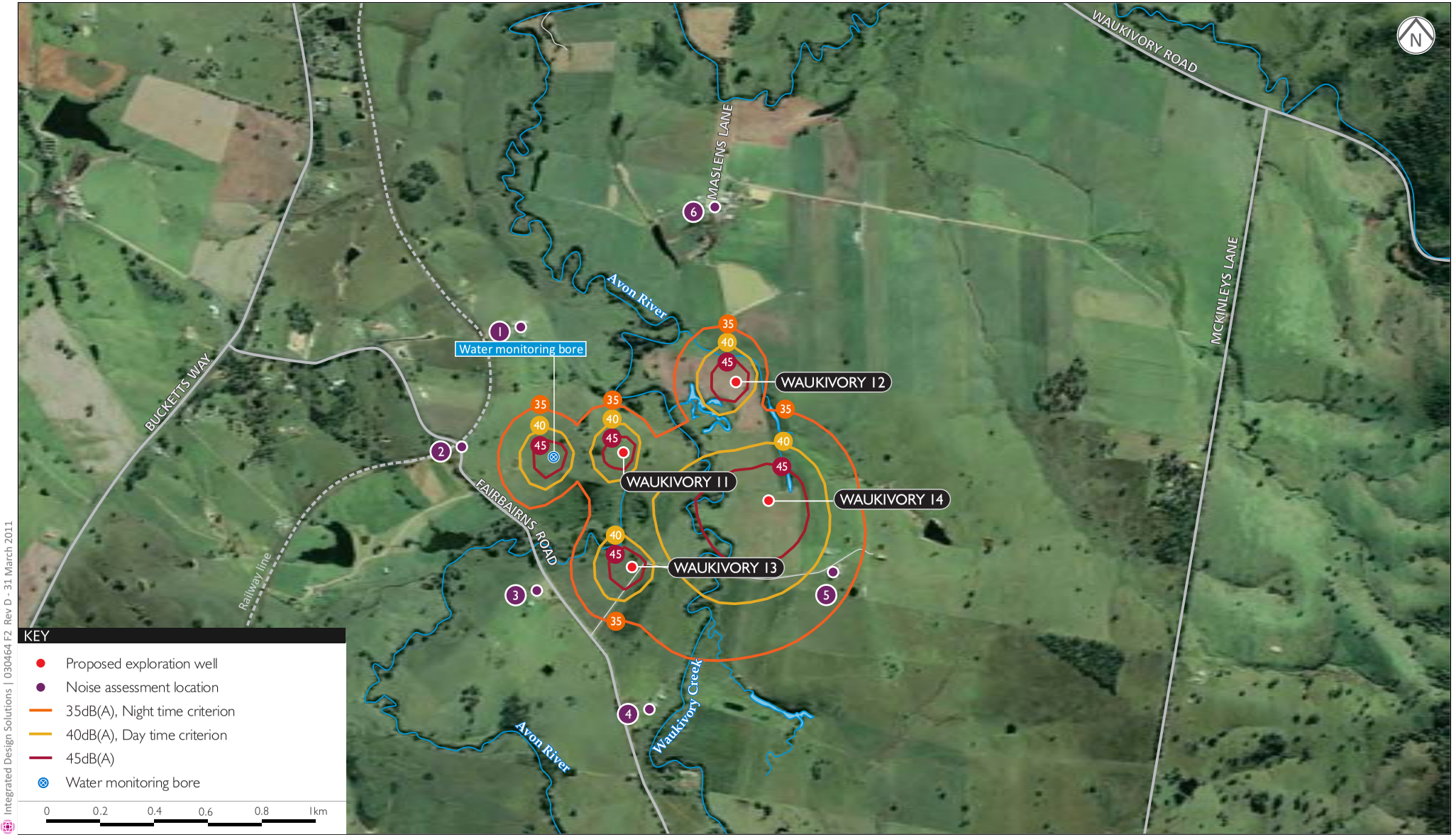
Type of Development	Criteria		
	Day (7 am– 10 pm), dB(A)	Night (10 pm– 7 am), dB(A)	Where criteria are already exceeded
Land use developments with potential to create additional traffic on collector road	$60L_{eq,15hr}$	$55\ L_{eq,9hr}$	Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access tracks; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB
Land use developments with potential to create additional traffic on local roads	$55\ L_{eq,1hr}$	$50\ L_{eq,1hr}$	

Proposed sleep disturbance criteria for the proposed exploration wells and water monitoring piezometer was again adopted using the ECRTN. The proposed night time criterion for the representative locations adopted in the assessment is 45dB(A)L_{max}, for intermittent type of events from the proposed works.

5.8.3 Predicted noise levels

i Noise assessment locations

The closest and potentially the most exposed noise sensitive receivers to the proposed exploration well locations and monitoring piezometer are residences as listed in Table 5.4. The proposed noise assessment locations are shown in Figure 5.2.



Predicted drilling outer envelope Leq noise levels - Mitigated drill and optimised layout dB(A)

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 5.2

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Table 5.4 Noise assessment locations

Location	Address
1	20 Grantham Road, Forbesdale, NSW 2422
2	unknown
3	176 Fairbairn's Road, Forbesdale, NSW 2422
4	237 Fairbairn's Road, Forbesdale, NSW 2422
5	197 Fairbairn's Road, Forbesdale, NSW 2422
6	114 Maslens Lane, Gloucester, NSW 2422

ii Drilling activities

The results of the noise modelling exercise for the drilling of the proposed exploration wells and the piezometer are presented below in Table 5.5. The table demonstrates that the drilling activities require mitigation measures, including specific orientation of equipment (i.e. layout configuration) to largely achieve prescribed daytime and out of hours noise criteria at identified receivers.

Table 5.5 Predicted Leq noise levels, dB(A) – drilling activities

	Receiver						Leq Noise Level Criteria, dB(A)	
	1	**2**	**3**	**4***	**5***	**6**	**Daytime**	**Out of hours**
Drilling activities (Unmitigated)								
WK11	**47**	**47**	**47**	**43**	**43**	37	40	35
WK 12	**45**	**42**	**42**	**41**	**46**	**48**	40	35
WK 13	**43**	**45**	**54**	**51**	**47**	**39**	40	35
WK 14	**41**	**41**	**44**	**45**	**53**	**42**	40	35
Piezometer	**50**	**54**	**50**	38	**41**	**41**	40	35
Drilling activities (Mitigated drill & layout)								
WK11	33	33	33	25	21	19	40	35
WK12	31	28	28	24	25	33	40	35
WK 13	28	31	**42**	33	24	19	40	35
WK 14	23	20	22	23	**37**	27	40	35
Piezometer	35	**40**	33	17	18	23	40	35
Drilling activities (Mitigated drill & layout, plus barrier)								
WK11	33	33	33	25	21	19	40	35
WK12	31	28	28	24	25	33	40	35
WK 13	18	21	32	33	24	19	40	35
WK 14	23	20	22	23	**37**	27	40	35
Piezometer	25	30	23	17	18	23	40	35

Note: Predicted exceedances of the criteria are shown in bold.

As shown in Table 5.5, the proposed drilling noise levels are predicted to meet daytime criteria without mitigation or barriers at two of the 24 predictions presented. Of the 22 daytime exceedances shown for drilling without any mitigation, nine results are marginal (≤3 dB) and four are not significant (≤5 dB). All daytime noise levels are well below the ICNG's 75 dB(A) 'significantly affected' goal. Other points of discussion for drilling are:

- WK 11:
  - Daytime - The unmitigated daytime drilling noise predictions satisfy criteria at one of the six assessment locations. Utilising the attenuated drill rig sound power levels, as specified in Appendix B, and optimised layout configuration, the criteria can be achieved at all locations.
  - Out of hours - The out of hours drilling noise is predicted to meet criteria at all assessment locations with the adoption of the attenuated drill rig sound power levels, as specified in Appendix B, and optimised layout configuration.
- WK 12:
  - Daytime - The unmitigated daytime drilling noise is predicted to exceed criteria at all six assessment locations. Utilising the attenuated drill rig sound power levels, as specified in Appendix B, and optimised layout configuration, the criteria can be achieved at all locations.
  - Out of hours – Similarly, out of hours drilling noise is predicted to satisfy criteria at all locations with the adoption of the attenuated drill rig sound power levels, as specified in Appendix B, and optimised layout configuration.
- WK 13:
  - Daytime - The unmitigated daytime drilling noise predictions satisfy criteria at one of the six assessment locations. The exceedances are 3 dB, 5 dB, 14 dB, 11 dB and 7 dB for locations one to five respectively. With the adoption of the attenuated drill rig sound power levels, as specified in Appendix B, and optimised layout configuration, five of the six assessment locations are predicted to satisfy daytime criteria. Introducing noise barriers to shield receivers to the west (ie location 3), shows that daytime drilling noise is predicted to meet criteria at all assessment locations.
  - Out of hours - Similarly, out of hours drilling is predicted to meet criteria at all six assessment locations with the adoption of the attenuated drill rig sound power levels, as specified in Appendix B, optimised layout configuration and noise barriers to protect assessment location 3.
- WK 14:
  - Daytime – The unmitigated daytime drilling noise is predicted to exceed criteria at all six assessment locations. The exceedances at are marginal at locations 1, 2 and 6 and not significant at location 3. With the adoption of the attenuated drill rig sound power levels, as specified in Appendix B, optimised layout configuration, daytime drilling noise is predicted to meet criteria at all locations.
  - Out of hours - Five out of the six assessment locations are predicted to satisfy the out of hours criteria. At location 5, the mitigated night time drilling noise is only marginally (2dB) above criteria. It is important to note that a difference in noise levels of 2dB is not

perceptible in practice. In our experience, at this noise level internal noise impact is not likely. The exceedances for night time drilling (assessed externally as required by the DECCW guidelines) are not likely to impact occupants of dwellings, given they would be indoors during the more sensitive sleep times. Furthermore, location 5 is owned by a neighbouring mining proponent.

- Water monitoring piezometer:

  - Daytime - The drilling noise satisfies the daytime criterion at location 4. The predicted exceedance for locations 5 and 6 is marginal (1 dB). The predicted exceedances at locations 1 to 3 are more significant. With the adoption of the attenuated drill rig sound power levels, as specified in Appendix B, optimised layout configuration, five of the six assessment locations are predicted to satisfy daytime criteria. Introducing noise barriers to shield receivers to the west (ie location 2), shows that daytime drilling noise is predicted to meet criteria at all assessment locations.

  - Out of hours – Similarly, out of hours drilling is predicted to meet criteria at all six assessment locations with the adoption of the attenuated drill rig sound power levels, as specified in Appendix B, and optimised layout configuration and noise barriers to protect assessment location 2.

It should be re-iterated that the above results for the attenuated drill rig sound power levels, as specified in Appendix B, and optimised layout configuration take advantage of the directional characteristics for the drilling orientation for the closest residence.

iii Fracture stimulation activities

Once a well is drilled, completed and cemented, selected coal seams would be perforated and hydraulically fractured (i.e. fracture stimulation) so the proposed exploration well is ready for testing. Fracture stimulation uses the hydraulic pressure of fluid pumped into gas wells to open coal seams and help increase gas flow to surface. Fracture stimulation under the proposed exploration wells would be undertaken only for WK 11 and WK 13 during the daytime shift (a period of 12 hours) with under-reaming activities occurring at WK 12 and WK 14. However, fracture stimulation activities may also occur at these wells should under-reaming not achieve the prescribed outcomes for pilot testing purposes.

Importantly, fracture stimulation will only occur for up to one hour per exploration well during the daytime period only. Predicted noise levels resulting from fractures stimulation activities were modelled unmitigated and with mitigation methods applied at identified residential assessment locations and are presented in Table 5.6.

Table 5.6 Predicted Leq noise levels, d(B)A – fracture stimulation activities

	Receiver						Leq Noise Level Criteria, dB(A)	
	1	**2**	**3**	**4***	**5***	**6**	**Daytime**	**Out of hours**
Fracture stimulation activities (Unmitigated)								
WK 11	**62**	**62**	**62**	**58**	**58**	**52**	40	35
WK 12	**60**	**57**	**57**	**56**	**61**	**63**	40	35
WK 13	**58**	**60**	**69**	**66**	**62**	**54**	40	35
WK 14	**56**	**56**	**59**	**60**	**68**	**57**	40	35

	Receiver						Leq Noise Level Criteria, dB(A)	
	1	2	3	4*	5*	6	Daytime	Out of hours
Fracture stimulation activities (Mitigated - Barrier)								
WK 11	**52**	**52**	**52**	**48**	**48**	**42**	40	NA
WK 12	**50**	**47**	**47**	**46**	**51**	**53**	40	NA
WK 13	**48**	**50**	**59**	**56**	**52**	**44**	40	NA
WK 14	**46**	**46**	**49**	**50**	**58**	**47**	40	NA

*Notes: 1. *These properties are owned by a neighbouring mining company.*

With respect to predicted fracture stimulation noise, all daytime noise levels are well below the ICNG's 75 dB(A) 'highly affected' level. Other findings include the following:

- Without mitigation, the results show that predicted daytime fracture stimulation noise would not meet criteria at all assessment locations for any wells. However, predicted noise levels are below the DECCW highly affected level of 75 dB(A); and
- With noise barriers in place as for drilling, fracture stimulation noise levels as received at the assessment locations are significantly reduced. However, they remain above recommended daytime criteria. Given that this activity is limited to day shift only and to approximately one hour duration at each exploration well, impacts are considered manageable through the community consultation notification process.

iv Operational activities (flaring)

Once the drilling and fracture stimulation activities have been completed, the proposed exploration wells are pilot tested for gas flow. During pilot testing, gas is brought to the surface via the well and sent to an enclosed flare where the gas is burned off.

Flaring is a relatively quiet activity compared to drilling or fracture stimulation and two standard shipping containers would be used to shield the flare and reduce noise emissions by at least 5dB. Predicted noise levels were modelled for the combined noise level of all four wells flaring simultaneously, as a worst case scenario, and are provide in Table 5.7. The results show that the predicted noise from flaring satisfies noise criteria at all receivers and hence no noise impacts from flaring are expected.

Table 5.7 Operational (flaring) noise levels

Receiver	Predicted Leq Noise Levels for all four wells combined	Noise Criteria, dB(A) Day/evening/night
1	21	35
2	20	35
3	27	35
4	23	35
5	25	35
6	20	35

Integrated Design Solutions | 030464 F3 Rev B - 21 March 2011

Predicted operational (Flaring) Leq noise levels from all wells combined, dB(A)

Proposed exploration wells - Waukivory 11 to 14

Client: AGL Energy

Figure 5.3

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v Sleep disturbance

Noise from possible intermittent activities include hammering using hand tools, metal to metal contact associated with out of hours drilling and similar activities. A typical source sound power (emission) level of 115dB(A) was used to predict maximum (Lmax) noise at receivers. Table 5.8 presents the predicted Lmax noise levels assessed against the sleep disturbance criterion (45dB(A)).

Table 5.8 Predicted Lmax noise levels, dB(A)

Well	Receiver						Sleep Disturbance Criteria, dB(A)
	1	2	3	4	5	6	
WK 11	47	47	47	41	43	41	45
WK 12	44	41	39	38	44	47	45
WK 13	41	44	54	50	46	36	45
WK 14	39	39	43	44	54	39	45
Piezometer	53	57	53	41	45	45	45

Noise from possible intermittent activities include hammering using hand tools, metal to metal contact associated with out of hours drilling and similar activities. A typical source sound power (emission) level of 115 dB(A) was used to predict maximum (Lmax) noise at receivers. Table 4.6 presents the predicted Lmax noise levels assessed against the sleep disturbance criterion (45 dB(A)). Noise emitted from these activities should be controlled and managed by appropriate measures. The results do not include the benefits of barriers, which if designed appropriately would reduce levels to satisfy criteria at most locations. The only except may be location 2 during drilling of the water monitoring piezometer, where a marginal 2dB exceedance is predicted (ie 57dB(A) minus 10dB for barrier, results in a 47dB(A)Lmax level). This potential marginal exceedance is however limited to one or two nights. As discussed previously, a 2dB difference in noise level is not perceptible in practice.

vi Traffic noise

The calculation and prediction of road traffic noise adopts a standards-based approach to modelling, in that noise propagation calculations are carried out in accordance with accepted standards used in various countries. The adopted algorithm is the United Kingdom Calculation of Road Traffic Noise (CoRTN) method.

The expected traffic generation for the project was based on project related traffic information and existing traffic volumes obtained from the RTA and are presented in Table 5.9.

Table 5.9 Traffic volumes per well site

Truck Movements/day	Days of Operation per well	Time of truck movements	Truck movements per hour
60	180	2 x 12hr shifts/7 days	2 to 3 - on average 5 - typical maximum

Based on the above truck and small vehicle movements, and an assumed average pass-by traffic speed of 50km/hr, predicted noise levels for existing and future (including site related) traffic at nominal setback distances are summarised against criteria in Table 5.10 and show no exceedances.

Table 5.10 Predicted traffic noise levels

	Bucketts Way				Local Roads			
Set Back Distance (m)	**Day Leq,15hr, dB(A)**		**Night Leq,9hr, dB(A)**		**Day Leq,1hr, dB(A)**		**Night Leq,1hr, dB(A)**	
	Existing	**Inc. Project**	**Existing**	**Inc. Project**	**Existing (negligible)**	**Inc. Project**	**Existing (negligible)**	**Inc. Project**
20	59	59	54	54	39	52	36	50
40	56	56	51	51	36	48	33	47
60	54	54	49	49	33	46	30	45
80	52	52	47	47	32	45	29	43
100	51	51	46	46	31	44	28	42
150	49	49	44	44	29	41	26	40
Criteria	**60**	**60**	**55**	**55**	**55**	**55**	**50**	**50**

5.8.4 Noise management

The noise assessment recommends mitigation of noise by adoption of the attenuated drill rig sound power levels, as specified in Appendix B, optimised plant layout, as well as noise barriers during drilling at some sites, and for fracture stimulation to shield these noise sources and reduce impacts at residences. With these measures in place, drilling noise is shown to satisfy recommended criteria at all locations during the day and night periods, with the exception of a marginal 2dB exceedance at night at location 5 (a property owned by a neighbouring mining company). It should be noted that drilling noise levels inside this residence are not likely to be significant, and hence impact to any occupants during the night period is not expected.

It is expected that whilst daytime noise criteria may be exceeded at residences by fracture stimulation activities, the predicted noise levels are well below the DECCW's highly noise affected levels. The exceedances are limited to approximately one hour during the daytime at each of the four exploration wells. Hence, daytime construction noise levels are considered manageable.

The assessment also finds that sleep disturbance issues at night can be mitigated to satisfy DECCW criteria at most locations and that road traffic noise levels are predicted to satisfy relevant DECCW criteria. Similarly, noise from exploration well operations (i.e. flaring) is predicted to satisfy noise criteria at all residences and hence impact is not likely from flaring noise.

Other good practice noise management measures that should be considered include the following:

- use noise monitoring during initial drilling and fracture stimulation operations at the first exploration well site to be constructed to affirm and calibrate noise predictions;
- orientate the drill rig to take advantage of directional noise characteristics for the closest residence for the given well site as described in this report;
- ensure the community is consulted and provide them with written notice well in advance of proposed activities;

- ensure all landholders of each well are consulted and supportive of the project's intention for out of hours activities;
- where possible obtain a drill rig with lower noise emission levels;
- use temporary noise barriers as described in this report; and
- employ all reasonable and feasible work practices to minimise any impacts.

5.9 Visual amenity

This section describes the existing visual character of the area surrounding the proposed activities, identifies potentially sensitive viewpoints in relation to these areas, and assesses the potential visual impacts of the proposed activities on visual amenity.

5.9.1 Existing environment

The landscape of the Gloucester region is characterised by forested mountain ranges, meandering rivers and undulating valleys which support a mix of land uses including agriculture, mining and residential development. The proposed activities are located in a valley formed between two mountain ranges, namely Mount Mograni to the east and Gloucester Buckets to the west. The valley is mostly cleared of native vegetation and the dominant land use is grazing. There are two waterways near the proposed activities, namely the Avon River and Waukivory Creek (refer to Figure 1.2).

There is a narrow area of riparian vegetation along the banks of the Avon River and Waukivory Creek and McKinleys Lane is lined with vegetation. There are three patches of remnant vegetation, two of which have an area of approximately 3 hectares (ha) and one of approximately 7 ha, located east of the proposed activities but west of McKinleys Lane.

The visual catchment of the proposed activities is the area in which they would be visible. The visual catchment is bound by McKinleys Lane to the east, Fairbairns Road to the south, Bucketts Way to the west and Maslens Lane to the north. The proposed activities are unlikely to be viewable from Bucketts Way and McKinleys Lane. WK 13 could be seen from Fairbairns Road and WK 12 and WK 14 could be seen from Maslens Lane. Additional potential visual receivers of the proposed activities are the residences shown on Figure 5.4.

The proposed activities are located on flat paddocks at the lowest elevations in the valley. The elevation from WK 11 progressively increases from approximately 100 m to approximately 148 m near Bucketts Way. This progression in elevation is similar for the proposed monitoring piezometer location. There is little difference in elevation between WK 12 and WK 14 and Maslens Lane. However, elevation increases from approximately 98m at WK 12 and WK 14 to approximately 140 m at McKinleys Lane. There is little difference in elevation between WK 13 and Fairbairns Road.

5.9.2 Impact assessment

Following a site inspection of the locations of the proposed works and the surrounding area, 13 viewscape locations were selected from which the proposed activities could be visible. Two of the viewscape locations are on public roads and the remainder are at residences. No locations on Bucketts Way and McKinleys Lane are included as viewscape locations due to the items within the intervening terrain between these roads and the proposed activities, which would obscure views. These items include the residential development near The Bucketts Way and the trees lining, and remnant patches of vegetation west of, McKinleys Lane. These viewscape locations are shown on Figure 5.4.

Potential impacts have been assessed by considering the visibility of the proposed activities from surrounding areas, the visual absorption capacity of the area with respect to the proposed activities, and the visual sensitivity of the viewscapes.

Visual absorption capacity is the ability of a landscape to be changed and still retain its existing visual characteristics, such as rural, built or natural character. It is determined by considering the visibility of the proposed activities and the degree of contrast between them and the local regional viewscapes.

Visual sensitivity is a measure of the level of concern attached by the surrounding land users to a change in the landscape character. It is based on factors including the number of people affected, landuse, visibility, the current degree of exposure to the style of development proposed, distance of viewers from the proposed activities, and the duration of viewing time.

The visual characteristics of each viewscape are described in terms of three horizontal sections. These are:

- foreground of the viewscape - this is the lowest horizontal section;
- mid-section of the viewscape - this is the middle section of the viewscape;
- upper section of the viewscape - this is the top horizontal section of the viewscape;

The locations of the viewscapes are detailed in Table 5.11. A summary of the visual impact assessment findings for each of the six viewscape locations is presented in Table 5.12.

Table 5.11 Potential visual receivers

Location	Address	Distance from proposed Waukivory exploration wells and water monitoring piezometer (m)				
		11	12	13	14	WMB
1	20 Grantham Road, Forbesdale	600	820	995	1,130	504
2	Fairbairns Road, Forbesdale	590	1,030	795	1,140	343
3	176 Fairbairns Road, Forbesdale	650	1,100	370	910	521
4	237 Fairbairns Road, Forbesdale	970	1,250	500	840	971
5	197 Fairbairns Road, Forbesdale	912	790	755	360	1,141
6	114 Maslens Lane, Gloucester	960	645	1,400	1,140	1,134
7	146 McKinleys Lane, Forbesdale	2,040	1,682	2,035	1,516	2,321
8	211 McKinleys Lane, Forbesdale	2,310	2,065	2,167	1,753	2,564
9	Maslens Lane	1,143	734	1,505	1,157	1,335
10	18 Grantham Road, Forbesdale	918	1,253	1,178	1,477	696
11	77 Fairbairns Road, Forbesdale	794	1,168	1,018	1,353	548
12	Fairbairns Road, Forbesdale	605	1,042	301	858	624
13	1383 McKinleys Lane, Forbesdale	2,029	1,648	2,039	1,512	2,321

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Viewpoint locations

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 5.4

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Table 5.12 Viewscape locations: visual impact assessment results

Viewscape location	Existing viewscape location details	Proposed activity sites potentially visible	Visual sensitivity	Visual absorption capacity	Significance of visual impacts
1, 2, 10 and 11	The foreground of these viewscape locations features relatively flat agricultural land. Additionally, the main northern railway features for locations 10 and 11. The mid-section of this viewscape comprises agricultural land and a narrow band of riparian vegetation associated with the Avon River and Waukivory Creek. The upper section of the viewscape features the woodland and mountain range associated with Mount Mograni. These viewscapes are located on higher ground near the western extent of the visual catchment.	Each of the proposed sites is potentially visible from locations 10 and 11 given that these are between 24 m and 31 m higher in elevation than the proposed sites and relatively uninterrupted views. However, the proposed WK 12, WK 13 and WK 14 sites are unlikely to be visible from locations 1 and 2 given that there is little difference in elevation and there is intervening riparian vegetation obstructing views. Lighting would likely impact each of these locations at night if the lights are not directed away from these potential receivers.	Low	High	This potential visual impact is considered minor.
3, 4 and 12	The foreground and mid-section of these viewscapes features relatively flat agricultural land. The upper-section of the viewscape comprises riparian vegetation associated with the Avon River and Waukivory Creek. These viewscapes are located at relatively flat and low ground at the southern extent of the visual catchment.	WK 13 would feature moderately in these viewscapes given its relatively close proximity. The other proposed sites would not be visible given intervening riparian vegetation. Lighting would likely impact each of these locations at night if the lights are not directed away from these potential receivers.	Moderate	Moderate	This potential visual impact is considered moderate.
5	The foreground of this viewscape features relatively flat agricultural land. The mid-section of this viewscape comprises agricultural land and a narrow band of riparian vegetation associated with the Avon River and Waukivory Creek. The upper section of the viewscape features the woodland and mountain range associated with Gloucester Buckets. This viewscape is located at an area of elevated terrain at the centre of the visual catchment and is surrounded by low grazing land.	WK 12 and WK 14 would feature moderately in this viewscape, particularly WK 14 given its relatively close proximity of to the location. WK 11, monitoring piezometer and WK 13 are unlikely to be visible given the intervening riparian vegetation. Lighting would likely impact this location at night if the lights are not directed away from this potential receiver.	Low	Moderate	This potential visual impact is considered minor.

Table 5.12 Viewscape locations: visual impact assessment results

Viewscape location	Existing viewscape location details	Proposed activity sites potentially visible	Visual sensitivity	Visual absorption capacity	Significance of visual impacts
6 and 9	The foreground of these viewscapes features relatively flat agricultural land. The mid and upper-sections of these viewscapes comprises agricultural land and a narrow band of riparian vegetation associated with the Avon River and Waukivory Creek. These viewscapes are located in an area of elevated terrain at the northern extent of the visual catchment and is surrounded by low grazing land.	WK 12 and WK 14 would feature moderately in this viewscape, particularly WK 12 given its relatively close proximity of it to the location. WK 11 and WK 13, and monitoring piezometer are unlikely to be visible given the intervening riparian vegetation. Lighting would likely impact this location at night if the lights are not directed away from this potential receiver.	Low	Moderate	This potential visual impact is considered minor.
7, 8 and 13	The foreground of these viewscapes features relatively flat agricultural land. The mid-section of these viewscapes comprises agricultural land and a narrow band of riparian vegetation associated with the Avon River and Waukivory Creek. The upper section of the viewscapes features the woodland and mountain range associated with Gloucester Buckets. Additionally, these locations have some vegetation in their immediate foreground. These viewscapes are located at an area of elevated terrain at the eastern extent of the visual catchment.	Locations 7 and 13 would have filtered views of each of the proposed sites. Location 8 is unlikely to see any of the proposed sites given intervening vegetation along McKinleys Lane and a stand of remnant vegetation to the west. Lighting would likely impact locations 7 and 13 at night if the lights are not directed away from these potential receivers.	Low	High	This potential visual impact is considered minor.

5.9.3 Mitigation measures

The proposed construction and drilling works are considered to be temporary and short term in nature. Furthermore the activities would not be a significant visual contrast from existing agricultural practices in the area, that is, the operation of machinery and construction of agriculture related infrastructure such as sheds, silos and conveyors. The flare structures to be constructed at the conclusion of drilling activities would comprise green shipping containers which may potentially contrast with the surrounding land use, namely grazing. In respect to the construction, drilling and flaring activities, the following general management measures would apply:

- the site would be maintained in an orderly manner;
- works would be completed within the shortest possible timeframe;
- all temporary signage associated with the works would be kept in good order;
- the spread of materials stockpiles, waste and vehicle parking would be minimised;
- where possible, all work equipment and materials would be contained within the designated boundaries of the works compound; and
- on completion of the works, all vehicles, construction equipment, materials and refuse relating to the works would be removed from work areas, and all areas would be restored to a level which matches as closely as possible, or is better than, the pre-work condition.

Additional to these measures, night lighting would be positioned to avoid potential impacts to the visual receivers identified in this section. All lights will be positioned so that they point to the north-east as there are no potential visual receivers located in this direction.

If any complaints pertaining to the visual characteristics of the proposed activities are received, a landscape management plan would be prepared detailing mitigation measures to be implemented. Such measures may include the installation of screening for short term operations such as construction and drilling, and tree plantings for longer term operations such as flaring.

5.9.4 Conclusion

The landscape surrounding the proposed activities is rural in nature and comprises undulating hills in a valley bound by two mountain ranges. Agricultural practices occur within the valley and are principally for the purpose of grazing. There is little vegetation in the valley other than a narrow strip of riparian vegetation associated with two waterways, namely the Avon River and Waukivory Creek, and some small patches of remnant vegetation. The proposed activities would not feature significantly against this landscape, given their similarity to existing agricultural practices.

Therefore, given the low visual sensitivity and moderate to high visual absorption capacity of the region and the management measures detailed below, it is unlikely that the proposed activities would significantly negatively impact the viewscapes within the visual catchment. In the case that any viewscape is significantly adversely impacted, a landscape management plan would be prepared which would detailed management measures to be implemented.

5.10 Air quality

5.10.1 Existing environment

The air quality in the vicinity of the proposed exploration wells is influenced by typical rural activities such as cattle grazing and trucking of rural products. There is a rural residential estate approximately one kilometre from the proposed sites as well as the main road (The Bucketts Way) which would influence the existing air quality mainly through vehicle transport, and dust during dry periods.

5.10.2 Impact assessment

i Vehicles and construction activities

The potential impact of the proposed works on air quality in the locality from the vehicles and construction is expected to be very minor. The main source of potential air quality issues would arise from vehicle emissions (although these are minimal), and potential dust rising during construction activities (i.e. drilling). Access to the majority of the proposed sites is expected to be via existing farm tracks. As referenced in Section 2, minor upgrades would be required to the proposed access tracks. These upgrades would comprise of compacted gravel to allow access for the required equipment including the drill rig. Dust generation by vehicles along these tracks would be minor and similar to existing farm uses.

During construction, construction plant and machinery as well as private vehicles would produce exhaust emissions. There is not expected to be a significant impact from the movement of private motor vehicles nor plant or equipment. As discussed below there are a number of water cart movements required over a relatively short time frame to enable the drilling to occur, which may have some noise impacts. This is discussed in Section 5.8.

The drill pads require minimal earthworks and would occupy a limited area. As such, dust generation from the drill rig would be negligible. Drill pads would also be utilised for fracture stimulation operations at identified exploration well sites, with the potential for some minor modifications to the site layout depending on the location of the well head and access track. There would be some supply truck and pumping unit movement in the area. Lined ponds would also need to be constructed as discussed in Section 2, which would require some minor earthworks.

ii Flaring

As previously noted in Section 2, flaring of gas burns off any combustible vapours produced from the gas well. The released gases and/or hydrocarbon vapour liquids are burned as they leave the flare stacks. Flaring is also considered the most environmentally friendly method to dispose of gas. The carbon dioxide (CO_2) produced from the burning process (i.e. the burning of methane gas) has less than one-twentieth the impact on the Earth's atmosphere than methane. Flaring is proposed to be conducted across the four well sites, over a short time period during the testing stage of the process. The main potential impacts of flaring are:

- noise;
- potential safety issues from the extremely hot flame;
- risk of the flare causing fire on surrounding vegetation; and
- emissions to the atmosphere.

To address the identified potential impacts above, operational measures would be implemented to address these impacts. These measures are outlined in the section below.

5.10.3 Mitigation measures

i Vehicles and construction activities

Although dust generation from the drill pads and access tracks, and vehicle emissions are expected to be minor the following mitigation measures are proposed to minimise and impact.

- speed limits on access tracks should be enforced to limit potential dust impacts;
- vehicles and equipment are required to be appropriately maintained to minimise exhaust emissions. Contractors would also need to ensure all equipment is maintained and service according to the manufacturers specifications;
- following the proposed fracture stimulation the drill pad can be reduced to some 10 m x 10 m further reducing the potential for dust generation. Once exploration activities are complete the disturbed area would be rehabilitated; and
- the construction of lined ponds would only be very short term construction activity involving an area of approximately 40 m x 40 m. Dust generation would be controlled during these works through suppression by water.

With the implementation of the prescribed mitigation measures listed above it is anticipated that there would be a very minimal impact on air quality from vehicles and construction works. It is also considered that the long term air quality impact is negligible from the proposed works.

ii Flaring

The following controls would be implemented during the flaring activities to minimise potential impacts:

- continuous flaring should take place within an enclosed flare assembly;
- ensure there is an adequate exclusion zone for safety and fire purposes; and
- the flaring of gas shall be limited to that necessary as part of the evaluation process, following which flaring shall cease.

Given that flaring is considered the preferred environmentally method for the disposal of methane and the implementation of the above management measures during the flaring activities, it is considered that the potential greenhouse gas emissions resulting from the proposed exploration wells are relatively minor.

5.11 Traffic

5.11.1 Existing environment

The main road in the vicinity of the proposed exploration wells is The Bucketts Way (Main Road No. 90). The Bucketts Way is a road managed by the Roads and Traffic Authority (RTA). Other roads that are proposed to be used for accessing the subject lots are local roads managed by Council. The main access points to the proposed exploration wells and monitoring piezometer would be Fairbairns Road, McKinleys

Lane (to the east of the well sites) or Maslens Lane to the north. Fairbairns Road would be used to access WK 11 and WK 13, and the monitoring bore while there are two options (McKinleys Lane and Maslens Lane) for accessing WK 12 and WK 14.

The RTA has developed a set of road classifications (refer to Table 5.13) indicating typical traffic volumes for different road types. The traffic volumes are expressed in terms of average annual daily traffic (AADT) counts. In practice, main roads tend to have higher AADT counts than local roads.

Table 5.13 RTA road hierarchy classification

Type of Road	Traffic Volume (AADT)	Peak Hour Volume (phv)
Arterial Road	Greater than 15,000	1,500 – 5,600
Sub-Arterial Road	5,000 – 20,000	500 – 2,000
Collector Road	2,000 – 10,000	250 – 1,000
Local Road	Less than 2,000	0 - 250

Notes: 1.Source: RTA Guide to Traffic Generating Developments (2002)

The most recent traffic counts undertaken by the RTA in the vicinity of the subject lots was in 2004, which recorded an AADT of 4,095 for The Bucketts Way. Traffic counts were recorded at a number of locations along The Bucketts Way. The results are presented in Table 5.14.

Table 5.14 Average annual daily traffic, 2004

Locality	Recording Location	2004 AADT
Gloucester	09.332 – The Bucketts Way	4,095
Stratford	09.330 – The Bucketts Way	1,555
Weismantles	09.919 – The Bucketts Way	1,643
Stroud	09.916 – The Bucketts Way	2,043

The 2004 AADT volumes classify The Bucketts Way in the vicinity of the subject lots as a “collector road” under the RTA classification (RTA, 2002). With the standard and accepted application of a growth rate of 2% per annum from the date of the recorded volume to calculate contemporary traffic volumes, The Bucketts Way would still be classified as a “collector road” and not as a “sub-arterial road” (5,000 to 20,000 AADT).

Under the RTA’s road hierarchy classification there is still significant capacity for The Bucketts Way to continue to be classified as a “collector road”. Although no data has been collected for peak hour movements, given the small size of the townships in this area, it is highly unlikely that the peak hour volumes would be close to the maximum identified for a “collector road”.

5.11.2 Access options

Each of the proposed exploration wells and proposed water monitoring piezometer would be accessed via council maintained roads and private access tracks within the subject properties (refer to Section 2).

WK 11, WK 13 and the water monitoring piezometer would be accessed via Fairbairns Road. WK 11 and the water monitoring piezometer would use an existing access track off Fairbairns Road that was

previously used for Waukivory 1 (refer to Figure 1.2). An existing access track would be used to access WK 13.

There are two options for accessing WK 12 and WK 14 and these are identified in Figures 5.5 and 5.6. Option 1 involves using an existing access track off McKinleys Lane (located to the east). The existing track currently used to access the dwelling on Lot 251 would be used to initially access WK 12 and WK 14. The existing track would need to be extended northwards across the paddock as identified in Figure 5.6 to enable heavier equipment (i.e. drill rig) to access the drill pads. It should be noted that Lot 251 is currently owned by Waukivory Road Pty Ltd, which is a subsidiary of Gloucester Resources. It is understood that an employee of Gloucester Resources currently resides at the dwelling on Lot 251 and that an agreement has been reached between the proponent and Gloucester Resources for this receptor.

Option 2 for access to WK 12 and WK 14 is via the existing Maslens Lane to the north. Maslens Lane passes an existing dairy farm and would need to be extended (i.e. compacted gravel upgrade) southwards to access the two proposed exploration wells.

5.11.3 Impact assessment

The proposed exploration wells and monitoring piezometer would be located on two properties and although lined ponds would be provided on-site, fracc/flowback water (water used in the fracture stimulation activities) would require disposal at an appropriately licensed facility following temporary storage in the lined ponds. In addition, following temporary storage on-site produced water from the production testing activities would be tankered to an appropriate storage facility and potentially re-used. There are a number of water management options for the proposed exploration wells which are discussed in Section 2.

It is estimated that a maximum of 617 trucks may be required across the four proposed exploration wells. The primary component of these traffic movements is the transportation of production water, however, this volume includes trucks for both the importing of water for the initial phases of the drilling process as well as the disposal of production water. This equates to approximately 153 trucks per proposed exploration well. It should be noted that should twinning be undertaken at WK 14, a few additional truck movements may be required.

For each proposed exploration well it is estimated that the truck movements would be conducted over approximately five days due to the expected flowback volumes from the drilling activities, which represents approximately 30 truck movements per day. Should twinning be undertaken at WK 14, the truck movements may extend to a sixth day, although this is expected to require a minimal number of additional movements.

These trucks would only operate during normal daytime work hours and would not operate during the night. Over a 12 hour working period this equates to approximately three trucks per hour per proposed exploration well. The number of water carts is dependent on the amount of water produced during the drilling process. Should the volumes of produced water be higher than expected it is likely that the number of movements would reach a maximum of five trucks per hour per well. It is proposed to transport the produced water to lined water storage areas located on “Tiedmans”, approximately 3 km to the east of the subject sites. From the proposed exploration wells, the trucks would access “Tiedmans” using a combination of the access tracks, Fairbairns Road, McKinleys Lane, Maslens Lane, Jacks Road, The Bucketts Way.

Given the identified spare capacity within the road network, the traffic generated from the proposed exploration wells is considered to be acceptable. A noise assessment of truck movements is presented in Section 5.8. It should be noted that the truck movements for the importation of water to the site and the

disposal of production water would occur over a short time frame. Although the proposed exploration wells are in place for up to six months, the process where water is imported and exported is over a short time frame.

In addition to the primary traffic generating activities of proposal, there would also be some minor and relatively infrequent additional traffic movements as a result of the proposed works. Drilling contractors would access the proposed exploration wells and water monitoring piezometer sites, and some materials would need to be delivered to the sites. Some AGL employees (e.g. geologists, technicians, supervisors) would visit the sites on occasions. The drill rig and ancillary equipment would be brought to the work sites. Prior to fracture stimulation operations there would be some heavy vehicle movements to deliver the frac pumps, tanks and sand.

During the testing phase of the works a contractor would initially visit each proposed exploration well on a daily basis to record data and inspect equipment and ensure ongoing management of the site. Should well blockages or pump failure occur during the production testing period a drill rig may return to the site. Some personnel would visit the monitoring bore site to collect samples as required. In addition, some equipment such as a truck and bobcat/small excavator would be required as part of the rehabilitation works.

5.11.4 Mitigation measures

As part of AGL's commitment to the community, appropriate notification would be afforded to the nearby residents indicating when the drilling would commence. AGL would also maintain a community phone hotline for any concerns residents may have about the works including the truck movements.

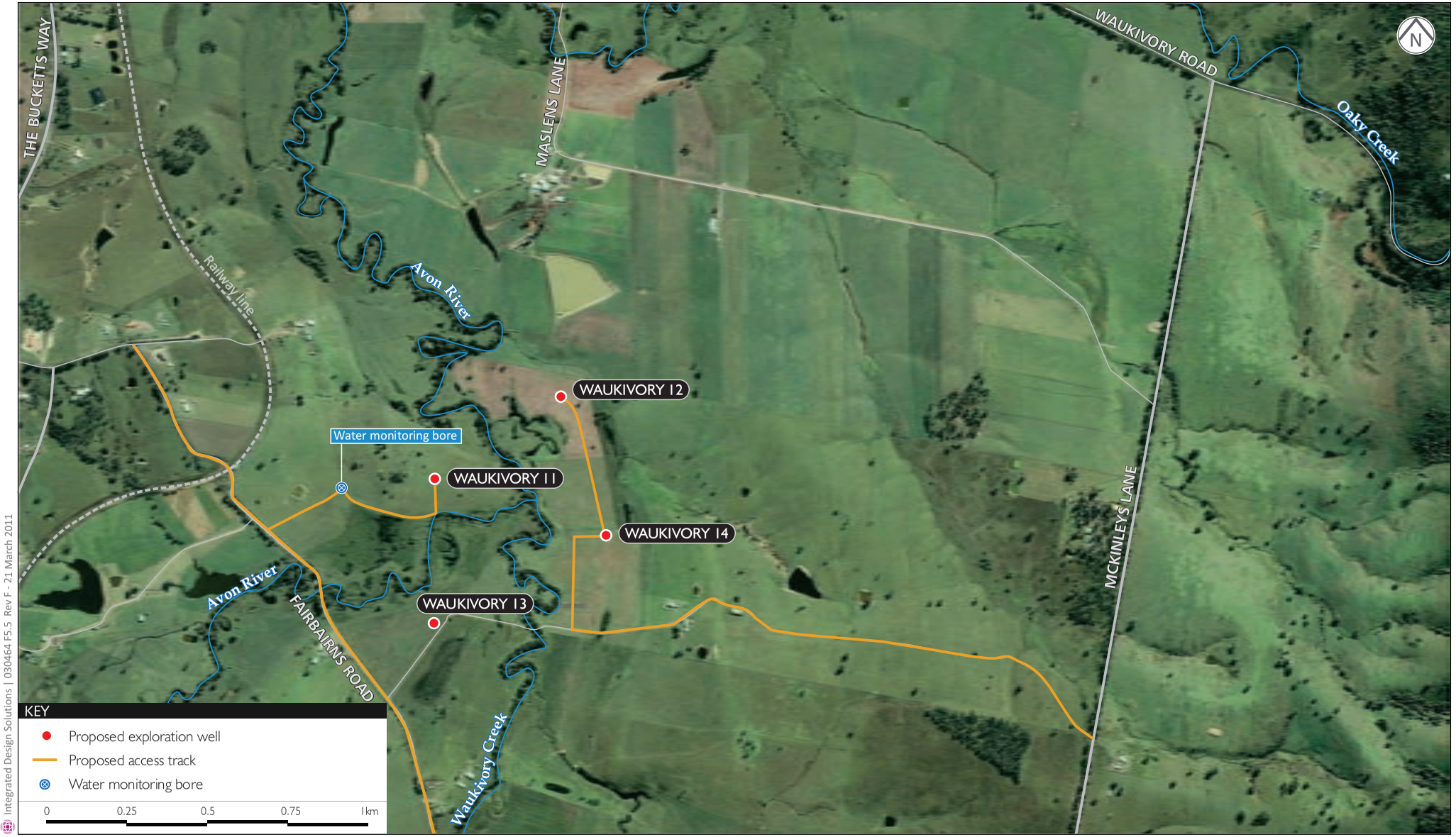
As discussed above, all vehicles should be maintained according to the manufacturer's specifications. Other noise based controls relating to vehicles are identified in Section 5.8.

It is envisaged that any access tracks constructed for the wells would be designed to be low impact (eg gravel). Once exploration activities are completed the tracks are rehabilitated in respect of the current agricultural land uses on the sites.

5.11.5 Conclusion

The primary source of traffic generation associated with the proposed exploration wells and water monitoring piezometer relates to the disposal of produced water, which occurs over a relatively short period of time. It is proposed that trucks transport the produced water from the sites utilising the prescribed access roads and The Bucketts Way and access the storage dams at "Tiedmans", approximately 3 km away to the south-east. An analysis of the traffic volumes within the local road network stated that there is sufficient capacity to accommodate the additional traffic movements over the short time frame.

In order to minimise community disruption resulting from the proposed activities, AGL would implement a notification procedure for nearby neighbours and maintain the community hotline.



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Proposed access tracks - Option 1

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 5.5

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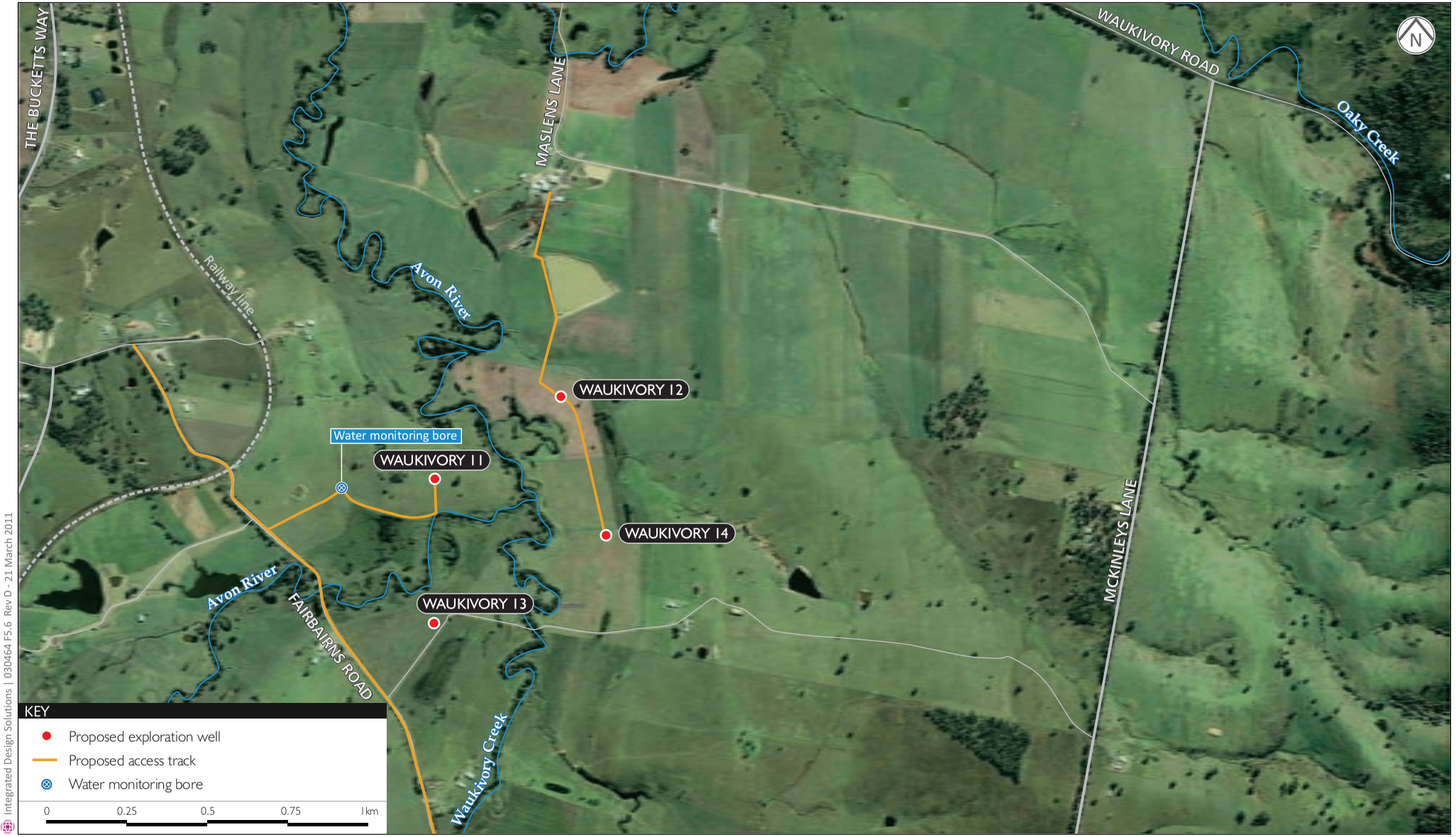

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Proposed access tracks - Option 2

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 5.6

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5.12 Fluid and chemical use

5.12.1 Drilling fluids

The four proposed exploration wells and water monitoring piezometer would be drilled utilising a circulation fluid of water containing one or more combinations of potassium chloride, bentonite clay, ploy anionic cellulose, partially hydrolysed polyacrylamide, xanthium gum, acrylic polymer, anionic surfactants and sodium carbonate or alternatively, high pressure air. No petroleum based drilling fluids or additives would be used during the drilling process.

Air circulation returns (namely drill cuttings) are directed to on-site tanks via a blooie line. Any drilling fluids containing excessive amounts of polymer or other additives would be removed from the site and disposed of in an appropriate manner. Any water remaining in the tanks at the completion of drilling would also be transported to an appropriate facility.

5.12.2 Fracture stimulation fluids

An injectivity test would be carried out prior to fracture stimulation operations, followed by fracture treatment by pumping water, frac sand and some additives into the target coal seam. Fracture stimulation operations would be carried out by specialised operators over one to three days per exploration well depending on the number of stages to be perforated and fractured. Fracture stimulation would only take place over 12 hours during the daytime. No night time fracture stimulation is proposed. The location prepared for the drilling operations would need to be modified for the fracture stimulation equipment, but the drill pad would provide adequate space for the contractors equipment and water storage area as identified in Section 2.

Once the wells have been drilled and cased a number of tests and logs are performed prior to undertaking the fracture stimulation procedure, in particular the review of the cement bond between the steel casing and the surrounding geological layers. Thus, fracture stimulation of target coal seams is undertaken post-drilling. Importantly, the final composition of the fracture stimulation fluid is not known until the testing and logging is completed . The fracture stimulation fluid is still composed of 99.5% water and sand, however, the additional additives are not determined until this testing and logging process has been completed.

As such, for the purposes of this REF an assessment of all fracture stimulation fluids previously used in the Gloucester Basin has been conducted, as well as any additional additives that may be used. The REF has taken the approach of assessing the worst case scenario to ensure that the impact of fracture stimulation fluids is negligible.

Previous additives included within the sand and water mixture that have been used in the vicinity for previous exploration wells include:

- guar gel, to thicken the water and suspend the sand. It is derived from the guar gum bean and is commonly found in ice cream as a food additive;
- magnicide, to treat water prior to the fracturing process to kill bacteria. It is commonly used as flame retardant in clothing;
- boric oxide (borax), to convert the linear gel to a thicker fluid. It is commonly used in the production of glass;

- potassium carbonate, which raises the pH to 9 to maintain effectiveness of other compounds such as cross linkers. It is found in detergents, soaps and shampoos;
- a hemicellulase enzyme used to break down guar gel upon return to surface into lined water storages;
- sodium persulphate, to help breakdown guar gel upon return to surface into lined storages. It is often used in hair dye and as a cleaner for printer circuit boards; and
- triethanolamine, also to help break down the guar gel upon return to surface into lined water storages. It is used as cosmetic products and also in household detergents.

These additives were used in four exploration wells which were subject to fracture stimulation in May and June 2009 as part of the GGP exploration program.

Other additives that may also be used in the fracture stimulation process that were not used in the May/June 2009 GGP program include:

- caustic soda, which is mostly used in the manufacture of pulp and paper, textiles, drinking water, soaps and detergents;
- cristobalite, which is used in glass, ceramics, porcelain, pottery, vitreous enamels, metal polish, scouring and grinding compound including scouring soaps, and powder. It can also be used in paper, filler in cosmetics, pharmaceuticals, toothpaste, insecticides, and in anticaking agents in foods;
- gelatine, is a common household product but can be used in photographic film, textile and paper adhesives, capsules for medicinal, matches, light filters, desserts, jellies, and as a culture medium for bacteria;
- citric acid, is a natural preservative and is also used to add an acidic, or sour, taste to foods and soft drinks. In biochemistry, it is important as an intermediate in the citric acid cycle, and therefore occurs in the metabolism of virtually all living things. It can also be used as an environmentally benign cleaning agent;
- sodium acetate, which is used in pharmaceuticals, cinnamic acid, soaps, photography, purification of glucose, meat preservation, medicine, electroplating, tanning, dehydrating agent, band as a food additive;
- claytreat 3C, is used as an antistatic agent in cosmetic products including hair conditioners and hair colouring preparations. Claytreat 3C is also used in all purpose household cleaning agents; and
- tridecyl alcohol, which is used in many types of consumer and industrial products like laundry detergents, all-purpose cleaning agents, dishwashing agents, emulsifiers, and wetting agents.

5.12.3 Impact assessment

The main potential impact of fracture stimulation fluids is from the interaction of the fluids with groundwater during the fracture stimulation process. The other potential source of groundwater contamination is for “contaminated” fluids leaching through the ground from the surface into the shallow groundwater aquifer. Fluids used in the drilling and fracture stimulation process are pumped out of the wells into tanks or lined water storage areas. Appropriate measures would be implemented to ensure

there is no leakage from the lined water storages, and any contaminated water is disposed of at an appropriate facility. Appropriate controls would also be put in place at the surface as described in Section 5.5.

Groundwater contained in the upper alluvial and shallow fractured rock aquifers (the only useful or beneficial groundwater sources in the Gloucester area) would not be impacted by drilling and fracture stimulation activities as these zones are cased and cemented off during the construction of the exploration wells and prior to the fracture stimulation activities.

There is potential for impact on the deeper (saline) groundwater during the drilling and fracture stimulation processes. In particular, the additives used in the fracture stimulation fluid and drilling fluids may enter the coal seam water bearing zones affecting the quality of this deep groundwater. However, this groundwater is too low in yield and too high in salinity to be considered a beneficial aquifer.

It is possible that increased permeability may be experienced within the deep coal seam zones following fracture stimulation of the target coal seams. However, these are not beneficial use aquifers as noted above. As these seams are dewatered, there is potential for lowering of hydrostatic pressure and water levels in the deep coal seams.

As evidenced in the list provided in Section 5.12.3, the additives used in the fracture stimulation fluids are derived from common household products. Four exploration holes were fracture stimulated in the vicinity of the site in May and June 2009. In this instance AGL have identified that a total 4.4 ML of water, 53.29 tonnes of sand, and 0.025 ML of additives were used. The fluid component of the fracture stimulation equates to approximately 0.05% of the volumes used.

All additives used in the fracture stimulation process have material safety data sheets (MSDSs) which are supplied by the manufacturer. Some additives may be imported from overseas, however, as a minimum for overseas MSDSs the Australian manufacturer/distributor or importer is required to be identified on the MSDS. The MSDS is also required to meet the *National Code of Practice for the Preparation of Material Safety Data Sheets* prepared by Safe Work Australia. MSDS's can be provided to DII, or other government agencies to assess the impact of any fracture stimulation additive.

5.12.4 Mitigation measures

As discussed in the above sections, the construction processes of the exploration well itself provides mitigation for potential cross-contamination of non-targeted aquifers and fluids used in fracture stimulation within the well. The potential for contamination of shallow beneficial use aquifers is minimised through the use of a pressure rated steel casing in the production of well design. All wells would be cased off and cemented in accordance with the requirements of DII. It should be noted that wells are cased beyond the uppermost beneficial use aquifers to ensure there is no contamination of the groundwater. The proposed exploration wells would be up to 1,000 m deep with beneficial use aquifers in the area typically 20 m to 75 m bgl.

AGL does not use any BTEX chemicals (benzene, toluene, ethyl benzene and xylene) as part of the fracture stimulation process. These components serve no purpose in fracture stimulation of CSG wells. AGL also required contractors who provide fracture stimulation services to provide a list of all fracture fluid additives to be used prior to the commencement of works. It should also be noted that as part of the GGP, in which these exploration wells are located, the conditions of approval identify that BTEX chemicals are not be used in the fracture stimulation process.

The four proposed exploration wells (and the water monitoring piezometer) are located within the GGP area. Whilst the management of the proposed exploration wells would be conducted through the EMP

(see Appendix C), the proposed monitoring piezometer would be incorporated into the broader groundwater monitoring network and the Groundwater Management Plan to be prepared for the GGP to assess connectivity and to ensure there are no adverse impacts on the groundwater aquifers in this northern part of the Gloucester Basin.

To ensure the impacts of drilling and fracture stimulation fluids is minimised the following mitigation measures are recommended:

- where practical, the most environmentally friendly fracture stimulation fluids should be used;
- no BTEX chemicals are to be used;
- no petroleum based drilling fluids or additives would be used during the drilling process;
- all water based drilling fluids would be contained in a series of tanks or lined water storages on site;
- any water remaining in the tanks or lined ponds at the completion of drilling is to be disposed of at an appropriate facility; and
- any drilling fluids with excessive amounts of polymer or other additives are to be disposed of at an appropriate licensed facility.

Following the logging and testing of the well, the characteristics of the targeted coal seams would be known and the fracture stimulation, including fluids to be used, would be designed accordingly. Notwithstanding the findings of the above assessment, the proponent will provide details of the fluids to be used prior to undertaking the fracture stimulation to DII, which is consistent with the GGP approval.

5.13 Other environmental aspects

5.13.1 Acid sulphate soils

A search of the Natural Resource Atlas revealed that the proposed exploration wells, water monitoring piezometer and access tracks are not located in an area of acid sulphate soils risk.

5.13.2 European heritage

A search of the NSW Heritage database and Australian Heritage database revealed no items of state or national significance within the vicinity of the proposed exploration wells, water monitoring piezometer and access tracks. A search of Gloucester LEP also revealed no items of local or regional heritage significance within the vicinity of the proposed works. Overall, it is considered that there would be no heritage items or areas impacts by the proposed works.

5.13.3 Bushfire

i Impact Assessment

There is a bushfire risk due to the presence of open pastures surrounding the proposed exploration well sites.

ii Mitigation measures

To minimise risk, contractors would be required to:

- 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;
- ensure facilities for fire fighting purpose are maintained on site, including a water pump and hoses;
- prohibit smoking and cease any activities which could cause sparks on days of extreme fire danger; and
- prohibit the lighting of fires on-site.

5.13.4 Contamination

i Existing environment

The land use history of the subject lots has been predominantly agricultural. The site has been degraded from these uses, and an on-site visit did not identify any obvious evidence of contamination (e.g. illegally dumped waste, fuel containers etc).

A search of orders issued by DECCW under the *Contaminated Land Management Act 1997* and actions taken under the *Environmentally Hazardous Chemicals Act 1985* revealed no orders or actions have been issued for the subject sites within the immediate vicinity.

ii Impact assessment

During the exploration drilling program no soil is proposed to be removed from the compound site, other than samples taken for laboratory testing. On the completion of drilling all excavated material would be backfilled.

iii Mitigation measures

It is noted that during any works, if any materials are encountered that are different (i.e. observable colours, discolouration or staining) an assessment of the materials should be undertaken by a NATA accredited laboratory.

5.13.5 Waste

i Impact assessment

There may be a minimal amount of waste (e.g. gravel, empty containers) generated as part of the proposed works.

ii Mitigation measures

A waste management plan should be included as part of AGL's overall EMP (provided in Appendix C) prior to any works taking place. The plan shall also make consideration of the resource management hierarchy principles outlined in the *Waste Avoidance and Resource Recovery Act 2001*, if appropriate. AGL should

make any contractors aware of the need to manage waste in accordance with the POEO Act, and DECCW's Waste Classification Guidelines.

5.13.6 Erosion and sediment control

i Impact assessment

Site preparation for each of the proposed exploration wells would involve minor earthworks for the construction of the drilling pads and lined water storage areas. Some gravel maybe brought in to construct access tracks. This disturbance creates the potential for increased erosion and sedimentation.

ii Mitigation measures

As part of the proposed works an erosion and sediment control plan would be prepared which would consider:

- exposing the smallest possible area of land for the shortest possible time;
- saving topsoil for reuse;
- controlling runoff onto, through and from the site;
- using erosion measures to prevent on-site damage;
- using sediment control measures to prevent off-site damage;
- rehabilitating disturbed areas quickly; and
- maintaining erosion and sediment control measures.

Consideration should also be afforded to the principles outlines in the Landcom guidelines 'Managing Urban Stormwater: Soils and Construction' (known as the "Blue Book").

5.13.7 Socio-economic and community considerations

Due to the limited duration of the proposed exploration wells, no significant social impacts are expected from the works. AGL is not expected to employ a large workforce that would require an upgrade of existing community and recreational facilities in the area. There would, however, be positive socio-economic affects associated with propose short term works including the flow on effects of employees spending their income on accommodation food and entertainment.

5.14 Cumulative impacts

This REF has considered the cumulative environmental impacts of the proposed four exploration wells, water monitoring piezometer and access tracks. A number of environmental investigations were undertaken as part of this REF. Consideration has been afforded to the wider area within the environmental assessments prepared as part of this REF, including the environmental investigations prepared as part of the wider GGP. The ecology report provided in Appendix A and summarised in Section 5.3, for example, examined the proposed sites in relation to proposed corridors and future wildlife movements in the area.

This REF has examined the impact of the four exploration proposed wells, water monitoring piezometer and access tracks and recommended a number mitigation and management controls to ensure that the proposed works have a negligible impact on the local environment and community. For example, a number of erosion and sediment controls would be put in place to ensure there is no impact on watercourses in the area. AGL and its contractors would also be required to undertake works in accordance with AGL's EMP and the recommendations of this REF, to ensure the wells would have a negligible impact on the local environment.

Overall, it is considered that if the recommendations of this report and appropriate controls are in place during the works the development is unlikely to have any cumulative environmental impact.

5.15 Summary

Table 5.15 below summaries the issues that have been identified as a result of the proposed wells based on the investigations undertaken as part of this REF, and management controls identified as a result of the environmental investigations. These recommendations should complement those identified in AGL's EMP. All workers on site should comply with the recommendations of this REF and AGL's EMP.

Table 5.15 Summary of issues environmental issues raised

Item	Potential Impact or Issue(s)	Management Considerations
Environmental management	No identifiable impacts at present.	Contractor shall maintain an Environmental Management System. Any environmental incident(s) shall be reported to the relevant authority. All contractors are to be made aware and comply with AGL's EMP for the GGP. All contractors should be made aware of the issues and management considerations identified in this REF.
Contamination	No identifiable impacts at present.	Spill kits are to be available and maintained on-site. Any chemical spills on-site shall be remediated in accordance with all occupational health and safety requirements. Any liquid or oils spilt during the works shall be immediately contained and cleaned up. All chemicals (including fuel) shall be stored and transport in accordance with hazardous material and safety regulations. Any contaminated soil identified on-site is to be removed from the site and disposed of at a licensed facility. If any materials (including soils) are encountered during construction works

Table 5.15 Summary of issues environmental issues raised

Item	Potential Impact or Issue(s)	Management Considerations
		that are different (i.e. observable odours, discolouration or staining) to those encountered on the site, work should cease and an assessment of the materials should be undertaken by a qualified environmental scientist.
Surface water	Potential impacts from water entering the drill pad site or water and sediment leaving the site and flowing into nearby watercourses	Prohibition of petroleum based drilling fluids and additives in the drilling and testing of the wells. Containment of contaminated water in tanks or lined ponds and where necessary removal and disposal at appropriate facilities. The prevention of discharge of drilling fluids to creeks. Use of sediment fences/traps, diversion drains, hay bales etc to prevent soil loss. The storage of fuel and lubricants on-site would be minimised. Any fuels or other fluids that need to be stored on-site should be stored in an appropriate place. Bunding of oil and fuel storages and maintenance of a spill control kit on-site. Provision and maintenance of spare tanks/pond capacity to contain overflow from the main tank/pond in the event of increased flow from the well. Upslope drains would divert upslope runoff water around disturbance areas. Restoration of all disturbed ground immediately following completion of the works.
Groundwater	Potential impact of wells contaminating the groundwater. Fluids from drilling and fracture stimulation leaching into the groundwater.	Water storages on-site would be appropriately lined to ensure no contaminated water leaks from the storages. Contaminated fracc/flowback water is to be disposed of appropriately. No drilling fluids are to be discharged to drainage lines or creeks. A pressure rated steel casing would be used in the production of well design.

Table 5.15 Summary of issues environmental issues raised

Item	Potential Impact or Issue(s)	Management Considerations
		All wells are to be cased off and cemented in accordance with the requirements of DII. Upon completion of exploration activities wells are to be plugged or capped in accordance with industry best practice. All works are to in accordance with a groundwater management plan.
Erosion and sediment controls	The potential for increased erosion and sedimentation through minor earthworks for the construction of the drilling pads and lined ponds. Some gravel maybe brought in to construct access tracks.	Exposing the smallest possible area of land for the shortest possible time. Saving topsoil for reuse. Controlling runoff onto, through and from the site. Using erosion measures to prevent on-site damage. Using sediment control measures to prevent off-site damage. Rehabilitating disturbed areas quickly. Maintaining erosion and sediment control measures.
Flora and fauna	No identifiable impacts at present.	Prior to work, contractors shall be briefed on the potential presence of threatened flora and fauna species. Saline water shall not be used for dust suppression. Regular inspections should be undertaken on on-site equipment to ensure no animals are trapped. Unnecessary access to vegetated areas should be avoided. Speed limits should apply to access tracks to avoid collisions with wildlife. All lands should be rehabilitated using native species endemic to the local area.
Heritage	None.	In the event that a potential European heritage or Aboriginal cultural heritage item or artefact is identified during on-site works, work is to cease, and the finding reported to DECCW.
Visual	Potential visual amenity issues for neighbouring residents.	Lighting used during night time works shall be located so as not to shine into any neighbouring dwellings. If any exploration wells become production

Table 5.15 Summary of issues environmental issues raised

Item	Potential Impact or Issue(s)	Management Considerations
		wells an appropriate visual assessment should be undertaken to ensure no longer term amenity issues.
Noise and vibration	Impact on residents from traffic noise, construction noise and fracture stimulation. Flaring	Optimal configuration and barriers during drilling and fracture stimulation would be employed to shield these noise sources and reduce impacts at residences. For the out of hours period, drilling noise levels with mitigation are predicted to marginally exceed ideal and conservative out of hours criteria and hence may not be acceptable at one locations. Therefore notification with this residential location (understood to be owned by a neighbouring mining company) may be needed. Sleep disturbance issues at night can be mitigated through the use of barriers to satisfy DECCW criteria. Vehicles and equipment should be maintained to an appropriate standard. Ensure the community is consulted and provide them with written notice well in advance of proposed activities. Ensure all landholders of each well are consulted and supportive of the project's intention for out of hours activities. Use temporary noise barriers as described in this report. Limit fracture stimulation to daytime hours only. Employ all reasonable and feasible work practices to minimise any impacts.
Air quality	Potential impact of dust and vehicle emissions.	All machinery, vehicles and equipment should be maintained in accordance with the manufacturers' specifications. Speed limits should apply to access tracks and within the drilling pad to reduce dust. Engines and machinery should be switched off when not in use. Any topsoil stockpiled should be subject to dust suppression controls (eg water cart). During the construction of lined ponds appropriate dust suppressions controls

Table 5.15 Summary of issues environmental issues raised

Item	Potential Impact or Issue(s)	Management Considerations
		should be in place. Following the proposed fracture stimulation the drill pad can be reduced to some 10 m x 10 m further reducing the potential for dust generation.
	Flaring.	Continuous flaring should take place within an enclosed flare assembly. Ensure a blow-out preventer is provided with all flares. Ensure there is an adequate exclusion zone for safety and fire purposes. The flaring of gas shall be limited to that necessary as part of the evaluation process, following which flaring shall cease.
Traffic	Potential noise and emissions from traffic.	Appropriate notification would be afforded to the nearby residents indicating when the drilling would commence. AGL would also maintain a community phone hotline for any concerns residents may have about the works including the truck movements. All vehicles should be maintained according to the manufacturers specifications (see also noise mitigation measures). Any access tracks constructed for the wells would be designed to be low impact (eg gravel). Access tracks would be limited to a speed limit of 45km per hour. Once exploration activities are completed the tracks are rehabilitated in respect of the current agricultural land uses on the sites.
Waste	Minor waste from the drilling (excluding fluids).	On site waste disposal is prohibited. Hazardous waste, if identified on site, should be managed and disposed of in accordance with existing guidelines and regulations. An on-site waste management plan to be prepared and is to be kept on-site.
Chemical Use	Potential environmental issues from	Where practical, the most environmentally

Table 5.15 Summary of issues environmental issues raised

Item	Potential Impact or Issue(s)	Management Considerations
	drilling or fracture stimulation fluids.	friendly fracture stimulation fluids should be used. No petroleum based drilling fluids or additives would be used during the drilling process. No BTEX chemical additives are to be used on site. All water based drilling fluids will be contained in a series of tanks or lined ponds on site. Any water remaining in the tanks or lined ponds at the completion of drilling is to be disposed of at an appropriate facility. Any drilling fluids with excessive amounts of polymer or other additives are to be disposed of at an appropriate licensed facility. Prior to fracture stimulation of the wells the proponent is to provide details of the fluids to be used.
Bushfire	Potential bushfire threat.	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. Ensure facilities for fire fighting purpose are maintained on site, including a water pump and hoses. Prohibit smoking and cease any activities which could cause sparks on days of extreme fire danger. Prohibit the lighting of fires on-site.
Social and economic	No significant impacts identified.	None.

6 On-site management of works

6.1 Safety and risk management

6.1.1 General site management

A site management plan should be prepared and be available on site for all employees and contractors. The site management plan would also include safety and risk management. A site induction should be undertaken with all employees and contractors.

6.1.2 General safety procedures

The following procedures would be implemented on the proposed exploration wells:

- suitable protective clothing, headgear and footwear are to be worn at all times in accordance with Workcover requirements;
- a comprehensive first aid kit, including a snake bite kit is to be available at all times on site;
- a reliable system of communication would be maintained on site to enable accidents to be reported and medical assistance to be obtained, if required;
- all drilling equipment is to be maintained according to the manufacturers specifications;
- all contractors would be required to use their own discretion as to whether working conditions are safe in the case of heavy rain, strong winds or electrical storms;
- appropriate signage for safety requirements would be placed at or near all gates; and
- no public access would be allowed to drilling sites.

6.1.3 Stock and injury loss

The land use on the subject lots is for agricultural purposes. There is stock present on the sites. As such, the drilling pad would be fenced off to prevent any stock or native animals (e.g. kangaroos) entering the "construction zone". Other smaller animals would be discouraged from entering the compound by ensuring all rubbish is correctly disposed. This should be included as part of a waste management plan. To ensure stock or native animal losses are negated, speed should be limited on the access tracks, which should be identified in the site management plan.

6.1.4 Road safety

The following measures would assist in mitigating road safety risks:

- the drilling specification would require all vehicles to comply with all statutory and licence requirements;
- access to the sites from local roads is at a location that has adequate visibility in both directions, where practical. Appropriate signage would need to be installed if this was not practical.

- speeds on local access tracks should be limited to no 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.

6.1.5 Drilling program

All contractor(s) would need to ensure that all persons employed by them on the sites are familiar with the site management plan, and manual of emergency response procedures for the drilling program.

6.1.6 Gas blowout

In accordance with the exploration licence conditions, the risk of blow out has been assessed based on previous testing and drilling in the GGP area. As no blow outs have been encountered in any of these wells the risk of blow out in the wells is unlikely. Nonetheless, blow out prevention equipment would be installed on all wells.

The blow out prevention equipment, including 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.

6.2 General environmental management of works

Any contractor(s) who undertakes work on the subject sites would be required to have any understanding of AGL's EMP. A copy of the EMP is provided in Appendix C. The EMP is kept on site together with an Emergency Response Procedure (ERP) and Safety/Site Management Plan.

7 Conclusions

7.1 Justification for the proposal

The drilling and testing activities outlined in the REF are being conducted at these sites to evaluate the coal seam and gas characteristics in accordance with the requirements of PEL No 285. In particular, the works are proposed in accordance with the Third Schedule, Work Program of the PEL. Under the conditions of this Schedule a minimum work program is required to be undertaken by AGL as agreed with DII, for the period of the license term.

7.2 Summary and mitigation measures

This REF has assessed the potential environmental impacts of four proposed CSG exploration wells, water monitoring piezometer and access tracks located near Gloucester, NSW. The REF has been prepared in accordance with the EP&A Act and EP&A Regulation.

The proposed exploration wells by AGL aim to explore the potential CSG in PEL No 285. The results of the environmental investigations prepared for this REF, including those prepared for the GGP anticipate that the proposed exploration wells would have no significant impacts on the environment. The assessment identified environmental interactions, such as noise, which would require the implementation of prescribed mitigation measures in order to minimise potential impacts resulting from the proposal. It should be noted that the identified noise issues would occur over a short timeframe.

A summary of issues raised during the preparation of this REF and proposed mitigation and management controls are identified in Section 5. Section 7.3 assesses the proposal against the requirements of clause 228 of the EP&A Regulation, which is required when preparing an REF under section 111 of the EP&A Act.

This REF has examined the cumulative impacts of the proposed exploration wells, water monitoring piezometer and access tracks. Environmental investigations prepared for the subject sites assessed the well locations in their broader environment. For example, the noise impact assessment considered the cumulative impacts of flaring on nearby neighbours and dwellings.

This REF has identified a negligible impact on beneficial groundwater as a result of fracture stimulation, provided appropriate management of fluids is conducted. This includes the exclusion of any BTEX chemicals in accordance with the GGP approval. Fracture stimulation techniques were used at four wells in the vicinity of the subject sites in 2009. No impacts have been identified from these wells from the information available. Prior to any fracture stimulation AGL is to provide DII with information regarding the fluids to be used including MSDSs.

Mitigation measures would be implemented address visual issues from neighbouring developments, including the direction of lighting equipment during night time works. The proposed exploration wells, access tracks and drilling pad have been examined in relation to a range of environmental issues including, but not limited to, surface water, groundwater, Aboriginal heritage, ecology, noise and air quality within the site and within the local area. The investigations prepared as part of this REF also considered previous environmental studies prepared in the Gloucester area.

The proposed exploration wells, water monitoring piezometer and access tracks are within PEL No. 285. Up to 110 wells have been approved by the PAC under Part 3A of the EP&A Act, however, the proposed wells identified in this REF are for exploration purposes which is covered under Part 5 of the EP&A Act. Where applicable, a holistic approach is taken by AGL in identifying how individual projects fit in with the

broader GGP. For example, the community consultative committee established by AGL is kept informed about all projects in PEL No. 285.

Overall, if the recommendations of this REF are followed, and the drilling program is implemented in accordance with current environmental standards and guidelines, including AGL's EMP, the proposed works should not have a significant impact on the environment.

7.3 Compliance with clause 228 of EP&A Regulation

It is considered that the proposed wells are compliant with clause 228 of the EP&A Regulations, as outlined in the table below.

Table 7.1 Compliance with clause 228

Factors to Consider	Compliance
Any environmental impact on a community.	The proposed works would have no significant impact on the community. Appropriate mitigation and management measures for potential environmental issues have been identified in this REF and would be included with AGL's EMP. These management methods, and the proposed development would be in accordance with Australian Standards and industry best practice.
Any transformation of a locality.	The proposed works have been identified to comply with the requirements of PEL 285. The proposed works are exploratory and are short term in nature. Nearby residents have been consulted about these exploration wells, water monitoring piezometer and access tracks and would continue to be consulted as works progress. Appropriate environmental controls have been identified that should be implemented during works. If so, there would be no transformation of locality as a result of the proposal.
Any environmental impact on the ecosystems of the locality.	A number of environmental assessments have been prepared for this REF which identify that the proposed works would not have any significant impact on environment and ecosystems of the locality. Appropriate mitigation measures would be in place during the drilling phase that would further ensure no significant impacts on the environment.
Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality.	The environmental assessments prepared for the proposed works have noted that the proposed development would not reduce the aesthetic, recreational, scientific or other environmental quality of the locality. The works would be undertaken in an existing environment already disturbed by agricultural land uses. The proposed wells are exploratory at this stage and the works a short term in nature, and are unlikely to cause any significant visual issues. An EMP would be in place prior to the commencement of works to ensure negligible environmental impacts during construction.
Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations.	The environmental investigations conducted for the subject sites have noted that the proposed works would not impact on the locality, Aboriginal cultural heritage, and non-indigenous heritage, nor social or visual significance of the area. The proposal would not impact on flora or fauna. An appropriate, industry standard, EMP would be in place prior to construction works to ensure no environmental impacts during drilling. The proposed exploration wells have been proposed as result of the requirements of the PEL and community consultation has been conducted. Ongoing consultations and implementation of an environmental management plan would also ensure that there are no long term impacts on the environment as a result of the proposed development.
Any impact on the habitat of protected fauna.	A flora and fauna assessment has been prepared for the proposed works which identifies that the works would have no impact on the habitat of protected fauna.

Factors to Consider	Compliance
Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air.	A flora and fauna assessment has been prepared for the proposed works which identifies that the works would not have any impact on endangered species or ecological communities.
Any long-term effects on the environment.	An assessment has been made of any environmental impacts that may occur as a result of the proposed works. The works would be undertaken in an existing environment that is already disturbed. With appropriate management strategies in place at the drilling stage by the contractor there would be no long term negative impacts on the environment. The contractor would be required to undertake works in accordance with the recommendations of this REF and AGL's EMP.
Any degradation of the quality of the environment.	The environmental assessment prepared for the proposed works have not identified any degradation of the quality of the environment. The works would be undertaken in the existing environment which is disturbed as a result of previous agricultural activities. Appropriate removal of waste, including drilling fluids and fracc/flowback water would be undertaken as part of the drilling works. An appropriate EMP would also be in place prior to the commencement of works to ensure the protection of the environment.
Any risk to the safety of the environment.	The proposed development does not pose any risk to the safety of the environment. The environmental assessment of the proposed works has not identified any significant impacts, and any future environmental risks as part of the drilling process would be managed through an appropriate environmental management plan. This plan would include the on-site management of safety and an emergency response plan.
Any reduction in the range of beneficial uses of the environment.	The assessment of environmental impact as a result of the proposed works has not identified any significant impacts. The subject sites are highly degraded and works are proposed as a result of the requirements identified in the PEL. With appropriate management strategies in place at the drilling and testing stage by the contractor there would be no reduction in the range of beneficial uses of the environment.
Any pollution of the environment.	The proposed exploration wells would be drilled and tested over a relatively short timeframe. Flaring is proposed at the wells to reduce greenhouse gas emissions. At the completion of testing the wells are capped, and if the well is to go into full production further approvals would be required. Appropriate erosion and sediment controls would be implemented as discussed, which would also be identified in a site EMP. All drilling and fracture stimulation fluids would need to be stored on site and disposed of in an appropriate manner. There are some potential noise pollution issues as a result of the works. The installation of barriers would allow noise levels to be managed at sensitive receivers in the vicinity of the well sites. There would a slight exceedance at one location during night time drilling, which will require landholder notification. Other than this noise can be managed for the proposed works. As noted the noise will be short term, and no cumulative impact is expected.
Any environmental problems associated with the disposal of waste.	A waste management plan would be included as part of the site environmental management plan which would address the disposal of waste. Any contaminated wastes uncovered during works should be removed and disposed of at an appropriate facility. All fluids and cuttings from the drilling process would be stored in tanks or lined ponds for disposal at an appropriate facility. Any general waste including oil containers would be disposed of appropriately. No problems are expected from the works in relation to waste.
Any increased demands on resources (natural or otherwise) that are, or are likely to become, in	The subject sites are highly degraded and do not contain any significant resources other than potentially gas. The small size of the sites means that the agricultural potential of the sites in today's market is relatively low. At present, the proposed exploration wells would not leave the CSG market in

Factors to Consider	Compliance
short supply.	short supply. These wells are proposed, at present, for testing. Further approvals would be required prior to the wells commencing full production. The wells are proposed in accordance with the requirements of the PEL as agreed with DII.
Any cumulative environmental effect with other existing or likely future activities.	The proposed works would not have any significant impact on the environment, now or into the future as discussed in Section 5. Appropriate mitigation and management of potential environmental issues, if adhered to, would have no significant impact on the environment. Any contractors would be required to undertake works in accordance with the recommendations of this REF and AGL's EMS, and EMP. If works are undertaken in accordance with these requirements any potential impacts on the environment can be managed and reduce the risk of any impact to the environment. Overall, it is considered that if the recommendations of this report and appropriate controls are in place during the construction process the development is unlikely to have any cumulative environmental impact. Consultations would be ongoing with the community and key stakeholders such as DII to ensure that the works are undertaken in accordance with industry best practice and current standards.

Appendix A

Flora and Fauna Assessment

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AGL Upstream Investments Pty Ltd

Gloucester Coal Seam Gas Project
Waukivory
Pilot Well Sites & Water Monitoring Site

Final

Ecological Assessment

March 2011

Alison Hunt and Associates Pty Ltd

TERRESTRIAL | MARINE | AQUATIC

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

APPENDICES

1 INTRODUCTION

1.1 Background

Alison Hunt & Associates Pty Ltd was commissioned by AGL Upstream Investments Pty Ltd (AGL) to undertake an ecological assessment of its proposal to construct four coal seam methane gas exploration wells known as Waukivory 11, 12, 13, 14 and a water monitoring bore all of which are located 5 km south of Gloucester, NSW (Figure 1).

The purpose of the study was to assess the potential direct and indirect impacts of the proposal on biodiversity particularly in relation to threatened species and endangered ecological communities. AGL is preparing a Review of Environment Factors (REF) in accordance with requirements of *Condition No. 1 (Environmental Assessment) of Petroleum Exploration Licence (PEL) No. 285*. This ecological assessment meets the requirements under Part 5A of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act), *Threatened Species Conservation Act 1995* (NSW) (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

Key ecological issues that required clarification include:

- The potential for endangered ecological communities, threatened species and / or their habitat listed under the TSC Act to occur within the study area;
- The potential presence of any matters of National Environmental Significance (NES) listed under the EPBC Act; and
- Any avoidance, management or mitigation options.

1.2 Proposal

The proposal includes the drilling of the four new coal seam methane pilot production boreholes shown in Figure 2 followed by downhole logging, running and cementing production casings in place,. Three of the four wells will be completed by either hydraulic fracturing or under reamed. One of the wells, either Waukivory 12 or 14, would be 'twinned' and both hydraulic fracturing and under reaming would take place at the one well site resulting in two boreholes drilled within the same pad area. The wells will have dewatering pumps connected to surface facilities. The work is expected to be completed over a period of approximately 6 weeks. Final stages of the work will involve production testing of the wells for approximately 12 - 15 months.

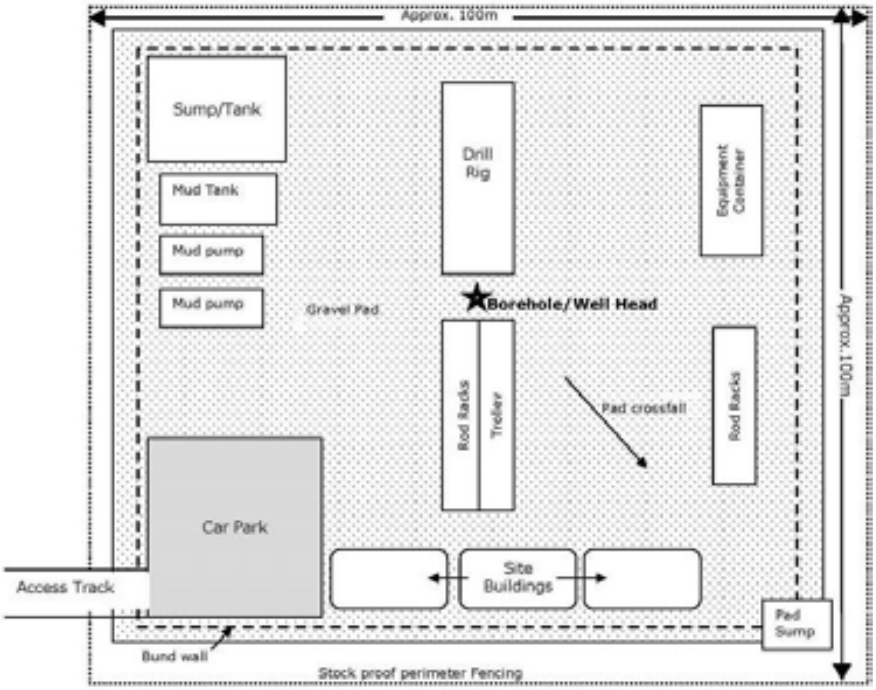
The drilling activities on each borehole site will involve temporary ground surface disturbance of an area approximately 70 m x 60 m. Water storage (turkeys nest) and flaring equipment during production testing will require a potential site disturbance of an additional area of up to 100 m x 100 m. All activities, including the construction of access roads, would be undertaken within existing cleared agricultural paddocks.

Diagram 1 shows the layout of a typical borehole pad. Access to most of the work area is available from existing farm tracks although at some sites new tracks would need to be constructed across cleared paddocks. In some instances upgrading of the existing tracks would be required in order to ensure safe heavy vehicular passage to the work sites. No major creek crossings would be altered.

Provision would be made for storage of drilling fluid for recirculation within the work area. Water would be stored in lined pits and / or tanks on site. Stock proof site fencing would be erected to delineate the work zone 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, wireline logging, perforation and stimulation operations. Access to drilling sites and heavy vehicle movements would be minimised during periods of heavy rain. New access tracks will be graded and vehicle speeds restricted in dry conditions to minimise dust generation.

At the completion of the exploration test program, AGL will suspend each well, remove surface equipment and other surface facilities, reduce the access area to a 10 m x 10 m area and restore the disturbed area as agreed with the Landholder. In the event that the well site(s) are no longer required or approved, for future production, AGL will plug and abandon the well, and restore the area to its original condition including respreading all topsoil and removing all roads as agreed with the Landholder.

Diagram 1 Typical borehole pad layout



A water monitoring bore would also be drilled and a logger installed to constantly measure water pressures and levels approximately 250 m west of Waukivory 11 (refer Figure 2) A pad size of approximately 50 x 30 m would be required for installation although this area would be rehabilitated at completion of installation with only the bore remaining on site. The final installation is shown in

Plate 1 Example of an installed water monitoring bore

1.3 Legislative Framework

A number of legislative requirements need to be met in relation to biodiversity issues for the proposed works and these may include but not necessarily be limited to:

1.3.1 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act requires assessment of proposed actions that are likely to cause significant impacts on matters of NES listed under the Act. The EPBC Act identifies seven matters of NES and these include:

- World Heritage properties;
- National Heritage places;
- Wetlands of international importance (Ramsar Wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

Those matters of NES relevant to this proposal may include threatened species, ecological communities and migratory species. If, after addressing the criteria set out in the Administrative Guidelines for the EPBC Act, it is concluded that a significant impact on matters of NES is likely then a referral to the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) may be required.

1.3.2 NSW *Environmental Planning and Assessment Act 1979*

Pursuant to the EP&A Act an assessment of the impacts of the proposed works on land that is critical habitat or on threatened species, populations or ecological communities, or their habitats listed under the TSC Act, must be undertaken in the form of an Assessment of Significance. This involves assessing potential impacts of the proposal based on seven criteria that aid in assessing if the proposal is likely to have a significant impact on threatened species or their habitat or endangered ecological communities at the site or that have the potential to occur. If the Assessment of Significance concludes that a significant impact is likely then a Development Application must be accompanied by a Species Impact Statement (SIS).

1.3.3 NSW *Threatened Species Conservation Act 1993*

The TSC Act applies to terrestrial and aquatic flora and fauna. This Act is administered by the NSW Department of Environment, Climate Change and Water (DECCW). Pursuant to the EP&A Act an assessment of the impacts of the proposed works in areas of critical habitat or is likely to affect threatened species, populations or ecological communities, or their habitats listed under the NSW *Fisheries Management Act 1994* (FM Act), must be undertaken in the form of an Assessment of Significance. This involves assessing potential impacts of the proposal based on seven criteria that aid in assessing if the proposal is likely to have a significant impact on threatened species or their

habitat or endangered ecological communities at the site or that have the potential to occur. If the Assessment of Significance concludes that a significant impact is likely then a Development Application must be accompanied by a Species Impact Statement (SIS).

1.3.4 State Environmental Planning Policy 44 - Koala Habitat Protection

State Environmental Planning Policy No. 44 Koala Habitat (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline by:

- Requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat;
- Encouraging the identification of areas of core koala habitat; and
- Encouraging the inclusion of areas of core koala habitat in environment protection zones.

The policy applies to 107 local government areas including Gloucester LGA and therefore this policy is considered in assessing this proposal.

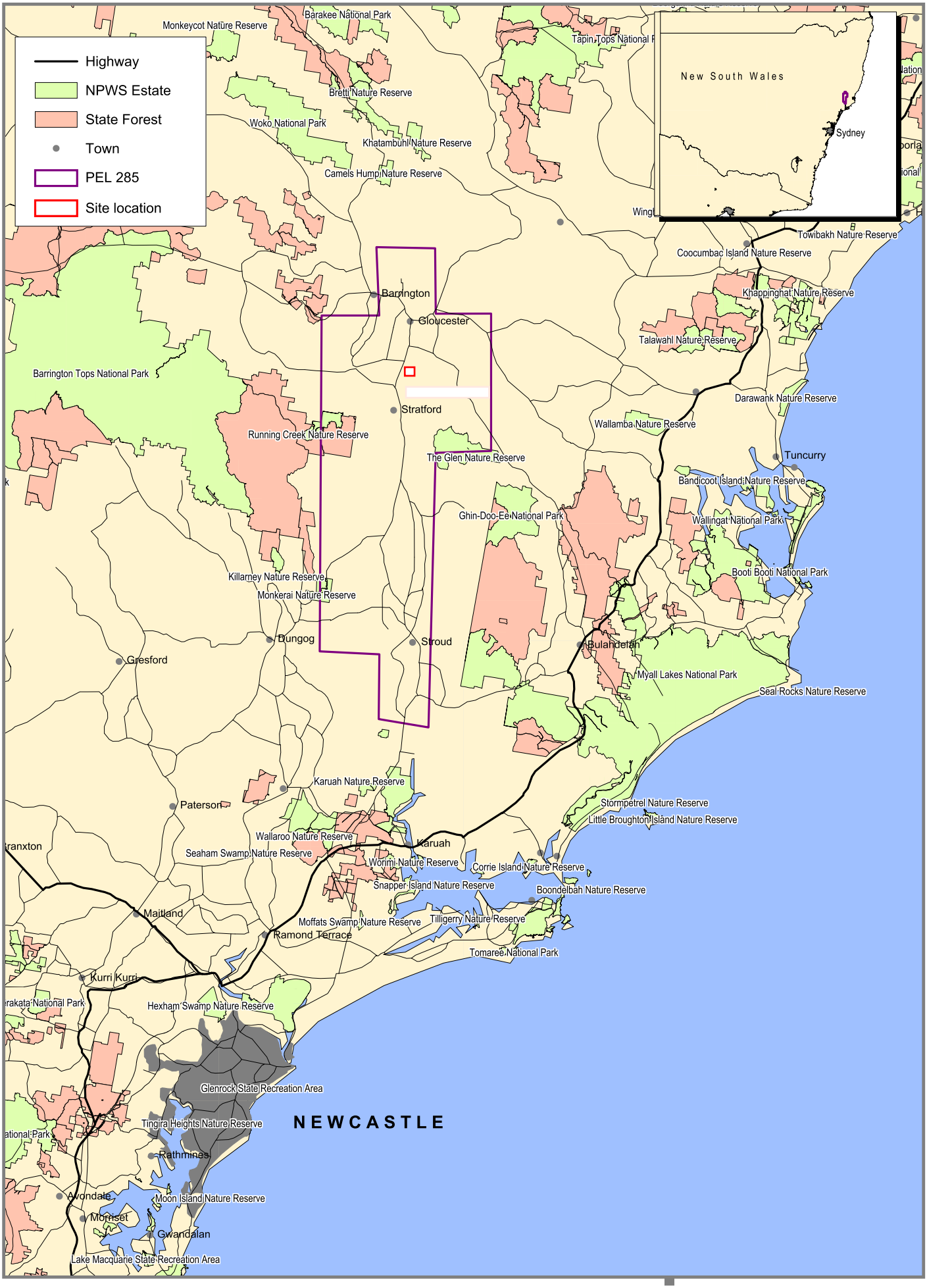


Figure 1 Location of Waukivory well sites

AH Ecology

Proposed Pilot Well Locations

Figure 2 Proposed Waukivory pilot well sites and monitoring bore site

Energy in action.

AGL

Author:	Upstream Gas
Date:	26/10/2010
Ref:	2575r1

Meters
0 100 200
Scale 1:5,000

N

Geocentric Datum of Australia 1994

Legend
- Proposed Pilot Wells
- Cored Well
- Railway
- Road
- Property Boundaries

Sources: AGL Energy Limited, MapData Sciences, SKM

2 METHODS

This assessment was designed to meet the requirements of the EP&A Act, TSC Act and EPBC Act. Several tasks were addressed including:

- A review of available literature and databases to assist with the identification of site values, especially in relation to threatened species, populations and endangered ecological communities;
- A field investigation to ascertain the 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 site and locality; and
- Preparation of preliminary recommendations to ameliorate and mitigate impacts.

2.1 Literature Review

Available literature and database records pertaining to the site and locality (i.e. within a 10 km radius) were reviewed. The full list of reference materials is provided in Section 7 and those of particular relevance are listed below:

- DECCW – Threatened species database records (DECCW 2010);
- SEWPAC – Online protected matters search tool for Matters of National Environmental Significance (NES) (SEWPAC 2010);
- AECOM 2009 Gloucester Coal Seam Gas Project. Ecological Assessment. Gloucester to Hexham. Report prepared for Lucas Energy, Gloucester NSW;
- Alison Hunt & Associates Pty Ltd 2009 Addendum. Gloucester Coal Seam Gas Project. Ecological Assessment. Gloucester to Hexham: Amended Sections. Report prepared for AECOM, Gordon NSW; and
- Alison Hunt & Associates Pty Ltd 2011 Gloucester Coal Seam Gas Project. Targeted Surveys. Draft. Report prepared for AGL.

2.2 Site Assessment

An assessment of the proposed Waukivory sites was undertaken on 17 November 2010. The locations of the proposed wells and associated infrastructure 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. Consequently, 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 proposal.

During the site assessment the dominant plant species were recorded and the likelihood of threatened fauna and flora assessed through determining if suitable habitat was present. For plants this included several factors including the vegetation types present, drainage patterns, weed invasion and present land use activities. A general fauna habitat assessment included an assessment of the nature and condition of habitats, specific resources and features of relevance for native fauna. In addition, indirect evidence of fauna (e.g. scats, feathers, fur, tracks, dens, nests, scratches, chew marks and owl wash) was recorded.

2.3 Limitations

This assessment was aimed at providing an overall assessment of the ecological values of the sites with particular emphasis on the likely presence of threatened species. This was undertaken through integration of data from a number of sources to allow an assessment of the impacts of the proposal. This study was not designed so that all species, whether resident or transitory to the site, would be recorded. It is therefore likely that a number of species not mentioned within this report would also utilise the resources of the site from time to time.

3 RESULTS

3.1 Environmental Setting

Gloucester and the proposed Waukivory pilot well 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 consists of grassy flats and gentle rises. 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. Soils comprise 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 (Lucas 2007).

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

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

With such significant conservation areas the LGA provides habitat for a number of species and endangered ecological communities listed on the schedules of the NSW TSC Act and Commonwealth EPBC Act and these are listed in Gloucester Shire Council's *Supplementary State of the Environment Report 2005*. A review of these lists indicated 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.

3.2 Gloucester Valley Vegetation

Native vegetation of the Gloucester Valley falls within the *Hunter-Macleay Dry Sclerophyll Forests* vegetation class which are transitional between the *Dry Coastal Valley Grassy Woodlands and Northern Hinterland Wet Sclerophyll Forests* of the steeper and wetter slopes (Keith 2004). Woodlands in the locality have previously been mapped by NPWS (1999) as *Ecosystem (ES) 145 Sydney Peppermint – Stringybark*, *ES 71 Ironbark*, *ES 47 Escarpment Redgum* and *ES 33 Dry Foothills Spotted Gum*. The canopy of vegetated areas is largely dominated by Spotted Gum (*Corymbia maculata*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Box (*E. moluccana*), Grey Gum (*E. punctata*), Small-fruited Grey Gum (*E. propinqua*), Grey Ironbark (*E. siderophloia*) and Forest Red Gum (*E. tereticornis*). The occurrence and dominance of these species is largely dependent on soils, drainage and proximity to drainage lines. Shrubs are characterised by Silver-stemmed Wattle (*Acacia parvipinnula*), Forest Oak (*Allocasuarina torulosa*), Coffee Bush (*Breynia oblongifolia*), Gorse Bitter Pea (*Daviesia ulicifolia*), Peach Heath (*Lissanthe strigosa*). White Root (*Pratia purpurascens*),

Mulga Fern (*Cheilanthes sieberi* subsp. *sieberi*), Barbed Wire Grass (*Cymbopogon refractus*), Kangaroo Grass (*Themeda australis*) and Wiry Panic (*Entolasia stricta*) dominate the understorey. These areas grade into the cleared, lower elevation, fertile soils used for agriculture.

3.3 Climate

Gloucester and surrounding areas experience their highest mean rainfall and highest mean temperatures between December and March with the highest rainfall occurring in March at 127 mm and the highest temperatures in January and February at 29 ^{o}C. During winter, rainfall drops to 47 mm during August with mean maximum temperatures of 19 ^{o}C during June and July, and mean minimum temperatures to 6 ^{o}C during July and August (Table 1).

Table 1 Mean rainfall recorded at Gloucester Post Office and mean temperature at Taree

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Mean rainfall (mm)	115	122	127	77	68	67	51	47	52	68	82	104	982
Mean maximum temperature (^{o}C)	29	29	27	25	22	19	19	20	23	25	27	28	24
Mean minimum Temperature (^{o}C)	18	18	16	13	10	7	6	6	9	12	14	16	12
Source: Bureau of Meteorology http://www.bom.gov.au/jsp/ncc/cdio/weatherData accessed 21 April 2009.													

3.4 Proposed Waukivory Pilot Well Sites and Monitoring Bore Site

The location of the proposed activities are all within highly modified environments that have been cleared of native vegetation, revegetated with introduced pasture species and used for grazing over a considerable number of years (Figure 2). None of the proposed sites contain remnant native shrubs or trees and none would be located in riparian areas or within seepage zones although some access roads would cross minor drainage lines. The lack of structural diversity of the sites means that fauna habitat resources, such as trees, shrubs, rocky areas and fallen timber, are extremely limited and in general, habitat suitable for fauna would generally be limited to those common species of native and introduced fauna regularly found in disturbed areas.

AGL

Revision DRAFT

Created 27 Jan 2011

Author Upstream Gas

N

W E

S

1:7,000

0 50 100 200 300 400

Meters

Map Grid of Australia, Zone 56
Geocentric Datum of Australia 1994

Gloucester Gas Project

Figure 3 Proposed Waukivory pilot well sites and Option 1 access tracks

STRICTLY CONFIDENTIAL

Revision DRAFT
Created 27 Jan 2011
Author Upstream Gas

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Meters

Map Grid of Australia, Zone 56
Geocentric Datum of Australia 1994

Gloucester Gas Project

Figure 4 Proposed Waukivory pilot well sites and Option 2 access tracks

STRICTLY CONFIDENTIAL

3.4.1 Waukivory 11

Waukivory 11 would be located in a paddock on a slight rise approximately 100 m up slope from the Avon River (Figure 3) (Plate 2). The paddock is currently being grazed and is dominated by pasture species, such as White Clover (Trifolium repens), Couch (*Cynodon dactylon*), Wimmera Ryegrass (*Lolium rigidum*) and *Carex* sp.

Access to Waukivory 11 would be via a track from Fairbairns Lane which would be constructed along a fenceline through agricultural paddocks. Near to the Avon River the track would head north for 100 m through a paddock to access the well site. Construction of this track would not require the removal of any shrubs or trees (Figure 2)

Plate 2 Proposed location of Waukivory 11

3.4.2 Waukivory 12

Waukivory 12 would be located within a relatively flat paddock approximately 60 m from a backwater of the Avon River (Plate 3). This backwater is completely cleared of native vegetation although several Red Gum trees were evident along the banks. The paddock is vegetated with species typical of grazing land in the Gloucester valley and these included Paspalum (*Paspalum dilatatum*), Perennial Ryegrass (*Lolium perenne*), *Carex* sp. and Kikuyu Grass (*Pennisetum clandestinum*) with scattered occurrences of Purpletop (*Verbena bonariensis*) and Fireweed (*Senecio madagascariensis*).

There are currently two options for access to Waukivory 12 (Figure 3 and Figure 4). Option 1 would be from the south via Waukivory 14 which would be accessed from an existing farm track upgraded to meet the requirements for transporting machinery. From Waukivory 14, a 500 m access track would be constructed through a paddock to reach Waukivory 12. Option 2 would be from the north along an existing farm access track to a dam and then through a paddock to the well site. This option would require the crossing of a shallow drainage line. No removal of native trees or shrubs would be required for either option.

Plate 3 Proposed location of Waukivory 12

3.4.3 Waukivory 13

Waukivory 13 would be located within a flat paddock 250 m west of the Gloucester River and 100 m south of the Avon River (Figure 3) (Plate 4). The location of Waukivory 13 is within a paddock dominated by Kikuyu and White Clover.

Access to the site would be from a gravel road which runs off Fairbairns Lane. The well site is located approximately 20 m inside the fenceline. There would be no trees or shrubs removed for construction of the access track.

Plate 4 Proposed location of Waukivory 13

3.4.4 Waukivory 14

Waukivory 14 would be located on a slight rise approximately 100 m upslope of the Gloucester River within a grazing paddock which is dominated by agricultural species typical of this setting (Plate 5). Access to this site would be along gravel road off Fairbairns Lane.

There are currently two options for access to Waukivory 14 (Figure 3 and Figure 4). Option 1 would be from the south along an existing farm track which would be upgraded to meet the requirements for transporting machinery. Option 2 would be from the north via Waukivory 12 along a 500 m track constructed within a paddock. No removal of native trees or shrubs would be required for either option.

Plate 5 Proposed location of Waukivory 14

3.4.5 Water Monitoring Bore Site

The water monitoring bore site would be located approximately 250 m west of Waukivory 11 in an agricultural paddock most recently used for grazing (Figure 2). The area is dominated by pasture species. The site would be located along the track proposed for access to Waukivory 11 (Figure 3). Construction of the track and bore installation would not require the removal of any trees or shrubs.

3.4.6 Fauna Habitat

The lack of structural diversity across the Waukivory pilot well sites means that fauna habitat resources, such as trees, shrubs, rocky areas and fallen timber, are extremely limited and in general, habitat suitable for fauna would be limited to those common species of native and introduced fauna regularly found in disturbed areas, such as the Eastern Grey Kangaroo (*Macropus giganteus*), European Red Fox (*Vulpes vulpes)*, Black Rat (*Rattus rattus*), House Mouse (*Mus musculus*), and domestic cats and dogs.

3.5 Conservation Significance

3.5.1 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

Although remote to the study area, Myall Lakes which is listed as a Wetland of International Significance (Ramsar Sites) is listed under the EPBC Act as being within the same catchment as the study area.

Predictive modelling indicates that 14 fauna, 13 flora and 12 migratory species listed under the EPBC Act have the potential to occur within the locality of the site (i.e. 10 km) and these are listed at Appendix A along with their likelihood of occurrence. There are no EPBC Act listed species with real potential to occur across the Waukivory sites or directly adjacent.

3.5.2 NSW *Threatened Species Conservation Act 1995*

Endangered Ecological Communities

A number of Endangered Ecological Communities (EEC) are listed as occurring within the Karuah Manning CMA and these are:

- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions;
- Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions;
- Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions;
- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion;
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions;
- Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion;
- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion;
- River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions;
- Sub-tropical Coastal Floodplain Forest of the NSW North Coast bioregion;
- Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions;
- Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions; and
- Sydney Freshwater Wetlands in the Sydney Basin bioregion.

The proposed Waukivory pilot well sites are highly modified with the majority of the area comprising paddocks and consequently none of the EECs listed above occur across the survey area.

Species

A total of 63 threatened species listed under the TSC Act have been recorded within the locality consisting of ten species of plant, one reptile, four amphibians, 25 birds and 23 mammals and these are listed at Appendix A. The survey area lacks the complexity required to provide habitat for a range of threatened species as pasturelands generally have few refuge areas or foraging resources, especially for mammals and reptiles. The Gloucester and Avon Rivers may provide refuge and some foraging habitat for some species (e.g. Glossy Black-cockatoo). However, these areas would not be altered as a consequence of this proposal. Road reserves along access roads may provide nesting and foraging habitat for the Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) which is listed as vulnerable under the TSC Act. Similarly, the Grass Owl (*Tyto capensis*) may occasionally forage across the study area as its favoured habitat is tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath, and cane grass, or sedges on flood plains.

Table 2 Threatened species for which habitat occurs locally

Species	Conservation Status	Habitat	Likelihood of occurrence on site
Grey-crowned Babbler *Pomatostomus temporalis temporalis*	V-TSC	Open woodland, particularly those with intact understorey.	Known to occur at the northern end of the Tiedmans block and is likely to occur in other 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.			

3.6 Corridors and Connectivity

The proposed pilot wells are situated in an agricultural landscape and most of the adjacent lands have been cleared with only isolated pockets of remnant bushland remaining within the broad valley area around Gloucester. The Gloucester River and Avon River and unnamed tributaries would provide the strongest linkages along the valley floor. This project is unlikely to affect movement corridors and connectivity for any species of plant or fauna within the locality as impacts are confined to small areas within agricultural paddocks.

3.7 SEPP 44 - Koala Habitat Protection

An assessment under *State Environment Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44) is required as the Gloucester LGA is listed under Schedule 1 of SEPP 44. This SEPP requires the identification and protection of core koala habitat within the LGA. Core koala habitat means an area of land with a resident population of koalas, evidenced by attributes such as breeding females (i.e. females with young) and recent sightings of and historical records of a population. Potential koala habitat means areas of native vegetation where the trees of the types listed in Schedule 2 of the Act, constitute at least 15% of the total number of trees in the upper or lower strata of the tree component. The proposed pilot well sites could not be considered core koala habitat or potential koala habitat as the proposed route lacks 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.

4 IMPACT ASSESSMENT

There are a number of disturbances that would be associated with the proposed works and these are listed in Table 3.

Table 3 Disturbances associated with the proposal

Proposal Stage	Disturbance
Site preparation	Clearance of existing groundcover and topsoil (to be stored for site rehabilitation).
	Import of gravel and erection of site fence around an area of up to 100 m x 100 m for the proposed well sites.
	Import of gravel and erection of site fence around an area of up to 50 m x 30 m for the water monitoring bore site.
Preparation of access tracks	Grading and improvement of access tracks for heavy vehicle access maximum 4m disturbance width. Existing bridge crossings of the Gloucester and Avon Rivers would not be altered.
Borehole drilling	Movement of vehicles to and from the established drill pad.
	Operational noise of drill rig and associated activities.

As a consequence, a number of direct and indirect impacts associated with construction and operation of the proposal have the potential to occur and these are discussed below.

4.1 Direct Impacts

4.1.1 Vegetation Clearance

The site is characterised by cleared land which has been used for grazing of stock over a number of years. A key aim of the proposal has been to locate the pilot wells and associated infrastructure in such a way as to avoid the removal of any trees and shrubs and this has been achieved. As the works are situated within paddocks, the majority of vegetation cleared would be agricultural pasture species and pasture weeds.

4.1.2 Loss of Fauna Habitat

Some habitat for grazing species, such as the Eastern Grey Kangaroo, would be temporarily lost from the site. These areas will be reinstated to their current condition through reseeding of pasture grasses and hence impacts would be temporary and minor. The proposal has been designed to avoid the removal of trees and there are not expected to be any additional direct losses of fauna habitat.

4.2 Indirect Impacts

4.2.1 Disturbance of fauna

Disturbance of fauna during construction could occur through an increase in noise and activity levels across the site, including an increase in traffic. Disturbance of fauna can result in changes to the behaviour and patterns of usage of resources by certain fauna species and / or increases in roadkill. As the majority of construction activities would be within the highly modified paddock areas of the site it is anticipated that this proposal would provide few risks to fauna.

4.2.2 Runoff and Sedimentation

There is the potential for impacts on drainage lines, down slope areas and the Gloucester and Avon Rivers during and following construction from run-off and sedimentation through earthworks and the removal of pasture. Provided stringent stormwater and sediment trapping systems are implemented and that revegetation of the area is undertaken as soon as is practical after construction, then indirect impacts are not anticipated. It is recommended that works not be undertaken during times of high rainfall and preferably during the drier months of the year, i.e. June to September (refer to Table 1).

4.3 Threatening Processes

It is unlikely that any key threatening processes listed under the TSC Act or EPBC Act would be exacerbated by this proposal as the pilot well sites and access ways have been located to avoid areas of native vegetation and riparian or seepage areas and no native vegetation would be cleared or important natural drainage patterns altered.

4.4 Priority Actions for Gloucester Shire Council LGA

There are 90 priority actions identified as being 'High priority' in the Gloucester Shire Council LGA and these include actions which apply to 31 threatened species, populations and communities, and one key threatening process. None of the actions of this proposal are inconsistent with any of the strategies or actions identified for this area.

4.5 NSW *Environmental Planning and Assessment Act 1979*

Two threatened species may potentially be impacted by this proposal and therefore Assessments of Significance as required under Part 5 of the EP&A Act, have been undertaken as a precautionary measure. These species are:

- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*);and
- Grass Owl (*Tyto capensis*).

The Assessments of Significance for these species are provided at Appendix B.

It was concluded that this proposal would not impact on any known breeding habitat for these species and it is unlikely to have a significant impact on foraging resources and that with the implementation of stringent management measures it is unlikely that any of these species would be significantly impacted by this proposal and therefore a Species Impact Statement is not necessary.

4.6 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The Waukivory sites and access tracks support very limited habitat for native fauna and flora as it is highly modified through clearing and agricultural land uses and it is unlikely that that any matters of NES would be significantly impacted by this proposal. It is considered that this proposal is unlikely to be considered a controlled action under the EPBC Act.

4.7 Cumulative Impacts

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

5 RECOMMENDATIONS

A number of recommendations and management measures are available and should be implemented to mitigate and ameliorate potential impacts within the locality. Central to these measures should be the preparation and implementation of a Construction Environmental Management Plan and Sediment and Erosion Control Plan.

5.1 Mitigation Measures

A number of mitigation measures are recommended to protect adjacent biodiversity.

5.1.1 Performance Objectives

- To minimise impacts on remaining biodiversity values of the well sites; and
- Protect biodiversity values across the locality.

5.1.2 Goals

Goals for the proposed works should be to:

- Minimise the amount of vegetation to be removed;
- Protect the remaining vegetation and fauna habitat;
- Ensure that erosion of the works areas does not occur and that sedimentation of adjacent areas is avoided; and
- Ensure that impacted areas are protected from erosion and weed invasion and restored to their current levels at the completion of the drilling operations.

5.1.3 Recommendations

Mitigation measures should include:

- Construction works be undertaken during drier periods;
- Preparation and implementation of a Construction Environmental Management Plan for the work on site which includes:
    - On site environmental management to advise machinery operators and other on-site personal on ways of minimising ecological impacts;
    - Fencing of the areas where work is being carried out to ensure that machinery remains in the designated works zone and to contain the area of disturbance;
    - Measures to control the number of vehicles entering the site(s)
    - Measures to control and strictly limit the speed of vehicles on the site to reduce the risk of fauna injuries;
    - Fencing the drilling sites with temporary stock-proof fencing and bunded where appropriate;

- Measures and requirements to ensure all drilling fluid is contained on site. No discharge of drilling fluid to waterways, aquatic and riparian environments would be permitted without suitable licences or approvals;
- Measures to control weeds across all sites would be implemented;
- Ongoing monitoring and, if necessary, restoration maintenance would be undertaken until grass cover has re-established;
- Rubbish should be collected and removed off site to prevent it attracting pests, entering waterways and causing harm to fauna;
- 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;

- Preparation and implementation of an Erosion and Sediment Control Management Plan prepared for the proposed redevelopment which includes:
  - Installation of sediment fences to prevent stormwater runoff and sediment entering the adjacent drainage lines and rivers;
  - Stockpiling of soil that may contain seeds of exotic species away from the creeks, drainage lines and other areas of native vegetation to prevent transportation to adjacent areas during rainfall or wind events; and
  - Measures to ensure that erosion and movement of sediments down slope do not occur during construction and these should include protection of bare ground with the use of jute mats or similar, weed control and revegetation of disturbed areas with pasture species.

6 CONCLUSIONS

The proposal would avoid the removal of native vegetation communities, and trees and shrubs, as the proposed well sites and access tracks would be constructed in agricultural paddocks which have been cleared and used for cropping and grazing over many years. It is considered that the minor and temporary nature of disturbance at the proposed well sites and along access tracks means that any impacts on flora and fauna are likely to be temporary and minor and could be managed to protect current values.

Assessments under the NSW EP&A Act, including those species, populations and communities listed under the TSC Act concluded that significant impacts are unlikely and that a Species Impact Statement is not required. Similarly, it was concluded that matters of NES listed under the Commonwealth EPBC Act would not be significantly impacted and consequently is unlikely to be considered a controlled action under the EPBC Act.

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APPENDIX A

THREATENED SPECIES RECORDED WITHIN THE LOCALITY OF PEL 285

Threatened Species recorded within the locality of PEL 285

Species / Community	Conservation Status	Habitat	Likelihood of occurrence on site
FLORA			
Asperula asthenes	V-TSC V-EPBC	Damp sites along river beds.	Mostly cleared paddocks. Unlikely-no habitat.
Angophora inopina Charmhaven Apple	V-TSC V-EPBC	Occurs must frequently in woodland / forest, wet heath, sedge woodland.	Mostly cleared paddocks. Unlikely-no habitat.
Callistemon linearifolius	V-TSC	Grows in dry sclerophyll forest on the coast and adjacent ranges.	Mostly cleared paddocks. Unlikely-no habitat.
Cynanchum elegans	E-TSC E-EPBC	Most frequently on the edge of dry rainforest vegetation.	Mostly cleared paddocks. Unlikely-no habitat.
Slaty Red Gum *Eucalyptus glaucina*	V-TSC V-EPBC	Grows in grassy woodland and dry eucalypt forest	Mostly cleared paddocks. Unlikely-no habitat.
Grevillea guthrieana	E-TSC E-EPBC	Grows along creeks and cliff lines in eucalypt forest, on granitic or sedimentary soil.	Mostly cleared paddocks. Unlikely-no habitat.
Small-flower Grevillea *Grevillea parviflora* ssp. *parviflora*	V-TSC V-EPBC	Occurs in a range of vegetation types from heath and shrubby woodland to open forest.	Mostly cleared paddocks. Unlikely.
Melaleuca groveana	V-TSC	Grows in woodland, heath and shrubland, often in exposed sites, at high elevations.	Mostly cleared paddocks. Unlikely-no habitat.
Brush Cherry *Syzygium paniculatum*	V-TSC V-EPBC	Occurs on gravels, sands, silts and clays in rainforests.	Mostly cleared paddocks. Unlikely-no habitat.
Tetratheca juncea	V-TSC V-EPBC	Mainly in low open forest / woodland with a mixed shrub understorey and grassy groundcover.	Mostly cleared paddocks. Unlikely-no habitat.

Species / Community	Conservation Status	Habitat	Likelihood of occurrence on site
FAUNA			
Stephens' Banded Snake *Hoplocephalus stephensi*	V - TSC	Rainforest and eucalypt forests and rocky areas.	Mostly cleared paddocks. Unlikely-no habitat.
Wallum Froglet *Crinia tinnula*	V - TSC	Paperbark swamps and sedge swamps of the coastal 'wallum' country.	Mostly cleared paddocks. Unlikely-no habitat.
Green & Golden Bell Frog *Litoria aurea*	E-TSC V-EPBC	Marshes, dams & stream-sides particularly those containing *Typha* or *Eleocharis*.	Cleared paddocks. Unlikely-no habitat..
Booroolong Frog *Litoria booroolongensis*	E-EPBC	Along the western-flowing streams of the Great Dividing Range.	Mostly cleared paddocks. Unlikely-no habitat.
Davies' Tree Frog *Litoria daviesae*	V - TSC	Permanently flowing streams above 400 m elevation.	Mostly cleared paddocks. Unlikely-no habitat.
Black-necked Stork *Ephippiorhynchus asiaticus*	E - TSC	Permanent freshwater wetlands. Feeds on fish, frogs, eels, turtles, crabs and snakes.	Mostly cleared paddocks. Unlikely-no habitat.
Powerful Owl *Ninox strenua*	V - TSC	Large tracts of forest from, from woodland and open sclerophyll forest to tall open wet forest and rainforest.	Mostly cleared paddocks. Unlikely-no habitat.
Grey-crowned Babbler *Pomatostomus temporalis temporalis*	V - TSC	Open woodlands.	May occur along vegetation bordering access tracks or along Gloucester and Avon Rivers.
Speckled Warbler *Pyrrholaemus sagittatus*	V - TSC	Eucalypt communities with grassy understorey.	Mostly cleared paddocks. Unlikely-no habitat.
Sooty Owl *Tyto tenebricosa*	V - TSC	Rainforest and moist Eucalypt forests.	Mostly cleared paddocks. Unlikely-no habitat.
Masked Owl *Tyto novaehollandiae*	V - TSC	Lives in dry eucalypt forests and woodlands.	Mostly cleared paddocks. Unlikely-no habitat.
Glossy Black-Cockatoo *Calyptorhynchus lathami*	V-TSC E-EPBC	Open woodlands with stands of She-oak.	Mostly cleared paddocks. Some foraging habitat along creeklines.

Species / Community	Conservation Status	Habitat	Likelihood of occurrence on site
Magpie Goose *Anseranas semipalmata*	V - TSC	Mainly found in shallow wetlands with dense growth of rushes or sedges.	Mostly cleared paddocks. Unlikely-no habitat.
Australasian Bittern *Botaurus poiciloptilus*	V-TSC	Emergent vegetation in freshwater & brackish wetlands.	Cleared paddocks. Unlikely-no emergent vegetation.
Bush Stone-curlew *Burhinus grallarius*	E-TSC	Open forests & woodlands with sparse grassy ground layer & fallen timber.	Mostly cleared paddocks. Unlikely-no habitat.
Brown Treecreeper *Climacteris picumnus*	V-TSC	Eucalypt forests & woodlands of inland plains and slopes of the Great Dividing Range. Less commonly found on coastal plains and ranges.	Mostly cleared paddocks. Unlikely-too coastal.
Barred Cuckoo-shrike *Coracina lineata*	V-TSC	Rainforest, eucalypt forests and woodlands, clearings in secondary growth, swamp woodlands and timber along watercourses.	Mostly cleared paddocks. Unlikely-no habitat.
Emu *Dromaius novaehollandiae*	EP-TSC	Open forest, woodland, coastal heath, coastal dunes, wetland areas, tea tree plantations and open farmland, and occasionally in littoral rainforest between Evans Head and Red Rock.	Unlikely-not known from area.
Comb-crested Jacana *Irediparra gallinacea*	V-TSC	Inhabits permanent wetlands with a good surface cover of floating vegetation, especially water-lilies.	Mostly cleared paddocks. Unlikely-no habitat.
Black Bittern *Ixobrychus flavicollis*	V-TSC	Forested, freshwater & saline wetlands. Breeding along watercourses.	Mostly cleared paddocks. Unlikely-no habitat.
Hooded Robin *Melanodryas cucullata*	V-TSC	Structurally diverse lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee.	Unlikely-no habitat.
Black-chinned Honeyeater *Melithreptus gularis gularis*	V-TSC	Upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts.	Unlikely-no habitat.
Swift Parrot *Lathamus discolor*	E-TSC E-EPBC	Occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations.	Cleared paddocks. Unlikely-no habitat.
Turquoise Parrot *Neophema pulchella*	V-TSC	Lives on edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	Cleared paddocks. Unlikely-no habitat.
Barking Owl *Ninox connivens*	V-TSC	Breeding HBT >20 cm diam. Forage woodlands, grassy woodlands, forests & into grasslands 250 m.	Unlikely – no substantial woodland areas within 250 m of sites.

Species / Community	Conservation Status	Habitat	Likelihood of occurrence on site
Powerful Owl *Ninox strenua*	V-TSC	Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest.	Cleared paddocks. Unlikely-no habitat.
Regent Honeyeater *Xanthomyza phrygia*	E-TSC E-EPBC	Inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak.	Cleared paddocks. Unlikely-no habitat.
Wompoo Fruit-Dove *Ptilinopus magnificus*	V-TSC	Occurs in, or near rainforest, low elevation moist eucalypt forest and brush box forests.	Cleared paddocks. Unlikely-no habitat.
Rose-crowned Fruit-Dove *Ptilinopus regina*	V-TSC	Sub-tropical and dry rainforest.	Cleared paddocks. Unlikely-no habitat.
Superb Fruit-Dove *Ptilinopus superbus*	V-TSC	Rainforest and similar closed forests.	Cleared paddocks. Unlikely-no habitat.
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.
Eastern Cave Bat *Vespadelus troughtoni*	V - TSC	Cave-roosting species found in dry open forest and woodland, near cliffs or rocky overhangs.	Cleared paddocks. Unlikely-no habitat.
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	V - TSC	Prefers moist habitats with trees >20 m. Roosts in HBT or under bark or in buildings.	Cleared paddocks. Unlikely-no habitat.
Golden-tipped Bat *Kerivoula papuensis*	V - TSC	Rainforest and adjacent sclerophylla forest.	Cleared paddocks. Unlikely-no habitat.
Large-eared Pied Bat *Chalinolobus dwyeri*	V-TSC V-EPBC	Roosts in caves, derelict mines frequenting low to mid elevation dry open forest and woodland close to these features.	Cleared paddocks. Unlikely-no habitat.
Little Bentwing-bat *Miniopterus australis*	V - TSC	Moist Eucalypt forests whilst roosting in caves and man-made structures	Cleared paddocks. Unlikely-no habitat.
Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*	V - TSC	Roosting – caves, derelict mines, storm-water tunnels, buildings. Foraging - forested areas.	Cleared paddocks. Unlikely-no habitat.
Eastern Freetail-bat *Mormopterus norfolkensis*	V - TSC	Dry sclerophylla forest & woodland. Roosts - hollows & under bark or man-made structures.	Cleared paddocks. Unlikely-no habitat.

Species / Community	Conservation Status	Habitat	Likelihood of occurrence on site
Large-footed Myotis *Myotis adversus*	V - TSC	Forages over streams and pools catching insects and small fish by raking their feet across the water surface	Cleared paddocks. Unlikely-no habitat. May forage along creeklines.
Greater Broad-nosed Bat *Scoteanax rueppellii*	V - TSC	Woodland, moist and dry eucalypt forest, and rainforest but prefers tall wet forest.	Cleared paddocks. Unlikely-no habitat.
Grey-headed Flying-fox *Pteropus poliocephalus*	V-TSC V-EPBC	Subtropical & temperate rainforests, tall sclerophylla forests & woodlands, heaths & swamps.	Mostly cleared paddocks. Unlikely-no habitat.
Spotted-tailed Quoll *Dasyurus maculatus*	V - TSC	Forests and heathlands.	Mostly cleared paddocks. Unlikely-no habitat.
Koala *Phascolarctos cinereus*	V - TSC	Eucalypt forests and woodlands.	Cleared paddocks. No habitat would be altered.
Squirrel Glider *Petaurus norfolcensis*	V - TSC	Eucalypt forests and woodlands.	Mostly cleared paddocks. Unlikely-no habitat.
Rufous Bettong *Aepyprymnus rufescens*	V - TSC	Tall, moist eucalypt forest to open woodland, with a tussock grass understorey.	Mostly cleared paddocks. Unlikely-no habitat.
Eastern Pygmy-possum *Cercartetus nanus*	V - TSC	Rainforest, sclerophylla forest & woodland to heath – but heath & woodland preferred. .	Mostly cleared paddocks. Unlikely-no habitat. Known from Tiedman block 3 km south of the sites.
Parma Wallaby *Macropus parma*	V - TSC	Moist eucalypt forest with thick, shrubby understorey.	Mostly cleared paddocks. Unlikely-no habitat.
Yellow-bellied Glider *Petaurus australis*	V - TSC	Occur in tall mature eucalypt forest generally in areas with high rainfall.	Mostly cleared paddocks. Unlikely-no habitat.
Squirrel Glider *Petaurus norfolcensis*	V - TSC	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest with heath understorey in coastal areas.	Mostly cleared paddocks. Unlikely-no habitat.
Brush-tailed Rock-wallaby *Petrogale penicillata*	E-TSC V-EPBC	Rocky escarpments, outcrops, steep slopes or cliffs – especially those with caves, ledges or overhangs & shrub cover.	Mostly cleared paddocks. Unlikely-no habitat.
Brush-tailed Phascogale *Phascogale tapoatafa*	V - TSC	Dry sclerophylla open forest with sparse groundcover. Also heath, swamps, rainforest & wet sclerophylla forest.	Mostly cleared paddocks. Unlikely-no habitat. Known from Tiedman block 3 km south of the sites.

Species / Community	Conservation Status	Habitat	Likelihood of occurrence on site
Common Planigale *Planigale maculata*	V - TSC	Rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas.	Mostly cleared paddocks. Unlikely-no habitat.
Long-nosed Potoroo *Potorous tridactylus*	V-TSC V-EPBC	Inhabits coastal heaths and dry and wet sclerophyll forests.	Mostly cleared paddocks. Unlikely-no habitat.
Red-legged Pademelon *Thylogale stigmatica*	V - TSC	Forest with dense understorey and ground cover.	Mostly cleared paddocks. Unlikely-no habitat.
Note: TSC = NSW *Threatened Species Conservation Act 1995*. EPBC = Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. V = Vulnerable, E = Endangered, Mig = Migratory, EEC = Endangered Ecological Community, EP = Endangered Population.			

APPENDIX B

ASSESSMENT OF SIGNIFICANCE UNDER THE EP&A ACT

APPENDIX B

Assessment of Significance

Background

As required under the Section 5 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:

- 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 subspecies 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. Across their range, breeding can occur throughout the year. However, within NSW, almost all observations of breeding activity have been from July to December (Higgins & Peters 2002).

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).

Critical habitat has not been declared 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:

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 proposal would only temporarily disrupt potential habitat for this species. Disturbance would be minimal and the borehole sites would be 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).

Critical habitat has not been declared 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 abatement plan prepared for the Grass Owl. Five PAS have been prepared for the Grass Owl and this proposal would not be inconsistent with any of the objectives of these PAS (DEC 2005a).

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.

Appendix B

Noise Impact Assessment

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29 March 2011

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Toni Laurie
Land and Approvals Manager
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Re: Gloucester Pilot Wells Waukivory 11 to 14 – Environmental Noise Assessment

Dear Toni,

1 Introduction

EMGA Mitchell McLennan Pty Ltd (EMM) has been engaged by AGL to conduct a preliminary noise assessment for the proposed pilot well exploration program in Gloucester, NSW. The subject of this study is pilot exploration wells identified as Waukivory (WK) 11 to 14.

This report assesses the potential environmental noise impact from the pilot project, including the noisiest construction related activities of drilling and fracture stimulation. It is understood that fracture stimulation is one of the well completion techniques available for exploration drilling, and dependent upon results of logging and testing, is likely to only be used for two of the four proposed exploration wells.

An alternate well completion method known as under-reaming is anticipated for two of the wells, and is similar to a standard drilling exercise which widens the hole beneath the cased and cemented section of the well. However, fracture stimulation noise predictions are presented in this noise report for all four exploration wells for reference in the event fracture stimulation is used for all wells. It is important to note that fracture stimulation will occur during the daytime shift only and for up to one hour at each of the four exploration wells.

In addition to the proposed exploration wells, a water monitoring piezometer will be established at a separate site west of WK 11. This will involve 24 hour drilling for up to four days to achieve a total depth of 300 m.

Also, the proposed WK 12 and WK 14 may undergo “twinning”. “Twinning” is a procedure in which two exploration wells are undertaken on the same drill pad site. The wells are within 6 m to 10 m apart at the surface therefore allowing both shallow and deeper coal seams to be pilot tested within the one pad in an efficient manner, should geological properties be suitable.

In comparison to the construction activities outlined above, operational activities will be relatively quiet and essentially relate to flaring of each proposed exploration well. Nonetheless, a noise impact assessment has also been undertaken of proposed operations. The potential increase in related road traffic noise has also been assessed.

2 Project description

The project description detail is provided in the Review of Environmental Factors (REF) report. From a noise perspective, the key elements include:

- Site establishment and preparation of well pad areas, as well as upgrading and preparation of established access tracks. Access to the constructed pads will be via council maintained roads and existing access tracks where possible. These activities will be confined to daytime only from Monday to Friday. Some new access tracks are likely to be required for WK 12, 13 and 14 to enable equipment to be moved across the existing grazing paddocks. An access track is required for WK 11 off the council maintained road (Fairbairns Road). A previous exploration well (Waukivory 1) was located to the immediate east of WK 11. The access track previously used for Waukivory 1 will be used to access WK 11. There is expected to be negligible impact from the construction of the access tracks.

- Drilling. Drilling of the exploration wells would be undertaken with a trailer or truck mounted drill rig. The type of drill rig to be used is typical of rigs used for coal seam gas drilling. This includes equipment to raise and lower rods in the well; drive gear for rotary drilling; wireline equipment for the recovery of core tubes; blow out prevention (BOP) equipment as a safety standard; and pumps for the circulation of drilling fluids. It is proposed that drilling will be conducted on a 24 hour basis for all four exploration wells. The drilling activity will be conducted on a constructed pad with an area of approximately 60 m by 40 m. With ancillary equipment, the pad maybe expanded to an area of 100 m by 100 m. The depth of the four exploration wells is expected to be approximately 1,000 m. Drilling of the water monitoring piezometer will likely be to a depth of 300 m. Should it be undertaken, the "twinned" wells at WK 12 and WK 14 will be shallower than the original well as it would target the shallower coal seams. All drilling is expected to be done using the same drill rig and there will not be any concurrent drilling at multiple sites.

- Fracture stimulation. Fracture stimulation is a common method used in coal seam gas operations to increase the permeability of the coal seam. This method uses the hydraulic pressure of fluid pumped into gas wells to open coal seams and help increase gas production. The fluid used in this process comprises approximately 99.5% water and sand, while 0.5% contains other additives. Fluids used during fracture stimulation are flushed from the coal seam and pumped to lined containment pits or tanks located on the surface and disposed of at appropriate off-site locations. Generally, only wells that intersect low permeability coal seams require fracture stimulation and these seams are usually very deep. Coal seam gas wells are fully lined with steel casing, which is securely cemented in place to isolate aquifers overlying the coal seam. The well must be fully cased and is perforated at specific intervals where the fracture stimulation is to be undertaken. Thus, fracture stimulation operations are controlled and designed so they are limited to coal seams and do not extend either above or below the targeted seam. It is proposed to utilise the fracture stimulation method for WK 11 and WK 13 but is not limited to these wells. Importantly, fracture stimulation will only occur for up to one hour per exploration well during the daytime period only (Monday to Friday 7am to 6pm and Saturday 8am to 1pm).

- Under-reaming. Under-reaming is a method that involves enlarging the size of a hole beneath the end of a casing. If suitable geological conditions exist an additional stage to open-hole completions can be added to widen the well where it intersects the target coal, which is located below the cased section of the well. After the well is cased a special reaming tool with rotating blades, jets or drill cones is used to ream out a cavity in the coal. Under-reaming is a useful process where there are

multiple seams and high permeability coal. Once the well has been widened at each seam, slotted casing is inserted across the coal interval and, where needed, gravel is packed between the walls of the cavity and casing to keep the cavity open. After under-reaming, the well is cleaned out with a fresh water flush. It is proposed to utilise the under-reaming method for WK 12 and WK 14 if the coal seam properties are found to be suited to this type of completion. Alternatively these wells may be fracture stimulated, should the under-reaming completion technique not produce sufficient flows for pilot testing purposes. Under-reaming will utilise the same drill rig as used in drilling and will be over a period of 24 hours per hole, with a 24 hour set-up phase.

- Flaring. A gas flare or flare stack is an elevated vertical stack or pipe for burning gas released during the production and processing of coal seam gas. Commonly referred to as "flaring", the flare burns gas that needs to be released for safety reasons. Flaring of gas burns off any combustible vapours produced from the gas well. The released gases and/or hydrocarbon vapour liquids are burned as they leave the flare stacks. Flaring is also considered the most environmentally friendly method to dispose of gas. The carbon dioxide (CO_2) produced from the burning process (i.e. the burning of methane gas) has less than one-twentieth the impact on the Earth's atmosphere than methane. As described later, the flare nozzle or the source of the noise in this process will be shielded by a solid structure (eg shipping containers). Once flaring begins, it will be continuous 24 hours per day and seven days per week.

All proposed activities are located on privately owned land in cleared grazing paddocks. Landholder consent has been obtained for the two lots identified for the four exploration wells. The work is expected to be completed over a period of approximately five to seven weeks. This includes testing, and as such drilling is not conducted over the entire period.

If the results of the drilling activities warrant further investigation, AGL may seek further approval from the Department of Industry and Investment (DII) to convert any of the exploration wells to production wells. In this situation the exploration well will be capped and suspended whilst the relevant approvals are sought. If further investigation of the exploration wells is not required the well will be plugged as per the Department of Primary Industries (DPI) Borehole Sealing Requirements, and the site rehabilitated.

3 Noise Goals

3.1 Construction noise

The construction component of the project will include site preparation and establishment, drilling and fracture stimulation (for some wells), before gas can be extracted and flared. Of these activities, the potentially highest noise emitting activities are drilling and fracture stimulation of the pilot wells. These exploration activities are temporary in nature therefore will be assessed according to construction noise guidelines.

3.1.1 Interim construction noise guideline

The NSW Department of Environment Climate Change and Water (DECCW) provides the Interim Construction Noise Guideline (ICNG) for the assessment and management of noise from construction works.

The ICNG provides two methodologies for the assessment of construction noise emissions:

- quantitative, which is suited to major construction projects with typical durations of more than three weeks; and
- qualitative, which is suited to short term infrastructure maintenance (less than three weeks).

The resultant methodology for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the nearest sensitive receivers, whilst the qualitative assessment methodology is a more simplified approach that relies more on noise management strategies.

Given the predicted construction duration is greater than three weeks, the quantitative assessment methodology is the most suitable assessment methodology. Table 3.1 is an extract from the ICNG, providing guidance for residential receivers only.

In addition, the DECCW suggests the following time restriction for the construction activities where the noise is audible at residential premises:

- Monday to Friday 7.00 am - 6.00 pm;
- Saturday 8.00 am - 1.00 pm; and
- no construction work is to take place on Sundays or public holidays.

Table 3.1 ICNG residential criteria

Time of Day	Management Level $L_{Aeq\ (15\ min)}$*	How to Apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: i) times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences ii) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

To establish appropriate construction noise criteria, the existing background noise levels need to be quantified for potentially affected residences. The DECCW provides the Industrial Noise Policy (INP) which includes guidelines for determining existing background noise levels. There is no existing background data for the surrounding sensitive receivers. In the absence of such background noise data for the potentially affected residences, the INP recommends adopting a conservative approach of setting a lower threshold background level typical of rural environments of 30dB(A). This is considered representative for the closest potentially affected residences to proposed well sites and was adopted for our assessment.

Based on the ICNG the noise criteria that will be adopted for residential receptors during construction activities are provided in Table 3.2.

Table 3.2 Residential construction noise criteria

Location	$L_{Aeq, 15min}$ Noise Criterion, dB(A)
Noise Assessment Locations (refer to Figure 1)	40, ie background plus 10dB (recommended hours) 35, ie background plus 5dB (Out of hours)

Notes: 1. The recommended construction hours are as described earlier.

As per the ICNG, out of hours construction works must be accompanied by a strong justification.

3.2 Industrial Noise Policy (INP)

Once the wells are established (drilled and, where required, fracture stimulated), they will extract gas and flare to the immediate environment. In noise assessment terms, it is this flaring (burning) of gas that will constitute the noisiest aspect of the operational phase of the project. The noise from flaring will be assessed against the NSW DECCW's Industrial Noise Policy (INP).

The DECCW, in its INP, provides guidelines for assessing industrial facilities. The INP states with respect to the criteria:

"*They are not mandatory, and an application for a noise producing development is not determined purely on the basis of compliance or otherwise with the noise criteria. Numerous other factors need to be taken into account in the determination. These factors include economic consequences, other environmental effects and the social worth of the development.*"

Assessment criteria depend on the existing amenity of areas potentially affected by a proposed development. Assessment criteria for sensitive receivers near industry are based on the following objectives:

- protection of the community from excessive intrusive noise; and
- preservation of amenity for specific land uses.

In order to ensure that these objectives are met, two separate criteria are prescribed by the DECCW, namely the intrusiveness criteria and the amenity criteria. A fundamental difference between the intrusiveness and the amenity criteria is that the former is applicable over 15 minutes in any period, while the latter covers the entire assessment period (i.e. day, evening and night).

3.2.1 Intrusiveness

The intrusiveness criterion requires that $L_{Aeq,15min}$ noise levels from a newly introduced source during the day, evening and night do not exceed the existing RBL by more than 5dB. This is expressed as:

$$L_{Aeq,15min} \leq RBL + 5 - K$$

where $L_{Aeq,15min}$ is the L_{eq} noise level from the source (i.e. site), measured over a 15 minute period and K is a series of adjustments for various noise characteristics. Where the RBL is less than 30dB(A), a value of 30 dB(A) is used.

As for construction noise criteria discussions above, the INP's minimum threshold background noise level of 30dB(A) will be adopted, resulting in an operational noise goal of **35dB(A)$L_{eq,15minute}$** for the day, evening and night time periods.

3.2.2 Amenity

The DECCW's amenity criterion requires industrial noise to be within an acceptable level for the particular locality and land use. Where ambient noise is already high, the acoustic environment should not be deteriorated significantly. The strategy behind the amenity criterion is a holistic approach to noise, where all industrial noise (i.e. existing and future) received at a given location does not exceed the recommended goals.

Private residences potentially affected by the project are covered by the DECCW's rural amenity category. The amenity criteria taken from Table 2.1 of the INP are given in Table 3.3.

Table 3.3 DECCW base amenity criteria

Location	Indicative area	Time period	Recommended $L_{eq,period}$ noise level, dB(A)	
			Acceptable	Maximum
Residential	Rural	Day	50	55
		Evening	45	50
		Night	40	45

Source: DECCW INP 2000

3.2.3 Project specific noise criteria

The INP requires that both the intrusiveness and amenity criteria are satisfied. However, the more limiting of the two becomes the project specific noise criteria (PSNC) or operational criteria for this exploration site alone. In this case and for all representative assessment locations, the intrusiveness criteria are the more limiting of the two and hence the PSNC are those presented earlier in Section 2.2.1 or **35dB(A)$L_{eq,15minute}$**.

3.3 DECCW road traffic noise criteria

For the assessment of potential road traffic noise impact from increases in road traffic due to the proposed pilot well project, we have adopted the DECCW Environmental Criteria for Road Traffic Noise (ECRTN, 1999), which provides external traffic noise criteria.

To determine suitable traffic noise criteria for a particular project, the road or roads must be categorised with respect to the ECRTN definitions. The current project will potentially create additional traffic on existing collector (The Bucketts Way) and local roads.

Hence, the most relevant ECRTN categories are:

- land use developments with potential to create additional traffic on collector roads; and
- land use developments with potential to create additional traffic on local roads.

Table 3.4 is an extract from the ECRTN and applies to the project.

Table 3.4 NSW DECCW Road Traffic Noise Criteria, 1999

Type of Development	**Criteria**		
	Day (7 am– 10 pm), dB(A)	**Night (10 pm– 7 am), dB(A)**	**Where criteria are already exceeded**
Land use developments with potential to create additional traffic on collector road	$60L_{eq,15hr}$	$55\ L_{eq,9hr}$	Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB
Land use developments with potential to create additional traffic on local roads	$55\ L_{eq,1hr}$	$50\ L_{eq,1hr}$	

3.4 Sleep disturbance criteria

The aforementioned criteria, which consider the average noise emission of a source over a specified time, are appropriate for assessing noise from relatively steady-state sources, such as pump noise and other equipment. However, on-site sources such as truck reversing alarms and hand tool clangs are intermittent (rather than continuous) in nature, and as such, need to be assessed using the L_1 or L_{max} noise metrics.

The most important impact of such intermittent noises would be to disturb the sleep of nearby residents during the DECCW defined night period of 10pm to 7am.

The DECCW's ECRTN policy indicates that levels below 50 dB(A) to 55 dB(A) inside residences are unlikely to wake sleeping occupants. The likely number of noise events per night should also be considered. If bedroom windows are open, this corresponds to an external maximum noise level of approximately 60 dB(A) to 65dB(A) at a residence. However, this is considerably higher than the DECCW's current position on sleep disturbance which is that L_1 or L_{max} noise from a source should not exceed the existing background noise level by more than 15 dB. For the purpose of this assessment, the descriptors L_{max} and L_1 may be considered interchangeable.

The latter more conservative sleep disturbance approach was adopted for this study, and hence the proposed night time criterion for the adopted representative locations becomes:

- 45dB(A)Lmax, for intermittent type of events from the exploration site alone.

EMGA | MitchellMcLennan

Proposed exploration wells and noise assessment locations

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 1

4 Predicted Noise Levels and Impact Assessment

The prediction of noise from the construction and operations was undertaken using the Environmental Noise Model (ENM) prediction software. The ENM predicts total noise levels at receivers from the concurrent operation of multiple noise sources. The model included consideration of factors such as the lateral and vertical location of plant, source-to-receiver distances, ground effects, atmospheric absorption, and meteorological conditions.

4.1 Noise assessment locations

The closest and potentially the most exposed noise sensitive receivers to the proposed pilot well sites are residences as listed in Table 4.1. The proposed exploration wells and noise assessment locations are shown in Figure 1. Importantly, locations 4 and 5 are residential properties owned by a neighbouring mining company and are understood to be currently unoccupied.

Table 4.1 Noise assessment locations

Location	Address
1	20 Grantham Road, Forbesdale, NSW 2422
2	unknown
3	176 Farbains Road, Forbesdale, NSW 2422
4*	237 Farbairns Road, Forbesdale, NSW 2422
5*	197Farbairns Road, Forbesdale, NSW 2422
6	114 Maslens Lane, Gloucester, NSW 2422

*Notes: 1. *These properties are owned by a neighbouring mining company.*

4.2 Construction noise levels

The drill activity for WK 11 to WK 14 would occur over a period of about five to seven weeks. It is proposed to undertake 24 hour drilling at each of the exploration wells due to the local geology, well conditions and integrity, and for safe operations.

Once a well is drilled, completed and cemented, selected coal seams will be perforated, fracture stimulated and the dewatering pumps run in the exploration well to ready it for production testing.

It is proposed to utilise the fracture stimulation method for WK 11 and WK 13, however this may be extended to WK 12 and WK 14 and hence results of noise modelling is provided for all four exploration well locations. It is understood that fracture stimulation will only occur during the daytime shift and for a period of approximately one hour.

Whilst preparatory and other activities occur prior to and in between drilling and fracture stimulation, the noisiest construction activities are drilling and fracture stimulation. Hence these activities were assessed in detail.

4.2.1 Sound emission input data

For the assessment of noise from the proposed drilling and fracture stimulation operations, sound emission or power levels used to predict received noise levels are provided in Tables 4.2 and 4.3. The data were extracted from previous noise audits conducted by Atkins Acoustics, "*Construction Noise Assessment Exploration Drilling, May 2009*" and "*Operation and Construction Noise and Vibration Assessment, October 2009*".

Table 4.2 Drilling plant noise levels

Source	Octave Band Centre Frequency Noise Level, dB										Overall dB(A)
	31.5	63	125	250	500	1k	2k	4k	8k	16k	
Mud Pump	108.5	113.7	114.9	109.6	106.9	103.2	98.5	91.3	83.5	80.9	**108.5**
Atlas Copco Generator	105.2	105.4	102.9	101.7	97.6	91.2	89.0	84.3	74.9	65.5	**98.5**
Drilltec G55	108.7	111.3	112.0	108.4	104.5	102.9	97.4	91.5	81.5	76.5	**107.3**
Total (minus mud pump)	110.3	112.3	112.5	109.2	105.3	103.2	98.0	92.3	82.4	76.8	**108.1**
Total (with mud pump)	112.5	116.1	116.9	112.4	109.2	106.2	101.3	94.8	86.0	82.3	**111.5**

Table 4.3 describes the fracture stimulation plant sound power levels.

Table 4.3 Fracture stimulation plant sound power levels

Plant	Quantity	dB(A)
Generator (diesel)	1	103
Reticulating Pumps	4	124
Mountain Mover	1	123
V12 Pump	4	117
	Total	**127**

4.2.2 Mitigation measures

An existing drilling configuration currently used by the proponent at another location in NSW includes a quieter drill rig together with a purpose designed plant layout to ensure noise leaving the site is minimised. The proponent has had a detailed noise monitoring report prepared (by SLR Heggies – refer to Appendix A) for the mitigated drilling arrangement. The report shows that noise emanating from the drilling compound varies from one side to the other and the derived sound power levels range from 98dB(A) at one end to 106dB(A) at the opposite end of the compound. The SLR data is shown in Table 4.4 below.

Table 4.4 Mitigated drill and optimised plant layout sound power levels

Source	Octave Band Centre Frequency Noise Level, dB											Overall, dB(A)
	16	31.5	63	125	250	500	1k	2k	4k	8k	16k	
Monitoring Location												
Location 87 (NE)	99	110	108	110	106	99	101	99	96	88	79	**106**
Location 88 (SE)	104	112	111	114	104	101	101	99	96	90	83	**106**
Location 89 (SW)	97	120	106	104	98	93	94	91	88	84	73	**99**
Location 90 (NW)	100	117	105	110	98	92	90	87	84	78	68	**98**
Overall	**101**	**116**	**108**	**111**	**103**	**98**	**99**	**96**	**93**	**87**	**79**	**104**

Note 1: Drill orientation as measured at MP12 on 17 August 2010.
Source: SLR Heggies report

This directional noise characteristic was incorporated into the model to predict received noise levels for each of the receivers. In each case the arrangement was such that the quieter side of the compound faced the closest receiver to achieve maximum benefit for the potentially worst exposed location.

Another form of noise mitigation that has been considered is physical barriers which could include commercially available temporary walls or shipping containers. With careful design of the site layout, barriers could be expected to result in a 10dB reduction in received noise levels.

4.2.3 Predicted noise levels

A summary of predicted noise levels for drilling and fracture stimulation operations for the six identified residential assessment locations are presented in Table 4.5 and 4.6 respectively. These residences are representative of the potentially worst affected and are isolated properties in the vicinity of the proposed exploration well sites. The results are for calm weather conditions only since effects of adverse weather (e.g. temperature inversions at night or source to receiver winds) do not noticeably increase received noise levels where source to receiver distances are relatively short (i.e. less than 1 km). This is demonstrated in Appendix D of the INP where a 3 ^{0}C/100 m temperature inversion is quoted to result in a 1 dB to 1.5 dB enhancement for distances ranging from 100 m to 5 km. Similarly, adverse winds are unlikely to result in a more than marginal (i.e. 3 dB) enhancement of predicted noise levels. Also, a combined inversion and wind effect (i.e. drainage situation) is not considered relevant to this project as noise sources are not significantly elevated as compared to receiver locations.

Given the exceedances of conservative criteria, additional mitigation measures in the form of temporary portable barriers were considered. A nominal 10 dB reduction was adopted for the benefits of barriers as described earlier. The results that exceed the daytime or out of hours criteria are shown in bold text (where relevant). For the water monitoring piezometer drilling, a calculation including a barrier is not provided as this operation is limited to one day shift only and it is not considered reasonable or feasible to install a barrier for one day.

Table 4.5 Predicted Leq Noise Levels, dB(A) - Drilling

	Receiver						Leq Noise Level Criteria, dB(A)	
	1	**2**	**3**	**4***	**5***	**6**	**Day time**	**Out of Hours**
Drilling activities (Unmitigated)								
WK 11	**47**	**47**	**47**	**43**	**43**	37	40	35
WK 12	**45**	**42**	**42**	**41**	**46**	**48**	40	35
WK 13	**43**	**45**	**54**	**51**	**47**	**39**	40	35
WK 14	**41**	**41**	**44**	**45**	**53**	**42**	40	35
Piezometer	**50**	**54**	**50**	38	**41**	**41**	40	35
Drilling activities (Mitigated drill & layout)								
WK 11	33	33	33	25	21	19	40	35
WK12	31	28	28	24	25	33	40	35
WK 13	28	31	**42**	33	24	19	40	35
WK 14	23	20	22	23	**37**	27	40	35
Piezometer	35	**40**	33	17	18	23	40	35
Drilling activities (Mitigated drill & layout, plus Barrier)								
WK 11	33	33	33	25	21	19	40	35
WK12	31	28	28	24	25	33	40	35
WK 13	18	21	32	33	24	19	40	35
WK 14	23	20	22	23	**37**	27	40	35
Piezometer	25	30	23	17	18	23	40	35

Notes: *1. *These properties are owned by a neighbouring mining company.*

2. Barriers during drilling were only applied to WK13 and Piezometer locations and only in a direction towards affected properties (ie privately owned properties shown to exceed criteria without barriers, which are locations 1, 2 and 3).

Table 4.6 Predicted Leq Noise Levels, dB(A) – Fracture stimulation

	Receiver						Leq Noise Level Criteria, dB(A)	
	1	2	3	4*	5*	6	Day time	Out of Hours
Fracture stimulation activities (Unmitigated)								
WK 11	**62**	**62**	**62**	**58**	**58**	**52**	40	35
WK 12	**60**	**57**	**57**	**56**	**61**	**63**	40	35
WK 13	**58**	**60**	**69**	**66**	**62**	**54**	40	35
WK 14	**56**	**56**	**59**	**60**	**68**	**57**	40	35
Fracture stimulation activities (Mitigated - Barrier)								
WK 11	**52**	**52**	**52**	**48**	**48**	**42**	40	NA
WK 12	**50**	**47**	**47**	**46**	**51**	**53**	40	NA
WK 13	**48**	**50**	**59**	**56**	**52**	**44**	40	NA
WK 14	**46**	**46**	**49**	**50**	**58**	**47**	40	NA

*Notes: 1. *These properties are owned by a neighbouring mining company.*

4.2.4 Discussion of results

The proposed drilling noise levels are predicted to meet daytime criteria without mitigation or barriers at two of the 24 predictions presented. Of the 22 daytime exceedances shown, nine results are marginal (≤3 dB) and four are not significant (≤5 dB). All daytime noise levels are well below the ICNG's 75 dB(A) 'significantly affected' goal. Other points of discussion for drilling are:

- WK 11:
  - Daytime - The unmitigated daytime drilling noise predictions satisfy criteria at one of the six assessment locations. Deploying the quieter drill and optimised layout configuration, the criteria can be achieved at all locations.
  - Out of hours - The out of hours drilling noise is predicted to meet criteria at all assessment locations with the adoption of the quieter drill and optimised layout configuration.
- WK 12:
  - Daytime - The unmitigated daytime drilling noise is predicted to exceed criteria at all six assessment locations. Deploying the quieter drill and optimised layout configuration, the criteria can be achieved at all locations.
  - Out of hours – Similarly, out of hours drilling noise is predicted to satisfy criteria at all locations with the adoption of the quieter drill and optimised layout configuration.

- WK 13:
  - Daytime - The unmitigated daytime drilling noise predictions satisfy criteria at one of the six assessment locations. The exceedances are 3 dB, 5 dB, 14 dB, 11 dB and 7 dB for locations one to five respectively. With the adoption of the quieter drill and optimised layout configuration, five of the six assessment locations are predicted to satisfy daytime criteria. Introducing noise barriers to shield receivers to the west (ie location 3), shows that daytime drilling noise is predicted to meet criteria at all assessment locations.
  - Out of hours - Similarly, out of hours drilling is predicted to meet criteria at all six assessment locations with the adoption of the quieter drill and optimised layout configuration and noise barriers to protect assessment location 3.
- WK 14:
  - Daytime – The unmitigated daytime drilling noise is predicted to exceed criteria at all six assessment locations. The exceedances at are marginal at locations 1, 2 and 6 and not significant at location 3. With the adoption of the quieter drill and optimised layout configuration, daytime drilling noise is predicted to meet criteria at all locations.
  - Out of hours - Five out of the six assessment locations are predicted to satisfy the out of hours criteria. At location 5, the mitigated night time drilling noise is only marginally (2dB) above criteria. It is important to note that a difference in noise levels of 2dB is not perceptible in practice. In our experience, at this noise level internal noise impact is not likely. The exceedances for night time drilling (assessed externally as required by the DECCW guidelines) are not likely to impact occupants of dwellings, given they will be indoors during the more sensitive sleep times. Furthermore, location 5 is owned by a neighbouring mining proponent.
- Water monitoring piezometer
  - Daytime - The drilling noise satisfies the daytime criterion at location 4. The predicted exceedance for locations 5 and 6 is marginal (1 dB). The predicted exceedances at locations 1 to 3 are more significant. With the adoption of the quieter drill and optimised layout configuration, five of the six assessment locations are predicted to satisfy daytime criteria. Introducing noise barriers to shield receivers to the west (ie location 2), shows that daytime drilling noise is predicted to meet criteria at all assessment locations.
  - Out of hours – Similarly, out of hours drilling is predicted to meet criteria at all six assessment locations with the adoption of the quieter drill and optimised layout configuration and noise barriers to protect assessment location 2.

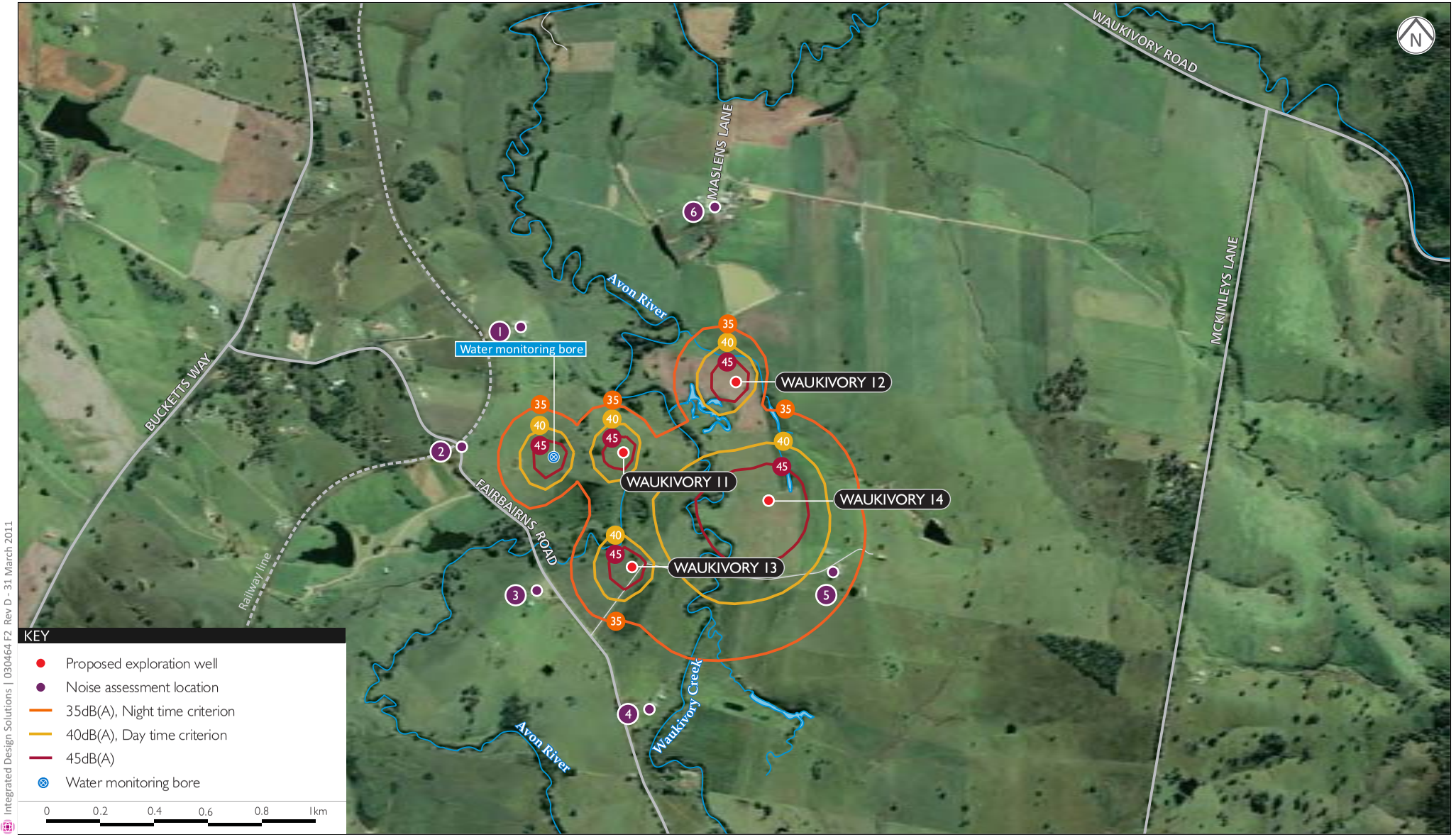
It should be re-iterated that the above results for the quieter drill and optimised layout configuration take advantage of the directional characteristics for the drilling orientation for the closest residence.

With respect to predicted fracture stimulation noise, all daytime noise levels are well below the ICNG's 75 dB(A) 'highly affected' level. Other findings include the following:

- Without mitigation, the results show that predicted daytime fracture stimulation noise will not meet criteria at all assessment locations for any wells. However, predicted noise levels are below the DECCW highly affected level of 75 dB(A).

- With noise barriers in place as for drilling, fracture stimulation noise levels as received at the assessment locations are significantly reduced. However, they remain above recommended daytime criteria. Given that this activity is limited to day shift only and to at most 1 hour at each exploration well, impacts are considered manageable through community consultation means.

The results of mitigated drilling activities are also presented graphically in Figure 2 as noise contours. The noise contours represent the outer envelope noise from drilling of one well at a time (i.e. not simultaneous drilling activities occurring at all four well locations).



Predicted drilling outer envelope Leq noise levels - Mitigated drill and optimised layout dB(A)

Proposed Exploration wells - Waukivory 11 to 14
Client: AGL Energy

Figure 2

EMGA | MitchellMcLennan

4.3 Operational (flaring) noise levels

The noise emission from flaring will be controlled using two standard shipping containers that will shield the flare and provide at least 5dB of noise reduction. This is a practice common used by the proponent at similar operations, where noise predictions suggest flare sound power levels are in the order of 85 dB(A) to 90 dB(A) (inclusive of the 5 dB shielding offered by the shipping containers). This is a relatively quiet activity as compared to drilling or fracture stimulation and is reflected in the results shown in Table 4.5 and Figure 3 noise contours. The results are for the combined noise level of all four exploration wells flaring simultaneously, as the case may be once all exploration wells are completed. The results are for calm weather conditions, for reasons discussed previously, for the construction phase. As demonstrated, the predicted noise from flaring satisfies noise criteria at all receivers and hence noise impact is not likely from flaring.

Table 4.7 Operational (flaring) noise levels

Receiver	Predicted Leq Noise Levels for all four wells combined	Noise Criteria, dB(A)
		Day/evening/night
1	21	35
2	20	35
3	27	35
4	23	35
5	25	35
6	20	35

Predicted operational (Flaring) Leq noise levels from all wells combined, dB(A)

Proposed exploration wells - Waukivory 11 to 14

Client: AGL Energy

Figure 3

EMGA | MitchellMcLennan

4.4 Sleep disturbance noise predictions

Noise from possible intermittent activities include hammering using hand tools, metal to metal contact associated with out of hours drilling and similar activities. A typical source sound power (emission) level of 115 dB(A) was used to predict maximum (Lmax) noise at receivers. Table 4.6 presents the predicted Lmax noise levels assessed against the sleep disturbance criterion (45 dB(A)). Noise emitted from these activities should be controlled and managed by appropriate measures. The results do not include the benefits of barriers, which if designed appropriately would reduce levels to satisfy criteria at most locations. The only except may be location 2 during drilling of the water monitoring piezometer, where a marginal 2dB exceedance is predicted (ie 57dB(A) minus 10dB for barrier, results in a 47dB(A)Lmax level). This potential marginal exceedance is however limited to one or two nights. As discussed previously, a 2dB difference in noise level is not perceptible in practice.

Table 4.8 Predicted Lmax Noise levels, dB(A)

Well	Receiver						Sleep Disturbance Criteria, dB(A)
	1	2	3	4	5	6	
WK 11	47	47	47	41	43	41	45
WK 12	44	41	39	38	44	47	45
WK 13	41	44	54	50	46	36	45
WK 14	39	39	43	44	54	39	45
Piezometer	53	57	53	41	45	45	45

5 Road Traffic Noise Assessment

The calculation and prediction of road traffic noise adopts a standards-based approach to modelling, in that noise propagation calculations are carried out in accordance with accepted standards used in various countries. The adopted algorithm is the United Kingdom Calculation of Road Traffic Noise (CoRTN) method.

The project related traffic information used in our assessment was provided by the proponent. However, to assess potential impacts we must first establish the existing traffic noise levels at receivers. For Bucketts Way the traffic data used for calculating the existing noise was that obtained from actual counts in 2004, as provided by the NSW RTA on their website. More recent data was not available and growth patterns over the years (refer to Table 5.1) are not consistent and do not allow for a reasonable estimate of 2011 volumes. The existing traffic volumes on local roads near the well sites were assumed to be negligible, which means our assessment will be conservative with respect to changes in traffic noise for these roads.

Table 5.1 Buckets Way Annual Average Daily Traffic (AADT) by Year – RTA Station 09.332

1982	1984	1986	1988	1990	1992	1995	1998	2001	2004
3,010	-	3,117	-	3,806	1,468	4,609	4,262	3,282	4,095

Source: NSW RTA website.

Table 5.2 summaries expected traffic generated by the project. In addition, it was assumed that a nominal 5 small vehicle movements would be generated by the site during shift changes.

Table 5.2 Traffic volumes per well site

Truck Movements/day	Days of Operation per well	Time of truck movements	Truck movements per hour
60	180	2 x 12hr shifts/7 days	2 to 3 - on average 5 - typical maximum

5.1 Road traffic noise calculations

Based on the above truck and small vehicle movements, and an assumed average pass-by traffic speed of 50 km/hr, predicted noise levels for existing and future (including site related) traffic at nominal setback distances are summarised against criteria in Table 5.3.

For Bucketts Way, the 15 hour daytime volume was estimated as 85% of the AADT, and the night being 15% of AADT, which is typical breakdown adopted by road traffic engineers.

The predictions for Bucketts Way indicate no change to existing traffic noise and in all cases, including local roads, are expected to satisfy the daytime and out of hours criteria.

Table 5.3 Predicted Traffic Noise Levels

	Bucketts Way				Local Roads			
Set Back Distance (m)	**Day Leq,15hr, dB(A)**		**Night Leq,9hr, dB(A)**		**Day Leq,1hr, dB(A)**		**Night Leq,1hr, dB(A)**	
	Existing	**Inc. Project**	**Existing**	**Inc. Project**	**Existing (negligible)**	**Inc. Project**	**Existing (negligible)**	**Inc. Project**
20	59	59	54	54	39	52	36	50
40	56	56	51	51	36	48	33	47
60	54	54	49	49	33	46	30	45
80	52	52	47	47	32	45	29	43
100	51	51	46	46	31	44	28	42
150	49	49	44	44	29	41	26	40
Criteria	**60**	**60**	**55**	**55**	**55**	**55**	**50**	**50**

6 Conclusion and Recommendations

EMM has completed a construction, operation and road traffic noise impact assessment of the proposed pilot exploration wells WK 11 to 14 near Gloucester, NSW. This assessment recommends mitigation of noise by adoption of the proponent's quieter drill rig and optimised plant layout, as well as noise barriers during drilling at some sites, and for fracture stimulation to shield these noise sources and reduce impacts at residences. With these measures in place, drilling noise is shown to satisfy recommended criteria at all locations day and night, with the exception of a marginal 2dB exceedance at night at location 5 (a property owned by a neighbouring mining company). It should be noted that drilling noise levels inside this residence are not likely to be significant, and hence impact to occupants during the night period is not expected.

It is expected that whilst daytime noise criteria may be exceeded at residences by fracture stimulation activities, the predicted noise levels are well below the DECCW's highly noise affected levels. The exceedances are limited to at most 1 hour during the daytime at each of the four exploration wells. Hence, daytime construction noise levels are considered manageable.

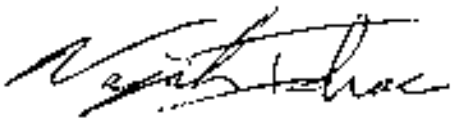
The assessment also finds that sleep disturbance issues at night can be mitigated to satisfy DECCW criteria at most locations and that road traffic noise levels are predicted to satisfy relevant DECCW criteria. Similarly, noise from exploration well operations (i.e. flaring) is predicted to satisfy noise criteria at all residences and hence impact is not likely from flaring noise.

Other good practice noise management measures that should be considered include the following:

- use noise monitoring during initial drilling and fracture stimulation operations at the first exploration well site to be constructed to affirm and calibrate noise predictions;
- orientate the drill rig to take advantage of directional noise characteristics for the closest residence for the given well site as described in this report;
- ensure the community is consulted and provide them with written notice well in advance of proposed activities;
- ensure all landholders of each well are consulted and supportive of the project's intention for out of hours activities;
- where possible obtain a drill rig with lower noise emission levels;
- use temporary noise barriers as described in this report; and
- employ all reasonable and feasible work practices to minimise any impacts.

We trust that the above information satisfies your needs and if you have any further questions please contact the undersigned.

Yours sincerely



Najah Ishac (MEngSc, BE, MIEAust, MAAS)
Director
nishac@emgamm.com

Appendix A

SLR Heggies Mitigated Rig Report

27 September 2010

30-2131 Ensign Drill Rig 20100927

AGL Energy Limited
Lot 35 Medhurst Road
MENANGLE NSW 2568

Attention: Mr Aaron Clifton

Dear Aaron

Ensign Drill Rig
Sound Power Levels

1 INTRODUCTION

Heggies Pty Ltd (Heggies) was engaged by AGL Energy Limited to conducted operator-attended noise measurements of the current Ensign Drill Rig currently operating at MP12 drill site. The aim of the measurements was to determine sound power levels (SWLs) of the drill rig and its main components. This report presents the results of the noise investigation together with a discussion comparing the measured levels against the data provided by Canadian consultants Noise Control Systems.

2 PLANT NOISE AUDIT

In order to determine the major noise emission contributors, on-site sound pressure level measurements of the drill operation were conducted on 26 August and 27 August 2010.

The measurement locations are shown in **Figure 1** and the measured L_{Aeq} noise levels (and distance from the nearest equipment item) are listed in **Table 1**. It is noted that the background noise levels in the area (i.e. while plant was not operating) was measured to be approximately 40 dBA.

The main areas or equipment items and measurement locations are identified in **Figure 1.**

Heggies Pty Ltd 2 Lincoln Street Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
T: 61 2 9427 8100 F: 61 2 9427 8200 E: sydney@heggies.com www.heggies.com
ABN 29 001 584 612

Figure 1 Measurement Locations

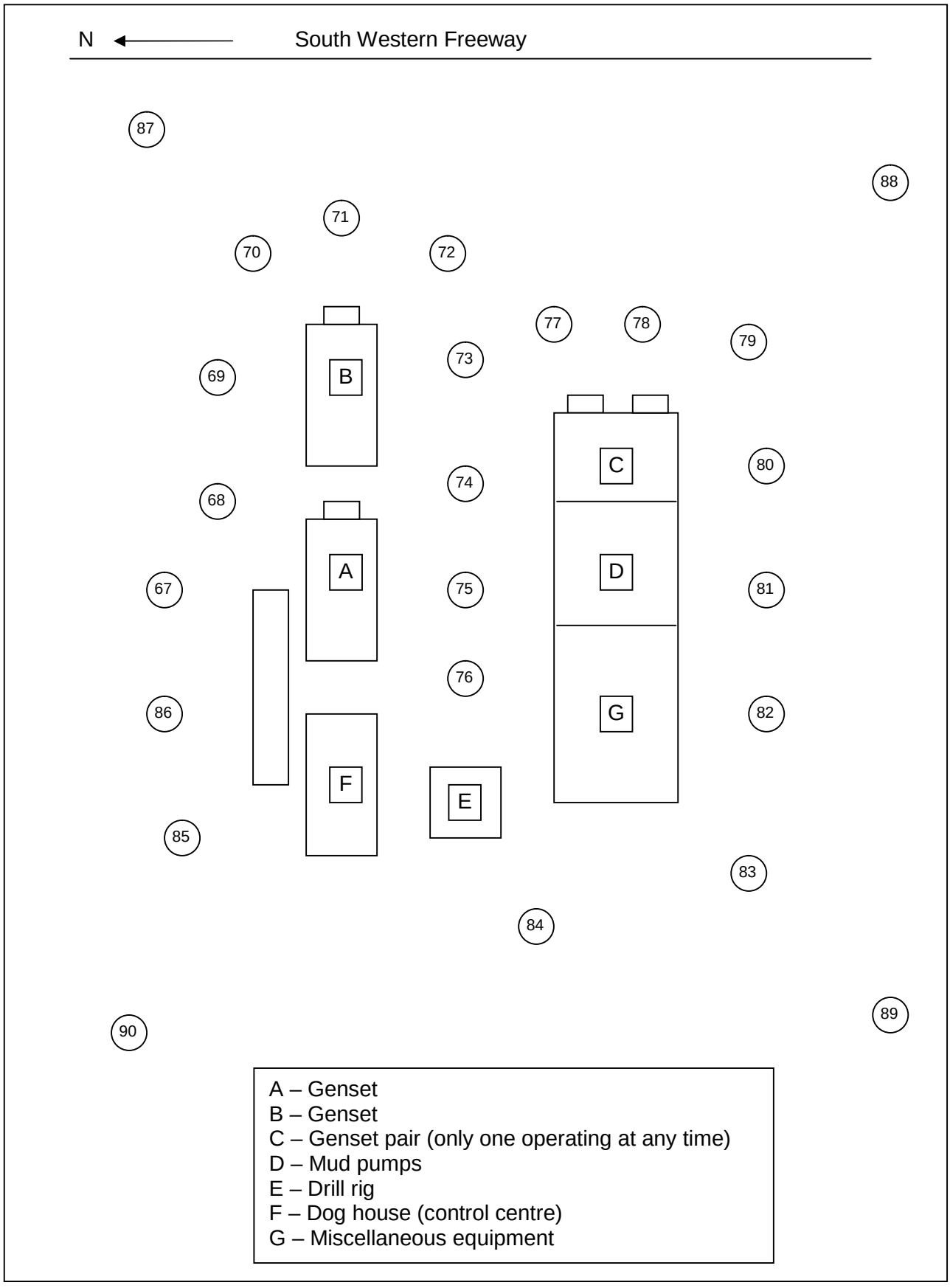


Table 1 Measured L_{Aeq} Noise Levels

Location Reference	Distance from Nearest Equipment (m)	L_{Aeq} Noise Levels
67	5	82 dBA
68	5	83 dBA
69	5	81 dBA
70	5	82 dBA
71	5	81 dBA
72	5	80 dBA
73	5	80 dBA
74	5	84 dBA
75	5	86 dBA
76	5	81 dBA
77	5	78 dBA
78	5	77 dBA
79	5	77 dBA
80	5	77 dBA
81	5	73 dBA
82	5	70 dBA
83	5	69 dBA
84	5	70 dBA
85	5	68 dBA
86	5	74 dBA
87	20	72 dBA
88	20	72 dBA
89	20	65 dBA
90	20	64 dBA

Table 2 presents the overall Sound Power Levels (SWL) for the main noise producing itmes and **Table 3** indicative SWLs different directions from the drill site. The noise from the site as a whole is directional and it is dominated by the Gensets (see **Figure 1**). The SWL results indicate that the Mud Pumps generate around 7 dBA less noise than the Gensets.

Table 2 Sound Power Levels for Main Noise Producing Items

Description	L_{Aeq}, SWL
A - Genset	106 dBA
B - Genset	107 dBA
C - Genset pair (one operating at any one time)	105 dBA
D - Mud pumps	99 dBA

It is noted that the noise emissions from the site is highly dependent on the orientation of the different items of equipment, and on shielding provided by less noisy items. The Sound Power Levels measured from the Dog house end of the site (Locations 89, 90) were around 7 dBA lower than SWLs at the opposite end of the site (Locations 87, 88) as shown in **Table 3**. The noise is predominately low frequency, with the most significant octave frequency bands being between 32 Hz to 125 Hz.

Table 3 Octave Band and Overall Sound Power Levels Measured at 20 m Locations

	Octave Band Sound Power Level											
Monitoring Location	**16 Hz**	**32 Hz**	**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**16 kHz**	**LAeq**
Location 87 (NE)	99	110	108	110	106	99	101	99	96	88	79	106
Location 88 (SE)	104	112	111	114	104	101	101	99	96	90	83	106
Location 89 (SW)	97	120	106	104	98	93	94	91	88	84	73	99
Location 90 (NW)	100	117	105	110	98	92	90	87	84	78	68	98
Overall	**101**	**116**	**108**	**111**	**103**	**98**	**99**	**96**	**93**	**87**	**79**	**104**

Note 1: Drill orientation as measured at MP12 on 17 August 2010.

3 COMPARISON AGAINTS NOISE CONTROL SYSTEMS SWL

The Noise Control Systems data consists of measurements of sound pressure level around the site, but none of these measurements has been taken at a distance of more than about 10 m from the plant. The noise levels predicted by Noise Control Systems at a distance of 200 m from the site range from 25 dBA up to 55 dBA. These levels correspond to estimated sound power levels (SWL) ranging from around 79 dBA up to 109 dBA for the different measurement locations.

Using the Noise Control Data (SWLs), Heggies previously estimated the overall sound power level of the drill rig as a whole to be approximately 109 dBA - 111 dBA (without and with the loader operating) and these values were used in the noise model for the MP23 site (see Heggies *letter 30-2131 20-300 Menangle Park 20100629*) i.e. 5 dBA higher than the overall SWL presented in **Table 3**.

4 CONCLUSIONS

The Sound Power Level survey of the Ensign drill operating at MP12 on 17 August 2010 found an overall operating SWL of 104 dBA for the drill.

I trust the above report meets your current requirements. Should you have any questions or require any additional information, please contact myself on 9427 8100.

Regards,

BRIONY CROFT
SENIOR CONSULTANT

Reviewed by: MB

Appendix C

Environmental Management Plan

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AGL Upstream Investments Pty Ltd

PROCEDURE

ENVIRONMENTAL MANAGEMENT PLAN

GLOUCESTER BASIN (PEL 285)

COAL SEAM METHANE GAS – EXPLORATION DRILLING AND PRODUCTION EVALUATION TESTING

Gloucester Gas Project

ENVIRONMENTAL MANAGEMENT PLAN

AGL Upstream Investments Pty Ltd

Document Control
Environmental Management Plan

Approval:

Authorising Officer	David Kelly
Title	Head of Land and Approvals, Gas and Power Development
Signature	
Date	17/4/09

Revision Status:

Revision	Date	Prepared By	Checked By	Approved By	Comments
0	April 2009	TL	SG	SG	

TABLE OF CONTENTS

1.0 PURPOSE

AGL has developed this Environmental Management Plan (EMP) to control and manage the environmental impacts of its activities in undertaking exploration drilling and production evaluation testing for coal seam methane gas in the Gloucester Basin.

This EMP has been prepared under the framework of the ISO 14001 Environmental Management System (EMS) standard.

The AGL Energy Health, Safety and Environment Policy and documentation should be considered in parallel with this EMP to promote a better understanding of the requirements and standards implied.

2.0 INTRODUCTION

This EMP has been developed for the activities currently being undertaken as part of AGL's exploration and production testing activities in the Gloucester Basin, as well as a basis for those that are proposed for the future as the project develops.

2.1 Background

The Gloucester Basin is located in New South Wales, approximately 100 km north of Newcastle. AGL is the operator for exploration activities for coal seam methane gas in the basin. The area is administered under Petroleum Exploration Licence (PEL) 285, which enables investigation of resources with a view to possible development of a production field in the near future.

The location of the PEL area is approximately centred on the township of Stratford, some 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 methane gas project, involving petroleum exploration activities including drilling and production evaluation testing.

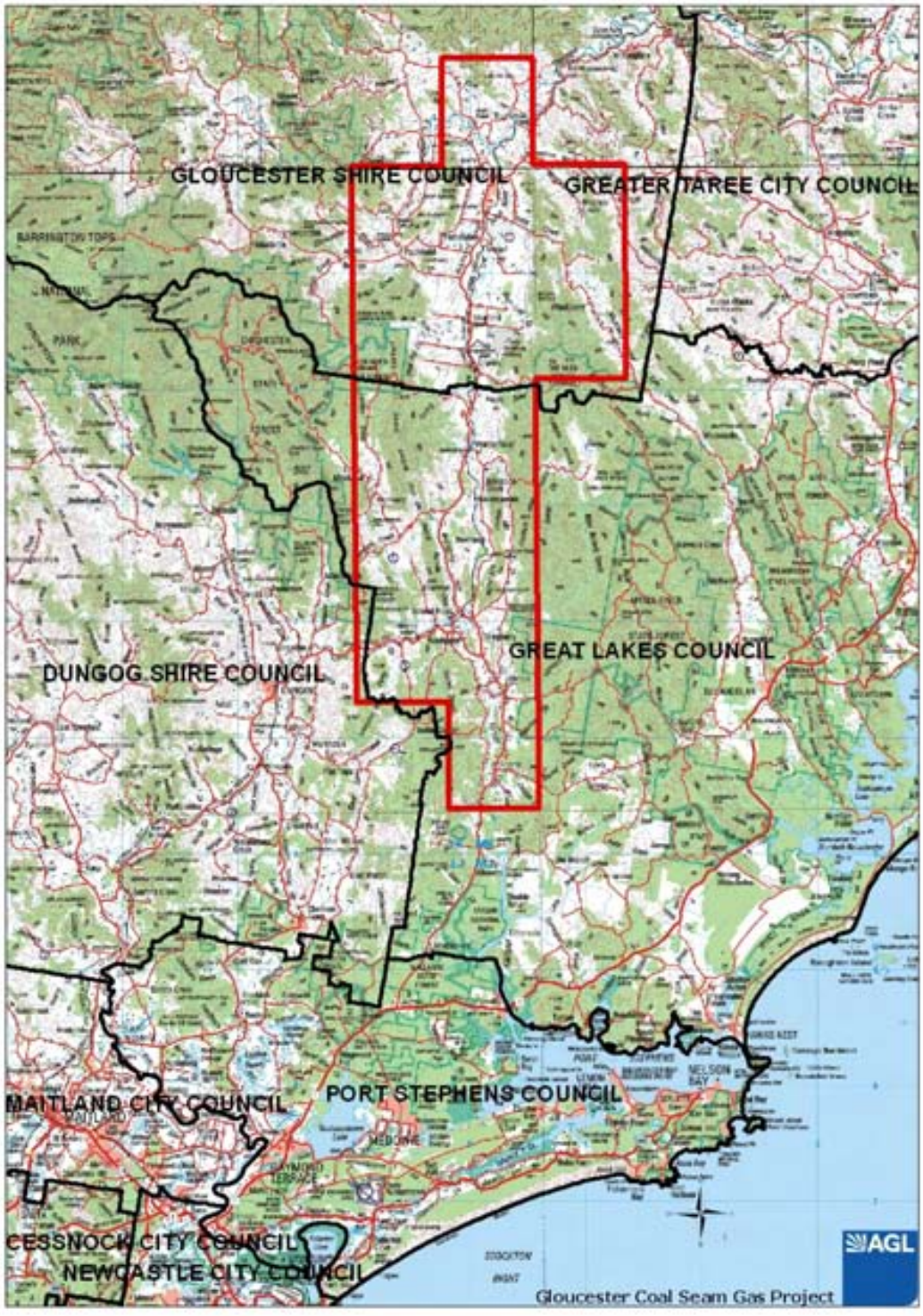

Figure 1– Project Area

2.2 Description of company activities

AGL is an ASX listed group and has been operating in Australia for 170 years and was one of its first listed companies. The company has activities in investing in sustainable energy businesses such as wind farms and innovative environmentally friendly projects such as the underground Bogong hydroelectric

power station in Victoria's High Country, and manages various coal bed methane assets, which include interests in permits in Queensland and NSW.

Coal seam gas (CSG) has developed rapidly in Australia over the last decade, emerging as a flexible, clean and competitive source of energy in an expanding economy seeking lower pollution fuels.

As extraction technology has developed and with the world increasingly carbon-conscious (coal seam gas produces approximately half the greenhouse gas emissions of coal) coal seam gas is seen as an increasingly valuable resource in Australia and abroad.

Extraction of coal seam gas differs from natural gas by targeting specific seams of coal, often at significant depths that make mining otherwise economically unviable. Removal of the gas is induced by reducing the hydrostatic pressure of water also contained in the coal seams. As the water is pumped out the reduction in pressure enables the flow of gas, which increases as the water level is reduced over time.

2.3 Scope

This EMP incorporates the environmental policies of AGL that are to underpin each activity the company takes in the exploration and development of coal seam methane prospects. AGL aims to meet, if not exceed best industry practice in environmental management associated with all its activities. This document has been produced in the framework of ISO 14001.

All subcontractors, consultants and suppliers working on any AGL project shall be bound to the requirements of the AGL Environmental Management Plan for that project, if they do not have in place a compliant Management System of their own.

3.0 OBJECTIVES & TARGETS

AGL aims to conduct its operations to the highest practicable level with regard to environmental protection and in accordance with all standards and regulation. AGL's environmental objectives include:

- To achieve a zero incident rate by good forward planning, implementation of environmental controls through training and awareness of all employees.

- To achieve compliance with all applicable regulatory requirements and other relevant industry standards and codes.

4.0 DEFINITIONS

For a full list of definitions, refer to **Environmental Management Systems – Specification with guidance for use** (Australia/New Zealand AS/NZS ISO 14001:2004) and **Occupational Health and Safety Management System**-AS/NZS 4801:2001).

5.0 ENVIRONMENTAL POLICY

a) AGL adheres to the AGL Health, Safety and Environment Policy, which has been developed with consideration for:

- The nature, scale and environmental impacts of the company's activities, products and services
- Prevention of pollution
- Statutory and other requirements
- Scope for continual improvement
- Providing a framework for setting and reviewing environmental objectives and targets

b) The Health, Safety and Environment Policy is communicated to all persons working for or on behalf of the organisation.

c) Top Management shall review this Policy at least annually.

6.0 PLANNING

6.1 Environmental Aspect Identification and Evaluation

AGL shall endeavour to minimise the impacts of its activities on the environment by identifying environmental hazards and putting into place controls to eliminate, where ever possible, any identified risk to the environment. Components of the environment to be considered include, but are not limited to:

- Water quality
- Marine environment
- Noise
- Air quality
- Visual quality
- Flora and fauna
- Heritage significance
- Surrounding community
- Vibration
- Natural resources

The Land and Approvals Manager and Operations Manager shall continually identify the environmental aspects of AGL's activities and develop safeguards/actions to mitigate the environmental impacts of these aspects. Resources for identifying a project's aspects include;

- EMP Status Plan,
- cross checked with Project Risk Assessments and
- JSEA record.

This information can then be used to formulate and revise the Project Environmental Management Plan, including a detailed environmental risk assessment and required actions to protect the environment. A register of

Activities, Aspects and Impacts has been developed as part of this process.

To determine those aspects that carry significant environmental risk, a risk assessment (as shown in Table 1) is used to rank the identified impacts. Environmental impacts are determined according to the:

- probability of occurrence; and
- severity of impact.

Likelihood	Minor	Important	Serious	Major	Catastrophic
Almost Certain	2.5 Moderate	5 High	7.5 High	20 Extreme	25 Extreme
Likely	2 Moderate	4 Moderate	6 High	16 Very High	20 Extreme
Possible	1.5 Low	3 Moderate	4.5 High	12 Very High	15 Very High
Unlikely	1 Low	2 Moderate	3 Moderate	8 High	10 Very High
Rare	0.5 Low	1 Low	1.5 Low	4 Moderate	5 High

Consequence

Table 1 - Risk matrix

The risk assessment enables AGL to prioritise and focus on those activities that present significant environmental risk to the organisation.

Table 2 summarises the activities, aspects and impacts along with the associated environmental risk.

Activity	Aspect	Impact	Likelihood	Severity	Consequence
All Activities	Vegetation clearing	Removal or damage to threatened or endangered species	Unlikely	Serious	Moderate
		Introduction of weed species	Likely	Important	Moderate
>Establishing drill pads & access tracks		Loss of visual amenity	Unlikely	Minor	Low
	Flora & Fauna	Removal of wildlife habitat	Likely	Important	Moderate
		Disturbance to local fauna	Likely	Important	Moderate
>Pond, sump & water storage construction	Soil & Erosion	Instability caused by earthworks	Likely	Serious	High
		Disruption to soil structure and horizons	Likely	Important	Moderate
		Runoff to local waterways	Possible	Major	Very High
>Drilling, perforation and fraccing		Contamination from hazardous materials	Possible	Major	Very High
	Noise	Heavy machinery movement for long durations	Almost Certain	Important	High
	Air	Dust creation from machinery and earthworks	Almost Certain	Important	High
>Pipeline and gathering line construction	Water	Runoff of sediment into local waterways	Possible	Serious	High
		Runoff of fuel and chemicals to surface and ground waters	Unlikely	Major	High
	Cultural Heritage	Disturbance of culturally sensitive sites	Possible	Serious	High
>Well operation	Waste	Inefficient resource use	Unlikely	Minor	Low
		Loss of visual amenity	Unlikely	Minor	Low
		Health risk	Unlikely	Minor	Low
	Bushfire	Personal safety	Rare	Major	Moderate
		Loss of property and wildlife habitat	Rare	Major	Moderate
	Community	Increased traffic	Almost Certain	Important	High
		Loss of amenity	Rare	Important	Low
Pond, sump & water storage construction	Flora & Fauna	Fauna falling into water sumps or storages	Unlikely	Serious	Moderate
	Soil & Erosion	Damage to soil structure from excavations	Almost Certain	Serious	High
		Enhanced risk of soil erosion	Almost Certain	Serious	High
	Water	Leaching of contaminated water into groundwater	Possible	Major	Very High
		Disposal of contaminated water	Almost Certain	Serious	High
Drilling, perforation and fraccing	Air	Dust or emission creation from heavy machinery	Likely	Important	Moderate
		Gas emissions from well	Likely	Critical	Moderate
	Noise	Increased noise nuisance from fraccing	Likely	Important	Moderate
	Soil & Erosion	Contamination from hazardous material spills	Likely	Serious	High
	Water	Contamination from hazardous material spills	Likely	Serious	High
Well operation	Air	Venting or release of greenhouse gases	Possible	Important	Low
	Soil & Erosion	Contamination of soils from inappropriate disposal of poor quality water	Possible	Important	Moderate
		Erosion caused by excess runoff from water disposal	Possible	Important	Moderate
	Water	Potential spill of poor quality water produced from wells to surface and ground	Possible	Serious	High

Table 2 – Register of Activities, Aspects and Impacts

6.2 Legal and Other Requirements

Environmental management for exploration activities throughout NSW is controlled largely by State Government legislation, although there is also applicable Commonwealth legislation which must be adhered to. AGL understands the importance of meeting its regulatory requirements, and therefore the Land & Approvals Manager will continually keep abreast of State and Federal legislation.

The current applicable legislation (outlined below) will be regularly reviewed and updated as required.

- Environment Protection and Biodiversity Conservation Act 1999 *(EPBC Act)*
- Environmental Planning and Assessment Act 1979 *(EPA)*
- State Environmental Planning Policy *(Major Projects)*
- SEPP(Infrastructure) 2007
- SEPP (Mining, Petroleum Production and Extractive Industries) 2007 *(SEPP (Mining))*
- SEPP 14 Coastal Wetlands *(SEPP 14)*
- SEPP 26 – Littoral Rainforests
- SEPP 33 – Hazardous and Offensive Industries
- SEPP 44 – Koala Habitat Protection

- SEPP - 71 Coastal Protection
- Pipelines Act 1967 *(Pipelines Act)*
- Petroleum (Onshore) Act 1991
- Water Act 1912 *(the Water Act)*
- Water Management Act 2000 *(WM Act)*
- Protection of the Environment Operations Act 1997 *(POEO Act)*
- Fisheries Management Act 1994 *(FM Act)*
- Roads Act 1993
- Native Vegetation Act 2003
- Heritage Act 1977
- Contaminated Land Management Act 1997
- Threatened Species Conservation Act 1995
- National Parks and Wildlife Act 1974
- Gloucester Local Environmental Plan
- Great Lakes Local Environmental Plan
- Australian Pipeline Industry Association Code of Environmental Practice

The AGL Environment Officer shall visit relevant Government department websites to ensure that this legislation is up to date, and shall advise personnel of changes and the impact on work activities. All environmental incidents must be recorded investigated and reported to project authority (including AGL Management) and or the appropriate local authority.

6.3 Objectives and Targets & Programmes

The AGL Gloucester Environmental Committee has set the objective of no breaches in compliance with statutory or other regulatory requirements. Therefore to achieve this, project specific objectives and targets have been set, taking into consideration the nature of activities, characteristics of the site, and the environmental aspects and impacts. These objectives and targets are included within the Environmental Management Procedures established for all key activities. Checklists are also in place to ensure procedures are followed.

The following procedures – included in Appendix 1 – have been developed to address identified activities and impacts:

- Produced Water Management
- Soil and Ground Stability
- Vegetation Management
- Bushfire Prevention
- Air Emissions
- Noise and Vibration
- Clearing and Grading
- Drilling, Perforation & Fraccing
- Pond Construction
- Trenching

- Cultural Heritage
- Community and Social Impact
- Waste Management
- Fuel and Chemical Storage and Spills
- Pipe stringing and welding
- Pipe laying and backfilling
- Hydrotesting
- Clean-up and Rehabilitation

The Project Environment Officer shall monitor, maintain records and report the progress made in achieving targets.

Objectives and targets shall be reviewed annually; however the following targets have been set as a minimum:

- Zero incident rate
- No breaches in compliance
- Participation in training, group meetings, environmental promotions, emergency drill and preparedness for control of potential environmental incident
- Effective management of subcontractors and project plant and equipment
- Effective implementation of safe work practices, risk analysis and risk controls
- Continual improvement in environmental performance
- Effective waste management and recycling

An Environmental Management Program has been developed to ensure all procedures are adhered to on an ongoing basis.

The Environmental Management Program includes the following information:

- Roles and responsibility
- What is to be monitored, frequency, methods for monitoring and storage of this information
- Targets and objectives
- Timeframes for achieving these objectives

The Environmental Management Program is to be reviewed at least annually, taking into consideration any changes in legislation, activities or the development of new technology.

7.0 IMPLEMENTATION AND OPERATION

7.1 Resources, Roles, Responsibility and Authority

Overall responsibility for the EMP lies with the Head of Land and Approvals. However, all staff and contractors are responsible for

undertaking activities in a way that minimises environmental impact with the aim of improving the company's environmental performance.

The organisational chart in Figure 2 outlines the key responsibilities attributed to AGL personnel involved in the development and implementation of the EMP. A description of the individual roles and responsibilities follows-:

- The Head of Land and Approvals has overall responsibility to ensure the EMP is implemented and is compliant according to the Environmental Policy. The Head of Land and Approvals will report to the Group General Manager.

- The Land and Approvals Manager is responsible for the development, implementation, monitoring and reporting in compliance with the operational components of the EMP, and Complaints Register. This includes the continuous improvement of environmental performance of people and equipment. This person reports to the General Manager.

- The Operations Manager is responsible for the daily operational requirements of site activities and associated facilities. This person will report to the General Manager.

A Project Environment Officer has been appointed to assist the Land and Approvals Manager and shall undertake the following-:

- Implement and monitor site or project specific plans
- Conduct Environmental Inductions for new employees
- Liaise with the Operations and the Land and Approvals Managers on environmental matters

Site staff shall carry out their duties as listed in their job descriptions in an environmentally responsible manner.

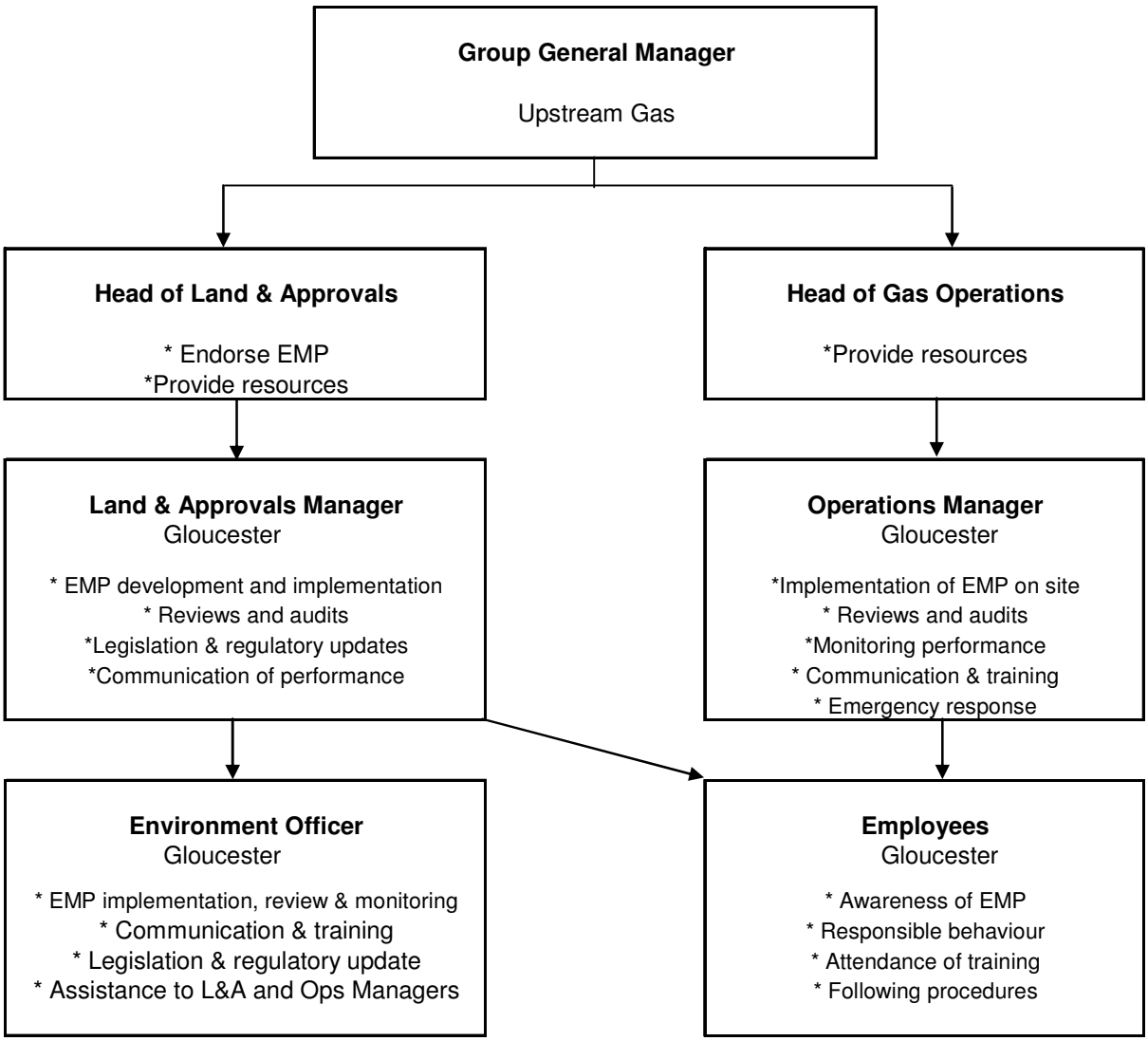

Figure 2 – Roles and Responsibilities

7.2 Competence, Training and Awareness

The authority for implementation and management of AGL Group environmental systems and controls is by competent people within the Group. Where circumstances demand, specialised skills and competencies will be employed.

New employees, project personnel and site visitors shall undergo a site induction.

Site inductions shall cover the following issues:

- Environmental aspects and impacts of the project
- Relevant legislation, permit conditions and other restrictions

- Compliance requirements and consequences of non-compliance
- Emergency procedures and contacts (covered in existing document)

Training and induction records for project personnel and visitors shall be kept on site, both electronically and on paper as Register of Plant & Equipment Licences, Site Induction Register and Site Visitors Register. Individual competencies for AGL employees and subcontractors will be regularly assessed by a competent environmental officer to ensure a high standard of environmental understanding.

Personnel selected to undertake tasks with the potential to cause significant environmental impact will not be deemed to be competent unless they have undergone the above training as a minimum.

7.3 Communication

The Land and Approvals Manager and Environment Officer shall be responsible for all environmental related communication, within AGL and with interested external parties and regulatory parties.

For project personnel, the location and access to sites shall be considered when deciding appropriate methods of communication.

Correspondence shall be documented in accordance with Data and Document Control.

7.4 Documentation

For details of all documentation contained within this EMP, refer to the appendix for an index.

All documents referenced in this EMP are contained in an Environmental Section within the Quality Folder on the project server.

7.5 Document Control

For control of documents refer to the procedure Data and Document Control / Project File System**.** Regular project weekly and/or monthly reporting of environmental status is required to ensure senior management is fully informed of environmental status of any project. Corporate systems will be reported on as a minimum annually or as legislation or other Government changes imply.

7.6 Emergency Preparedness and Response

An Emergency Response Procedure has been developed for the project to identify, prevent, mitigate and respond to accidents that are likely to have an environmental impact.

A Safety Management Plan has also been developed for the project to identify and mitigate against safety risks on site.

These procedures shall be reviewed with input from Project Managers and site personnel, at least annually or after the occurrence of an emergency event. Any changes to procedures must be approved by senior management.

Site Management shall display these plans in prominent locations around sites.

Site Management shall enlist local emergency response crews to carry out mock drills to test these procedures and the preparedness of site and emergency personnel.

8.0 CHECKING

8.1 Monitoring and measurement

The Environmental Monitoring Program details the procedures and timing for ongoing monitoring, review and revision of environmental management procedures.

All monitoring equipment shall be maintained as specified in the procedure for Inspection and Testing.

Refer to the Routine Environmental Monitoring Checklist and Site Inspection for a list of routine site environmental monitoring and inspection requirements.

Project Managers and Project Environment Officers shall identify project or site specific monitoring requirements, carry out a Hazard Identification and Risk Assessment, assign personnel to monitor and record this information, to track performance of operational and maintenance procedures, check for compliance with statutory or other requirements and targets and objectives and predict the likelihood of future corrective action.

8.2 Evaluation of Compliance

A review of applicable legislation shall be undertaken periodically to determine AGL's compliance with its applicable legal requirements.

A review of any industry standards or codes that are applicable to AGL's activities shall be undertaken periodically to determine AGL's compliance with those requirements to which it subscribes.
Records shall be kept of the above evaluations. Any deficiencies shall be recorded and corrective actions draw up and communicated to all affected personnel.

8.3 Non-conformance and Corrective and Preventative Action

Non conformances and corrective actions shall be dealt with as given in procedure Non Conformance**.**

8.4 Environmental Management Plan Audit

Internal Environmental Management Plan Audits shall be carried out in accordance with Internal Audit Procedures.

The Environmental Management Program will detail the timing of EMP audits, but at the minimum these should be conducted every three months.

External audits shall be conducted at least annually by suitably qualified auditors.

Any non-conformance or corrective action report shall be addressed as soon as practicably possible and be signed off during the completion of the next scheduled audit.

The results of audits shall be made available to all employees and AGL Management.

8.5 Management Review

To ensure continual improvement and effectiveness of the Environmental Management Plan, AGL Management shall participate in Management Reviews of the Plan at least annually.

Management reviews shall cover the following areas:

- Results of audits conducted;
- AGL's overall environmental performance;
- Frequency or recurrence of environmental incidents;
- Effectiveness of existing procedures (SWPs and JSEAs) for hazard identification, risk assessment and control;
- Changes in legislation, codes of practice or Australian Standards that may have an affect on compliance requirements and consequently existing risk control measures;
- Employee suggestions or recommendations;
- Any feedback from Government Agencies on environmental performance; and

- Recommendations for improvement of the Environmental Management System.

The details of Management Review meetings such as comments, observations and recommendations shall be documented.

Management shall assign responsibilities and timeframes for follow up action on recommendations to ensure these are implemented.

9.0 ASSOCIATED DOCUMENTS

AGL

* Safety Management Plan
* Emergency Response Procedure

OTHER

* AS/NZS ISO 14001:1996 Environmental Management Systems, *REVISED 2004* Environmental Management System – Specification with guidance for use (Australia/New Zealand AS/NZS ISO 14001: 2004)

'POEO' Protection of the Environment Operations Act 1997

APIA Environmental Policy and Code for Environmental Practice

State and Federal Occupation Health and Safety Legislation

NSW Government Environmental Management Systems Guidelines 1998

AS/NZS 4360:2004 Risk Management

ENVIRONMENTAL MANAGEMENT PLAN

Appendix 1 – Environmental Management Procedures

1. Produced Water Management	
Goals	To avoid potential impacts to quality of local ground and surface water systems and the surrounding environment
Responsibility	Operations Manager
Performance Objective	◗ To reuse at least 10% per year of the production water for agricultural purposes. ◗ To prevent contamination of watercourses and creeks, particularly with regard to salinity. ◗ To prevent contamination of surrounding soils, particularly with regard to salinity and sodicity. ◗ To minimise impact on riparian, aquatic and water dependant flora and fauna.
Mitigation Measures	◗ All produced water to be collected in localised storages. ◗ Storage ponds to be lined with a suitable polyurethane liner to prevent contamination of soil. ◗ Sufficient freeboard to allow for 1-in-100-year 72 hour rainfall event to be maintained in all storages. ◗ Production to cease when freeboard is exceeded until water can be appropriately disposed of. ◗ Water quality monitoring to be undertaken on an ongoing basis to inform disposal options. ◗ Disposal options to be discussed and agreed with relevant authorities. ◗ Comprehensive assessment of disposal options to be undertaken, giving preference wherever possible to beneficial use. ◗ Where irrigation using product water is approved, ongoing soil quality monitoring will be undertaken to assess any impacts on the local environment. ◗ Water quality monitoring to be undertaken prior to irrigation events.
Performance Measures	◗ Proportion of production water applied to beneficial use (eg irrigation). ◗ No uncontrolled release of produced water into the environment.
Monitoring / Auditing / Reporting	◗ Water quality monitoring to be conducted for each well (water quality monitoring procedures in place). ◗ Stored produced water to be quality monitored prior to release for agricultural purposes. ◗ Audits of produced water management procedures to be undertaken each three months, with implementation of any recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of audits and regular monitoring will be documented and incorporated into the EMP. Corrective actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Engineering Design and Specifications for Produced Water Storages. ◗ Water Quality Monitoring Procedures. ◗ Produced Water Management Plan (under development).

2. Soil and Ground Stability	
Goals	To prevent project work areas, including well drill pads, pipeline alignments, surface water storages and access tracks, from becoming vulnerable to soil erosion.
Responsibility	Land and Approvals Manager
Performance Objective	To control and manage access to, and work at all site locations with the following objectives: ◗ to minimise the potential for soil erosion; ◗ to adequately prevent or control sediment release to land, waterways, and dams; ◗ to avoid unacceptable damage to native vegetation or wildlife habitats; ◗ to prevent impact on agricultural production or other legitimate land uses; ◗ to minimise the risk of the exposure of buried assets; ◗ to adequately control the subsidence of any subsurface earthworks; and ◗ to undertake all earthworks, including site remediation, such that soil horizons and structure are maintained as far as possible.
Mitigation Measures	◗ Sedimentation traps shall be installed where appropriate to prevent sedimentation runoff into waterways, dams, and agricultural land. ◗ Erosion control structures to be regularly inspected to ensure they are in good condition and operating effectively. ◗ If erosion is occurring due to inadequate vegetation, revegetation of the erosion area should be undertaken. Revegetation works should be conducted in consultation with the landowner and relevant authorities. ◗ Vehicular access should be restricted to stable ground where possible. Additional care should be taken near waterways and drainage lines, especially after rainfall. ◗ Restored ground should be routinely checked for subsidence and/or exposure, particularly at waterways and drainage lines and especially after flooding rains. If restoration is to occur, any imported soil will require landowner approval and shall be free of weeds and /or contamination. ◗ Drilling pad areas will be reduced to that required for operation once drilling and associated activities are complete. Sumps will be drained and the area surrounding the wellhead restored to its original condition. ◗ Earthen banks of above-ground water storages will be either lined with a geomembrane or planted with vegetation to avoid erosion and sediment runoff. ◗ The volume of produced water applied during any approved irrigation should be such that there is no risk of soil erosion. ◗ A monitoring program should be developed to monitor potential impacts associated with soil and ground stability.
Performance Measures	◗ Reduced soil erosion in highly susceptible areas. ◗ Reduced amounts of sediment discharge to land and watercourses. ◗ No impact to existing agricultural land or existing land uses.
Monitoring / Auditing / Reporting	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.

2. Soil and Ground Stability	
	◗ Inspections of all work sites should be undertaken on a regular basis, particularly following any major work. At the least, an audit of procedures will be undertaken every three months. ◗ Well pads should be inspected following establishment and again when any work is undertaken to increase or reduce the pad size. ◗ Areas prone to soil erosion should be inspected following significant rainfall.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	Erosion & Sediment Control ◗ Daily Site Environmental Controls Checklist ◗ Site Environmental Checklist

3. Vegetation Management	
Goals	To protect all work areas from soil erosion and to ensure the integrity of all wildlife habitats is maintained while protecting visual amenity
Responsibility	Land and Approvals Manager
Performance Objective	To control and manage work areas and access to all site areas with the following objectives: ◗ to promote and maintain stable vegetation cover; ◗ to minimise impact to native flora and fauna; ◗ to minimise soil erosion and sedimentation; ◗ to avoid losses to agricultural production; ◗ to reduce visual impacts; and ◗ to prevent and control weed invasions.
Mitigation Measures	◗ In areas of poor vegetation cover and where further impacts are likely, appropriate management measures shall be taken to ensure reseeding of these areas occurs. ◗ Regrowth trees within 3 metres of any trench centreline shall be removed to ensure tree roots do not pose a risk to pipeline integrity. ◗ Access tracks shall be maintained to ensure they remain navigable, including periodic reduction of regrowth. ◗ Areas where recent revegetation has taken place shall remain free of vehicles or machinery movement until such time that they are deemed suitable again for traffic. ◗ Appropriate flora species will be selected for revegetation, and suitable guidance will be sought and consultation undertaken to ensure this. ◗ Vegetation outside strictly delineated work areas – such as drill pads or a pipeline corridor – should not be disturbed. ◗ A monitoring program shall be developed to assess the success of revegetation. Further revegetation may be required where previous attempts are less than adequate.
Performance Measures	◗ Reduced soil erosion. ◗ No areas within the project area to be without adequate vegetation cover.
Monitoring / Auditing / Reporting	◗ Regular monitoring by patrol officers. ◗ Sites to be inspected regularly following revegetation until deemed successful. ◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of any recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Corrective actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Site Environmental Checklist ◗ Weed Control Checklist ◗ ROW Clear and Grade Checklist

4. Weed Management	
Goals	To prevent the introduction and spread of Declared Plants and environmental weeds.
Responsibility	Land and Approvals Manager
Performance Objective	◗ No new weed species to be introduced into the area. ◗ The growth potential of existing noxious weeds in the project area should be minimised.
Mitigation Measures	◗ Pre Construction Procedures ◗ An inventory of noxious weed species occurring in the project area to be undertaken and appropriate weed control procedures to be developed based on regulatory pest plant control guidelines, regional weed control programs and an assessment of weed risk. ◗ Washdown and Hygiene Procedures ◗ All on-site personnel will follow the following weed hygiene procedures: o Prior to arrival at the project area, all vehicles, equipment and portable infrastructure (including trailers, generators, workshop and accommodation huts etc.) will be washed down (spray-cleaned). o Cleaning procedures need to remove soil and organic matter from the surfaces of vehicles, equipment and portable infrastructure, including undercarriage and running gear. o Proof of inspection, such as “washdown tickets” from state operated facilities, is required for all vehicles coming from known area of infestation, before permission is granted to enter uninfected tenure areas. If the vehicle is not considered clean by a trained weed inspector, it shall be re-washed and re-inspected before certification. o A weed washdown sticker (coloured yellow) is to be placed on the windscreen of vehicles that have been certified weed free. o Vehicles and machinery certified weed free shall be noted in the Weed Register to be updated regularly and located at the Site Office. ◗ Liaise with Local Councils and other authorities for specific weed data sets. ◗ Only approved access tracks and roads are to be used for access to the project area. ◗ Appropriate training of all personnel. ◗ Superintendents and supervisors will be briefed on the recognition of noxious weeds.
Performance Measures	◗ During construction, regular field inspections for the presence of weeds will be undertaken, particularly in problem areas, and weed control carried out as determined by the land and Approvals Manager in consultation with Environmental Authorities. ◗ It will be the responsibility of the Operations Manager to ensure that proper weed management controls have been undertaken.
Monitoring / Auditing / Reporting	◗ Regular monitoring by patrol officers. ◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of any recommendations and corrective actions. ◗ Any introduction of declared flora or other environmental weeds will be reported to the Land and Approvals Manager who will notify relevant

4. Weed Management	
	authorities.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Corrective actions shall be closed out by senior management according to an agreed responsibility and timescale. ◗ If a substantial outbreak of a declared noxious weed is found in the project area, the following will be implemented: o Vehicle movement through the area will be immediately halted. o The Operations Manager will be notified as soon as practicable and in turn will notify relevant Local Council of the location of the weed problem. In addition, the local Land Protection Officer and the Administering Authority shall also be notified. o The area will be assessed and treated, if necessary, by hand pulling individual plants or by boom or spot spraying, before any earth moving equipment or machinery enters the area. Under no circumstances will the plants found be chopped slashed or burned due to the potential for spreading seeds. o Any vehicle leaving the affected area will be rewashed and inspected. The vehicle will then obtain a new certification sticker with a new register number and date of inspection.
Associated Documents	◗ Weed Control

5. Bushfire Prevention	
Goals	To prevent the cause of bushfire as a result of operational activities.
Responsibility	Operations Manager
Performance Objective	◗ To minimise the risk of bushfire; ◗ To protect the public and personnel; ◗ To protect property and minimise damage or loss; ◗ To protect flora, fauna and habitats; ◗ To prevent the spread of bushfire in the event of ignition; and ◗ To provide adequate response in the event of ignition.
Mitigation Measures	Implement measures to prevent and respond to bushfire incidents that are in accordance with the following-: ◗ AS2885.3 ◗ Safety and Emergency Plans ◗ Bushfire management plans which include prevention, preparedness, emergency contacts, equipment, response and training. ◗ Project activities should adhere to regulatory and local fire authority guidelines and comply with fire restrictions, notification requirements and permitting procedures. ◗ All vehicles shall be equipped with appropriate vehicle fire extinguishers. ◗ Firebreaks are to be installed around facilities. ◗ Regular checks to ensure there is no build up of debris or vegetation matter that could cause an ignition. ◗ Where combustible or flammable chemicals are required to be stored on site, appropriate fire fighting equipment shall be available. Incompatible chemicals should not be stored together, and where possible, flammable liquids should be stored in a flammable liquids cabinet.
Performance Measures	◗ No outbreaks of bushfire as a result of project activities.
Monitoring / Auditing / Reporting	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of a bushfire are to be documented and incorporated within this EMP. Corrective actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ AS2885.3 ◗ Safety Management Plan ◗ Emergency Response Plan

6. Air Emissions	
Goals	To minimise the release of air pollutants.
Responsibility	Operations Manager
Performance Objective	◗ To minimise atmospheric emissions; ◗ To minimise greenhouse gas emissions; ◗ To minimise the creation of safety hazards; and ◗ To minimise disturbance to the community.
Mitigation Measures	**GAS** ◗ The venting of coal seam methane gas from site infrastructure shall be minimised. ◗ The flaring of gas from production wells shall be limited to that necessary as part of the production evaluation process, following which flaring will be halted. ◗ Flaring is recognised as preferable to venting of coal seam methane gas, as the associated greenhouse gas emissions are reduced by a factor of more than 20. ◗ Where possible, planned venting of gas shall be conducted under favorable meteorological conditions to help assist rapid dispersion of the gas. ◗ Leak detection surveys shall be periodically performed along any pipeline as per AS2885.3 requirements. ◗ Where gas is to be released to the atmosphere, it should be flared wherever technically and economically feasible. ◗ Gas vent areas are to be located in accordance with regulatory and relevant Australian Standard requirements. ◗ Consultation with nearby residents and local authorities shall be undertaken prior to any major venting exercise. **DUST** ◗ To minimise dust problems in the project area the following mitigation measures should be adopted as appropriate-: ◗ revegetate with existing species and restrict access until the vegetation is established; ◗ ensure designated speed limits are being observed and are appropriate; ◗ minimise vehicular movement; ◗ utilise geotextiles, hessian, mulched vegetation to help settle high dust areas; and ◗ Use dust suppression water where appropriate and available. ◗ Areas impacted by heavy bulldust should be stripped and the subsurface watered to provided a firmer base.
Performance Measures	◗ Zero complaints from local residents or regulatory authorities.
Monitoring / Auditing / Reporting	◗ Monitoring will be on a regular basis during inspections by patrol officers. ◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.

6. Air Emissions	
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Corrective actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ AS2885.3 ◗ Dust Control

7. Cultural Heritage	
Goals	To avoid impact on sites which have heritage or cultural value.
Responsibility	Land and Approvals Manager
Performance Objective	◗ To avoid impact to known sites or sites discovered within or near the project area. ◗ To implement an effective consultation program with traditional landowners, community groups, regulatory authorities, and other relevant stakeholders.
Mitigation Measures	◗ The inventory of heritage sites compiled for the Cultural Heritage Management Plan shall be referred to prior to any maintenance or construction activity. ◗ Heritage sites within or close to project areas shall be adequately marked or barricaded off to ensure they are not disturbed. ◗ Patrol officers and field operations staff shall be adequately trained in Cultural and Heritage issues and management. ◗ A consultation program shall be implemented to help facilitate discussions between traditional owners, community groups, regulatory authorities, and relevant stakeholders.
Performance Measures	◗ Zero complaints from traditional owners, regulatory authorities, community groups or relevant stakeholders. ◗ No disturbance to heritage or cultural sites.
Monitoring / Auditing / Reporting	◗ Monitoring during construction, operation or maintenance activities. ◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Regulatory legislation. ◗ Project Environmental Assessments (detail heritage locations from database searches).

8. Community and Social Impact	
Goals	To foster positive relationships with local communities and avoid negative impacts, including on visual amenity, traffic and local businesses.
Responsibility	Land and Approvals Manager
Performance Objective	◗ To engage interested parties in consultation at all stages. ◗ To manage vehicle traffic to minimise disruption to local traffic flows. ◗ To use local suppliers and businesses wherever possible. ◗ Design permanent infrastructure such that there is no impact on visual amenity.
Mitigation Measures	◗ Development of relationships with local interest groups. ◗ Implementation of a stakeholder consultation plan. ◗ Minimising vehicle movements, particularly on routes of high flow or at peak times. ◗ Using local suppliers and businesses wherever possible. ◗ Planning and designing permanent infrastructure with consideration for existing visual amenity.
Performance Measures	◗ Regular presentations to local councils and interest groups to update community on project progress. ◗ Zero complaints from local residents about traffic disruptions. ◗ No loss of visual amenity.
Monitoring / Auditing / Reporting	◗ Monitoring of community relationship by Land and Approvals Manager, including consideration of ways in which consultation with all interest groups can be improved. ◗ Reporting of all complaints and community consultation.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of any complaints will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Stakeholder Consultation Plan (under development).

9. Waste Management	
Goals	To operate more efficiently and thereby reduce waste outputs; to recycle and reuse materials where possible; and to dispose of waste materials appropriately.
Responsibility	Operations Manager
Performance Objective	◗ To avoid the contamination of soil and water; ◗ To minimise potential health risks to workers and the public; ◗ To minimise adverse effects on native vegetation and wildlife.
Mitigation Measures	◗ Development and implementation of detailed waste management procedures. ◗ Management measures for solid waste materials such as timber, pallets, drums, plastic, glass, metal and rubber to include: ▪ stockpiling reusable and recyclable materials such as pallets, timber skids, drums, and scrap metals; ▪ installation of designated bins at all sites for aluminium cans, glass, and paper; and ▪ disposal of general refuse at approved local authority landfill sites. ◗ Disposal of hazardous wastes such as waste oils or chemicals shall be in accordance with the relevant regulatory requirement. Management measures should include-: ▪ provision of a designated safe storage area for wastes prior to their collection and transport to an offsite facility for either reuse, recycling, treatment, or disposal. The facility is to be approved by the relevant local authority; and ▪ appropriate design measures for storage areas to prevent any spills to the local environment. ◗ Sewerage disposal should be either an approved septic system or mobile chemical treatment systems. ◗ Management procedures for the disposal of general refuse, such as food scraps, domestic garbage, and commercial waste, should include-: ▪ collection and transport to an approved local authority landfill site; ▪ on site disposal at camp or work sites should only be considered for remote sites, providing approval from the relevant local authority has been granted or if storage of the refuse poses a health risk; ▪ site facilities to be maintained to an orderly and hygienic standard; and ▪ litter bins to be provided at all sites and regular site maintenance to be conducted to ensure litter accumulation is avoided.
Performance Measures	◗ Re-use and recycling program being maintained. ◗ Site facilities are kept clean.
Monitoring / Auditing /	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations

9. Waste Management	
Reporting	and corrective actions. ◗ Monitoring on a regular basis by all staff.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Waste Minimisation & Disposal ◗ Waste Management Checklist

10. Fuel and Chemical Storage and Spills	
Goals	To minimise risk of a fuel or chemical spill and minimise environmental impacts should a spill occur.
Responsibility	Operations Manager
Performance Objective	◗ To avoid any fuel or chemical spills; ◗ To avoid unacceptable safety hazards; ◗ To prevent the contamination of soil and water; and ◗ To minimise atmospheric emissions.
Mitigation Measures	◗ The storage and handling of fuels and chemicals shall be in accordance with AS 1940:1993 – *The storage and handling of flammable and combustible materials* and relevant legislation. ◗ When purchasing chemicals, the material safety data sheets (MSDS) should also be obtained and made available on site to personnel. Personnel handling chemicals shall be appropriately trained and provided with the necessary personal protective equipment. ◗ Chemical use should be minimised and only a practicable amount of chemicals shall be stored on site. ◗ Appropriate design measures for storage areas, such as bunding and grease traps, to be employed to prevent any spills from being released into the local environment. ◗ Appropriate handling procedures for fuels and chemicals should be developed to help prevent spills to the local environment. ◗ Fuels and chemicals should not be stored or handled in the vicinity of waterways or creeks where possible. ◗ Workforce training shall be provided for fuel and chemical handling and spill response and recovery procedures.
Performance Measures	◗ Zero fuel or chemical spills to the local environment.
Monitoring / Auditing / Reporting	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions. ◗ Monitoring on a regular basis by all staff.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ AS 1940:1993 – *The storage and handling of flammable and combustible materials* ◗ Control of Hazardous Substances (General) ◗ Control of Hazardous Substances (Solvents & Flammables)

11. Noise and Vibration	
Goals	To ensure that noise from well construction and operation is within acceptable limits at adjacent residential premises and other noise sensitive receptors.
Responsibility	Operations Manager
Performance Objective	◗ Minimise the level and time of noise disturbance.
Mitigation Measures	◗ Local residents shall receive adequate notice of potential noise incursions. ◗ Heavy traffic use of local roads will be restricted to the hours of 6 am to 6 pm Monday to Saturday. ◗ Construction camp stores and stockpiles shall be located as far as possible from noise sensitive areas. ◗ Where practicable, excessively noisy construction activities (fraccing) shall be scheduled for periods which are less likely to result in a noise nuisance. ◗ Construction equipment shall be equipped with appropriate noise abatement devices. ◗ Noise generating equipment shall be located at appropriate distances from residences and/or will be enclosed or screened if necessary. ◗ Noise Abatement procedures will be undertaken in accordance with Section 3 of the EPP Noise 1997. ◗ If required, blasting shall be undertaken in accordance with criteria for reasonable noise from Schedule 2 of the EPP Noise 1997.
Performance Measures	◗ Zero noise related complaints received during construction.
Monitoring / Auditing / Reporting	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions. ◗ In response to noise complaints, noise monitoring will be undertaken at locations close to where the activities are occurring.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale. ◗ Complaints received about noise and will be investigated within 24 hours and, if required, operating activities will be modified to reduce noise impacts.
Associated Documents	◗ Noise Control

12. Clearing and Grading	
Goals	To ensure successful vegetation rehabilitation through topsoil management and to minimise the impact to ecological communities from the clearing of vegetation.
Responsibility	Operations Manager
Performance Objective	◗ Minimise disturbance of flora and fauna habitats. ◗ Avoid adverse impacts on cultural and heritage sites. ◗ Optimise the success of vegetation rehabilitation. ◗ Minimise soil erosion and degradation. ◗ Minimise the risk of weeds spreading. ◗ Minimise impact on visual amenity. ◗ Minimise modification to surface water flows (drainage lines) and water quality. ◗ Minimise disruption to landholders and third parties. ◗ Minimise erosion due to disturbance of sodic soils.
Mitigation Measures	◗ Conduct searches of the EPA Contaminated Sites Register prior to construction. ◗ Known EPA Contaminated Sites to be avoided. ◗ No clearing outside of designated well and pipeline construction areas. ◗ No clearing of remnant vegetation or protected species for access tracks or temporary work space. ◗ Reduction in clearing through sensitive environments will be marked clearly on alignment sheets and in the field. ◗ Permits must be obtained prior to any clearing being conducted. ◗ Cleared vegetation will be stored (not burnt) for respreading during re-instatement. ◗ Cleared vegetation or soil is not to be pushed up against trees or stored against fencelines. ◗ Erosion control measures will be installed where appropriate to minimise topsoil loss. ◗ Topsoil depth removal will be typically be 20 – 30 cm. In areas of agricultural cropping this will be increased to 40 - 50 cm. ◗ Topsoil will be stored above the potential floodline, particularly at water courses and known flooding areas. ◗ Special consideration will be given to the handling of sodic soils to ensure that they are exposed for as short a time as practicable to minimise potential erosion impacts.
Performance Measures	◗ Topsoil and vegetation to be removed and stored appropriately to allow for successful reinstatement. ◗ No damage to flora and fauna from unapproved or unplanned vegetation clearing. ◗ Erosion control measures installed during clear and grade.
Monitoring / Auditing / Reporting	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.

12. Clearing and Grading	
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Right of Way Clearing & Grading

13. Drilling, Perforation and Fraccing	
Goals	To avoid impacts on the local environment, including on vegetation, soils and surface and ground water, from drilling and associated activities; and to minimise associated noise impacts and air emissions.
Responsibility	Operations Manager
Performance Objective	◗ Minimise disturbance of flora and fauna habitats. ◗ Minimise noise impacts during well construction. ◗ Minimise impacts on local soil environment from vehicle movement and pad construction. ◗ Minimise impacts on local surface waters associated with well construction. ◗ Minimise risk of contamination of groundwater.
Mitigation Measures	◗ Observance of all relevant Procedures as described above to minimise risks associated with erosion and soil stability, ground and surface water contamination, noise impacts, air emissions, waste and fuel and chemical management, and vegetation and weed management, ◗ Observance of detailed Drilling and Testing EMP, which is to be available in the Site Office.
Performance Measures	◗ Zero complaints relating to noise from local residences. ◗ No contamination of surface or ground water, or local soil environments. ◗ Successful restoration of drill pads at completion of construction activities.
Monitoring / Auditing / Reporting	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Drilling and Testing EMP

14. Pond Construction	
Goals	To avoid impacts on the local environment, including on vegetation, soils and surface and ground water, from construction of produced water storages.
Responsibility	Operations Manager
Performance Objective	◗ Minimise impacts associated with construction of produced water ("turkey's nest") storages.
Mitigation Measures	◗ Observance of all relevant EMPs as described above to minimise risks associated with erosion and soil stability, ground and surface water contamination, noise impacts, air emissions, waste and fuel and chemical management, and vegetation and weed management, ◗ Design and construction of storages based on engineering specifications to minimise environmental impacts, including: ▪ storage capacity to take into consideration probable water production rate as well as climate conditions, in order to minimise risk of spillage; ▪ installation of geomembrane liner to eliminate leaching; ▪ inclusion of spillway to facilitate safe spillage during exceptional conditions; ▪ operational guidelines to minimise risk of spillage; and ▪ cut-and-fill construction techniques to avoid the need to import soil from other sites.
Performance Measures	◗ No soil erosion or air emissions. ◗ No contamination of surface or ground water, or local soil environments. ◗ Successful operation of water storages such that there are no spills to the environment.
Monitoring / Auditing / Reporting	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Conceptual Design and Specifications for Produced Water Storages.

15. Trenching	
Goals	To reduce the impact of trenching on the topsoil quality, native fauna, domestic stock and agricultural production of the land.
Responsibility	Operations Manager
Performance Objective	◗ Minimise risk of topsoil and subsoil mixing. ◗ Successful rehabilitation of native vegetation and agricultural cropping. ◗ Minimise disruption to landholders and other stakeholders. ◗ Avoid damage to third party buried infrastructure.
Mitigation Measures	◗ Trenching is to be undertaken as per agreed specifications. ◗ Third Party infrastructure will be identified and accurately shown on alignment sheets and marked in the field prior to trenching. ◗ Trenching Supervisor and Superintendent will be instructed of the procedure if a previously unidentified contaminated site is uncovered during construction. This includes: – Stopping trenching at the location; – Relocation and starting trenching 50 m ahead; – Advising the Operations Manager and Land and Approvals Manager; – Instigating site assessment according to EPA; – Instigating actions according to the assessment. This may include remediation of the site or movement of the pipeline alignment to avoid the site. ◗ Trench spoil (subsoil) is to be separated from the topsoil. ◗ Subsoil will be stored above the potential floodline, particularly at water courses and known flooding areas. Erosion control measures will be installed where appropriate to minimise erosion risk. ◗ All major roads will be bored. ◗ If an open cut crossing of a road or track is necessary, consultation will be undertaken with landholders and third parties. Detours and signage will be installed as required. ◗ Where appropriate, gaps in the topsoil will be provided, and subsoil and vegetation stockpiled to assist the movement of livestock and native fauna. ◗ Where appropriate, gaps in soil stockpiles and resultant backfill mounds will be provided to mitigate the potential impact of overland flow that is not parallel to the backfill mounds. ◗ The trench will be left open for the minimum period practical. It will not be left open for extended periods on slopes leading to a watercourse or drainage line. ◗ Native fauna ramps shall be installed at the ends of trenching (at least every 1 km), and at each normal break e.g. road and water crossing.
Performance Measures	◗ Disruption to landholders and third parties to be minimised. ◗ Trench spoil (subsoil) and topsoil to be separated. ◗ Trench plugs and erosion mitigation measures implemented to reduce the risk of erosion. ◗ Ramps to be installed at trench breaks and appropriate locations.
Monitoring / Auditing /	◗ During construction, the work areas will be regularly inspected to assess the implementation of the construction mitigation management

15. Trenching	
Reporting	procedure. ◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Trenching ◗ Road Crossings Open Cut

16. Pipe Stringing and Welding	
Goals	To reduce the impact of stringing and welding on landholders and the environment.
Responsibility	Operations Manager
Performance Objective	◗ Minimise the disturbance to landholders and third parties. ◗ Minimise the risk of bushfire. ◗ Ensure that native fauna and livestock have access across the pipeline.
Mitigation Measures	◗ Trucks delivering pipe shall be scheduled during daylight hours and along designated access roads to minimise noise and dust impacts. ◗ All pipeline packaging and welding waste shall be removed from site to an approved disposal facility. ◗ When the pipe is strung, ensure gaps are left to allow access for native fauna and livestock. The gaps shall be aligned with access tracks, stored vegetation and topsoil, fences and gates. ◗ Pipeline caps shall be placed over the ends of the pipe to prevent dust and wildlife from getting in. ◗ During welding, the following pre-cautions will minimise the risk of starting bushfires: – Working area shall be cleared of vegetation; – Welding trucks shall be equipped with a fire fighting unit with adequate water storage capacity and fire extinguishers. Welding crews shall be trained in the use of the fire fighting equipment; and – Water trucks (used for dust suppression) shall be available with water storage capacity in the event of a fire.
Performance Measures	◗ Disruption to landholders and third parties is minimised. ◗ Native fauna and livestock have areas where they can cross the easement. ◗ No uncontrolled fires to be started.
Monitoring / Auditing / Reporting	◗ During construction, the work areas will be regularly inspected to access the implementation of construction mitigation management procedures. ◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Pipeline Stringing & Welding

17. Pipe laying and Backfilling	
Goals	To reduce the impact of pipe laying and backfilling on the environment.
Responsibility	Operations Manager
Performance Objective	◗ Minimise the disturbance to landholders and third parties. ◗ Minimise the risk of topsoil and subsoil mixing. ◗ Ensure that native fauna and livestock have access across the pipeline.
Mitigation Measures	◗ Erosion berms will be constructed on slopes to divert rainfall away from the alignment. ◗ Compaction over the working area will be ripped prior to re-spreading of topsoil. ◗ Trench plugs to be provided and backfilled soils compacted along the trench to prevent erosion along backfilled trench. ◗ A small crown shall be left over the backfilled trench to allow for settling. Breaks of the crown shall be provided to allow for water flow across the alignment at regular points. These breaks shall be determined using the overland flowpaths developed by the relevant authority. ◗ Pipeline markers will be installed according to land use to locate the pipeline. ◗ Topsoil will only be respread over the working area following the backfilling of all subsoil. Topsoil will not be used as padding material. ◗ In areas of particularly sodic soil, special precautions will be taken to ensure that topsoil and sodic subsoil is not mixed. In addition, these areas will be backfilled at a quicker rate to ensure minimal exposure time for highly erodible soils. Sodic soils will be placed at the base of the trench to further limit exposure. ◗ Obvious low-lying floodways will be identified during the pipeline route survey process to identify those areas requiring a management of floodway strategy to be developed and applied in order to mitigate potential erosion impacts. ◗ At the start of each day, any exposed trench shall be inspected for the presence of wildlife and, if found, it should be appropriately removed. ◗ The ends of exposed pipe shall be sealed at the end of each day. ◗ At the end of each day, no extensive lengths of trench shall be left exposed.
Performance Measures	◗ Subsoil returned to the trench prior to topsoil. ◗ Appropriate erosion berms to be installed on sloped areas.
Monitoring / Auditing / Reporting	◗ During construction, the work areas will be regularly inspected to access the implementation of construction mitigation management procedures. ◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Pipeline Laying & Backfilling ◗ Backfill & Reinstatement Gas Pipelines

18. Hydrotesting	
Goals	To minimise all impacts associated with hydrostatic testing on the surrounding soil and water environments.
Responsibility	Operations Manager
Performance Objective	◗ Minimise impacts to soils, groundwater and general water quality. ◗ Minimise the amount of water used. ◗ Minimise the risk of soil erosion.
Mitigation Measures	◗ If water quality is sufficient, water will be sourced from existing storages within the production field. ◗ If another source of water is required, it shall be approved in advance by the Environment and Land Manager. ◗ All permits to source water shall be approved in advance. ◗ Biodegradable biocides shall be selected where possible. ◗ Ensure there is no damage from discharge of the water. ◗ All additional approvals from landholders and for water disposal options. ◗ Where sufficient water is not available it will be trucked in as required. ◗ Water quality testing procedures and values will be approved prior to discharge by the Environment and Land Manager. ◗ Prior to discharge, the Land and Approvals Manager shall be consulted about the water quality and testing required, and consult with Council and relevant authorities. ◗ Discharge hydrotest water to land to avoid runoff to creeks, agricultural drainage lines, erosion or flooding. At the discharge point materials shall be used to reduce the force and to dissipate the water to avoid soil erosion.
Performance Measures	◗ Testing Procedures will be in accordance with AS 2885. ◗ Discharge will be within all regulatory and landholder requirements.
Monitoring / Auditing / Reporting	◗ Monitor test water discharges from the site to ensure compliance with water standards. ◗ During construction, the work areas will be regularly inspected to access the implementation of construction mitigation management procedures. ◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions.
Corrective Action	◗ Should the disposal of hydro-test waters fail to meet the performance criteria the Construction Contractor will review disposal options. ◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale.
Associated Documents	◗ Pipeline Testing & Commissioning

19. Clean Up and Rehabilitation	
Goals	To rehabilitate all disturbed areas to a land use capability compatible with the surrounding land use. Any rehabilitation will utilise all actable methods to ensure that a stable land form is reinstated.
Responsibility	Land and Approvals Manager
Performance Objective	◗ Minimise loss of vegetation and habitat; ◗ Minimise erosion and sediment runoff; ◗ Minimise the risk of subsidence; ◗ Minimise the loss of visual amenity; ◗ Minimise the modification of drainage patterns; and ◗ Minimise the damage to any infrastructure.
Mitigation Measures	◗ Minor surface roughness will be encouraged when spreading topsoil to trap water and seed. ◗ Other cleared vegetation will be removed and disposed of in consultation with the appropriate landholder or respread over cleared areas to assist in seed distribution and provide shelter for fauna. ◗ Areas affected by operations and development will be re-profiled to original and stable contours, re-establishing surface drainage lines and other land features. ◗ Erosion and sediment controls will be installed if necessary. Existing soil erosion measures will be reinstated to a condition at least equal to the pre-existing state. ◗ Above-ground infrastructure shall be fenced to discourage third party, stock and wildlife entry. ◗ Signs, fences or other barriers shall be installed where appropriate to prevent unauthorised easement access. ◗ Permanent pipeline warning signs shall be erected along easements. ◗ In general, revegetation will occur through the re-spreading of cleared topsoil and vegetation. Active revegetation will only occur where stabilisation is required to prevent erosion. ◗ Where active revegetation is required, local native species will be selected in preference to introduced. ◗ In other areas where seeding or replanting is required, the seed mix will be agreed with the relevant land holder. ◗ Environmental features such as rocks and dead timber will be replaced in cleared areas as appropriate. ◗ Trees will be permitted to grow within 3m of the pipeline as long as: – pipeline integrity is not affected; – regrowth is considered; and – signage remains visible.
Performance Measures	◗ Land and infrastructure affected by the planning, construction and post construction phases will be restored to pre-disturbance status or better. ◗ No new weed species to be introduced. ◗ Revegetation shall return areas to similar composition as surrounding vegetation. ◗ Drainage patterns returned following construction.

19. Clean Up and Rehabilitation	
Monitoring / Auditing / Reporting	◗ Audits will be conducted in accordance with the Environmental Management Program, with implementation of the recommendations and corrective actions. ◗ Monitoring on a regular basis by all staff.
Corrective Action	◗ Investigations/corrective actions undertaken as a result of the audit or regular monitoring will be documented and incorporated into this EMP. Correction actions shall be closed out by senior management according to an agreed responsibility and timescale. ◗ Investigate complaints and take all steps to restore area according to land holder requirements.
Associated Documents	◗ Site Clean Up & Clearance ◗ Pipeline Clean Up & Rehabilitation