Supplementary Review of Environmental Factors Shallow Aquifer Monitoring Bore (SAMB) Project Kahlua - PEL 1 Gunnedah Basin

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Executive Summary

Background

Santos QNT Pty Ltd (Santos) has entered into a Farmin Agreement with the titleholder of PEL 1, Australian Coalbed Methane Pty Ltd to explore for petroleum (in accordance with the *Petroleum (Onshore) Act 1991*). Santos has been appointed the Operator for and on behalf of the titleholder under the Farmin Agreement.

The Kahlua Shallow Aquifer Monitoring Bore (SAMB) project is an ancillary activity to the approved Kahlua Coal Seam Gas (CSG) Pilot program for drilling and completing Kahlua 2, 3, 4 and 5 pilot wells information on which was submitted in the Review of Environmental Factors which received the approval of the Department of Industry and Investment (DII) on 8 September 2010 to drill and complete the Kahlua four well pilot. This document has been prepared in accordance with Condition 1.0 of the PEL 1 licence instrument to enable a determination to be made by DII under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Kahlua Shallow Aquifer Monitoring Bore (SAMB) is an activity ancillary to the drilling and completion of those wells. The purpose of the SAMB project is to obtain data regarding potential changes in shallow aquifer levels within the vicinity of the pilot test area prior to, during and following the single well pilot test activities at Kahlua 2,3,4 and 5.

The purpose of this Supplementary Review of Environmental Factors is to assess the relevant environmental impacts of the proposed SAMB project to the fullest extent possible under section 111 of the EP&A Act and clause 228 of the *Environmental Planning and Assessment Regulation.*

The Proposal

Santos proposes to drill and complete two shallow aquifer monitoring bores, one within 80m of the pilot wells (on the Kahlua 4 lease) and one approximately 2kms away from the pilot wells adjacent to the plugged and abandoned Kahlua 1 core hole.

The two SAMBs (known as KAHLUA SAMB 1 and KAHLUA SAMB 2) will be located on privately owned land presently used for agricultural and petroleum activities. The exact location of the KAHLUA SAMB 2 bore will be determined following further consultation with the landowner.

Santos has negotiated agreements in place regarding land access, compensation and rehabilitation with the landholder of the land on which all of the SAMB Program is to be carried out. Regular contact with all landholders is to be maintained during the proposed activities at the site.

The purpose of the SAMB project is to provide Santos, the Regulator and the Community with data regarding potential changes in shallow aquifer levels within the vicinity of the pilot test area prior to, during and following the single well pilot test activities.

This data can then be used to objectively assess the impact on the aquifer systems due to CSG production activity and to differentiate it from potential impacts due to existing aquifer uses and natural variations.

The SAMB program is proposed to be located on an operating farm. The land is zoned 1(a) Rural (Agriculture Protection) in the Gunnedah Local Environmental Plan 1998 (LEP).

The borehole sites will be located on land that has been previously cleared for petroleum (KAHLUA SAMB 1) and rural (KAHLUA SAMB 2) activities. The nearest residence

(although vacant) is located more than 500m to the west of KAHLUA SAMB 2 and the nearest watercourse is greater than 40 metres from either site.

The maximum ground disturbance footprint during the drilling phase is 40m x 40m using a truck mounted water bore rig. Utilization of the planned Kahlua 4 drilling lease is planned to minimize footprint for one of the water bores sites. For ongoing monitoring the bore sites will be fenced to an area of approximately 2m x 2m surrounding the bore tubing stub. This fenced off area will have an adjacent solar panel and small data logger / telemetry box for remote monitoring which may potentially be in a small separate fenced area.

It is anticipated that the bores will be drilled to depths of between 100m and 200m. The bores are not expected to intercept commercial coal seams based on available offset data. The bores will not lift significant volumes of water to surface and will not lift water continuously to surface or have the capability to do so on completion. The well design effectively isolates all formations from each other and from the surface and all data collected will be available in real time.

Potential Environmental Impacts

The proposed SAMB sites will avoid any threatened species and critical habitat identified in the desktop assessment and field assessment by an ecologist for the Kahlua Pilot Program (Santos 2010).

The proposed activities have associated potential environmental impacts, which are common to water bore drilling activities carried out elsewhere in the Gunnedah Basin. It is considered that the potential impacts can be successfully mitigated with the application of the management measures outlined in Section 4. The measures utilised by Santos and it contractors for the water bore drilling will be consistent with the APPEA Code of Environmental Practice and are typical of good hydrocarbon field practice.

Section 5A of the *Environmental Planning and Assessment Act 1979* lists seven factors to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats. commonly referred to as the seven part test of significance. An assessment was made against the seven factors and concluded that:

- There are no known threatened species that would be impacted by the planned activities. The size and nature of the proposal is unlikely to affect the life cycle of any viable populations of threatened flora/fauna if present.
- There are no known endangered populations that have been identified that would be impacted by this proposal. The size and nature of the proposal is unlikely to affect the life cycle of any viable populations of endangered populations if present at the sites.
- There are no known endangered ecological communities or critically endangered communities that have been identified that would be impacted by this proposal.

No vegetation will be removed for the SAMB program and therefore the planned activities will not constitute a threatening process.

The potential environmental impacts have been assessed. It is considered that the likely potential environmental impacts with mitigation measures in place are negligible, and therefore the activities are not likely to have a significant impact on the environment. In particular, it is expected that:

- Impacts on landholders will be negligible;
- Impacts to air quality will be negligible, localised and insignificant;
- Adverse effects on water resources will be negligible;

- Off-site impacts to soils will be avoided and on-site impacts will be negligible and temporary;
- Noise impacts will be short term, and no threatened species or communities are likely to be significantly impacted;
- There will be no significant use of, or impact to, natural resources including groundwater;
- Impacts on the community and visual amenity will be negligible and short term, particularly as the sites are in a sparsely populated area;
- Impacts to heritage places or sites will be avoided;
- Disturbances to pastoral and cropping land use will be negligible and short term and managed in consultation with affected landholder(s); and
- There will be no significant cumulative environmental impacts.

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1 Introduction

1.1 Background

Santos QNT Pty Ltd (Santos) has entered into a Farmin Agreement with the titleholder of PEL 1, Australian Coalbed Methane Pty Ltd to explore for petroleum (in accordance with the *Petroleum (Onshore) Act 1991*). Santos has been appointed the Operator for and on behalf of the titleholder under the Farmin Agreement.

Santos submitted a review of environmental factors for the drilling and completion of four pilot wells near Kahlua (known as Kahlua 2, 3, 4 and 5) to obtain information on coal depths, seam sizes, continuity and quality to assess the coal seam gas potential of the Gunnedah Basin in PEL 1.

Santos received approval from the Department of Industry and Investment (DII) on 8 September 2010 to drill and complete those wells. The Kahlua Shallow Aquifer Monitoring Bore (SAMB) project is an activity ancillary to the drilling and completion of those wells. The purpose of the SAMB project is to obtain data regarding potential changes in shallow aquifer levels within the vicinity of the pilot test area prior to, during and following the single well pilot test activities at Kahlua 2, 3, 4 and 5.

This supplementary review of environmental factors for the SAMB project has been prepared in accordance with Condition 1.0 of the PEL 1 licence instrument to assist the DII to make a determination under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) in relation to the SAMB project. It assesses the relevant environmental impacts of the proposed SAMB project to the fullest extent possible as required by section 111 of the EP&A Act and clause 228 of the *Environmental Planning and Assessment Regulation.*

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1.2 Proponent Contact Information

The correspondence address for Santos is:

Operator:	Santos QNT Pty Ltd (ABN 33 083 077 196) for and on behalf of the Titleholder Australian Coalbed Methane Pty Ltd
Address:	Level 22, Santos Place, 32 Turbot Street, Brisbane, Qld, 4000
Telephone:	07 3838 3676
Email:	reception.brisbane@Santos.com
Contact Person:	Mr J Pinedo, Team Leader Implementation

1.3 Structure

This supplementary REF consists of:

- Section 1: Introduction and contact details
- Section 2: Summary of relevant regulations applicable to the activity;
- Section 3: Proposed activities including location and timing;

- Section 4: Outline of the potential environmental impacts and mitigation measures; and
- Section 5: Concluding comments on the likely impacts.

2 Legislation & Planning Framework

2.1 Planning Framework

2.1.1 Overview

The *Environmental Planning & Assessment Act 1979* (EP&A Act) is the primary legislation regulating land use planning in NSW. It provides the framework for the development of state and local planning instruments that through their hierarchy determine the statutory process for environmental impact assessment. Under the EP&A Act there are three distinctive processes, which are:

- Part 3A, regulates specific types of 'projects' and requires an Environmental Assessment report to be prepared and submitted to the Department of Planning for the Planning Minister's approval;
- Part 4, regulates 'development' and requires a development application accompanied by a Statement of Environmental Effects to be submitted to council for development approval; and
- Part 5, regulates 'activities' and requires a Review of Environmental Factors for consideration by the determining authority.

Accordingly, the SAMB is to be assessed under Part 5.

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A determining authority, for the purposes of this activity, is defined in Part 5 of the EP&A Act to include, but is not limited to a public authority whose approval is required before an activity may be carried out. In relation to petroleum exploration licences the DII is the determining authority for approving exploration activities covered by this supplementary REF. In order to assist the determining authority to comply with its obligations under Part 5 of the EP&A Act, Santos has considered s.111 of the EP&A Act and Clause 228 of the *Environmental Planning Regulation* (See Section 4.2) in preparing this supplementary REF.

2.1.2 Environmental planning instruments

The Environmental Planning Instruments (EPIs) regulate the permissibility to undertake an activity and the type of assessment process that is required. EPI is the generic term used to describe state environmental planning policies, regional environmental plans and local environmental plans.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (SEPP 2007) recognises the importance to New South Wales of mining, petroleum production and extractive industries. SEPP 2007 seeks to facilitate the orderly and economic use of land containing mineral, petroleum and extractive material resources, whilst encouraging ecologically sustainable development.

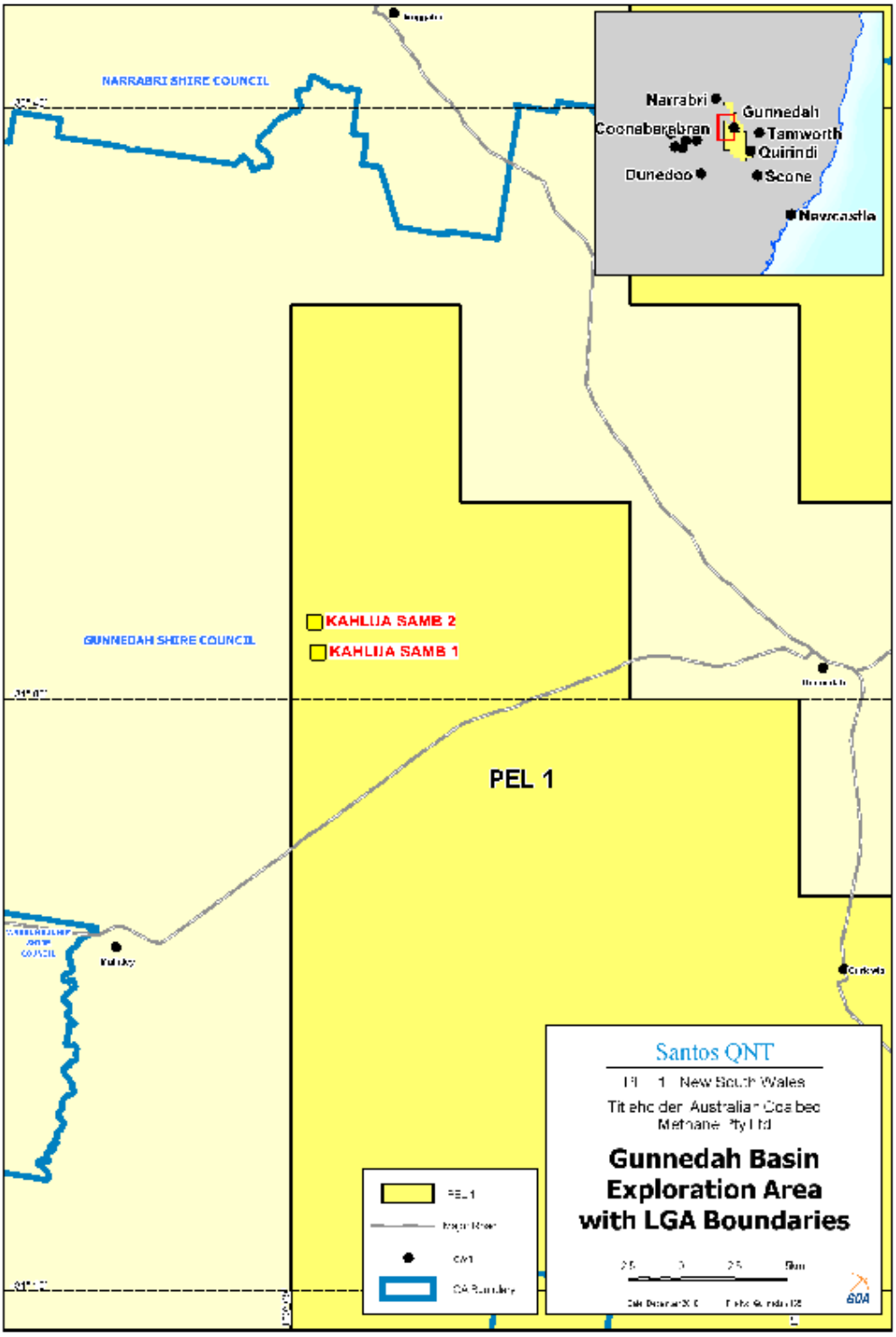
Subject to certain exemptions, SEPP 2007 allows development for the purposes of petroleum exploration to be carried out without development consent under Part 4 of the EP&A Act. The definition of petroleum under SEPP 2007 includes any naturally occurring hydrocarbon, whether in gaseous, liquid or solid state. SEPP 2007 has the effect that the proposed four wells may be carried out without development consent but will be subject to the assessment process under Part 5 of the EP&A Act.

2.1.3 Zoning and Local Environmental Plans

The shire councils of Narrabri, Gunnedah and Liverpool Plains regulate the Local Environmental Plans (LEP) applicable to PEL 1. Figure 2.1 shows the location of the various LGAs and the proposed SAMB locations.

The proposed sites fall within the local government area of Gunnedah Shire Council (GSC). Further details are presented in Table 3.1 and Figure 3.1. The sites are zoned Zone no. 1(a) Rural (Agricultural Protection) under Gunnedah LEP 1998. Development for the purposes of petroleum exploration is permissible with development consent within Zone 1(a). However, SEPP 2007 has the effect of making development of the purposes of petroleum exploration permissible without development consent but subject to Part 5 of the EP&A Act.

Figure 2.1: Local Government Areas Covering PEL 1



2.2 Legislative Requirements, Petroleum Licenses and Approvals Required

Petroleum (Onshore) Act 1991 (NSW)

Santos has entered a Farmin Agreement with the holder of PEL 1 Australian Coalbed Methane (ACM) that grants the right to Santos as Operator to explore for petroleum subject to meeting landholder and legislative requirements.

Prior to any exploration on private land, an access agreement and compensation arrangements must be agreed between the titleholder (or its agent) and the landowner (Petroleum (Onshore) Act 1991, Part 4). Section 69 specifies the issues that an access agreement may cover, including :

- periods during which access may be permitted;
- parts of the land on which exploration may be undertaken;
- conditions to be observed during exploration, and
- compensation to be paid to the landholder.

In preparing this supplementary REF the necessary considerations found at the DII website at http://www.dpi.nsw.gov.au/minerals/titles/landholders-rights have been considered.

Santos has negotiated an acceptable agreement with any affected landowner for an access and compensation in regard to this site.

Environmental Planning and Assessment Act 1979 (NSW)

Santos, on behalf of the titleholder, must also obtain an approval from the DII prior to carrying out drilling activities. Before granting the approval, the DII is required to comply with Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The DII is required to consider the environmental impact of the activity to the fullest extent possible. The purpose of this REF is to provide an environmental assessment of the proposed activity to enable DII to consider the environmental impact of the activity under Part 5 of the EP&A Act.

Under Section 5A of the EP&A Act, the DII is also required to consider whether the activity is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats. Section 5A lists seven factors to be considered, commonly referred to the 'seven part' test of significance. These are as follows:

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;

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;

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;

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.

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

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

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

Protection of the Environment Operations Act 1997 (NSW)

Under the *Protection of the Environment Operations Act 1997*, it is an offence to pollute waters. There are also broad offences of wilfully or negligently causing a substance to escape that causes or is likely to cause environmental harm without lawful authority.

Pollution incidents causing or threatening material harm must be notified to the Environment Protection Authority. Under Section 147 material harm means:

- harm to the environment is material if:

a) it involves actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial or it results in actual or potential loss or property damage of an amount or amounts in aggregate, exceeding $10,000 (or such other amount as is prescribed by the regulations); and

b) and loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment.

National Parks and Wildlife Act 1974 (NSW)

The *National Parks and Wildlife Act 1974* (NPW Act), protects Aboriginal objects and places (under Part 6). Under Section 90(1) the Director-General may issue an Aboriginal heritage impact permit. It is an offence to harm or desecrate Aboriginal objects or places (section 86) but it is a defence under section 87 if the defendant shows that:

(a) the harm or desecration concerned was authorise by an Aboriginal heritage impact permit; and

(b) conditions to which that Aboriginal heritage impact permit was subject were not contravened.

The NPW Act with the Threatened Species Conservation Act 1997 (NSW) also protects threatened species, populations and ecological communities, their habitats and critical habitats (Part 8A).

Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) protects matters of national significance. Santos does not consider that this proposal will trigger

this Act, and does not propose to lodge a referral to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities .

Water Act 1912 (NSW)

Under the *Water Act 1912* there is a requirement to obtain a Water bore licence for each of Kahlua 2,3,4 and 5. The relevant Acts are summarised in Table 2.1.

Table 2.1: PEL 1 Licence Conditions and Applicable Legislation

Legislation	Requirements of Schedule 2 Licence Conditions	Administering Authority
Petroleum (Onshore) Act 1991	The activities do not cause other than minimal/nil impact on features listed in Section 75 (i.e. of Aboriginal, Architectural, archaeological, historical or geological interest). Where these are present, an exploration protocol acceptable to the Department must be completed prior to exploration commencing to ensure that exploration activities will not have an adverse impact on these features. Full rehabilitation in accordance with Department guidelines/standards is carried out after completion of the exploration activities.	Department of Industry & Investment – Mineral Resources
Environmental Planning and Assessment Act 1979	Assess the impact of the activity on the environment under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) from the DPI-MR prior to carrying out drilling activities.	Department of Primary Industry – Mineral Resources
Threatened Species Conservation Act 1995	The Licence holder is required to consult the register of Critical Habitat kept by the Director–General, and consider the significance of any notations in respect of the area of any proposed exploration activity	Department of Environment, Climate Change and Water
Fisheries Management Act 1994	Consult the register of critical habitat kept under this Act.	Department of Primary Industries – Fisheries
National Parks and Wildlife Act 1974	The activities do not contravene Part 6 (Aboriginal objects and Aboriginal places) of this Act.	National Parks and Wildlife Service
Native Vegetation Conservation Act 1997(now 2003)	The licence holder must not cut, destroy, ringbark or remove any timber or other vegetative cover on any land subject of the licence except such as directly obstructs or prevents the carrying on of operations. Any clearing not authorised under the *Petroleum (Onshore) Act 1991*, must comply with the provisions of this Act.	Department of Environment, Climate Change and Water
Rural Fires Act 1997	Santos must take all precautions against causing an outbreak of fire and must comply with the provisions and regulations of the Act and must not burn off any grass, foliage or herbage without the current consent of the owner or occupier and the local fire authority.	NSW Rural Fires Service
Water Act 1912	Santos must take all precautions against intersecting an aquifer and will obtain Water Bore Licenses.	New South Wales Office of Water

3 Project Description

3.1 Location

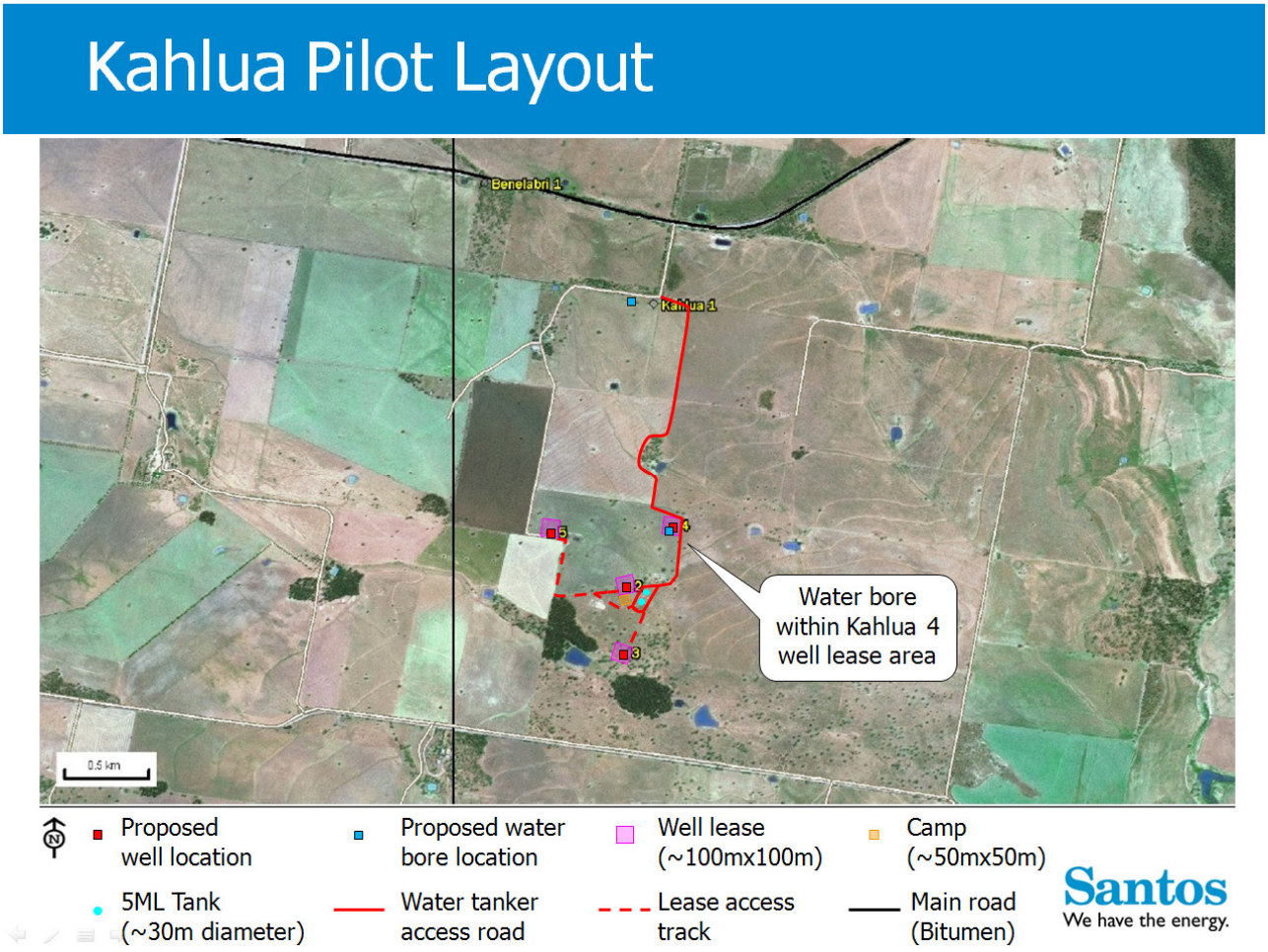
The proposed shallow aquifer monitoring bores are located on privately owned land presently used for agricultural and petroleum activities. KAHLUA SAMB 1 is on the existing Kahlua 4 lease and KAHLUA SAMB 2 is approximately 2kms away from Kahlua 2 adjacent to the plugged and abandoned Kahlua 1 core hole.

Table 3.1 shows the approximate co-ordinates of the proposed sites. Figure 3.1 shows the location of the SAMB bores in relation to the Kahlua Pilot Area.

Table 3.1: Co-ordinates for the proposed sites (GDA94) – Pre Scout Estimate

Name	Latitude	Longitude	LGA	Nearest Town
KAHLUA SAMB 1	-30°58’ 47	150°00’ 48	Gunnedah	Gunnedah
KAHLUA SAMB 2	-30°58’ 01	150°00’ 41	Gunnedah	Gunnedah

Figure 3.1: Kahlua SAMB Locations



3.2 Planned Activities

3.2.1 Land Access

Santos has contacted and negotiated an access, compensation and rehabilitation agreement with the affected landowner. A scouting survey has been undertaken in consultation with the landholder to locate the site of the two bores such that impacts are minimal on the property operations.

3.2.2 Drilling Activities

Santos proposes to undertake water bore drilling and completion activities to a depth of approximately 100m – 200m (see Figure 3.2). The proposed activities include:

- Constructing or upgrading access tracks as required;
- Constructing lined drilling sumps as required and otherwise preparing an area of maximum dimensions 40m x 40m to accommodate the drilling rig and associated vehicles;
- Drill and completing each bore using a Truck Mounted Water Bore Drilling Rig;
- Drill 10" conductor hole to 5-10m and case with 8" casing to hold back unconsolidated soils
- Drill hole (diameter 6") between 100m and 200m deep (location dependant) to 30m into Trinkey Formation using mud rotary and/or rotary air hammer methods as required
- Conduct open hole logging as required
- Conduct permeability testing as required
- Install steel tubing in the hole (expected tubing grade is 2-3/8" 4.7# J55 EUE) with attached downhole equipment:
  - (i) 3 (+/- 1) Quartz Pressure Gauges across key formations of interest
  - (ii) Gauge control and data lines with associated tubing clamps
- Cement the downhole equipment in place
- Install solar powered data logger and telemetry at surface; and
- Fencing off the surface monitoring systems once in place.

Access to the sites will be via the existing road network. Vehicular activity will be minimised when the ground is soft after rain.

During site preparation earthworks, there will be some soil disturbance at KAHLUA SAMB 2 only as a level drill pad may need to be constructed. The area to be disturbed for drilling activity will be approximately 40 by 40 metres.

The number of employees present at each site is expected to be up to 10 persons. The hours of operation during the drilling will be on a 12-hour a day basis.

Drilling activities are temporary and will not have any long-term impact on the visual amenity of the area. The drilling and completion of each of the bores is expected to occur over a 7 day period not including lease build, completion operations or site restoration. Lease construction and rehabilitation activities of up to 42 days per well will be additional to this period and may not occur concurrently to the drilling activities.

Shallow Aquifer Monitoring Bores will be installed prior to the start of the pilot test. Formation Pore Pressure data will be continuously monitored by the SAMB's and Santos will receive and record the data via the installed telemetry system. Data will be reported

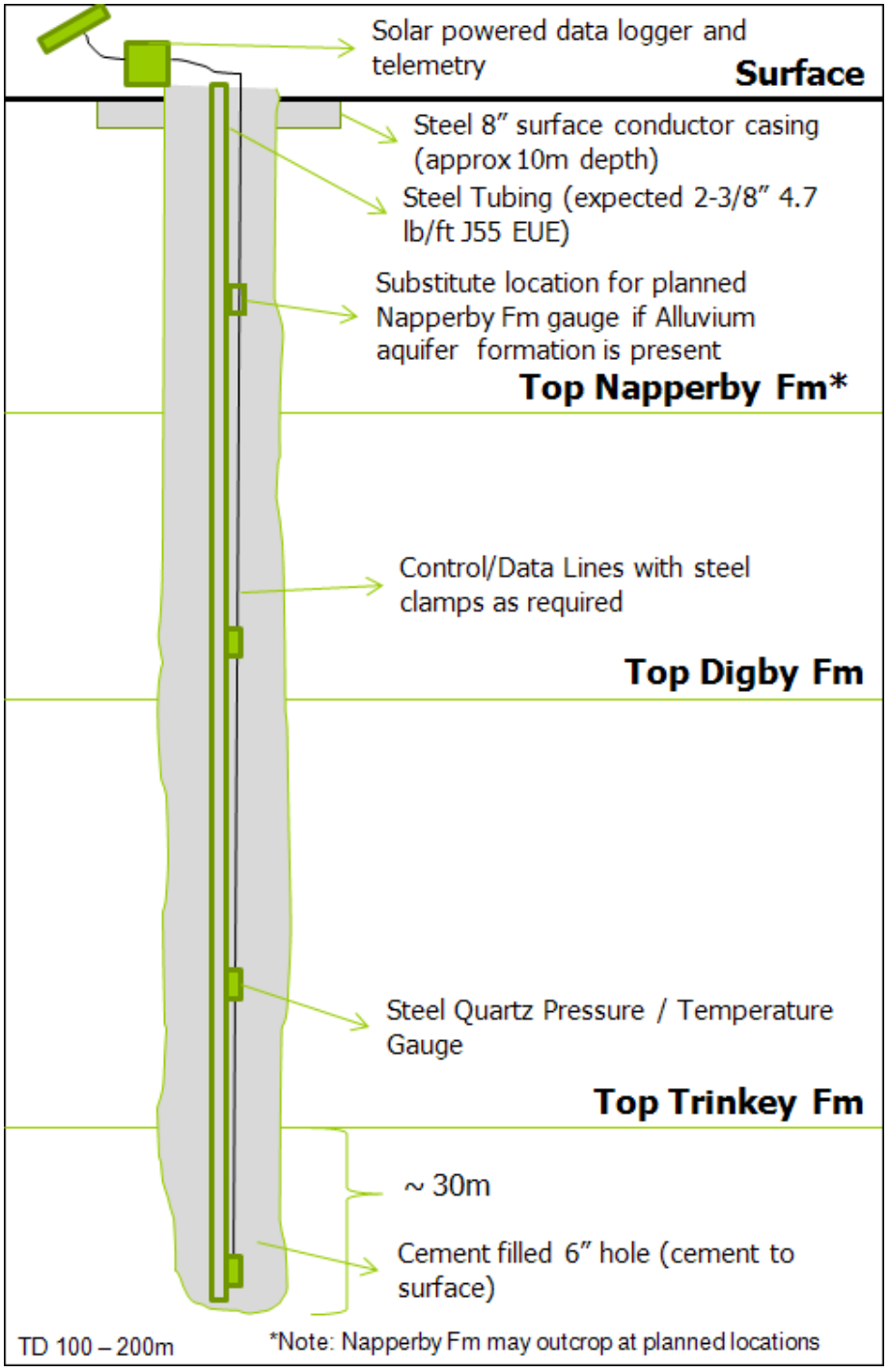
to stakeholders on a regular schedule which is to be agreed. No water will be produced from the SAMB's following completion so they will not be able to be used to measure water quality data. Monitoring of data is planned to continue for as long as the downhole and telemetry systems remain functional and in-use.

Permeability testing is expected to be conducted up to three (3) times per bore via the Lugeon testing method. The permeability tests are performed by isolating a specific interval with inflatable straddle packers via wireline through the drilling rods.

Prior to the start of the test, water is injected into the section isolated by the straddle packers to ensure the section to be tested is saturated. The test consists of injecting water into the isolated section at constant pressure and monitoring the water injection rate for ten minutes (or longer while the injection rate stabilises). The injection pressure is then increased in two steps with monitoring of the injection rate conducted for ten minutes as for the first part of the test. The injection pressure is then decreased in two steps with monitoring of the injection rate for ten minutes for each step. The water injection rate is recorded at one-minute intervals during each step.

A lugeon value is calculated from the injection pressure and injection rate for each pressure step in the test. The lugeon values determined from each of the five pressure settings is then assessed to determine the flow regime in the formation (laminar, turbulent, dilation, wash-out or void filling). From this analysis a representative lugeon value, which is converted to hydraulic conductivity, is determined for the geologic unit.

Figure 3.2: Bore Details



3.2.3 Completion Activities

All completion activities will be contained within the existing lease area and therefore no additional disturbance will be required. Completion activities will be to install monitoring

equipment into the new well. These activities will occur immediately following drilling (see Figure 3.2).

If at the time of completing the activities Santos choose not to continue with the monitoring, the bores will be plugged and abandoned and all land disturbances will be rehabilitated back to there pre-existing land use.

3.3 Justification of the Activity

The SAMB program is a necessary step in the ongoing exploration and evaluation of the hydrocarbon potential in PEL 1, which to date has undergone limited petroleum exploration. Discovery of coal seam gas resources in the area has the potential to increase the state's reserves and revenue from gas, and underpin future exploration or production in the region.

The purpose of the SAMB project is to provide Santos, the Regulator and the Community with data regarding potential changes in shallow aquifer levels within the vicinity of the pilot test area prior to, during and following the single well pilot test activities at Kahlua 2, 3, 4, and 5.

3.4 Evaluation of Alternatives

There is no reasonable industry alternative to the drilling method proposed in Section 3.2 if the aquifer monitoring is to be conducted prior to and during the Kahlua pilot program whilst maintaining the same number of multi-level monitoring bores at the same expected accuracy and precision of data measurement.

4 Environmental Impacts and Mitigation Measures

4.1 General

A detailed description of the proposed activities area was provided in the REF Kahlua Pilot (Santos 2010) and therefore is not repeated here.

The following section addresses the potential and actual impacts of Santos' operations in relation to this supplementary REF.

4.1.1 EHSMS

Santos' EHSMS governs the methodology in which Santos conducts its business with regard to Safety and the Environment. There are 14 standards relevant to the Environment describing how the company will conduct its activities considering relevant legislation and oil and gas industry best practice.

The activities will be undertaken in accordance with Santos' Environmental, Health and Safety Management System (EHSMS), the Australian Petroleum Production and Exploration Association Code of Environmental Practice – October 2008 (APPEA 2008) and the Schedule of Onshore Petroleum Exploration and Production Safety Requirements (DPI, 1992).

4.1.2 Risk Assessment

A risk assessment was carried out to identify the potential environmental impacts associated with the proposed activities. Santos' Risk Matrix (see Appendix B) was used to determine the risk rating for each of the environmental elements identified as potentially being impacted. The risk ratings were determined prior to applying mitigation strategies and safeguards and then after considering measures to reduce risk. The unmitigated risk rating and residual risk ratings are both provided and ranged from a 1-3, which means that the risk identified can be managed through routine monitoring and procedures.

Table 4.1 shows the risk matrix including the management controls and performance management indicators that will be utilised by Santos during the drilling activities. The focus of environmental management is to avoid where possible, then minimise and mitigate any impacts.

Table 4.1: Risk Assessment for the Proposed Activities

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
Air Emissions	• Expected air emissions / air quality issues associated with the short term activities may include: • Minor fugitive emissions from vehicle exhausts; and • Dust emissions from earthworks and vehicular movements.	**1**	• Reducing the speed of vehicles on field roads. • Watering of roads when appropriate or when agreed. • Investigating dust complaints and responding appropriately.	**1**	• Minimal complaints from Landholders regarding dust impacts. • Amicable resolution of complaints	• All complaints made by the Landholder and any subsequent actions are to be recorded in the Complaints Register.
Community – Social and Economic	• Adverse impact upon the landholders activities, property or infrastructure. • Adverse impact upon the community or surrounding landholders.	**2**	• A Land access agreement is in place prior to the commencement of the activities. • The proposed sites will be located within previously disturbed areas. • Land no longer required for normal operations will be rehabilitated and	**1**	• All land disturbed by Santos is to be returned to a condition consistent with the adjacent area and in consultation with the landholder.	• Santos records contracts with landholders.

[1] UMRR = Unmitigated Risk Rating

[2] RRR = Residual Risk Rating

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
			where practical returned to its previous use in consultation with the Landholder.			
Bushfire	• Threat to the community, flora and fauna or sensitive areas.	**2**	• Drilling sites will be selected such that a cleared buffer exists outside the drilling pad area to maintain an effective barrier against bushfires. • A fire control water pump and hoses on site will be maintained. • Liaison will occur with the local rural fire service officer. • Open fires on the surface of the land will be prohibited. • Hot work (e.g. welding) specific procedures will be in place. • If deemed necessary based on pre-job scouting The site will be cleared to minimise the potential for	**1**	• No fires occur as a result of the proposed activities.	• Incident notification records.

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
			ignition of surrounding pasture. • Diesel machinery will be utilised for all activities.			
Cultural Heritage	• Indigenous heritage: Sites or artifacts of indigenous culture may be inadvertently damaged. • Non-Indigenous Heritage: Sites or artifacts of non-indigenous settlement may be inadvertently damaged.	**2**	• A cultural heritage clearance form is completed prior to undertaking ground breaking activities. • Proposed activities will occur in cleared and previously disturbed areas.	**1**	• Cultural heritage clearance completed prior to ground disturbance. • No indigenous or non-indigenous sites are disturbed by the proposed activities.	• Records of any cultural heritage site are maintained.
Flora and Fauna	• The proposed locations have previously been highly disturbed by agricultural and petroleum activities. • No threatened flora or fauna or sensitive areas will be impacted by the proposed activities.	**2**	• Use of areas already disturbed. • No unplanned or unapproved damage to flora and fauna. • Restoration of non required disturbed areas to commence as soon as practical.	**1**	• Ongoing monitoring to assess the success and integrity of construction and rehabilitation measures and ensure appropriate follow-up rehabilitation measures are implemented where required.	• Santos will maintain records during construction and operation of all monitoring and assessment activities.
Weed Management	• Introduction or spread of weeds through the movement of earthworks equipment, drilling rig	**2**	• All vehicles coming from declared weed infested to non-declared weed areas	**1**	• Identify and document areas of new weed infestations in the	• Vehicle Hygiene Records.

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
	and general traffic.		are required to utilise vehicle washing facilities or any temporary washing facilities established for this purpose. • All vehicle movements are restricted to defined areas agreed upon with the Landholder/s. • Land disturbance is to be minimised to prevent the germination of weed seeds that may already exist in the soil. • If a declared weed or weed of concern is discovered, it shall be monitored to ensure it does not spread from the area of infestation. • All land disturbed by Santos is to be returned to a condition consistent with the adjacent area or to landholder		Incident Management System.	

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
			requirements at the end of the rehabilitation process.			
Noise Emissions	• Activities to be undertaken during drilling operations include drilling, running casing and cementing. • All activities apart from access to the site are confined to the drill pad with all work carried out during daytime hours only. • Main vehicle movements are based around personnel movements to and from site. There are however the occasional deliveries and other personnel accessing the site outside of these times.	**2**	• Landholder notification will be given prior to commencement of drilling. • Equipment will be maintained so that noise levels remain constant. • Complaints will be responded to in a timely manner. • Where noise disturbance cannot be avoided, Santos will investigate alternative arrangements to suit the landholder. • Noise barriers will be implemented if necessary • The equipment used for the mobilisation and powering of the drilling rig have mufflers installed on their respective power plants and prime	**1**	• All noise complaints will be recorded in the Complaints Register. • Amicable resolution of complaints	• Maintenance carried out on equipment is to be recorded. • Complaints Register.

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
			movers.			
Soils, Land Use and Terrain	• Soil erosion from the disturbed land at the drill site and access tracks. • Spills causing contaminated land.	**2**	• All activities associated with land disturbance will be discussed with the Landholder prior to commencement. • The area of all disturbances will be determined and placed within Santos' Geographic Information System (GIS). • Bunding of all areas storing or handling fuel, fuel using equipment, and chemicals, in line with Australian Standard 1940; The Storage and Handling of Flammable and Combustible Liquids • Construction and Use of erosion control devises	**1**	• The sites are rehabilitated upon completion of the activities.	• Records of disturbance are maintained within Santos' GIS.
Waste	• No waste will be disposed of on site.	**3**	• General and recyclable wastes	**1**	• Post construction checks to ensure all	• Waste management

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
	• Domestic waste including sewage.		(including glass, paper and plastic) generated during construction will be transported to landfill and recycling facilities on a routine basis. • Regulated waste will be collected by licensed contractors for off-site disposal. • Sewage will be collected by licensed contractor for off-site disposal. • Complaints are addressed in a timely manner. • Waste is disposed of at appropriate end point. • All waste management non-compliances are managed in the Incident Management System. • Any complaints from the landholders regarding waste management are		waste has been appropriately removed and disposed of. • Operational checks to establish that all waste has been appropriately removed from the operational areas, or correctly stored and waiting for removal.	records. • Complaints register.

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
			recorded in the Santos Complaints Register.			
Surface and Ground Water Resources	• Incident or accident that may result in a release of oils or other chemicals maintenance fluids to the ground. • Transport of sediments disturbed by erosion of soils during construction activities.	**2**	• Water removed from site will be managed by a contractor licensed to carry and handle water. • Bunding of all areas storing or handling fuel, fuel using equipment, and chemicals, in line with Australian Standard 1940 – 1993; The Storage and Handling of Flammable and Combustible Liquids • Where applicable maintenance of roads, drains, bund walls, contour and diversion banks, will occur. All drainage structures are to be maintained for the life of the development. • During rehabilitation, diversion banks and ripping along the contour will be completed to prevent	**1**	• No incidents where substances are released to surface or ground water causing contamination. • Diversion mechanisms in place, regularly checked and maintained to redirect natural stormwater movement where required.	• Records of spills, leaks and associated clean ups are to be managed using the Incident Management System. • Maintenance carried out to remedy any erosion and water channelling is to be recorded using the Incident Management System. • Records of water storage inspections to be maintained.

Aspect	Potential Impacts	UMRR[1]	Management Controls	RRR[2]	Performance Indicator	Records
			the concentration and momentum of water flow as required. • Casing the well with cement and steel before different formations are intersected; casing is pressure tested; • Cementing to surface before well completion; • During rehabilitation, diversion banks and ripping along the contour will be completed to prevent the concentration and momentum of water flow as required.			

4.2 Clause 228 Checklist

Clause 228 of the EP&A Regulation states that for the purpose of Part 5 of the EP&A Act the following factors are to be taken into account concerning the impact of an activity on the environment. These factors are considered below.

Table 4.2: Clause 228 Checklist

Factor	Positive/Negative Impact
Any environmental impact on the community The proposed site lies approximately 22 km west of Gunnedah. Minor short term impacts such as increase local traffic would be experienced. Safeguards proposed in Table 4.1 would minimise these impacts.	Short term negative
Any transformation of a locality There would be localised and non-permanent visual impact on the immediate vicinity of the hole for the duration of the programme. Safeguards proposed in Table 4.1 would minimise these impacts.	Short term negative
Any environmental impact on the ecosystems of the locality The area of proposed activities is highly disturbed, no environmental impacts of the ecosystems of the locality would occur as a result of the project.	Nil
Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality During drilling there may be a reduction in these values due to affecting visual amenity. Given the short term nature of activities and the safeguards/mitigation detailed in Table 4.1 the potential for a reduction is considered negligible.	Nil
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 No locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations occur near the proposal area.	Nil
Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974) The proposal would not significantly impact on the habitat of protected fauna.	Nil
Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air The proposal would not endanger any species of animal, plant or other form of life, whether living on land, in water or in the air.	Nil

Factor	Positive/Negative Impact
Any long-term effects on the environment The proposal would have no long-term effects on the environment.	Nil
Any degradation of the quality of the environment There is potential for minor short term environmental degradation due to visual or dust impacts. Safeguards proposed in Table 4.1 would minimise these impacts.	Minor short term negative
Any risk to the safety of the environment The proposal may result in short term potential risks to the safety of the environment due to incidents and spills. The likelihood and consequence of an incident occurring would be reduced through the application of Santos's EHSMS Standards and mitigation proposed in Table 4.1.	Minor short term negative
Any reduction in the range of beneficial uses of the environment The footprint of activities for the proposal would not result in any reduction in the range of beneficial use of the environment.	Nil
Any pollution of the environment The proposal may result in short term potential risk of pollution of the environment due to incidents and spills. The likelihood and consequence of an incident occurring would be reduced through the application of Santos's EHSMS Standards and mitigation proposed in Table 4.1.	Nil
Any environmental problems associated with the disposal of waste Drill cuttings would be essentially inert and any drilling fluid conditions would be biodegradable or similarly inert and would be allowed to dry onsite and disposed of in drilling sumps. Any other waste generated by the activities will be collect and removed from site for disposal at approved landfill sites. Given the short term of the propose activity waste production will be minimal.	Nil
Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply Resources required for the proposal are not in limited supply in the area.	Nil

5 Conclusions

Drilling of the proposed SAMB program is a necessary step in evaluating the hydrocarbon potential of PEL 1. Discovery of coal seam gas resources in this area has the potential to increase the state's reserves and revenue from gas and underpin future exploration or production in the region.

A Land Access Agreement is in place for the landholder where the proposed pilot sites are located and that agreement addresses matters of access, compensation and rehabilitation. Santos will communicate with neighbouring landholders so as to identify any concerns with regard to planned activities.

The proposed activities have associated potential environmental impacts, which are common to water bore drilling activities such as those carried out elsewhere in the Gunnedah Basin. It is considered that the potential impacts can be successfully mitigated with the application of the management strategies outlined in Section 4.

For the proposed activities outlined in Section 3.2 and with the implementation of the management measures outlined in Section 4, it is expected that:

- Impacts on landholders will be minimal;
- Impacts to air quality will be minor, localised and insignificant;
- Adverse effects on water resources will be minimal during drilling;
- Off-site impacts to soils will be avoided and on-site impacts will be minor and temporary;
- The potential noise impacts will be short term, and no threatened species or communities are likely to be impacted;
- There will be no significant use of, or impact to, natural resources;
- Impacts on the community and visual amenity will be insignificant and short term, particularly as the sites are in a sparsely populated area;
- Impacts to known heritage places or sites will be avoided;
- Disturbances to pastoral and agricultural land use will be minor and short term and managed in consultation with affected landholder(s); and
- There will be no significant cumulative environmental impacts.

6 References

Australian Petroleum Production and Exploration Association (APPEA) (2008), *Code of Environmental Practice October 2008*, Published by APPEA Canberra ACT.

Department of Primary Industries (DPI) (1992), *Schedule of Onshore Petroleum Exploration and Production Safety Requirements*, published by the NSW Department of Primary Industries.

Santos (2010), *Review of Environmental Factors Kahlua Pilot Wells - Drilling and Completions - PEL 1 Gunnedah Basin,* report prepared by Santos QNT Pty Ltd.

Golder & Associates (2010), *Water Report,* independent report prepared for SantosQNT Pty Ltd.

Appendix A.

Water Assessment Report prepared by Golder & Associates Pty Ltd

Appendix B.

Santos Group Risk Assessment Matrix

Santos Group Risk Matrix					
	Consequences				
Consequence Type	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
Health and Safety	Minor injury - first aid treatment	Injury requiring medical treatment with no lost time	Injury requiring medical treatment, time off work and rehabilitation	Permanent disabling injury and/or long term off work	Fatality
Natural Environment	Negligible impact on fauna/flora, habitat, aquatic ecosystem or water resources. Incident reporting according to routine protocols	Impact on fauna, flora and/or habitat but no negative effects on ecosystem. Requires immediate regulator notification	Short term impact on sensitive environmental features (e.g. gibber plain). Triggers regulatory investigation.	Long term impact of regional significance on sensitive environmental features (e.g. wetlands). Likely to result in regulatory intervention/action	Destruction of sensitive environmental features. Severe impact on ecosystem. Regulatory & high level Government intervention/action.
Reputation	Minimal impact to reputation	Some impact on business reputation	Moderate to small impact on business reputation.	Significant impact on business reputation and/or national media exposure.	Critical impact on business reputation /or international media exposure
Financial	Financial loss from $0 to $500,000	Financial loss from $500,000 to $5 Million.	Financial loss from $5 Million to $50 Million	Financial loss from $50 Million to $100 Million	Financial loss in excess of $100 Million

			Consequences				
Consequence Type			**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
			I	**II**	**III**	**IV**	**V**
Almost Certain Is expected to occur in most circumstances	**Likelihood**	**A**	**2**	**3**	**4**	**5**	**5**
Likely Could occur in most circumstances		**B**	**1**	**3**	**3**	**4**	**5**
Possible Has occurred here or elsewhere		**C**	**1**	**2**	**3**	**3**	**4**
Unlikely Hasn't occurred yet but could		**D**	**1**	**1**	**2**	**2**	**3**
Remote May occur in exceptional circumstances		**E**	**1**	**1**	**1**	**1**	**2**

	Risk Level	Guideline for Risk Management
	5	Immediate action or suspend activity. Notify VP. RMP by 1 week
	4	Allocate manager responsibility, notify VP - RMP by 2 weeks
	3	Allocate manager responsibility - RMP by 1 month
	2	Manage by specific monitoring of controls. RMP by 3 months
	1	Manage by routine procedures and regular monitoring