



Review of Environmental Factors

Kiandool I core hole – PEL 238, Gunnedah Basin, NSW

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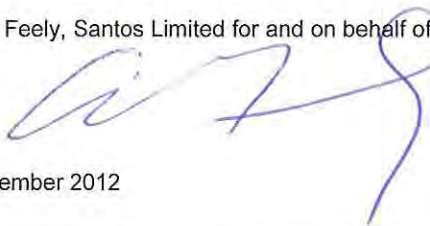
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Name	Signature	Date
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Contents

CONTACT INFORMATION AND DECLARATION	3
EXECUTIVE SUMMARY	10
1.0 INTRODUCTION	14
1.1 Background	14
1.2 Structure of REF	14
2.0 THE PROPOSED ACTIVITY	15
2.1 Summary of the activity	15
2.2 Regional location context	15
2.3 Stakeholder consultation	20
2.3.1 Consultation activities	20
2.3.2 Influence of consultation on design and management of proposed activity	21
2.3.3 Ongoing consultation arrangements	22
2.3.4 Stakeholder conflict management	22
2.4 Justification of the activity	23
2.4.1 Objectives	23
2.4.2 Strategic need	23
2.4.3 Method and scale	24
2.4.4 Location	24
2.4.5 Consistency with ecologically sustainable development principles	24
2.5 Analysis of alternatives	25
2.6 Description of the activity	26
2.6.1 Site preparation	26
2.6.2 Well design and construction	28
2.6.3 Sampling, testing and logging	29
2.6.4 Well completion	29
2.6.5 Monitoring bore operation and maintenance	30
2.6.6 Site water requirements	35
2.6.7 Staff and hours of operation	35
2.6.8 Timing and duration	35
2.6.9 Rehabilitation	35
2.7 Mitigation strategy	36
2.7.1 Water source protection strategy	36
2.7.2 Waste management strategy	37
2.7.3 Beneficial re-use of drill cuttings	38
2.7.4 Noise management strategy	38
2.8 Access arrangements	39
2.9 Other approval requirements	39

3.0	THE SITE	40
3.1	Site description and plan	40
4.0	EXISTING ENVIRONMENT	45
4.1	General description	45
4.1.1	Climate and weather	45
4.1.2	Topography	45
4.1.3	Vegetation	47
4.1.4	Soils	47
4.1.5	Geology	48
4.1.6	Land use	49
4.1.7	Air and noise	53
4.1.8	Infrastructure and services	53
4.2	Surface and groundwater sources	53
4.2.1	Surface water	53
4.2.2	Groundwater	55
4.3	Threatened species, populations and ecological communities	55
4.3.1	Flora	55
4.3.2	Fauna	56
4.4	Aboriginal cultural heritage	57
4.5	Historic cultural and natural heritage	57
5.0	REGULATORY CONTEXT	58
5.1	Commonwealth legislation	58
5.1.1	Environment Protection and Biodiversity Conservation Act 1999	58
5.2	NSW legislation	58
5.2.1	Petroleum (Onshore) Act 1991	58
5.2.2	Environmental Planning and Assessment Act 1979	59
5.2.3	Threatened Species Conservation Act 1995	62
5.2.4	National Parks and Wildlife Act 1974	63
5.2.5	Native Vegetation Act 2003	63
5.2.6	Protection of the Environment Operations Act 1997	63
5.2.7	Heritage Act 1977	64
5.2.8	Water Act 1912 and Water Management Act 2000	64
6.0	POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION	67
6.1	Physical and chemical aspects	67
6.1.1	Soil quality and land stability	67
6.1.2	Surface water	69
6.1.3	Groundwater	70
6.1.4	Hazardous substance and chemical use	71
6.1.5	Air quality and greenhouse gases	71

6.1.6	Noise	72
6.1.7	Waste	74
6.2	Biological	75
6.2.1	Flora and fauna	75
6.3	Community	77
6.3.1	Community services, infrastructure and sites of importance	77
6.3.2	Economic issues	77
6.3.3	Amenity and public safety	78
6.4	Natural resources	78
6.4.1	Agricultural land	78
6.4.2	Other natural resources	80
6.5	Cultural heritage	80
6.5.1	Aboriginal cultural heritage	80
6.5.2	European cultural heritage impacts	81
6.6	Matters of National Environmental Significance	81
6.7	Potential cumulative impacts	82
6.7.1	Potential impacts	82
6.7.2	Mitigation measures	83
7.0	SUMMARY OF POTENTIAL IMPACTS	84
7.1	Clause 228 Factors	85
8.0	CONCLUSION	87
9.0	STATEMENT OF COMMITMENTS	88
	TERMS AND ABBREVIATIONS	92

Tables

Table 2-1 Consultation activities undertaken for the proposed activity and results	20
Table 2-2 Issues raised on previous Kiandool 1 REF	21
Table 2-3 Consistency of proposed activity with ESD principles	25
Table 2-4 Estimated cut and fill volumes if traditional construction methods used	27
Table 2-5 Duration of proposed activity	35
Table 2-6 Estimated waste volumes	37
Table 3-1 Coordinates (MGA zone 55) for Kiandool 1	40
Table 4-1 Mean climate data	45
Table 4-2 Environmentally sensitive areas	50
Table 4-3 Threatened flora species records within 10 kilometres of site	55
Table 4-4 Threatened fauna species records within 10 kilometres of site	56
Table 6-1 Offset distances required to comply with noise affected level	73
Table 6-2 Matters of National Environmental Significance	81
Table 7-1 Summary of potential impacts	84
Table 7-2 Clause 228 factors	85
Table 9-1 Statement of commitments	88

Figures

Figure 2-1 Location of Kiandool 1	17
Figure 2-2 Local government areas	18
Figure 2-3 Protected areas	19
Figure 2-4 Conceptual lease layout	31
Figure 2-5 Access track and lease area location	32
Figure 2-6 Well schematic	33
Figure 2-7 DAMB diagram	34
Figure 3-1 Survey of lease area	44
Figure 4-1 Regional contours	46
Figure 4-2 Stratigraphy of Gunnedah Basin	49
Figure 4-3 Mining titles	51
Figure 4-4 Strategic agricultural land	52
Figure 4-5 Drainage	54

Plates

Plate 3-1 View of lease area	40
Plate 3-2 <i>Callitris glaucophylla</i> forest on site	41
Plate 3-3 Red sandy soils on site	41
Plate 3-4 View of existing access track	42
Plate 3-5 Creek adjacent to access track where it has been widened to form a dam	42
Plate 3-6 Cattle grid at entrance to access track	43

Appendices

- Appendix 1: Ecological assessment
- Appendix 2: Cultural heritage assessment
- Appendix 3: AHIMS Search Results
- Appendix 4: EDA Rig 1 Source noise level measurements
- Appendix 5: Agricultural impact study

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Executive summary

Overview

Santos Limited (Santos), for and on behalf of the titleholders of Petroleum Exploration Licence 238 (PEL 238), proposes to drill a petroleum exploration core hole, known as Kiandool 1, and carry out ancillary activities at 545 Culgoora Road, approximately nine kilometres west of Narrabri, NSW (the proposed activity). The purpose of Kiandool 1 is to investigate the potential coal seam gas resource of the Gunnedah Basin within PEL 238.

The proposed activity is permissible without consent and requires assessment and determination under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Resources and Energy Division within the Department of Trade & Investment, Regional Infrastructure and Services (DTIRIS) is the determining authority for the proposed activity.

RPS Australia East Pty Ltd (RPS) has prepared this Review of Environmental Factors (REF) to assess the potential environmental impacts of the proposed activity. The REF addresses the requirements of section 111 of the EP&A Act, clause 228 of the *Environmental Planning and Assessment Regulation 2000*, and the *ESG2: Environmental Impact Assessment Guidelines* (DTIRIS 2012) (ESG2 Guidelines).

Proposed activity scope

The scope of the proposed activity includes:

- using the existing 1.9 kilometre long access track from Culgoora Road to transport materials, equipment and personnel to the lease area
- upgrading the existing access track, including constructing approximately 100 metres of new access track, should this be determined necessary during detailed design
- establishing a lease area up to one hectare in size (lease area)
- drilling the Kiandool 1 core hole to a depth of approximately 1,000 metres
- sampling, testing and logging of the core hole
- installing, operating and maintaining a deep aquifer monitoring bore (DAMB) and supporting infrastructure, similar to existing groundwater monitoring bores operating within the region
- rehabilitating the majority of the lease area to reduce its size to nine square metres for the DAMB, surface infrastructure and fencing (partial rehabilitation)
- rehabilitating the remainder of the lease area, including removal of surface infrastructure and fencing, once the DAMB is no longer required for groundwater monitoring purposes (full rehabilitation).

Construction of the proposed activity is scheduled to commence in the first quarter of 2013 and will take approximately three months for site preparation, drilling and completion. These activities may occur up to 24 hours per day, seven days per week. The DAMB will be in place for a period of up to 30 years.

Justification

The proposed activity is necessary for the ongoing exploration and evaluation of the hydrocarbon potential in PEL 238 and will underpin future coal seam gas (CSG) production in the region. Development of the gas industry would bring capital investment and economic benefits to the region. It would also help to secure supply for domestic gas and alleviate the state's reliance on imported gas. The installation and operation of

the DAMB at the proposed location will add a further monitoring point to Santos' Groundwater Monitoring Network for the area. The proposed activity will be consistent with ecologically sustainable development principles and is therefore justified.

Potential environmental impacts

The primary potential environmental impacts of the proposed activity would occur during site establishment, drilling and completion activities, and partial rehabilitation of the lease area for approximately three months in duration. Operation of the DAMB and final rehabilitation of the site is unlikely to result in any more than inconsequential impacts to the environment.

The potential impacts of site establishment, drilling and completion activities are summarised below.

Soil quality and land stability

The proposed activity will involve disturbance, including vegetation clearing, topsoil stripping and earthworks, of up to 1.06 hectares of land and use of an existing 1.9 kilometre long access track. This will increase the erosion potential of the site and may result in loss of topsoil or spoil. Soil contamination may occur as a result of spilled chemicals or hazardous substances during the works. With the implementation of the mitigation measures identified in the REF, the potential impacts to soil quality and land stability are expected to be negligible to low adverse as defined in the ESG2 Guidelines.

Surface water

Increased erosion of the site may result in increased sediment loads in surface runoff and increased turbidity and suspended sediment in receiving waters. The quality of surface waters may also be degraded as a result of spilled chemicals or hazardous substances, spilled drilling mud, discharge of general site wastewater, litter, or pollutants and contaminants released during flooding of the site. With the implementation of the mitigation measures identified in the REF, the potential impacts to surface water are expected to be negligible to low adverse.

Groundwater

The well will be designed and constructed in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity*. Potential impacts on groundwater sources include cross contamination of aquifers, contamination of aquifers by drillings mud, or discharge of groundwater to the surface if the well is not constructed properly. The proposed activity is not expected to lift any groundwater. With the implementation of the mitigation measures identified in the REF, the potential impacts to groundwater are expected to be negligible to low adverse.

Hazardous substance and chemical use

Potential impacts associated with the use and storage of chemicals and potentially hazardous substances include outbreak of fire, and pollution of land, water and air. With the implementation of the mitigation measures identified in the REF, the potential impacts from hazardous substance and chemical use are expected to be negligible to low adverse.

Air quality and greenhouse gases

The primary air pollutants from the proposed activity will include dust, exhaust emissions from plant and vehicles, and vented methane and carbon dioxide. These emissions will be unlikely to impact the nearest sensitive receptor which is located approximately 1.3 kilometres north of the site. The primary greenhouse gas emissions from the proposed activity will include exhaust from plant, machinery and vehicles (carbon),

and methane and carbon dioxide from venting. These emissions will not significantly contribute to State or National greenhouse gas emissions. With the implementation of the mitigation measures identified in the REF, the potential impacts to air quality are expected to be negligible to low adverse.

Noise

The proposed activity will generate noise during site preparation, drilling and completion and rehabilitation. These activities may occur up to 24 hours per day, seven days per week. Conservative noise testing and modelling of a heavy drill rig and high pressure concrete truck indicates that the nearest sensitive receiver is unlikely to be noise affected during drilling and cementing activities in still isothermal conditions. During a temperature inversion, this receiver may be noise affected. On site noise monitoring and feasible and reasonable mitigation measures are proposed. With the implementation of the mitigation measures identified in the REF, potential noise impacts are expected to be low adverse.

Waste

The proposed activity will generate various waste streams such as vegetation waste, packaging materials, domestic waste, drilling mud and oil/fuel and chemical containers. Drilling mud, listed as a trackable waste under schedule 1 of the *Protection of the Environment Operations Act 1997* (POEO Act), will be transported by an appropriately licensed contractor to an approved fluids batching and reuse facility. Potential impacts associated with the generation and management of waste include leaching of chemicals and other pollutants to water and soils, illegal dumping and associated issues, littering and odour. With the implementation of the mitigation measures identified in the REF, potential impacts from waste are expected to be low adverse.

Flora and fauna

The proposed activity will require up to 1.06 ha of vegetation removal, including one hectare of 'Ironbark shrubby woodlands of the Pilliga area, Brigalow Belt South' community and 0.06 hectares of *Angophora floribunda* Forest. These communities do not correspond to any threatened ecological communities (TECs) listed under either the *Threatened Species Conservation Act 1995* (TSC Act) or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). No TSC Act or EPBC Act listed threatened species, populations, ecological communities, or their habitats, are likely to be impacted by the proposed activity. With the implementation of the mitigation measures identified in the REF, potential impacts on flora and fauna are expected to be negligible.

Community

The proposed activity will increase the level of activity on the property and may temporarily increase noise and dust levels and generate additional traffic along Culgoora Road. With the implementation of the mitigation measures identified in the REF, these impacts are expected to be low adverse.

Potential benefits of the proposed activity will include economic benefits to Narrabri and the surrounding region through the introduction of a temporary workforce and the purchase of materials.

Natural resources

The proposed activity will temporarily prohibit agricultural production on up to 1.06 hectares of rural land. The site is not location on strategic agricultural land under the *Strategic Regional Land Use Plan New England North West* (the SRLUP). The property is currently used as a lifestyle property with occasional grazing. The impact on the production value of the property is considered negligible in terms of the gross value of livestock production in the Narrabri Shire. There will be no permanent land capability reduction of agricultural resources as a result of the proposed activity. Therefore, the proposed activity will not have an unreasonable

impact on agricultural resources and production at the site or within the Narrabri Shire local government area.

The proposed activity will not impact any areas reserved for conservation purposes and will not affect future coal mining of the area. The proposed activity will require fill material and minor quantities of non-renewable resources such as fuel. Potential impacts on natural resources are expected to be negligible.

Cultural heritage

The proposed activity will not impact on any known Aboriginal or European cultural heritage sites, objects or places. There is some potential for unknown Aboriginal or European cultural heritage sites, objects or places to be uncovered during site preparation (including clearing and earthworks). With the implementation of the mitigation measures identified in the REF, potential impacts on Aboriginal and European cultural heritage are expected to be negligible.

Conclusion

The proposed activity is minor in scale and the construction, drilling and completion activities associated with the core hole will be temporary. While the DAMB will be operational for a period of up to 30 years, it will only occupy a nine square metre area on the property and the impacts associated with operation and maintenance of it will be minor. The site of the proposed activity has been selected to avoid significant environmental and heritage constraints, and reduce impacts to the surrounding community. On balance, the proposed activity will have a negligible to low adverse impact on the environment and community. The proposed activity is not likely to significantly affect the environment or any threatened species, populations or ecological communities, their habitats or critical habitat and does not require preparation of an environmental impact statement (EIS) or species impact statement (SIS).

1.0 Introduction

1.1 Background

Santos Limited (Santos) for and on behalf of the titleholders of PEL 238 proposes to drill a petroleum exploration core hole, known as Kiandool 1, and carry out ancillary activities at a property on Culgoora Road, to the west of Narrabri, NSW (the proposed activity). The purpose of Kiandool 1 is to investigate the potential coal seam gas (CSG) resource of the Gunnedah Basin within PEL 238.

Petroleum exploration holes are classified as a Category 3 activity under the conditions of PEL 238. Category 3 activities require notification to the Resources and Energy Division within the Department of Trade & Investment, Regional Infrastructure and Services (DTIRIS) and in most circumstances, a specific determination of the proposed activity under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This Review of Environmental Factors (REF) has been prepared by RPS Australia East Pty Ltd (RPS) for Eastern Energy Australia Pty Ltd as the CSG operator for and on behalf of the titleholders of PEL 238 to assess the environmental impact of Kiandool 1. The current titleholders for PEL 238 are Eastern Star Gas Limited and TRUenergy Gunnedah Gas Pty Ltd.

This REF assesses the potential environmental impacts of the proposed activity and, in doing so, will assist DTIRIS in fulfilling the obligations under section 111 of the EP&A Act. The REF addresses the requirements of clause 228 of the *Environmental Planning and Assessment Regulation 2000* and the ESG2: *Environmental Impact Assessment Guidelines* (ESG2 Guidelines) released by DTIRIS in March 2012 (DTIRIS 2012a). The relevant requirements of the draft *Additional Part 5 requirements for petroleum prospecting: A supplement to ESG2 Environmental Impact Assessment Guidelines* have also been considered in preparing the REF.

A REF for Kiandool 1 was previously prepared in 2011 for a core hole in a different location to that currently proposed. The NSW Office of Water (NOW) and the Office of Environment and Heritage (OEH) provided submissions on the application to DTIRIS. While the previous project was not progressed, the submissions from NOW and OEH have been taken into account for the revised activity (refer to Table 2-3).

1.2 Structure of REF

The structure of the REF is as follows:

- Section 1 introduces the proposed activity and provides an overview of the REF.
- Section 2 describes the proposed activity.
- Section 3 describes the site.
- Section 4 describes the existing environment.
- Section 5 discusses the relevant planning legislation associated with the proposed activity.
- Section 6 assesses the potential environmental impacts of the proposed activity and recommends mitigation measures to ensure any impacts are appropriately managed.
- Section 7 summarises the potential environmental impacts of the proposed activity.
- Section 8 concludes the REF.
- Section 9 provides the statement of commitments.

2.0 The proposed activity

2.1 Summary of the activity

The proposed activity will occur on private freehold land at 545 Culgoora Road (the property), nine kilometres west of Narrabri, within PEL 238. Santos will conduct the activities for and on behalf of the titleholders of PEL 238 and is working with the landowner of the property (the landowner) to establish a land access agreement for 545 Culgoora Road.

The scope of the proposed activity includes:

- using the existing 1.9 kilometre long access track from Culgoora Road to transport materials, equipment and personnel to the lease area
- upgrading the existing access track, including constructing approximately 100 metres of new access to straighten out a bend in the existing track approximately 700 metres from Culgoora Road, should this be determined necessary during detailed design
- establishing a lease area up to one hectare in size (lease area)
- drilling the Kiandool 1 core hole to a depth of approximately 1,000 metres
- sampling, testing and logging of the core hole
- installing, operating and maintaining a deep aquifer monitoring bore (DAMB) and supporting infrastructure, similar to existing groundwater monitoring bores operating within the region
- rehabilitating the majority of the lease area to reduce its size to nine square metres for the DAMB, surface infrastructure and fencing (partial rehabilitation)
- rehabilitating the remainder of the lease area, including removal of surface infrastructure and fencing, once the DAMB is no longer required for operation (full rehabilitation).

The proposed activity does not include extended production, well production or pilot testing.

Construction of the proposed activity will take approximately three months from site preparation until completion of the DAMB. Partial rehabilitation of the lease area will occur within approximately six months of completion of the well as a DAMB, where practicable. Full rehabilitation will occur only once the DAMB has is no longer required for operation, which may be up to approximately 30 years.

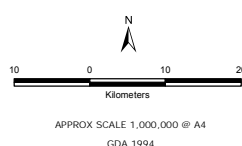
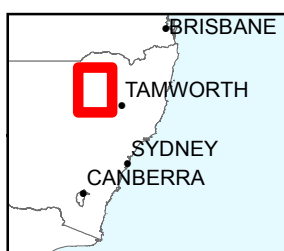
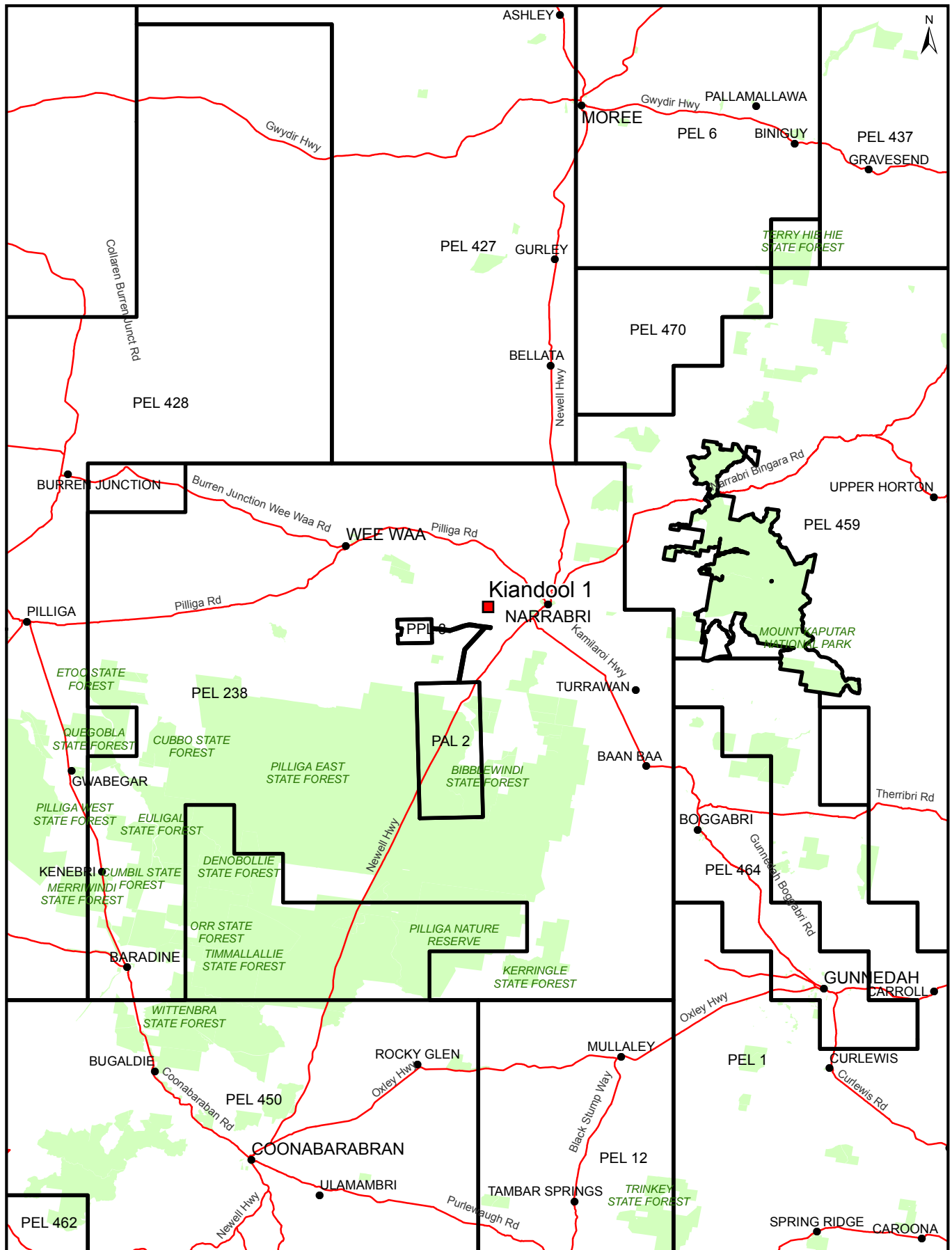
The total area of potential disturbance assessed in this REF is 2.2 hectares. This includes the one hectare lease area, the existing access track of 1.14 hectares (1.9 kilometres long by six metres wide) and a 0.06 hectare section of the new access track (100 metres long by six metres wide). References to 'the site' throughout this REF include the lease area, existing access track and new section of track.

The proposed activity is described in more detail in section 2.6.

2.2 Regional location context

The site is located in the north eastern section of PEL 238 (refer to Figure 2-1). PEL 238 covers an area of approximately 7,915 square kilometres and extends across three local government areas (LGAs) including the Narrabri Shire, Warrumbungle Shire and Gunnedah Shire. The site is located within the Narrabri Shire LGA (refer to Figure 2-2).

The site is located approximately nine kilometres west of Narrabri and 25 kilometres south east of Wee Waa. The site is not within close proximity to any protected areas, though various State Forests, conservation areas and one National Park are located at distances of greater than 10 kilometres. These areas are identified in Figure 2-3.



Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

DATA SOURCES

Base topographic data © Commonwealth of Australia (Geoscience Australia) 2006.

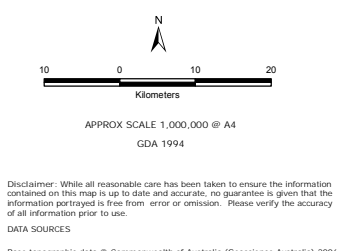
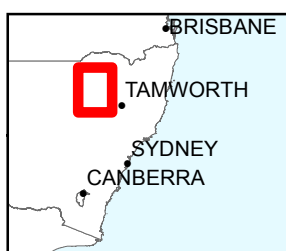
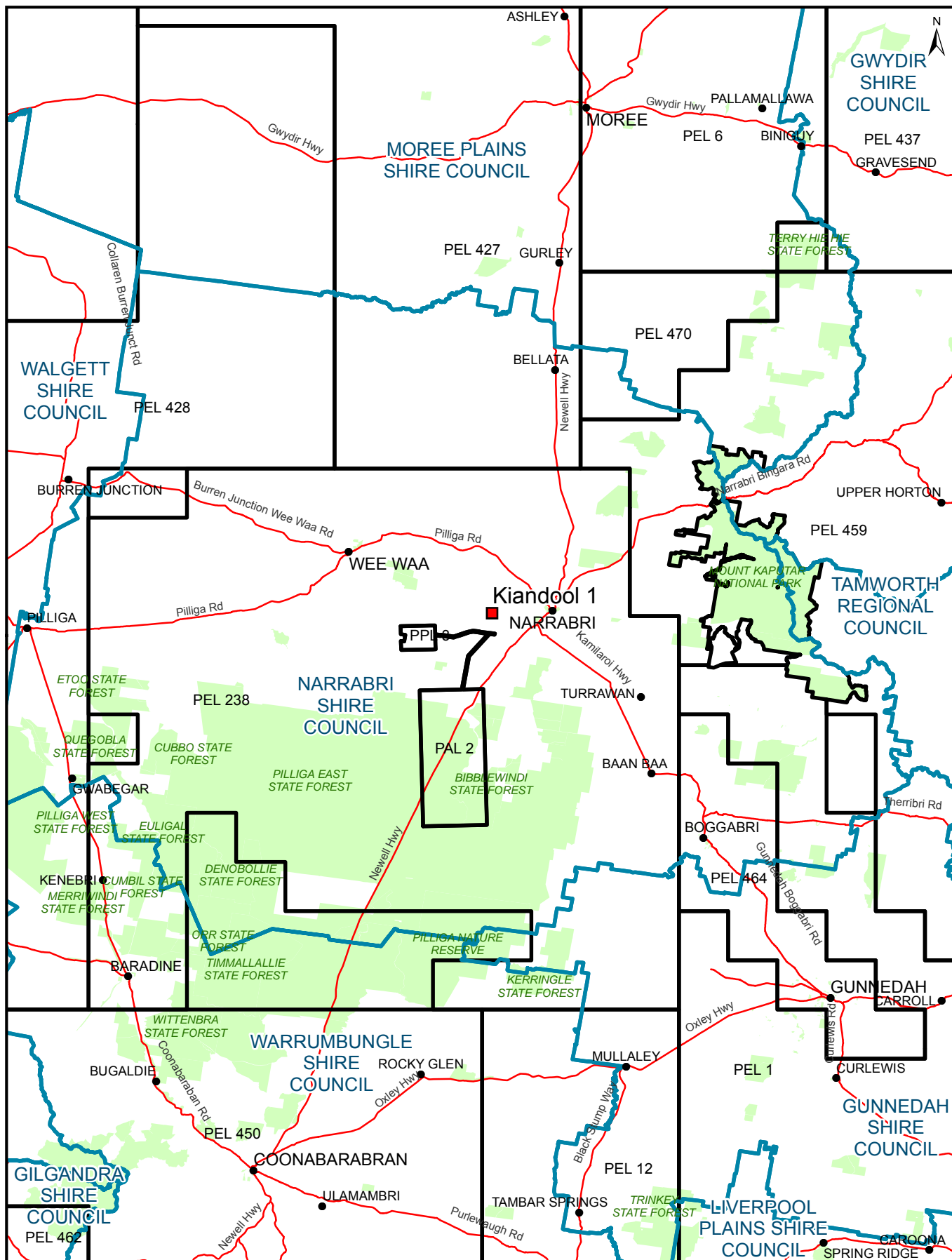
LEGEND

- Town
- Kiandool 1 Core Hole
- Main Road
- ▭ Petroleum Lease
- State Forest / Reserve / Park

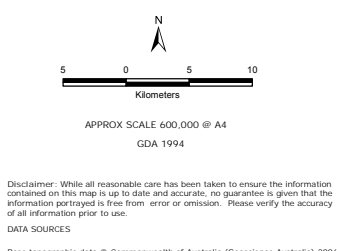
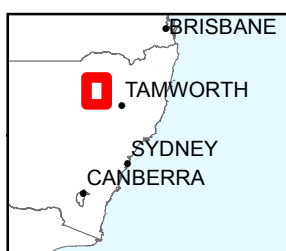
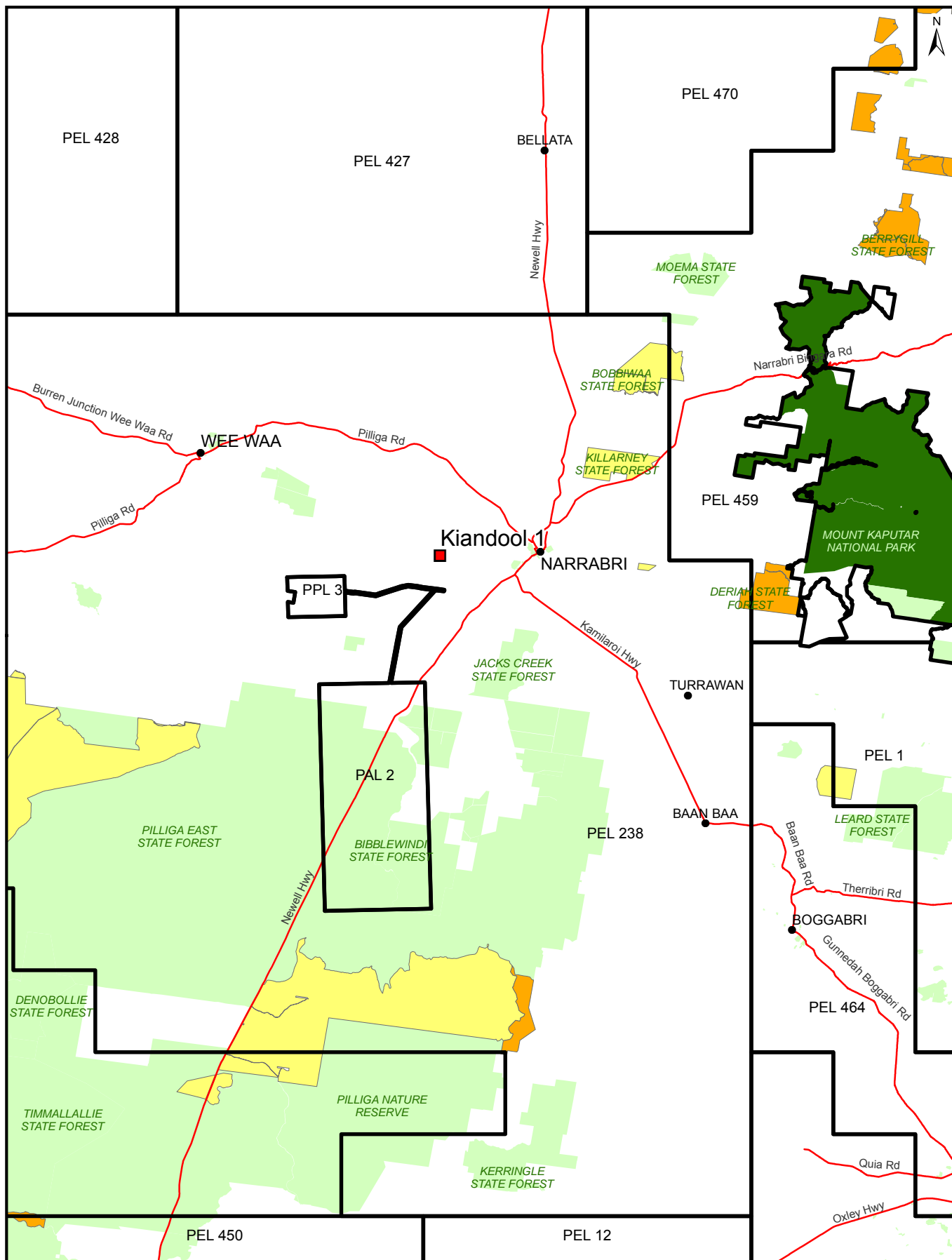


FIGURE 2-1

Location of
Kiandool 1



RPS
FIGURE 2-2
Local Government Areas



RPS
 FIGURE 2-3
 Protected areas

2.3 Stakeholder consultation

2.3.1 Consultation activities

Current and planned consultation for the proposed activity, and results of this consultation, are summarised in Table 2-1.

Table 2-1 Consultation activities undertaken for the proposed activity and results

Stakeholder	Date	Consultation	Results of consultation
Landowner	Ongoing	Santos has engaged in face to face meetings with the landowner throughout the proposed activity development and environmental assessment phases. The landowner accompanied Santos on a scout of the lease area during the environmental assessment phase. A land access and compensation agreement is being negotiated with the landowner. This includes a farm management plan which aims to ensure that the proposed activity and the landowner's use of the property can occur concurrently.	The location of the lease area was influenced by the landowner's requirements. A farm management plan has been developed.
Local councils	-	On finalisation of the land access agreement with the landowner a briefing will be held with the Narrabri Shire Council	Updated information will be provided once complete.
Adjoining, and/or affected, landholders	-	On finalisation of approval with the landowner, engagement with neighbouring landholders is planned to occur.	Updated information will be provided once complete.
Adjoining, and/or affected, authorisation or title holder	-	PEL 238 is overlaid with mining titles however the proposed activity site is not located within an existing mining title.	-
Affected infrastructure authorities (electricity, telecommunications, water, pipeline, road, rail, port authorities)	-	Meeting scheduled with local representatives from NSW Rail Corporation, to discuss and outline the proposed activity and in particular, use of the level rail crossing to access the site.	Updated information will be provided once complete.
Relevant government agencies	-	The relevant government agencies will be consulted with this REF document providing the basis for the consultation.	Updated information will be provided once complete.
Local Aboriginal communities	September – October 2012	The Narrabri Local Aboriginal Land Council has been consulted with and meetings held.	Santos will introduce a team dedicated to cultural and Indigenous affairs in NSW. This team will consult with the local Aboriginal community.
The general community	August 2012	The Santos Community Consultation Committee Narrabri Shire was formed by Santos and meets regularly on a monthly basis.	The Santos Community Consultation Committee Narrabri Shire has requested particular topics be discussed at each monthly meeting to inform them on the coal seam gas activities being conducted by the Santos group of companies.

2.3.2 Influence of consultation on design and management of proposed activity

As identified in Table 2-1, Santos has consulted with the landowner of the property on which the site is located, and prepared a farm management plan for the property. The farm management plan forms part of the agreement between Santos and the landowner and aims to ensure that Santos and the landowner's activities can occur in concurrence.

Consultation with the landowner influenced the location of the proposed lease area and the timing of consultation with other stakeholders. Consultation with other stakeholders, as outlined in the Table 2-1, is planned to be undertaken at a time agreed by the landowner.

A REF for a core hole at an alternative location on the property was submitted to DTIRIS by Eastern Star Gas in 2011 but was not progressed. NOW and OEH reviewed the REF and raised a number of issues that needed addressing. These issues have influenced the design and management of the proposed activity and are identified in Table 2-2.

Table 2-2 Issues raised on previous Kiandool 1 REF

Stakeholder	Issue raised	How issue has been addressed
NOW	Construction activities within 40 m of a water body require a controlled activity approval under the <i>Water Management Act 2000</i> (WMA).	The lease area will be located more than 40 m from Pig Creek. The access track comes within 15 m of Pig Creek at its closest point. However, clause 39 of the <i>Water Management (General) Regulation 2001</i> exempts the need for a controlled activity approval under the WMA (refer to section 5.2.8).
	Bores must be constructed by drillers with a licence under the National Water Drillers Licensing Accreditation Scheme.	A driller that holds a license under the National Water Drillers Licensing Accreditation Scheme will be on site during drilling of the top hole and until the surface casing is set, cemented and pressure tested (refer to section 2.7.1.2).
	The bore will require a licence under Part 5 of the <i>Water Act 1912</i>	As water sharing plans are in place for surface and groundwater sources at the site, water licensing will be governed by the <i>Water Management Act 2000</i> . This is further discussed in section 5.2.8.
	Sourcing of water may require licensing.	Water will be sourced from Narrabri's potable water supply or, if available, from production water from pilot wells operating in accordance with appropriate licences. A separate licence will not be required for Kiandool 1 (refer to sections 2.6.6 and 5.2.8).
	A site specific erosion and sediment control plan should be provided.	Erosion and sediment controls will be implemented in accordance with best practice guidelines (refer to section 6.1.1).
	A waste management plan detailing containment of drilling by-products, spoil and produced water, mitigation measures for preventing accidental spill and remediation actions to be undertaken in the event of a spill should be provided. Drilling sump to be lined with impervious material to prevent pollution entering groundwater.	Waste management is addressed in sections 2.7.2 and 6.1.7).
	An aquifer monitoring/ modelling plan should be developed.	The well will be completed as a DAMB which will provide information about groundwater levels and flows (refer to section 2.6.4).
OEH	Noise mitigation measures must be provided including a commitment to using mobile and stationary equipment with sound power levels equivalent or lower than used in the predictive noise modelling.	Noise impacts and management are addressed in sections 2.7.4 and 6.1.7).

Stakeholder	Issue raised	How issue has been addressed
	An Aboriginal cultural heritage assessment which includes consideration of the drainage line should be prepared.	A due diligence cultural heritage assessment was prepared (refer to sections 4.2.4 and 6.5.1).
	A site assessment of threatened species should be prepared.	An ecological assessment of the proposed activity, including a field survey of the lease area, was carried out (refer to sections 4.4 and 6.5.1).
	All drilling cuttings and fluids are to be removed from site and disposed of in accordance with legislative requirements under the POEO Act and the <i>Protection of the Environment Operations (Waste) Regulation</i> .	Management of drilling fluids and cuttings is described in sections 2.7.2 and 2.7.3.
	Address risk associated with flooding and ensure appropriate contingencies including mud pits.	Flooding is addressed in section 6.1.2.

2.3.3 Ongoing consultation arrangements

Further consultation will occur in accordance with Table 2-1.

Santos' Community Engagement Team Leader for NSW has prepared a plan to inform and consult with all relevant landholders and community members on the CSG activities in the area surrounding the site. This plan will come into effect once the proposed activity is approved. The Santos Community Engagement Team Leader is a representative on the Santos Community Consultation Committee Narrabri Shire and plans to inform and advise this committee on activities in accordance with the landowner's request.

The Santos Community Consultation Committee Narrabri Shire will continue to meet on a monthly basis and ongoing updates of the proposed activity will be presented. Santos' Land Access team will continue to engage and consult with the landowner at the property. Santos' Land Access team will also work with the landowner to engage neighbouring landholders. Santos will conduct a community open day in Narrabri to outline its exploration drilling program in the area.

2.3.4 Stakeholder conflict management

Santos' primary approach to conflict management is open and proactive communications with all stakeholders as outlined in the consultation plan outlined above. Santos is well established within the local community in terms of its offices and resident employees, approximately 15 of whom were born and raised locally.

All of Santos' landholder and local community face-to-face contact personnel live in the community and are well known. Santos employees are in daily contact with members of the community in the towns and out in the field. Written communications to directly affected landholders are either preceded by or immediately followed up by personal contact with the landholder by one of the local community liaison staff members in order to ensure that the information provided has been received and is understood by recipients as well as to gather their response/feedback. Santos has a telephone number available 1800 071 278 for community members to lodge enquiries. Enquiries may also be lodged at: <http://www.santos.com/contactnsw>. These activities are reviewed each day and a report provided to the Santos Energy NSW Community & Government Affairs team to discuss, review and respond.

The stakeholder communications plan for the proposed activity is approved by the senior management of Santos' Eastern Australia Business and will be subject to weekly and monthly review by Santos' NSW management.

For the proposed activity, Santos will maintain a database of:

- all project related concerns or complaints received from individual members of the community or representative bodies with which we are consulting;
- the response provided or action taken; and
- tracking notes on progress to resolution.

Santos has well established dispute escalation and resolution procedures in place that are designed to identify and apply special focus to any matters which are not readily resolved successfully by its community relations officers and local management.

In addition, despite the substantial environment protection improvements and rehabilitation works involved in the exploration program, Santos is aware of the potential for anti-CSG protest action at some sites which may lead to some cases of civil disobedience. Santos has in place a civil disobedience response management plan as part of its ongoing safety management processes. This plan has been developed in consultation with the relevant authorities.

2.4 Justification of the activity

2.4.1 Objectives

The objectives of the proposed activity are to:

- drill a core hole to allow investigation of the potential CSG resource of the Gunnedah Basin within PEL 238
- install a groundwater monitoring bore (DAMB) to allow any impacts to groundwater sources, as a result of future exploration and production activities, to be monitored over time.

2.4.2 Strategic need

The proposed activity is necessary for the ongoing exploration and evaluation of the hydrocarbon potential in PEL 238, 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 and production in the region. Undertaking the proposed activity is essential to the evaluation of the potential resource.

The proposed activity is consistent with the *Strategic Regional Land Use Plan New England North West* (the SRLUP) which recognises the region's potential for CSG production and identifies the site and surrounding land as having high coal seam gas resources. The SRLUP states that development of the gas industry in the region would bring capital investment and economic benefits, and has the potential to play a significant role in the delivery of reliable energy in a carbon strained economy, provide security of supply for domestic gas and alleviate the state's reliance on imported gas.

The SRLUP emphasises the importance of protecting valuable agricultural land and natural environments. The site has been selected to minimise the impacts of the proposed activity on both agricultural land and biodiversity. Further discussion of potential impacts on biodiversity and agricultural land is provided in sections 6.2.1 and 6.4.1 of the REF respectively.

The installation and operation of the DAMB at the proposed location will add a further monitoring point to Santos' Groundwater Monitoring Network for the area.

2.4.3 Method and scale

The proposed activity will include drill core and cutting sampling and testing, which is the only feasible method available to obtain reliable and accurate gas content, composition and permeability data for the local CSG resource. Geophysical methods available, such as seismic, show the structure of the basin but do not provide the ability to sample and analyse the stratigraphy of the Gunnedah Basin to quantify coal seam gas potential and are therefore not suitable in this instance.

The proposed activity for a single core hole and installation and operation of a DAMB is of minor scale and will have minimal environmental impacts.

2.4.4 Location

The location of the core hole is a substantial factor in the evaluation of the potential CSG resource. The site is free from significant environmental constraints and will require minimal vegetation clearing. It is therefore considered a suitable site for the proposed activity. The site selection process is further discussed in section 2.5.

2.4.5 Consistency with ecologically sustainable development principles

The proposed activity is considered justified and is consistent with the principles of ecologically sustainable development (ESD). ESD is a primary object of the EP&A Act and is defined under section 4 of the EP&A Act as having the same meaning as section 6(2) of the *Protection of the Environment Administration Act 1991*, being:

6(2) for the purposes of subsection (1)(a), ecologically sustainable development requires the effective integration of economic and environmental considerations in decision-making processes. 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) 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,*
- (c) conservation of biological diversity and ecological integrity—namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,*
- (d) improved valuation, pricing and incentive mechanisms—namely, that environmental factors should be included in the valuation of assets and services.*

The proposed activity's consistency with these principles is outlined in Table 2-3.

Table 2-3 Consistency of proposed activity with ESD principles

Principle	Proposed activity's consistency
Precautionary principle	<p>A precautionary approach was taken during the site selection process which aimed to avoid significant environmental constraints, thereby minimising the risk of serious or irreversible harm to the environment as a result of the proposed activity.</p> <p>During the environmental assessment process, investigation into a range of issues was carried out to determine the full potential impacts of the proposed activity. This included commissioning cultural heritage and ecological technical studies, and drawing on information from technical specialists including geologists and hydrogeologists. Conservative 'worst case' scenarios, such as a 1 ha lease area, were considered as part of the environmental assessment process.</p>
Intergenerational equity	<p>The lease area will be fully rehabilitated when it is no longer required for operation. This will ensure that potential impacts of the activities are not left to be addressed by future generations. The proposed activity will not consume significant quantities of non-renewable resources or produce significant quantities of waste that will lead to long term environmental implications.</p>
Conservation of biological diversity and ecological integrity	<p>The lease area was selected to avoid potential impacts to biodiversity and ecological integrity as much as possible. The small area of vegetation required to be removed for the proposed activity (up to 1 ha for the lease area and 0.06 ha for the new access track, if required) will not result in significant impacts to any threatened species, population or ecological community, or their habitat.</p>
Improved valuation, pricing and incentive mechanisms	<p>While clear and widely accepted standards have not yet been established for the application of this principle, Santos acknowledges and accepts the financial costs associated with all the measures required for the proposed activity to avoid, minimise, mitigate and manage potential impacts of the proposed activity.</p>

2.5 Analysis of alternatives

There is limited previous targeted drilling in this area of the Gunnedah Basin that is sufficiently deep for petroleum exploration purposes. The proposed activity is essential to gain knowledge of the gas content, composition and detailed stratigraphic data.

Santos undertook an analysis of feasible alternatives to carrying out the proposed activity. There were no lower impact alternatives to the proposed activity available that would adequately assess the potential gas resource.

Suitable locations for the proposed activity were carefully considered by the project team, in consultation with specialist consultants and taking into account the underlying geology, the biophysical environment and the current land use at each location.

An alternative location to the proposed site was investigated for the proposed activity. The alternative site was located approximately 1.2 kilometres north of the proposed lease area, close to Culgoora Road. Eastern Star Gas Ltd submitted a REF assessing the impacts of Kiandool 1 at this alternative site to DTIRIS in July 2011 however later withdrew the application, as it was located approximately 700 metres from the nearest sensitive receptor.

This new proposed site was selected based on the principles of impact avoidance and harm minimisation. It was broadly identified by Santos' geologists and refined in consultation with the landowner and with the assistance of RPS cultural heritage, ecological and environmental consultants. The site is located 1.3 kilometres from the nearest sensitive receptor therefore reducing noise and amenity impacts as compared to the previous site investigated. It has also been subject to previous disturbance and has few environmental constraints.

2.6 Description of the activity

2.6.1 Site preparation

2.6.1.1 [Site entry and access](#)

Entry to the site will be from Culgoora Road. Access to the lease area will be provided via the 1.9 kilometre existing access track from Culgoora Road. The existing access track generally runs in a north-south direction along the western boundary of the property and crosses a cattle grid near its entry point on Culgoora Road. It consists of compacted dirt for approximately 1.5 kilometres and of compressed grass for approximately 400 metres. The existing access track bends and turns east briefly, approximately 700 metres from its entry point on Culgoora Road.

The existing access track may need to be upgraded prior to undertaking the other works. Potential track upgrade works could include:

- re-grading the existing dirt portion of the existing access track
- clearing and grading the existing grass portion of the existing access track
- top dressing the existing access track with gravel to reduce dust and provide all weather access
- widening the property gates and cattle grids
- installing culverts to convey surface water flows across the existing access track.

An additional 100 metres of new access track may also need to be constructed to straighten out the bend in the existing access track and allow more efficient access. If required, construction of the new access track would involve clearing 0.06 hectares of vegetation, grading and top-dressing.

The requirement for any existing access track upgrade works will depend on the requirements of the selected contractor and specific drilling rig to be used, and will be determined during the detailed design of the proposed activity to ensure minimal disturbance.

2.6.1.2 [Lease establishment](#)

The lease area will be up to 100 by 100 metres in size. Santos is currently reviewing the design of its lease areas to reduce disturbance and minimise environmental impacts of its activities. Lease area establishment has traditionally involved constructing a level pad with cut and fill. Santos is now investigating the feasibility of using industrial matting as an alternative to traditional construction methods. The industrial matting consists of impervious, non-absorbent material which could be placed directly onto slashed vegetation. This would reduce the need for vegetation and topsoil removal and earthworks.

The lease area will be established using one or a combination of the following methods:

- Constructing a level pad using cut and fill. Vegetation and topsoil would be stripped from the lease area and stockpiled on site. The lease area would have an approximate level of 213.93 metres Australian Height Datum (AHD) and would be graded to one corner where an environmental pit would be constructed to capture runoff. The environmental pit would have a total capacity of approximately 54 cubic metres (being six by six metres in size and 1.5 metres deep) and would be lined with heavy grade impermeable plastic. A rectangular cellar pit (approximately three metres long, 1.5 metres wide and three metres deep) would be excavated in the location of the core hole. Estimated cut and fill volumes for this construction method are identified in Table 2-4.

- Laying industrial matting across the lease area. Vegetation would be slashed prior to laying the matting. A cellar pit would be excavated at the core hole location.

Table 2-4 Estimated cut and fill volumes if traditional construction methods used

	Cut	Fill
Lease area	Approximately 960 m ³ topsoil	Approximately 210 m ³ gravel

Other activities during establishment of the lease area may include:

- transporting civil works equipment, such as bulldozers, excavators, graders, rollers, a cementing unit, a conductor drilling unit, water trucks, and support and light vehicles, to the lease area
- setting up portable amenities on site
- excavating a cuttings pit and lining with heavy grad impermeable plastic sheeting
- installing and cementing a 7" conductor casing (typical) at approximately eight to 20 metres depth ahead of the rig arriving on site
- fencing the lease area.

2.6.1.3 Drilling rig and equipment setup

The major plant, equipment and temporary buildings to be used during drilling activities will include:

- drilling rig and supporting equipment (such as pipe handler and mud pump)
- surface tanks
- metal bins, baskets, skids and sea containers to house equipment
- mechanical vibrating screens
- power generator units
- lighting towers
- site offices
- vent tank.

These plant, equipment and temporary buildings will be transported to the lease area and set up prior to drilling activities. They will remain in place for the duration of the drilling and completion works which will be approximately six months. The types of buildings and containers that may be present on the site are shown in the conceptual lease layout (Figure 2-4).

The vent tank will be installed to capture fluids and gas from the well if required. This tank is a re-enforced steel container, approximately 10 by three metres in size, with internal baffles and piping to allow for the separation of gas and liquids. The tank will be designed to contain any fluids vented. This captured and contained fluid will be removed, as required, and disposed of by a licensed waste disposal company. Minor volumes of methane (CH₄) and carbon dioxide (CO₂) may be emitted from the vent tank from time to time.

Other equipment will be required on site during the course of the drilling activities, including wireline trucks, cementing trucks and service company vehicles. These vehicles will exit and enter the site via the access track as required.

The conceptual lease layout is shown in Figure 2-4. The location of the access track and lease area within the property is shown in Figure 2-5.

2.6.2 Well design and construction

2.6.2.1 Well design and drilling

The well will be designed and constructed in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012b). Drilling and construction of the well will involve:

- Drilling an open hole with an approximate diameter of 6-1/8" through alluvial and/or weathered rock material into competent rock (Upper Napperby Formation), known as the casing setting depth.
- Installing 4-1/2" casing to the casing setting depth and cementing in place back to surface. The surface casing will be set 25 to 50 metres below a regional impermeable seal or competent formation.
- Installing a blow out preventer (BOP) on top of the casing.
- Drilling out the casing shoe using a 3-7/8" rotary drilling assembly and drilling open hole to a predetermined coring point.
- Once the coring point is reached, drilling will carry on using a combination of 3-7/8" diameter coring and rotary drilling techniques through multiple coal seam and other formations to the planned total depth, which is approximately 1,000 metres.

Once at total depth, open hole testing and geophysical logging will be completed (refer to section 2.6.3).

Following completion of testing and logging, the well will be completed with down hole gauges and cemented back to surface, and remain as a deep aquifer water monitoring bore (DAMB) (refer to section 2.6.4).

In the event that drilling is unable to be completed due to geological constraints or other drilling issues, a suitable alternative location will be selected within the existing lease area. DTIRIS would be consulted at this time.

A schematic of the well is provided in Figure 2-6.

2.6.2.2 Drilling mud and additives

During the rotary drilling process, water-based drilling mud is designed to:

- clear rock fragments and other solids (drill cuttings) from the bore hole and bring them to surface
- apply enough pressure against subsurface formations to prevent fluids and gases from flowing into the well
- prevent clays from swelling and keep the bore hole open until casing has been cemented in place
- cool and lubricate the drilling equipment.

Chemicals may be added to the drilling mud, or held as a contingency on site, to facilitate safe and efficient drilling of the core hole. The primary additives that may be used are potassium-sulphate and potassium-formate to help control swelling clays. Should these be deemed as unsatisfactory by the Santos Onsite Company Representative (OCR) or the drilling contractor, potassium chloride may be used, which is a proven and more conventional additive. Other chemical additives may be used as weighting agents, viscosifiers or polymers. A list of the possible additives to be used and Material Safety Data Sheets (MSDS)

for these are provided on the Santos website: <http://www.santos.com/exploration-acreage/nsw-csg/reports-and-publications.aspx>.

The drilling mud will be transported to the site in a trailer prior to the commencement of drilling and stored in surface tanks on site. During operations, the drilling mud will mix with naturally occurring rock and soil and return these to the surface. The drilling mud will pass through mechanical vibrating screens to separate out drill cuttings. The liquid component of the drilling mud will flow into the surface tanks for recirculation throughout the drilling process. The drill cuttings will be transferred to metal bins or a lined pit and stored on site until drilling is completed.

Losing drilling fluid is undesirable as it is the primary means of controlling the core hole. In the event that losses are detected, a lost circulation material (LCM) will be mixed into the mud to prevent further losses. LCM is made of cellulose or other natural material and works by blocking the pores in the permeable/fractured rock.

Once drilling of Kiandool 1 is complete, drilling mud will be transported to a treatment and processing facility in Narrabri so it can be reused in future drilling operations. The drill cuttings will be tested to determine the appropriate management and reuse methods. This process is described in sections 2.7.2 and 2.7.3.

2.6.2.3 Cementing

The cementing of casing strings will be performed by a recognised professional cementing company who will provide bulk cement facilities, high pressure cementing pumps and mixing pumps to mix and pump the slurries required. The equipment will be operated in a manner that will minimise any spills. Pressure tested steel lines will connect the cementing unit to the well to allow fluids to be pumped to the well and these fluids will be positioned in the well following correctly formulated engineering design and good oilfield practice.

Following completion of cementing, excess fluids and cement slurries will be segregated in steel waste tanks and removed and disposed of by a licensed waste disposal company.

2.6.3 Sampling, testing and logging

The purpose of the proposed activity is to determine coal depths and thicknesses, and obtain meaningful estimates of coal gas-in-place reserves and deliverability. This will require accurate formation evaluation data gained from gas content, gas composition and permeability tests.

During coring, core samples will be collected and tested on site and then sent to an accredited laboratory for further analysis. Testing and analysis will include stratigraphy evaluation and gas content and composition analysis. Adsorption isotherm analyses will be undertaken on selected coal samples recovered to assess the potential gas storage capacity of the coal seams.

Once coring has been complete, geophysical logging and down hole well tests will be carried out. Well tests will be undertaken on targeted intervals to collect and evaluate reservoir pressure and permeability.

2.6.4 Well completion

Following downhole logging and testing, the well will be completed as a DAMB. The DAMB will enable monitoring of multiple deep aquifers and pressure responses of these aquifers to regional CSG activities. The DAMB will form part of a network of monitoring bores operated by Santos within the Namoi Catchment.

The DAMB completion design consists of multiple piezo resistive sensors installed on a slimhole tubing string cemented in place. The upper volume of cement will provide a gas-tight seal between the tubing and formations from above the top piezometer to 150 metres overlap into and above the surface casing shoe.

The lower design will enable the pressure gauges to measure the formation pressures with minimal vertical permeability. A cementing assurance swellable packer will be run above each piezometer to provide a secondary seal to the cement.

The slim hole tubing string will be cemented over two stages to minimise the risk of gas migrating to the surface. The first stage will involve setting cement from total depth to approximately 50 metres inside the surface casing shoe. This will be left in place for approximately three to six months and monitored. Once it is established that there is no gas migration to the surface, the DAMB will be completed by cementing the remainder of the slimhole tubing string in place. If any issues with the seal are detected, the hole may need to be repaired using a work over rig.

A 7-1/16" suspension cap with pressure gauges will be installed on top of the wellhead, which will protrude up to one metre above the ground surface for the three to six month monitoring period.

The DAMB will be fenced off and marked with signage. A solar panel and other surface infrastructure may be installed to allow automatic collection and transmission of data following the final cement placement.

The DAMB design is shown in Figure 2-7.

2.6.5 Monitoring bore operation and maintenance

Once installed, the DAMB will measure groundwater pressure and temperature within various strata and enable groundwater levels and flows to be monitored. The data will most likely be automatically transmitted via telemetry to a production database. The DAMB will remain in place for as long as it is able to gather useful data, which may be up to 30 years. During operation, occasional maintenance and other field vehicles will need to access the DAMB for maintenance on surface facilities and other similar activities. This will occur approximately once per year or in the event that a problem with its operation is detected

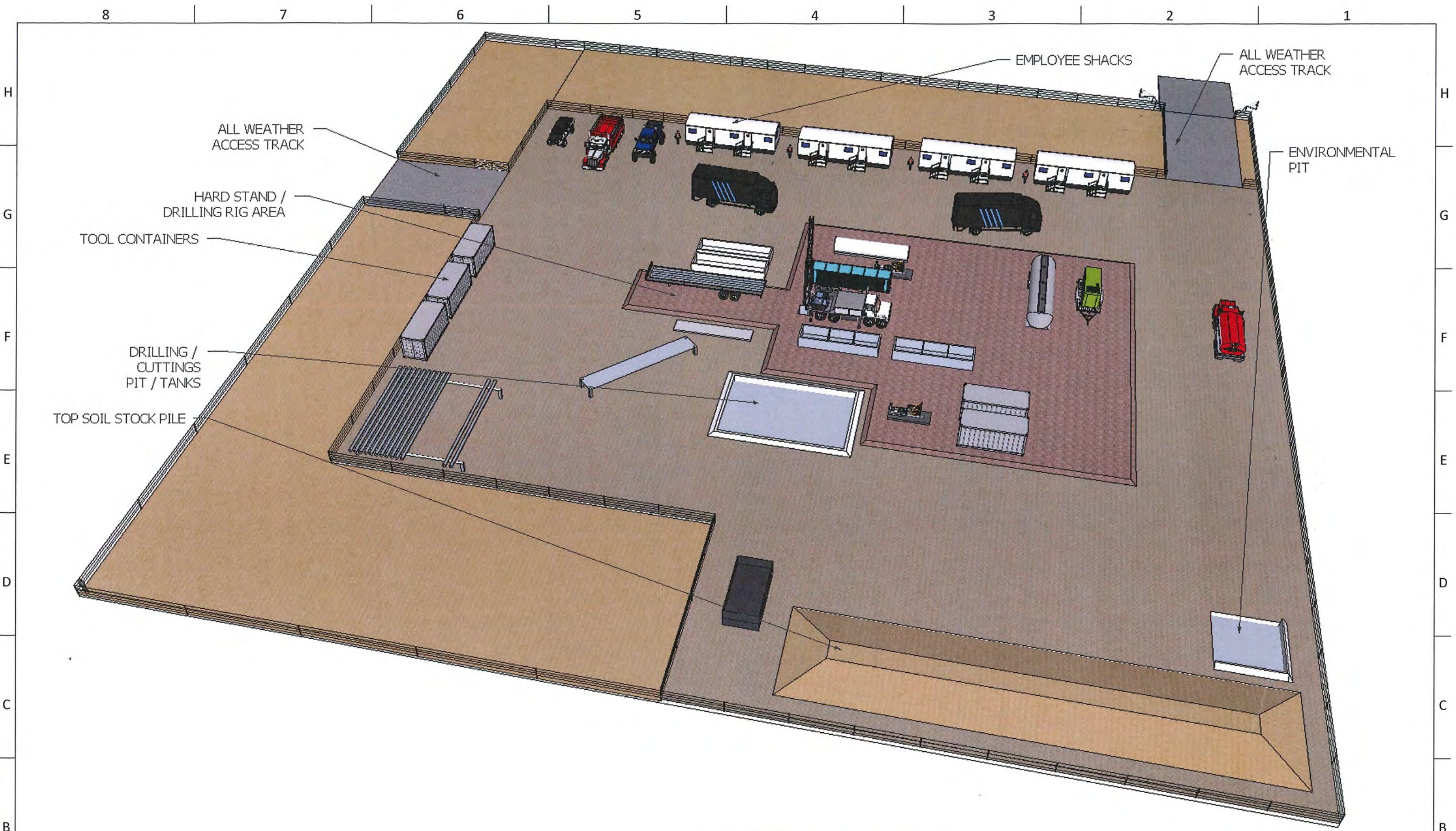


Figure 2-4 Conceptual lease layout

Santos
We have the energy.

CONCEPTUAL RIG LAYOUT

REV.	DESCRIPTION	DATE	BY	CHECKED	INITIAL	DATE	APPROVED	INITIAL	DATE
A	ISSUED FOR APPROVAL	26-09-12	BW	BW	<i>BW</i>	26-09-12	ML	<i>ML</i>	26-09-12

SIZE A3	FSCM NO	DWG NO 7099 - 390 - LAY - 0001	REV A
SCALE 1:300	SHEET	1 OF 1	

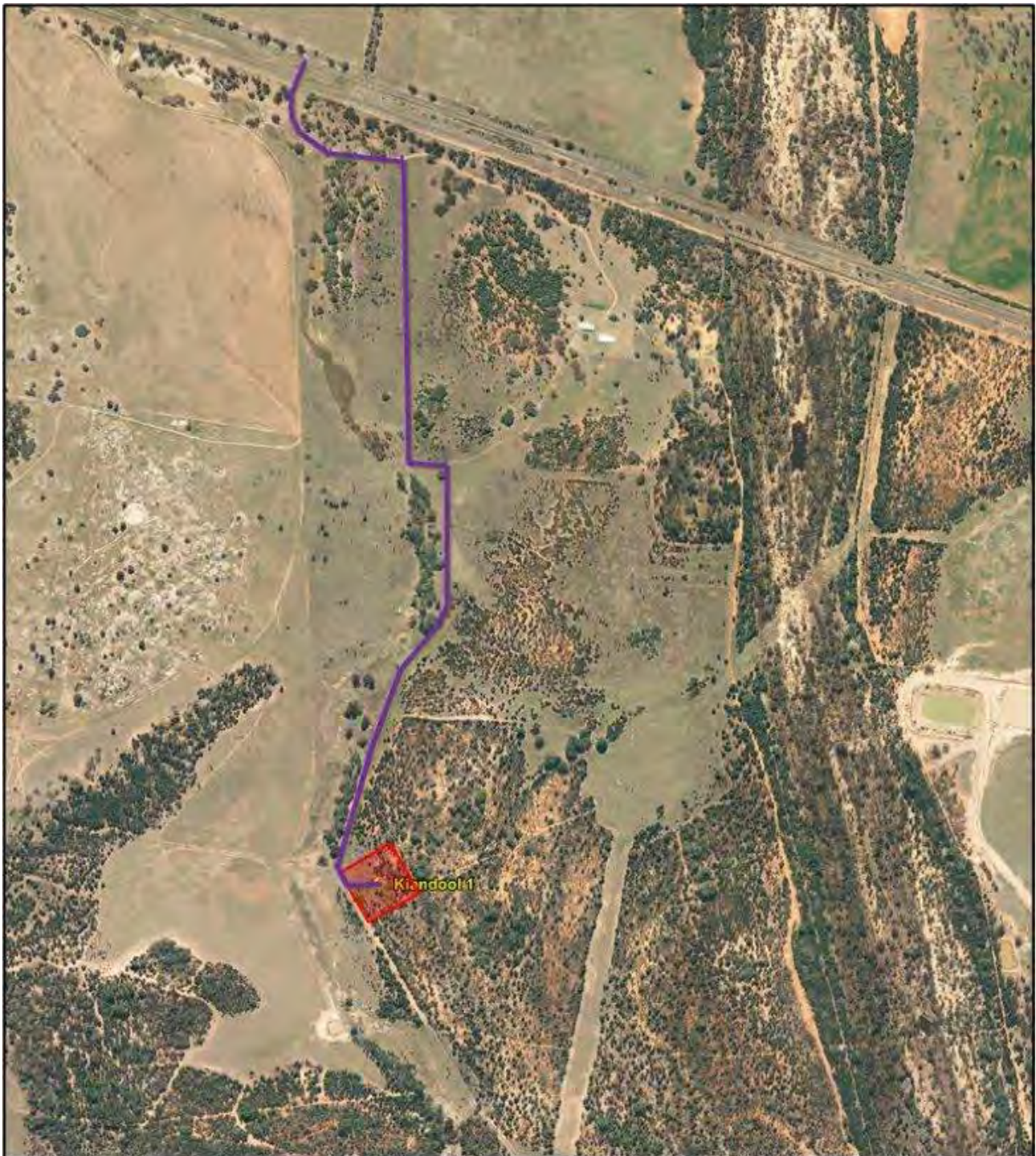
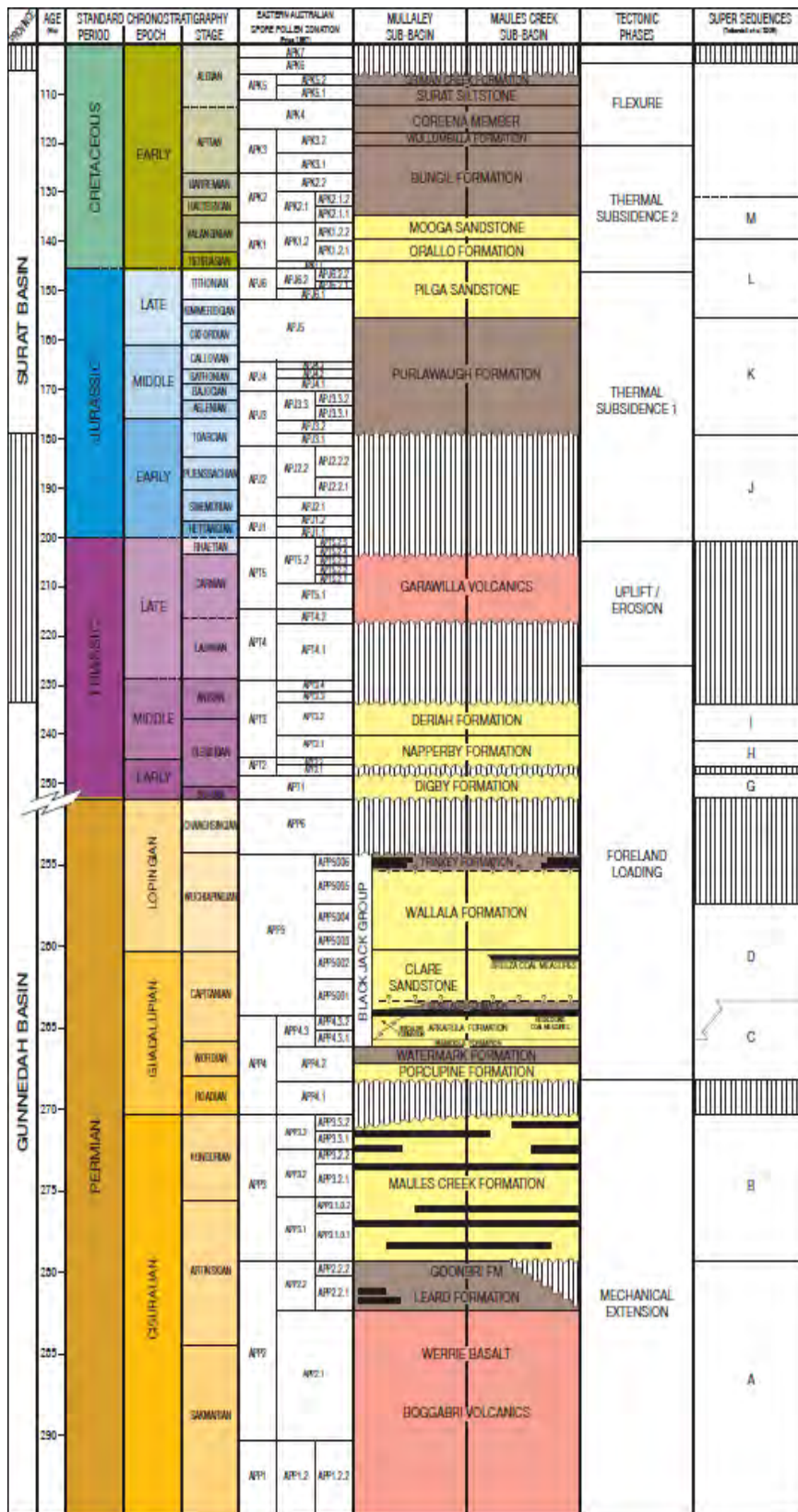


Figure 2-5 Access track and lease area location



Surface - Kiandool-1

7" 23 ppf Conductor shoe
at +/- 10 mMD/TVD

4-1/2" Casing shoe at
+/- 380 mMD/TVD

3-7/8" Hole to +/- 819 m
MD/TVD

Note:

- (1) Due to Napperby Formation Top and Top Piezometer setting depth uncertainties, 4-1/2" casing setting depth may need to be adjusted
- (2) Coal seam depths and thickness will be confirm after drilling and logging
- (3) Hole TD may be revised during the 3-7/8" section, depending on Basement Top depth.
- (4) These changes would not result in substantially different environmental impacts.

Notification or application would not be made to the government in the event of any changes.

Figure 2-6 Well schematic

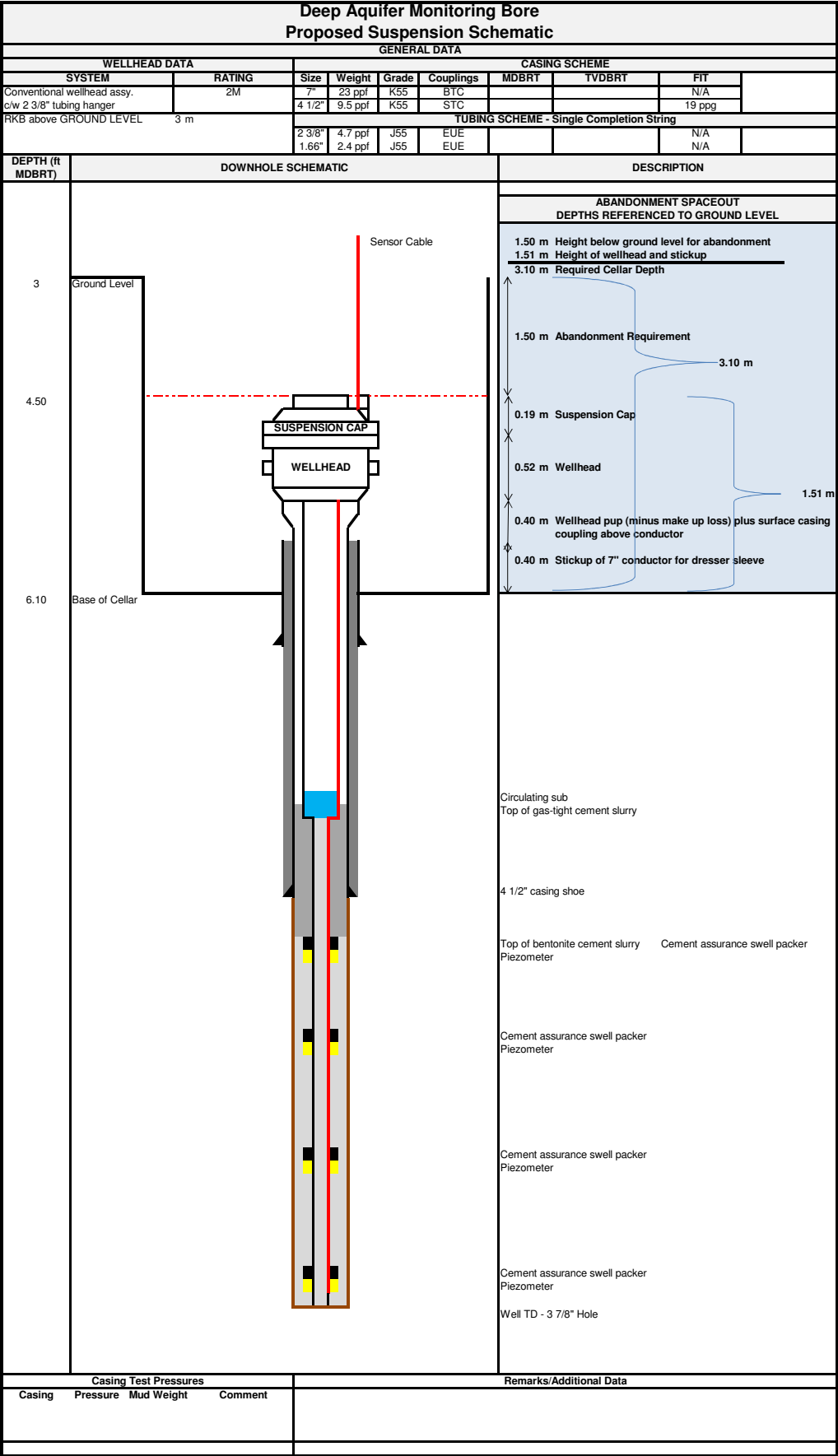


Figure 2-7 DAMB diagram

2.6.6 Site water requirements

Approximately 0.22 mega litres of water will be required for drilling and general site activities in total. This will be sourced from Narrabri's potable town water supply and trucked to the site. Alternatively, production water from pilot wells would be used when available for the preparation of drilling mud. Water licensing requirements are discussed in section 5.2.8.

2.6.7 Staff and hours of operation

Approximately 24 employees and contractors may be present on the site each day during drilling, completion and rehabilitation activities. Once the DAMB has been installed, only occasional maintenance staff will access the site.

The hours of operation will be subject to negotiation and agreement with the landowner but may be up to 24 hours per day, seven days per week. Personnel movements to and from site will be minimised outside of a single shift change per day but may be necessary during specific activities or in the event of an incident.

2.6.8 Timing and duration

Site preparation and drilling is planned to commence in the first quarter of 2013, subject to approval. Site preparation, drilling and completion activities are expected to take around three months. The expected duration of the main work phases is identified in Table 2-5.

Table 2-5 Duration of proposed activity

Phase	Duration
Site preparation	14 days
Drilling and completion	15–40 days
DAMB operation	Up to 30 years

2.6.9 Rehabilitation

The lease area will be partially rehabilitated following completion of the DAMB to its pre-operational condition or better as agreed with the landowner. The only infrastructure that will remain in place after partial rehabilitation would be the DAMB and associated surface infrastructure and fencing. The outer boundary of the DAMB (including surface infrastructure and fencing) will be approximately three by three metres in size.

Partial rehabilitation of the lease area may include:

- removing impermeable plastic lining from any pits (such as the environmental pit and cuttings pit if required)
- beneficially re-using drill cuttings determined to comply with the POEO Act and the *Protection of the Environment Operations (Waste) Regulation 2005* in accordance with the *Excavated Natural Material Exemption 2012* issued by the EPA on 19 October 2012 (the 'excavated natural material exemption') (refer to section 2.7.3) for general site shaping or as other non-structural fill
- removing temporary buildings
- contouring where necessary to prevent water channeling
- replacing top soil

- reseeding disturbed ground and planting trees and shrubs (where applicable, as agreed with the landholder)
- removing fencing from around the lease area
- fencing the DAMB and associated surface infrastructure
- removing any waste materials for appropriate disposal or recycling
- weed control.

Any improvements to the existing access track will be retained for the benefit of the landowner.

Partial rehabilitation of the lease area will occur within six months of installation of the DAMB where practicable and considering external factors such as the weather and availability of resources.

Once the DAMB is no longer required for groundwater monitoring purposes, final rehabilitation will take place. This will include removing surface infrastructure and fencing, and undertaking revegetation and weed control.

2.7 Mitigation strategy

Santos has many years of experience in undertaking exploration activities for CSG. As a result, it has developed an extensive understanding of the steps and measures that should be taken to prevent or minimise its impact on the environment, human health and safety when undertaking exploration activities, including drilling activities. A suite of mitigation measures and a statement of commitments have been developed, as outlined in sections 6 and 9 of this REF, and will be applied when carrying out the proposed activity. The commitments are tailored to CSG exploration activities, and are consistent with many of the principles used in the various guidelines in NSW in relation to biodiversity conservation, Aboriginal cultural and other heritage protection, pollution noise, dust, stormwater, sediment and erosion control, and waste management measures.

In addition, Santos uses compliance tracking and incident management systems throughout its operations. These internal systems will be applied to monitor performance against the commitments outlined in this REF.

Water source protection and waste management strategies for the proposed activity are described in sections 2.7.1 and 2.7.2. Drill cuttings will be recovered for beneficial re-use on the site, as described in section 2.7.3.

2.7.1 Water source protection strategy

2.7.1.1 Surface water protection

Potential surface water impacts and mitigation measures are identified in section 6.1.2 of this REF.

The lease area design and site management practices will minimise the risk of pollutants or contaminants being discharged to the environment. As described in section 2.6.1.2, Santos will investigate using industrial matting to minimise vegetation disturbance and earthworks required for lease construction. Drilling mud, drill cuttings, and chemicals, fuels and oils, will be contained in surface tanks, bins and other appropriately bunded areas to ensure that surface runoff is clean.

Where traditional construction methods are used to construct the lease area (instead of, or in combination with, industrial matting), the lease area will be graded toward an environmental pit where all surface water

runoff will be directed and contained. Water captured in the environmental pit will be removed by a licensed contractor for off-site treatment or disposal, or tested and treated to an appropriate quality prior to discharge.

The site will be regularly inspected by an appropriately qualified and/or experienced environmental professional during site establishment, drilling and completion and partial rehabilitation activities, to ensure that environmental protection measures are effective and that risks to surface waters from pollution are mitigated.

2.7.1.2 Groundwater protection

Potential groundwater impacts and mitigation measures are identified in section 6.1.3 of the REF.

The proposed activity will be designed and constructed in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012b) and will minimise potential groundwater impacts. A driller that holds a license under the National Water Drillers Licensing Accreditation Scheme will be on site during drilling of the top hole and until the surface casing is set, cemented and pressure tested. During this time, there will be 24 hour coverage by one person working the day shift and on call at site during the night. This will ensure that the appropriate knowledge of water legislation and regulation in NSW and technical skills are employed to avoid impacts to groundwater sources.

During drilling, the circulating drilling mud will establish a wall cake and maintain pressure on the various aquifers intercepted. This will prevent the ingress of groundwater to the core hole and discharge of groundwater to the surface. It will also limit the ingress of drilling mud into the aquifers to the immediate vicinity of the core hole.

At the completion of drilling, the hole will be cased with pipe and cemented into place. This will provide a solid barrier to prevent any future ingress, mixing or discharge of groundwater and cross contamination of aquifers.

While there is minimal risk of impacts to aquifers as a result of the proposed activity, Santos will seek permission (from landowners) to access registered groundwater monitoring bores within two kilometers of the site to undertake groundwater monitoring prior to drilling, to establish baseline conditions, and on completion of drilling, to determine if there are any impacts. Where access to bores is granted (and the bore is functioning), monitoring will include water level measurements and quality observations in the field, and sampling for analysis by an accredited laboratory.

The DAMB will monitor any impacts to aquifers over time as a result of any ongoing CSG exploration or production in the region.

2.7.2 **Waste management strategy**

The proposed activity will generate a number of waste streams. The main waste types and estimated volumes generated during site establishment, drilling, completion and partial rehabilitation activities are identified in Table 2-6.

Table 2-6 Estimated waste volumes

Waste	Estimated volume
General site waste, such as packaging materials, scrap metal and chemical/fuel/oil containers and domestic waste	20 m ³
Sewage waste	1.5 m ³ /month
Mud contaminated cement slurry	10 m ³

Waste	Estimated volume
Drilling mud	55,000 L (345 barrels)

General site waste and mud contaminated slurry will be segregated according to their classifications under the *Waste Classification Guidelines Part 1: Classifying Waste* (DECCW 2009) and stored in bins or skips on site. These wastes will be removed from the site at the completion of drilling activities for disposal or recycling at an appropriately licensed waste management or recycling facility.

Sewage waste will be removed from the site, be a licensed contractor for treatment and disposal, as required.

At the completion of drilling, drilling mud will be removed from the site, by a contractor licensed under the *Protection of the Environment Operations Act 1997* (POEO Act) to transport trackable wastes, with the appropriate waste transport certificates. The drilling mud will be taken to an appropriately approved and licensed fluids batching and reuse facility where it will be treated for reuse in future drilling activities to minimise waste generation.

Other waste management measures are identified in section 6.1.7.

2.7.3 Beneficial re-use of drill cuttings

Drill cuttings will be sampled to determine whether they qualify as excavated natural material under the excavated natural material exemption. Sampling and analysis will be undertaken in accordance with *Australian Standard 1141 Methods of Sampling and Testing Aggregates* and will include tests for:

- metals (mercury, cadmium, lead, arsenic, chromium, copper, nickel and zinc)
- electrical conductivity
- pH
- Total Polycyclic Aromatic Hydrocarbons
- Total Petroleum Hydrocarbons
- Benzo(a) pyrene
- Total Chlorinated Hydrocarbons
- percentage component of rubber, plastic, bitumen, paper, cloth, paint and wood.

Drill cuttings, which qualify as excavated natural material, will be re-used on site during rehabilitation of the lease area.

If testing determines that the drill cuttings exceed the limits set by the excavated natural material exemption, a contractor licensed to transport trackable wastes, with the appropriate waste tracking certificates, will remove them from the site. Any such cuttings will be disposed off site at an appropriately licensed waste facility.

2.7.4 Noise management strategy

The proposed activity will generate noise, particularly during drilling and cementing activities, which may occur up to 24 hours per day, seven days per week. The noise management approach will include:

- consultation with potentially affected receivers

- monitoring of noise impacts
- implementation of feasible and reasonable work practices
- complaint management and response.

The potentially affected noise receivers, which include the landowner of the property and two adjoining landowners, will be notified of the proposed activity prior to commencing works. This will include details of the timing and duration of noise generating activities.

Santos will aim to maintain noise levels at the rating background level (RBL) plus 10 dB(A) during standard working hours (7am to 6pm Monday to Friday and 8am to 1pm Saturday) and the RBL plus 5 dB(A) outside of standard working hours. The RBL at the site has not been confirmed but is assumed to be no more than 30 dB(A). Noise monitoring will be conducted at the site to confirm the RBL prior to the proposed activity commencing.

Noise testing of the drilling rig will be carried out prior to its arrival on site to confirm predicted noise levels. Noise monitoring will be conducted at the commencement of drilling and cementing activities to confirm actual noise levels.

Where noise levels exceed the RBL plus 5 dB(A) during standard working hours, or the RBL plus 10 dB(A) outside of standard working hours, feasible and reasonable work practices will be implemented to reduce noise levels. Such practices may include:

- training contractors to operate plant and equipment in ways that minimise noise generation
- scheduling deliveries to occur during day time hours where practicable
- inspecting and maintaining equipment to ensure it is in good working order
- reducing throttle setting and turning off equipment when not in use.

In the event of a noise complaint, the source of the noise will be investigated. Where necessary, Santos will offer to conduct noise monitoring from the proposed activity at the affected receivers house. If it is determined that noise levels are unacceptable, further feasible and reasonable work practices or mitigation measures will be implemented.

2.8 Access arrangements

The proposed activity is to be undertaken on private, freehold land. A land access and compensation agreement will be negotiated with the landowner prior to construction activities commencing.

2.9 Other approval requirements

Assessment and determination of the proposed activity under Part 5 of the EP&A Act, and approval under the *Petroleum (Onshore) Act 1991*, is required before the activity can commence.

Drilling activities will require an aquifer interference approval in accordance with section 91 of the WMA and the *NSW Aquifer Interference Policy* (NOW 2012). This is discussed further in section 5.2.8.

3.0 The site

3.1 Site description and plan

The site is located on a rural private freehold property at 545 Culgoora Road, approximately nine kilometres west of Narrabri, within Lot 2 of DP1037235.

The coordinates of the core hole are identified in Table 3-1.

Table 3-1 Coordinates (MGA zone 55) for Kiandool 1

Name	Easting	Northing
Kiandool 1 core hole	758044.94	6641740.11

The following photographs illustrate the site.



Plate 3-1 View of lease area



Plate 3-2 *Callitris glaucophylla* forest on site



Plate 3-3 Red sandy soils on site



Plate 3-4 View of existing access track



Plate 3-5 Creek adjacent to access track where it has been widened to form a dam



Plate 3-6 Cattle grid at entrance to access track

A survey of the lease area is shown in Figure 3-1.

4.0 Existing environment

4.1 General description

4.1.1 Climate and weather

The Bureau of Meteorology (BoM) weather station considered the most representative of the site is Narrabri West Post Office. Narrabri Airport AWS is the closest station to the site with recent temperature statistics (Narrabri West Post Office has statistics up to 2002). The local climate can be regarded as semi-arid due to hot summers and mild winters. The average daily maximum temperature is 26.5°C, while the average daily minimum temperature is around 11.7°C (BoM, 2012). Annual rainfall is 659.7 mm and is known to range between 297.4mm (lowest record) and 1012.1mm (highest record). Rainfall is summer dominant with approximately 40% of rainfall occurring between December and February.

As shown in Table 4-1, based on mean temperature records the warmest month is January and the coolest month is July. October receives the greatest rainfall and April the least.

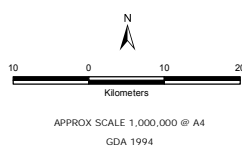
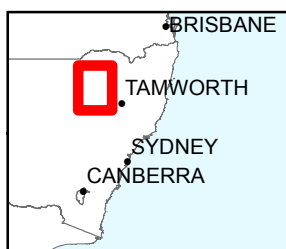
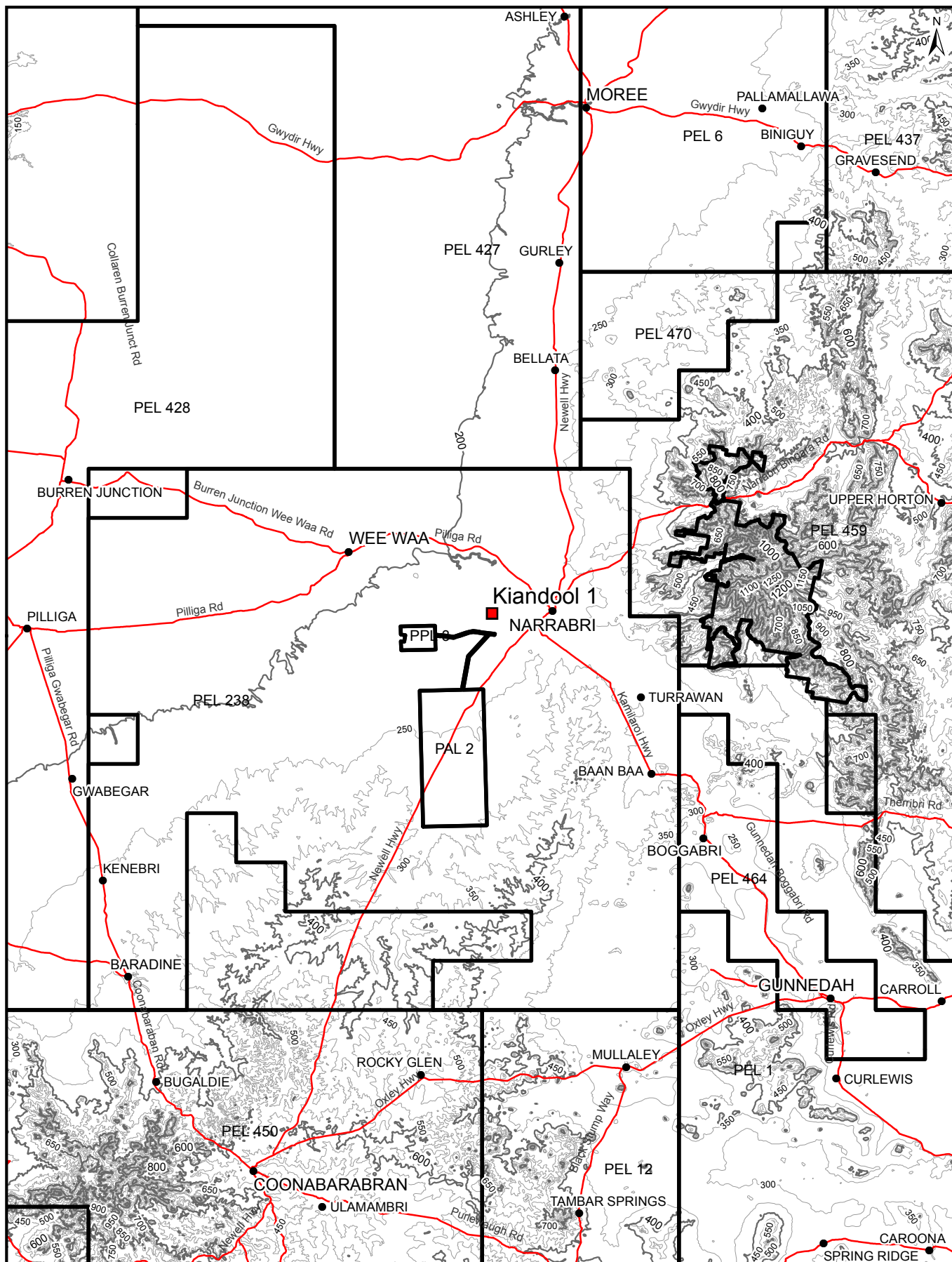
Table 4-1 Mean climate data

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Max Temp (°C)	33.8	33.2	31.2	27.3	22.5	18.7	18	19.8	23.4	30.1	33	33
Mean Min Temp (°C)	19.3	19.1	16.4	11.9	8.3	5.2	3.7	4.6	7.6	11.7	14.8	17.7
Mean Rainfall (mm)	82.3	62.1	56.8	38.9	47.9	48.2	46.3	41.1	42.5	82.9	61.8	78.3

4.1.2 Topography

The proposed site is relatively flat. The regional topography is characterised by flat to very flat (approximately 1:1000), gently sloping land with little or no vertical relief. Elevations in the area range between 180 and 220 metres AHD.

The topography of the site and surrounds is shown in Figure 4-1.



Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

DATA SOURCES

Base topographic data © Commonwealth of Australia (Geoscience Australia) 2006.

LEGEND

- Kiandool 1 Core Hole
- Town
- Main Road
- Contour - Index
- Contour - Intermediate
- Petroleum Lease



FIGURE 4-1

Regional Contours

4.1.3 Vegetation

The primary vegetation community within the site is 'Ironbark shrubby woodlands of the Pilliga area, Brigalow Belt South'. This vegetation community is not commensurate with any threatened ecological communities listed under either the *Threatened Species Conservation Act 1995* (TSC Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Vegetation within the lease area represents a disturbed remnant of this community generally exhibiting a monoculture of *Callitris glaucophylla* (White Cypress Pine), absent shrub layer and grassy ground layer (refer to Plates 4-1 and 4-2). The height of the upper strata is approximately eight to 12 metres and the projected foliage cover approximately 30-40 per cent across the lease area. The lower stratum consists of *Themada Australia* (Kangaroo Grass), *Sporobolus crebre* (Slender Rat's Tail Grass), *Drosera* sp., *Aristida* sp., *Wahlenbergia* sp., *Opuntia stricta* (Prickly Pear), *Conzysa* sp., *Panicum* sp. and *Chrysocephalum* sp. The height of the lower strata is up to one metre and the projected foliage cover is 95 per cent.

The grass portion of the existing access track comprises native and non-native grasses that have been compressed from regular vehicle movement. Vegetation within the potential new section of access track comprises *Angophora floribunda* forest. Species present within this community include *Angophora floribunda*, *Lomandra* sp., *Acacia deaneii*, *Allocasuarina* sp., *Bidens pilosa* (Farmer's Friends). The vegetation was not considered to be part of any threatened ecological communities listed under the TSC Act or EPBC Act.

4.1.4 Soils

The soils across the region vary depending on the local sediment source. Duplex soils comprising fine, sandy loam topsoil overlaying harsh, clay subsoils are present in the region. These soils are typical of those derived from the Pilliga Sandstone and are highly siliceous (Norris, 1996).

The *NSW Landscapes Technical Manual* (Eco Logical, 2008) describes soils at the site as being characterised by:

- deep texture contrast soils with deep yellow sand underlain by sodic clays to the south
- red brown sands underlain by brown to grey silt to the north.

During the site visit, the soils were noted to comprise red sandy topsoil overlaying sandy loam.

According to the *Draft Inherent Soil Fertility mapping of the New England – North West region* (OEH 2012), the inherent soil fertility of the site is moderately low. While this broad scale mapping is not suitable for property level assessment, it can provide an indication of the site's suitability for agricultural use.

The soil characteristics indicate the following soil limitations may be present:

- low plant available water
- poor nutrient availability
- prone to erosion and severe scalding
- highly erodible and easily degraded if over used.

A search of the contaminated land record database maintained by the OEH indicated records of seven contaminated sites within the Narrabri Shire LGA. None of these sites are located near the proposed activity. Given the historical and present use of the site for agricultural purposes, contaminants may be present within the soil as a result of pesticide use or hydrocarbon spills.

4.1.5 Geology

PEL 238 is located in the central portion of the Gunnedah Basin where Jurassic and Cretaceous Surat Basin sediments unconformably overlie Permo Triassic Gunnedah Basin sediments (Figure 4-1). The Gunnedah Basin, covers an area of more than 15,000 square kilometres and is defined in structural terms as being bounded to the east by the Hunter Mooki Thrust Fault System and the New England Fold Belt, and to the west by the Lachlan Fold Belt onto which the Gunnedah Basin sediments gradually onlap.

Metavolcanics, meta-sediments and minor ignimbritic volcanics of the Lachlan Fold Belt form much of the basement under the western part of the Gunnedah Basin and the Rocky Glen Ridge. Widespread Late Carboniferous and Early Permian mafic lavas were succeeded by paralic-lacustrine environments with sediments of the Leard and Goonbri Formations deposited. This was followed by low energy fluvial conditions in which the coal measures of the Maules Creek Formation were deposited.

An Early Permian transgression then inundated the area and deposited shallow marine para-conglomerate, sandstone and siltstone of the Porcupine and lower Watermark Formations and culminating in the deposition of the upper Watermark Formation marine claystone.

The Black Jack Formation was deposited in a major delta system with a dominantly northeast sediment source from the New England region. A minor westerly provenance associated with the emergence of the Lachlan Fold Belt is also apparent. The New England provenance of the lower Black Jack Formation resulted in generally quartz lithic and arkosic sandstones with limited reservoir potential. The sandstones were deposited in a lower delta plain/marginal marine environment.

Deposition of the lower Black Jack Formation sediments was followed by an episode when marine conditions affected the Gunnedah Basin, with the deposition of sandstones of poor to fair reservoir quality. Deposition of the western derived quartzose sandstones was followed by very widespread coal swamp conditions depositing the thick Hoskissons Coal seam that is readily correlated across the Basin. The thickness of the Hoskissons Coal ranges from less than one metre in the west to more than 12 metres in the north and to 18 metres in the south-east.

Late Permian volcanic activity and tectonism to the east resulted in renewed deposition of more lithic sediments with an easterly provenance and consequently the upper Black Jack Formation has only limited potential for reservoir development. A period of tectonism, uplift and erosion of variable intensity throughout the Basin followed Late Permian deposition. The end of the Permian is marked by a major regional unconformity.

A basal conglomerate that has been derived from the New England Fold Belt marks the Digby Formation. This unit thickens towards the east and onlaps onto the older sediments and basement to the west. Reservoir quality is generally poor due to a tight sandstone matrix. Thick near-shore marine shales of the overlying Napperby Formation are considered a potential seal to any hydrocarbons reservoir in the Digby Formation.

Unconformably overlying the Napperby, the Jurassic age Purlawaugh Formation is fluvial dominated, generally consisting of thinly interbedded carbonaceous claystone, siltstone and thin coal seams. There can be abundant carbonaceous fragments with thin beds of flint and clay. Within the Purlawaugh Formation there is development of intra-formational aquitards deposited in meandering river/lacustrine system.

The Pilliga formation conformably overlies the Purlawaugh Formation. The Pilliga Formation is described as medium to very coarse grained, well sorted, angular to subangular quartzose fluvial sandstone. Minor interbedded mudstone, siltstone and fine grained sandstone and coal. The Pilliga Formation is the major aquifer in the northern Gunnedah Basin.

The stratigraphy of the Gunnedah Basin is shown in Figure 4-2.

NEW STRATIGRAPHY (Tadros 1993a, e; 1995 & herein)							DEPOSITIONAL SYSTEMS (modified from Tadros 1988b, Tadros & Hamilton 1991, Hamilton 1993a & herein)
PERIOD	PALYNOLOGY ZONE	GROUP	SUBGROUP	FORMATION	MEMBER	SEAM	
TRIASSIC	MIDDLE	PT2.2- PT3		GARRAWILLA VOLCANICS			GARRAWILLA VOLCANICS
				DERIAH FORMATION			
	EARLY	PT1- PT2.1		NAPPERBY FORMATION			NAPPERBY LACUSTRINE SYSTEM
PERMIAN	LATE	PP5	BLACK JACK GROUP	DIGBY FORMATION	ULINDA SANDSTONE		DIGBY ALLUVIAL SYSTEM
					BOMERA CONG.		
				TRINKEY FORMATION	SPRINGFIELD C.M.	DOONA	EASTERN FLUVIAL SYSTEM
					CLIFT C.M.		
		PP4.3	COOGAL SUBGROUP	WALLALA FORMATION			
				CLARE SANDSTONE	BREEZA C.M.		LACUSTRINE & WESTERN FLUVIAL SYSTEMS
			BROTHERS SUBGROUP	BEHELARI F.M.	HOWES HILL C.M.		HOWES HILL C.M. SYSTEM
				BEHELARI F.M.	CAROONA C.M.		ARARU SHALLOW- MARINE SYSTEM
				PAMBOOLA FORMATION	MELVILLES C.M.		UPPER WATERMARK / LOWER BLACK JACK DELTA SYSTEMS
	EARLY	PP4.2	MILLIE GROUP	WATERMARK FORMATION			PORCUPINE- LOWER WATERMARK MARINE-SHELF SYSTEM
				PORCUPINE FORMATION			
		PP3.2- PP3.3	BELLATA GROUP	MAULES CREEK FORMATION		BROWN	LEARD-MAULES CREEK ALLUVIAL/ LACUSTRINE SYSTEMS
		PP3.1		GOONBRI & LEARD FORMATIONS			
		PP2.2					
		PP2.1		BOGGABRI VOLCANICS, WERRIE BASALT, METAVOLCANICS & METASEDIMENTS			BOGGABRI VOLCANICS & WERRIE BASALT

September 2007, GUNDAH 002a

Figure 4-2 Stratigraphy of Gunnedah Basin

4.1.6 Land use

The site is located on a rural property of approximately 160 hectares in size, predominantly used as a lifestyle property with occasional stock grazing. The nearest residential dwelling to the site is the landowner's residence located approximately 1.3 kilometres north of the lease area. The next nearest dwellings to the site are located approximately 1.4 kilometres to the north-north west and 1.4 kilometres to the south-east of the lease area.

The SRLUP identifies the site and surrounding land as having high CSG resources and underground coal exploration potential. Both CSG and coal mining are growing industries in the region with numerous existing CSG wells, and a number of existing mines located within 100 kilometres of the site. While PEL 238 is overlaid with mining titles, the site is not located within an existing mining title. Refer to Figure 4-3.

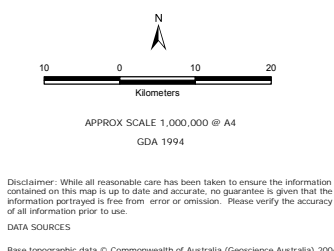
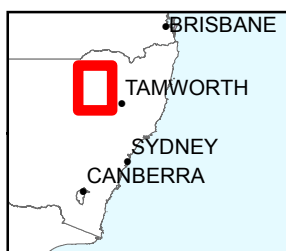
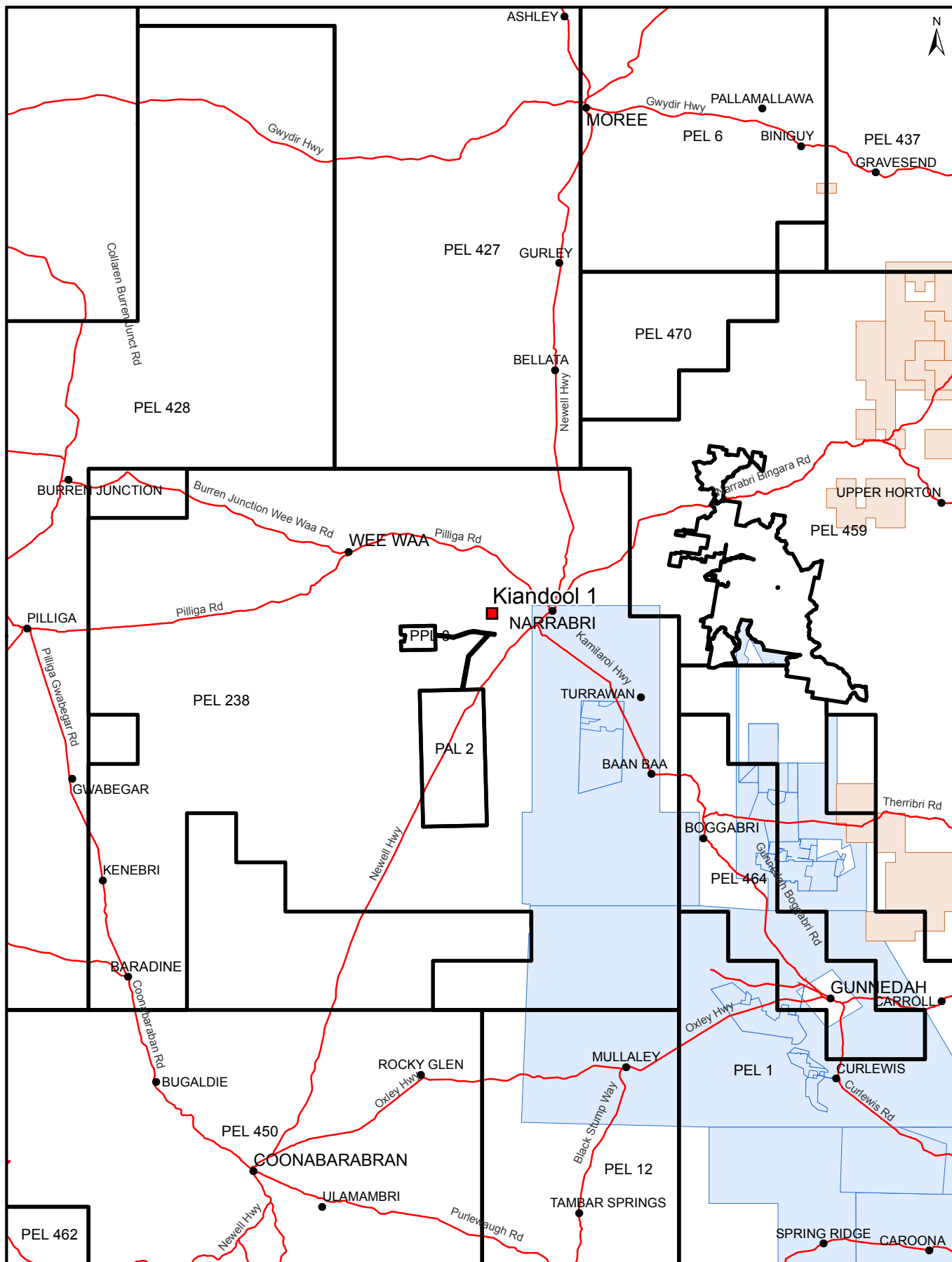
The dominant land use in the Namoi catchment is sheep and cattle grazing which accounts for 61 per cent of land use by area. Wheat, cotton and other broad acre crops are grown along the alluvial floodplains. Of the 1,120 square kilometres irrigated in the year 2000, around 800 square kilometres was used for cotton production in the Lower Namoi catchment (CSIRO, 2007).

The site is not located within land mapped as biophysical strategic agricultural land (SAL) under the SRLUP. Based on the broadscale mapping provided in the SRLUP, the nearest biophysical SAL is located approximately 2.1 kilometres north east of the site. Refer to Figure 4-4.

The site is not located within an Environmentally Sensitive Area of State Significance, as defined under State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) (refer Table 4-2).

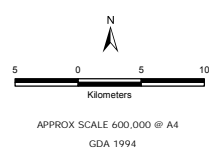
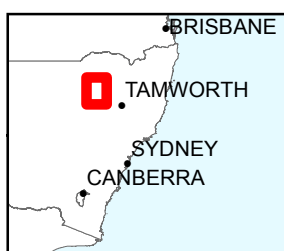
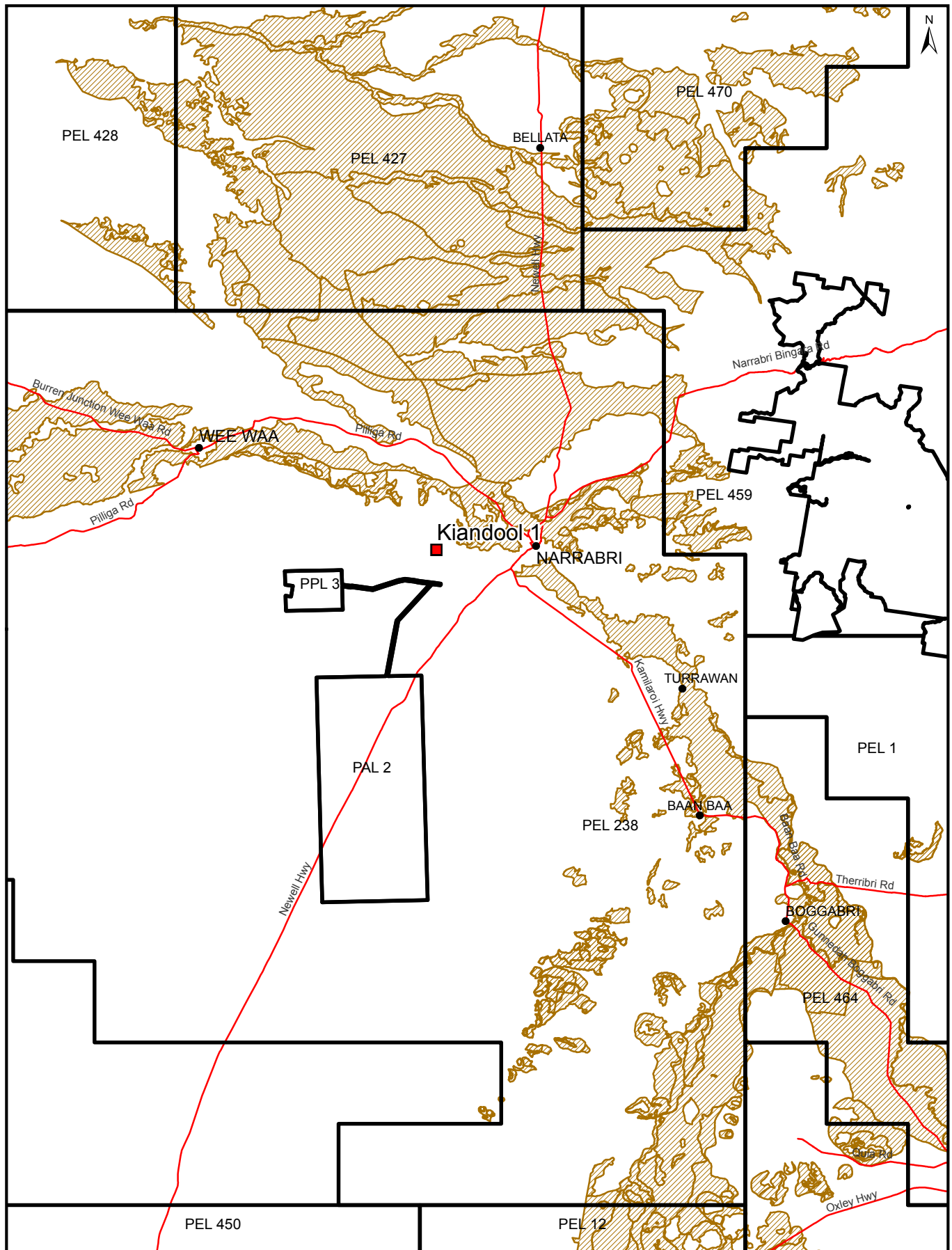
Table 4-2 Environmentally sensitive areas

Is the proposed activity located on or within any of the following:	Yes/No
Coastal waters of the State	No
Lands protected under SEPP 14 – Coastal Wetlands?	No
Lands protected under SEPP 26 – Littoral Rainforests?	No
Aquatic reserves dedicated under the <i>Fisheries Management Act 1994</i> or a marine park under the <i>Marine Parks Act 1997</i> ?	No
Wetland areas dedicated under the Ramsar Wetlands Convention?	No
A World Heritage Area declared under the World Heritage Convention?	No
Land identified in an environmental planning instrument as being of high Aboriginal cultural significance?	No
An area reserved or dedicated under the <i>National Parks and Wildlife Act 1974</i> ?	No
Land, places, buildings or structures listed on the State Heritage Register?	No
Is the proposed activity located within land reserved or dedicated within the meaning of the <i>Crown Lands Act 1989</i> for preservation of flora, fauna, geological formations or for other environmental protection purposes?	No
Land identified as being critical habitat under the <i>Threatened Species Conservation Act 1995</i> or Part 7A of the <i>Fisheries Management Act 1994</i> ?	No



- LEGEND**
- Kiandool 1 Core Hole
 - Town
 - Main Road
 - ▭ Petroleum Lease
 - Mineral Title
 - Coal Title

RPS
 FIGURE 4-3
 Mining Titles



Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

DATA SOURCES

Base topographic data © Commonwealth of Australia (Geoscience Australia) 2006.

LEGEND

- Kiandool 1 Core Hole
- Town
- Biophysical Strategic Cropping Land
- Main Road

Petroleum Lease



FIGURE 4-4

Strategic
Agricultural Land

4.1.7 Air and noise

There are few sensitive air and noise receptors surrounding the site. The nearest is located approximately 1.3 kilometres north of the lease area and approximately 170 metres from the access track at its nearest point.

Regional air quality is likely influenced by mining activities, grazing, land clearing and soil preparation, sowing and harvesting of crops, vehicle and heavy machinery movements, bushfires, burn-offs and use of combustion heaters. There are no OEH air quality monitoring stations within the local vicinity of the site; however, the primary air pollutants of concern within the Narrabri region are likely to be dust (particulate matter PM₁₀) caused by mining operations, transport of coal and farming activities such as ploughing, and fine particulates (PM_{2.5}) from vehicle emissions.

Birds and insects, wind and occasional vehicles travelling along Culgoora Road influence background noise levels at the site. Baseline noise monitoring has not been conducted at the site. A rating background level (RBL) of 30dB(A) is typical of rural areas and has been assumed for the purposes of noise assessment.

4.1.8 Infrastructure and services

Culgoora Road is a two-way two line rural road linking Narrabri to Culgoora and Wee Waa. The Walgett Branch rail line runs east alongside Culgoora Road. This line extends from the Main North rail line at Narrabri in the east to Walgett in the west. It is used to transport wheat and is operated by NSW Rail Corporation. The access track to the site crosses this rail line.

No known telecommunication, power, water or other services occur at the site.

4.2 Surface and groundwater sources

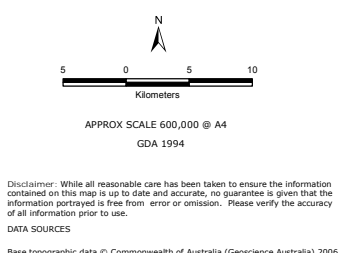
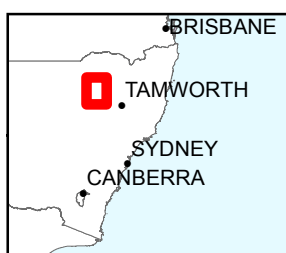
4.2.1 Surface water

The site is located within the Namoi River catchment which covers an area of approximately 42,000 square kilometres stretching from Woolbrook in the east to Walgett in the west. The catchment is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south and the Nandewar Ranges and Mount Kaputar to the north. Major tributaries of the Namoi River include Coxs Creek and the Mooki, Peel, Cockburn, Manilla and Macdonald rivers, all of which join the Namoi River upstream of Boggabri (NCMA, 2012).

The subject site is located within the Bohena sub-catchment of the Namoi River catchment. The Bohena sub-catchment covers an area of approximately 830 square kilometres south of Narrabri and is the northern extension of the Borah sub-catchment. The Bohena sub-catchment is drained by Bohena, Cowallah and Bibblewindi creeks (NCMA, 2012).

Figure 4-5 shows the drainage in the vicinity of the lease area. The main creek system within the study area is Bohena Creek. Pig Creek, a tributary of Bohena Creek, is located approximately 75 metres west of the proposed lease area boundary, within the neighbouring property, and runs adjacent to the existing access track. Pig Creek has been widened in a section north of the lease area and enters the property in this location (refer to Plate 3-5). The creek is located 15 metres from the access track at its closest point; however, is separated from the access track by a two metre high earthen bund in this location.

Surface water quality within the catchment is influenced by agricultural runoff, spray drift, and vapour transport (NCMA, 2012).



RPS

FIGURE 4-5
Drainage

4.2.2 Groundwater

Groundwater in the Namoi River catchment supports the irrigation industry and also provides the water supply for many towns and intensive industries. There are a total of 700 license holders in the Namoi River catchment (NOW, 2011). The Upper Namoi and Lower Namoi Alluvium form the principal aquifers of the Namoi River Catchment and are heavily used for irrigation (Schlumberger Water Services, 2012). The Namoi catchment is licensed to provide over 343,000 mega litres of groundwater entitlement per year.

The Namoi Alluvium is characterised by high permeability and storage capacity, and generally good water quality, though this varies within different layers (Schlumberger Water Services, 2012). The alluvium aquifer has a thickness of between 115 and 130 metres and some bores in the area yield more than 200 litres per second (NCMA, 2012). Permeability, storage and recharge rates are lower in the consolidated rocks surrounding the alluvium (Schlumberger Water Services, 2012).

The Great Artesian Basin (GAB) underlies the site. The GAB covers 1.7 million square kilometres and contains 8,700 million mega litres of artesian water. Aquifers of the GAB are generally suitable for domestic and town water supply (GABCC, 1998).

A licensed groundwater bore is located approximately 350 metres north of the proposed lease area, adjacent to the existing access track.

4.3 Threatened species, populations and ecological communities

An Ecological Assessment of the proposed activity was prepared by RPS and is attached at Appendix 1. The Ecological Assessment included:

- database searches, including the EPBC Act Protected Matters Search Tool and Atlas of NSW Wildlife, for threatened species, populations and ecological communities within 10 kilometres of the site
- review of aerial photography and National Vegetation Information Systems mapping within the vicinity of the site
- an ecological field survey on 20 June 2011.

The findings of the assessment are outlined below.

4.3.1 Flora

Threatened species database searches indicated records for six threatened flora species listed under the EPBC Act and/or TSC Act. These species and their threat status are identified in Table 4-3. None of the threatened flora species were identified within the site or surrounds despite targeted searches being carried out during the ecological field survey. No regionally significant flora was identified within the site.

Table 4-3 Threatened flora species records within 10 kilometres of site

Species	Listing ¹		Identified during field survey
	TSC Act	EPBC Act	
Ooline (<i>Cadellia pentastylis</i>)	V	V	No
Finger Panic Grass (<i>Digitaria porrecta</i>)	E	E	No
Spiny Pepper-cress (<i>Lepidium aschersonii</i>)	V	V	No
A leek orchid (<i>Prasophyllum</i> sp. <i>Wybong</i> (C. <i>Phelps</i> ORG 5269))	CE	CE	No

Species	Listing ¹		Identified during field
Cobar Greenhood Orchid (<i>Pterostylis cobarensis</i>)	V	V	No
<i>Tylophora linearis</i>	V	E	No

Table note: 1. CE = critically endangered, E = endangered, V = vulnerable

One listed noxious weed, Prickly Pear, was identified within the site. Prickly pears (includes all *Opuntia* species other than *O. ficus-indica*) are a Class 4 weed under the *Noxious Weeds Act 1993*. This means that the growth and spread of the weed must be controlled according to the measures specified in a management plan published by the local control authority, and the plant may not be sold, propagated or knowingly distributed.

4.3.2 Fauna

Threatened species database searches indicated records for 14 threatened fauna species listed under the EPBC Act and/or TSC Act and 10 migratory species listed under the EPBC Act within 10 kilometres of the site. These species are identified in Table 4-4. None of the threatened fauna species were identified within the site or surrounds despite targeted searches being carried out as part of the field survey.

Table 4-4 Threatened fauna species records within 10 kilometres of site

Species	Listing ¹		Identified during field survey
	TSC Act	EPBC Act	
Regent Honeyeater (<i>Anthochaera Phrygia</i>)	CE	EM	No
Red Goshawk (<i>Erythrotriorchis radiates</i>)	E	V	No
Squatter Pigeon (<i>Geophaps scripta scripta</i>)	E	V	No
Malleefowl (<i>Leipoa ocellate</i>)	E	VM	No
Superb Parrot (<i>Polytelis swainsonii</i>)	V	V	No
Australian Painted Snipe (<i>Rostratula australis</i>)	E	VM	No
Murray River Cod (<i>Maccullochella peelii peelii</i>)	-	V	No
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	V	V	No
South-eastern Long-eared Bat (<i>Nyctophilus corbeni</i>)	V	V	No
Brush-tailed Rock Wallaby (<i>Petrogale penicillata</i>)	E	V	No
New Holland Mouse (<i>Pseudomys pilligaensis</i>)	V	V	No
Koala (<i>Phascolarctos cinereus</i>)	V	V	No
Five-clawed Worm-skink (<i>Anomalopus mackayi</i>)	E	V	No
Border Thick-tailed Gecko (<i>Uvidicolus sphyrurus</i>)	-	V	No
Fork-tailed Swift (<i>Apus pacificus</i>)	-	M	No
Great Egret (<i>Ardea alba</i>)	-	M	No
Cattle Egret (<i>Ardea ibis</i>)	-	M	No
White Bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>)	-	M	No
White-throated Needletail (<i>Hirundapus caudacutus</i>)	-	M	No
Latham's Snipe (<i>Gallinago hardwickii</i>)	-	M	No
Rainbow Bee-eater (<i>Merops ornatus</i>)	-	M	No

Table note: 1. CE = critically endangered, E = endangered, V = vulnerable, M = Migratory

The Grey Crowned Babbler (*Pomatostomus temporalis temporalis*), listed as Vulnerable under the TSC Act 1995, was recorded in close proximity to the site during the field survey. While not detected during the field survey, the Superb Parrot (*Polytelis swainsonii*) is considered to have the potential to occur within the site.

4.4 Aboriginal cultural heritage

A due diligence cultural heritage investigation of the site was carried out in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales 2010* (DECCW 2012) (refer to Appendix 2). This investigation included a desktop review of the environmental and archaeological contexts of the site and surrounding area, a search of the Aboriginal Heritage Information Management Systems (AHIMS) database maintained by OEH, and an archaeological field survey on 20 June 2012.

The AHIMS search results indicated that there are no previously recorded Aboriginal heritage sites or previously declared Aboriginal places within one kilometre of the site (refer to Appendix 3 for search results). A review of previous literature indicated a number of sites within the broader Narrabri region, but none were located in close proximity to the proposed activity.

No Aboriginal heritage sites, objects or culturally modified trees were identified during the archaeological field survey. There is potential for Aboriginal objects to have been located in the vicinity of the site, as it is within 200 metres of waters (Pig Creek). However, the site is on disturbed land (as defined in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales 2010*) from previous agricultural activities. It is therefore reasonable to conclude, in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales 2010*, that there are no known Aboriginal objects or a low probability of objects occurring at the site.

No other landscape features, such as sand dune systems, ridge lines, cliff faces, caves or rock shelters, which indicate the likely existence of Aboriginal objects, are located within the vicinity of the site.

The *Native Title Act 1993* confirms that native title is extinguished over all freehold land validly granted on or before 23 December 1996. As this is freehold land, no native title claims, indigenous land use agreements or joint management arrangements will be affected by the proposed activity.

4.5 Historic cultural and natural heritage

Database searches indicated that there are no items of National Heritage significance within or in near proximity to the site. No items listed NSW State Heritage Register (or of State significance) occur within the site and no European heritage items listed under the Narrabri Local Environmental Plan 1992 (Narrabri LEP) occur in, or near the site. Several European heritage items of local or state significance listed under the Narrabri LEP or Commonwealth Register of National Estate occur within the Narrabri LGA. However, these are not located in the vicinity of the proposed activity.

No relics or items of European cultural heritage value were recorded on the site during the archaeological field survey.

5.0 Regulatory context

5.1 Commonwealth legislation

5.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) provides for the protection of certain Matters of National Environmental Significance (MNES) listed under the Act, which include:

- World Heritage Areas
- National Heritage Places
- Ramsar wetlands of international importance
- Commonwealth listed threatened species and ecological communities
- Listed migratory species
- Commonwealth marine areas
- Great Barrier Reef Marine Park
- Nuclear actions.

Under the EPBC Act, Commonwealth approval is required from the Minister of Sustainability, Environment, Water, Population and Communities (Minister) for any action that will have or is likely to have a significant impact on a MNES, or on the environment of Commonwealth land or on the environment if the action is proposed to be taken by a Commonwealth agency (known as a 'controlled action').

A person proposing to take a controlled action must refer the proposal to the Minister for determination. A person proposing to take an action that the person thinks is not a controlled action may refer the proposal to the Minister for the Minister's decision whether or not the action is a controlled action.

An EPBC Act Protected Matters Search Report was generated for a 10 kilometre radius surrounding the site to determine whether any MNES are likely to be affected the proposed activity. In addition, an Ecological Assessment was prepared to determine whether the proposed activity will be likely to impact on any nationally listed threatened species or ecological communities, or migratory species.

An assessment of the proposed activity against MNES is provided in section 6.6. The proposed activity will be unlikely to impact on any MNES, or the environment on Commonwealth land and is not proposed to be taken by a Commonwealth agency. Therefore, the proposed activity is unlikely to constitute a controlled action and Santos does not propose to lodge a referral to the Minister.

5.2 NSW legislation

5.2.1 Petroleum (Onshore) Act 1991

The *Petroleum (Onshore) Act 1991* (Petroleum Act) regulates the onshore exploration for and production of petroleum. Under the Petroleum Act, petroleum means:

(a) any naturally occurring hydrocarbon, whether in a gaseous, liquid or solid state, or

(b) any naturally occurring mixture of hydrocarbons, whether in a gaseous, liquid or solid state, or

(c) any naturally occurring mixture of one or more hydrocarbons, whether in a gaseous, liquid or solid state, and one or more of the following, that is to say, hydrogen sulphide, nitrogen, helium, carbon dioxide and water,

and includes any substance referred to in paragraph (a), (b) or (c) that has been returned to a natural reservoir, but does not include coal or oil shale or any substance prescribed to be a mineral for the purposes of the Mining Act 1992.

The holder of an exploration licence has the right to prospect for petroleum on the land comprised in the licence. The proposed activity will be undertaken within the area of PEL 238 granted under the Petroleum Act. Under PEL 238, the following categories of works can be undertaken:

Category 1

- geological mapping
- rock sampling (by hand held equipment)
- all reconnaissance drilling other than petroleum exploration holes
- geophysical surveys other than seismic
- airborne surveys

Category 2

- access tracks or line clearing involving formed construction or significant native vegetation disturbance

Category 3

- petroleum exploration holes
- seismic surveys.

The proposed activity falls under Category 3. Under Condition 1 of PEL 238, Category 3 activities require notification to the Division of Resources and Energy (within DTIRIS), and in most cases assessment under Part 5 of the EP&A Act and approval of the Division of Resources and Energy. This REF is being submitted in accordance with Condition 1 of PEL 238.

5.2.2 Environmental Planning and Assessment Act 1979

5.2.2.1 Overview

Development in NSW is assessed and approved under either Part 4 or Part 5 of the EP&A Act. Development is assessed under Part 5 if the relevant environmental planning instruments provide that the development does not require development consent and is not exempt development, and the development is either carried out by a determining authority or requires the approval of a determining authority.

The proposed activity falls within the Narrabri Shire LGA. The site is zoned as 1(a) General Rural under the Narrabri Local Environmental Plan 1992 (Narrabri LEP). The proposed activity is permissible with development consent under the Narrabri LEP; however, the Mining SEPP removes the requirement for development consent.

The Mining SEPP aims 'to provide for the proper management and development of mineral, petroleum and extractive material resources for the social and economic welfare of [NSW]'. Clause 6 of the Mining SEPP

provides that development for the purposes of petroleum exploration may be carried out without development consent. Clause 6 applies despite the provisions of the LEP. This has the effect that the proposed activity is required to be assessed under Part 5 of the EP&A Act.

A determining authority, for the purposes of this activity, is defined in Part 5 to include a public authority whose approval is required before an activity may be carried out. DTIRIS is the determining authority for the proposed activity for the purposes of Part 5 of the EP&A Act.

5.2.2.2 [Assessment under Part 5 of the EP&A Act](#)

Under Part 5 of the EP&A Act, a determining authority is required to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

The determining authority must consider whether the proposed activity is likely to significantly affect the environment or threatened species, populations or ecological communities, or their habitats to determine whether an Environmental Impact Statement (EIS) or Species Impact Statement (SIS) is required. In deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats, section 5A of the EP&A Act requires the following factors to be taken into account (the 'seven part' test of significance):

- (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,

(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.

This REF has been prepared to assist the determining authority in meeting the obligations of section 111 of the EP&A Act. The REF concludes that the proposed activity is not likely to significantly affect the environment or threatened species, populations or ecological communities or their habitats.

5.2.2.3 Narrabri Local Environmental Plan 1992

While the proposed activity does not require consent under Part 4 of the EP&A Act, consideration has been given to the relevant zone objectives under the Narrabri LEP. As stated above, the site is located within land zoned 1(a) General Rural, the objectives of which are to promote the proper management and utilisation of resources by:

- a) *protecting, enhancing and conserving:*
 - i. *agricultural land in a manner which sustains its efficient and effective agricultural production potential,*
 - ii. *soil stability by controlling and locating development in accordance with soil capability,*
 - iii. *forests of existing and potential commercial value for timber production,*
 - iv. *valuable deposits of minerals, coal, petroleum and extractive materials by controlling the location of development for other purposes in order to ensure the efficient extraction of those deposits,*
 - v. *trees and other vegetation in environmentally sensitive areas where the conservation of the vegetation is significant to scenic amenity or natural wildlife habitat or is likely to control land degradation,*
 - vi. *water resources for use in the public interest,*
 - vii. *areas of significance for nature conservation, including areas with rare plants, wetlands and significant habitats, and*
 - viii. *places and buildings of archaeological or heritage significance, including the protection of Aboriginal relics and places,*
- b) *preventing the unjustified development of agricultural land for purposes other than agriculture,*
- c) *preventing residential development of prime crop and pasture land, except where it is ancillary to agriculture or another use permissible in the zone,*
- d) *facilitating farm adjustments,*
- e) *ensuring that any allotment created for an intensive agricultural pursuit is potentially capable of sustaining a range of such purposes or other agricultural purposes,*
- f) *minimising the cost to the community of:*
 - i. *fragmented and isolated development of rural land, and*
 - ii. *providing, extending and maintaining public amenities and services.*

The proposed activity will contribute to promoting efficient extraction of valuable deposits of minerals, coal and petroleum. The site's location outside of the main town centre will minimise potential impacts to the surrounding community. Therefore, the proposed activity is considered to be a suitable activity within zone 1(a) (General Rural).

5.2.2.4 State Environmental Planning Policy No. 44 – Koala Habitat Protection

State Environmental Planning Policy No. 44 – Koala Habitat Protection (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'.

Schedule 1 of SEPP 44 lists LGAs to which SEPP 44 applies and includes the Narrabri LGA. SEPP 44 applies to local councils determining development applications under Part 4 of the EP&A Act. Although SEPP 44 does not apply in relation to the assessment of development under Part 5 of the EP&A Act, it has been considered in the preparation of this REF.

SEPP 44 requires that before granting development consent under Part 4 of the EP&A Act for development on land over 1 hectare in area, a consent authority must form a view as to whether the land is 'potential' or 'core' koala habitat. Potential koala habitat is defined as:

areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

Core koala habitat is defined as:

an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

Where core koala habitat is found to occur, SEPP 44 requires that a site-specific koala plan of management be prepared.

RPS undertook field surveys across the site as part of an Ecological Assessment (refer to Appendix 1). No Koala food tree species were found to be present on the site. Therefore, the site is not considered to be potential or core Koala habitat.

5.2.3 **Threatened Species Conservation Act 1995**

The TSC Act sets the framework for the listing of threatened species, populations and ecological communities, and key threatening processes in NSW, and the preparation and implementation of recovery plans and threat abatement plans.

The TSC Act also provides the mechanism for applying for and obtaining licences to take actions, which could result in harm to a threatened species, population or ecological community, or their habitat, or damage to critical habitat.

Section 5A of the EP&A Act lists seven factors that must be taken into account in determining the significance of a potential impact on 'threatened species, populations or ecological communities (or their habitats)' listed under the TSC Act (refer to section 5.2.2). The assessment of significance (7-part test) is used to determine whether activities are 'likely' to cause 'a significant impact' on threatened biota and thus whether an SIS is required.

The Ecological Assessment prepared for the proposal identified a number of threatened species and ecological communities as having the potential to occur on the site. One threatened fauna species, the Grey Crowned Babbler, listed as Vulnerable under the TSC Act was recorded within approximately 500 metres of the site. One species, the Superb Parrot, was considered as having potential to occur within the site, however was not recorded during the field survey. Given that the species are highly mobile and the habitat

on site is not considered to be a core habitat, a 7-part test was not considered necessary for the proposed activity.

5.2.4 National Parks and Wildlife Act 1974

5.2.4.1 Threatened species

Part 8A of the *National Parks and Wildlife Act 1974* (NPW Act) regulates the undertaking of activities, which may impact on threatened species, populations and ecological communities listed under the TSC Act and their habitats. The NPW Act provides that a person must not harm any animal that is a threatened species, population or ecological community, pick any plant which is part of a threatened species, population or ecological community, damage any critical habitat or damage any habitat of a threatened species, population or ecological community without a licence being obtained under the NPW Act or TSC Act or unless another exception applies.

The NPW Act provides that these requirements do not apply if the action was essential for the carrying out of an activity in accordance with an approval of a determining authority under Part 5 of the EP&A Act where the determining authority has complied with Part 5. This REF has been prepared to assist the determining authority to comply with Part 5 of the EP&A Act (refer to section 5.2.2).

5.2.4.2 Aboriginal cultural heritage

The NPW Act conserves places, objects and features of significance to Aboriginal people.

It is an offence under the NPW Act to:

- harm or desecrate an object that the person knows is an Aboriginal object except in accordance with an Aboriginal heritage impact permit (AHIP)
- harm or desecrate Aboriginal objects and Aboriginal places except in accordance with an Aboriginal heritage impact permit or where the person can show they exercised due diligence to reasonably determine that no Aboriginal object will be harmed.

A cultural heritage assessment of the site was prepared in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales 2010* (DECCW 2012). The assessment determined that the proposed activity will not impact on any known Aboriginal objects or places. Provided that the mitigation measures identified in section 6 are carried out, impacts to any unknown Aboriginal objects or places should be avoided. Therefore, an AHIP is not required for the proposed activity.

5.2.5 Native Vegetation Act 2003

The *Native Vegetation Act 2003* (NVA) seeks to encourage revegetation and rehabilitation of land with appropriate native vegetation, provide incentives to landholders to manage native vegetation on their properties, and end broad scale clearing, unless it improves or maintains the environment.

Under section 25(h), the NVA does not apply to any clearing that is part of an activity carried out in accordance with an approval under Part 5 of the EP&A Act. Under section 25(m), the NVA does not apply to any clearing authorised under the Petroleum Act.

5.2.6 Protection of the Environment Operations Act 1997

The primary objective of the *Protection of the Environment Operations Act 1997* (NSW) (POEO Act) is to 'protect, restore and enhance the quality of the environment in New South Wales, having regard to the need

to maintain ecologically sustainable development'. The POEO Act requires environmental protection licences (EPLs) be obtained for the carrying out of 'scheduled activities' or pollution of waters.

The proposed activity will involve the transport of a trackable waste listed under Schedule 1 of the POEO Act. This will be carried out by a waste contractor with the appropriate EPL.

The proposed activity does not involve a 'scheduled activity' and it is not proposed to obtain an EPL.

5.2.7 Heritage Act 1977

The main objective of the *Heritage Act 1977* (Heritage Act) is to encourage the conservation of the heritage of NSW. The site is not listed on the State Heritage Register under the Heritage Act.

The Heritage Act also prevents impacts on 'relics', which are defined as:

any deposit, artefact, object or material evidence that:

(a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and

(b) is of State or local heritage significance.

Under the Heritage Act, it is an offence to disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed unless the disturbance or excavation is carried out in accordance with an excavation permit. No items of heritage significance listed under either the Narrabri LEP 1992 or on the NSW State Heritage Register occur on the site. A number of items of local and State heritage significance occur within the Narrabri LGA, however these are not located in close proximity to the site.

5.2.8 Water Act 1912 and Water Management Act 2000

The *Water Act 1912* (Water Act) and *Water Management Act 2000* (WMA) are the key pieces of legislation regulating access and impacts to surface and groundwater resources in NSW. Where a water sharing plan is in place, the WMA governs the issuing of water access licences (WALs) and water management and activity approvals. There are five water sharing plans in force for surface and ground water surrounding or beneath the subject site, including:

- Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2012
- Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources
- Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012
- Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources 2008
- Water Sharing Plan for the Upper Namoi and Lower Namoi Groundwater Sources 2006

Therefore, the WMA applies to the proposed activity.

5.2.8.1 [Water access licences](#)

Under Part 2 of the WMA, it is an offence to take water from a source regulated by the WMA unless in accordance with a water access licence (WAL). Water used for the proposed activity will be sourced from Narrabri's potable town water supply or a reverse osmosis plant in the Narrabri area and will not require a WAL.

A WAL is also required for the taking of groundwater, whether for consumption or incidentally, unless an exemption applies. The proposed activity is not expected to produce any groundwater. Notwithstanding, exemptions for requiring WALs are listed under Part 1 of Schedule 5 of the Water Management (General) Regulation 2011 (WM Regulation) and include:

Any person lawfully engaged in prospecting or fossicking for minerals or petroleum under the Mining Act 1992 or the Petroleum (Onshore) Act 1991—in relation to:

(a) the taking of water required for such prospecting or fossicking pursuant to a lease, licence, mineral claim or environmental assessment permit under the Mining Act 1992 or a petroleum title under the Petroleum (Onshore) Act 1991 (an authority), up to a maximum of 3 megalitres for all such prospecting or fossicking pursuant to each such authority in any water year, and

(b) the taking of up to 3 megalitres of water required for all other such prospecting or fossicking in any water year.

If approved, the proposed activity will be carried out within PEL 238 under the Petroleum Act and therefore would be unlikely to require a WAL in the event that some groundwater is produced.

5.2.8.2 [Flood work approval](#)

Under section 90 of the WMA, a flood work approval is required to construct and use flood work at a specified location. Flood work is defined within the WMA and includes a work in the vicinity of a river or within a floodplain (as declared under the WM Regulation) that is of such a size or configuration that it is likely to have an effect on the flow of water to or from a river or the distribution or flow of floodwater in times of flood. Clause 13 of Schedule 9 of the WMA Act provides that any land that was designated as a floodplain under Part 8 of the Water Act is taken to be a floodplain for the purposes of the WMA Act. The Namoi River - Narrabri to Wee Waa floodplain, as declared under the Water Act, is located nearby but not on the site. The proposed activity is considered unlikely to affect the flow of water to or from any river, or the distribution or flow of floodwaters. Therefore, a flood work approval is not required for the proposed activity.

5.2.8.3 [Aquifer interference approvals](#)

Under section 91 of the WMA, an aquifer interference approval is required to penetrate, interfere or obstruct flows within an aquifer, or take or dispose of waters from an aquifer. Accordingly, an aquifer interference approval will be required for the drilling activities.

Section 97(6) of the WMA states that ‘an aquifer interference approval is not to be granted unless the relevant Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to the aquifer, or its dependent ecosystems, as a consequence of its being interfered with in the course of the activities to which the approval relates’.

The *NSW Aquifer Interference Policy* (the Policy) was released in September 2012 to clarify the requirements for obtaining water licences and approvals for aquifer interference activities. The Policy establishes and objectively defines minimal impact considerations for groundwater sources, connected water sources, and their dependent ecosystems, culturally significant sites and water users.

Section 3.3 of the Policy defines a number of activities that are considered to have a minimal impact on water-dependant assets, and includes:

- monitoring bores and wells that are undertaken as a result of an environmental assessment under Part 5 of the EP&A Act and constructed and decommissioned in accordance with standards equivalent to the *Minimum Construction Requirements for Water Bores in Australia*

- core holes intersecting the water table if they are decommissioned in such a way as to restore aquifer isolation to that which existed prior to the construction of the bore, work or activity and that the decommissioning is conducted within a period of 28 days following completion of the bore, work or activity.

The proposed activity is consistent with the above definitions and having regard to it being a corehole and monitoring bore it is considered to have a minimal impact on water-dependant assets.

5.2.8.4 Controlled activity approval

Under section 91 of the WMA, a controlled activity approval is required to carry out specified controlled activities on waterfront land. Waterfront land is taken to mean land within 40 metres of a water body. Controlled activities include the removal of vegetation or material, or deposition of material.

Clause 39 of the WM Regulation provides that activities specified in Part 2 of Schedule 5 of the regulation are exempt from requiring controlled activity approvals under the WMA. Part 2 of Schedule 5 includes any activity carried out in accordance with a right in force under the Petroleum Act. Therefore, a controlled activity approval is not required for the proposed activity.

6.0 Potential environmental impacts and mitigation

This section of the REF addresses the potential environmental impacts associated with the proposed activity and identifies mitigation measures to ensure any impacts are appropriately managed.

Potential impacts have been categorised in accordance with the ESG2 Guidelines. Impact categories include:

- negligible
- low adverse
- medium adverse
- high adverse
- positive.

6.1 Physical and chemical aspects

6.1.1 Soil quality and land stability

6.1.1.1 [Potential impacts](#)

The proposed activity may require vegetation clearing, top soil removal and earthworks for establishment of the lease area and upgrading of the access track. The total area of disturbance will be up to one hectare for the lease area and up to 1.2 hectares for the access track. Any topsoil and spoil generated during site preparation activities will be stockpiled on site for the duration of site preparation, drilling, testing and completion activities until rehabilitation of the site occurs.

While the site is relatively flat, any vegetation clearing and earthworks will increase the site's erosion potential and may result in loss of topsoil/spoil, and sedimentation of waterways, particularly Pig Creek. Potential impacts to surface waters are further discussed in section 6.1.2.

Incomplete or inadequate rehabilitation of the site could create long term erosion and land stability issues.

Drilling activities will produce drilling fluid and drill cuttings. These materials are unlikely to present an erosion hazard as drilling mud and cuttings will be contained in surface tanks, metal bins or lined pits.

Delivery trucks and personnel vehicles exiting the site may track sediments onto Culgoora Road.

Erosion and sedimentation will be reduced through the measures identified in section 6.1.1.2.

The proposed activity could result in soil contamination as a result of spilled or leaked chemicals (such as drilling fluid additives), fuel or oil. Spills or leaks could occur during handling, use, storage or transit of chemicals, fuels and oils. Spills or leaks may also occur during refuelling or maintenance of plant or equipment.

There is minimal risk of soil contamination occurring due to the use of drilling mud as this will be water-based and will contain non-toxic additives. Drilling mud and cuttings are therefore unlikely to be contaminated.

Measures to reduce the risk of contamination as a result of the proposed activity are identified in section 6.1.1.2.

6.1.1.2 Mitigation measures

The management process for drilling mud and cuttings, described in section 2.7.2 of the REF, will safeguard against contamination of the site. The following measures will be implemented to minimise potential impacts to soils and reduce the risk of contamination:

- Culgoora Road will be closely monitored during the works and where necessary, a street sweeper will be called to clean up any sediment tracked onto the road.
- Where the lease area is constructed using traditional methods (instead of using industrial matting), topsoil and other soil horizons will be stripped, handled and stockpiled separately.
- Excess spoil generated during site preparation activities will be stockpiled on site and used as backfill during site rehabilitation. No uncontaminated soil or spoil will be removed from the site.
- Stockpiles will be managed according to best management practices such as the measures outlined in *Managing Urban Stormwater: Soils and Construction* (Landcom 2004) ('the Blue Book') or the *Best Practice Erosion and Sediment Control Guidelines* (IECA, 2008) (IECA Guidelines). This will include:
 - » Maintaining topsoil stockpiles at a height of no greater than two metres to preserve the seed bank.
 - » Stabilising stockpiles using a temporary sterile cover crop or other acceptable materials once site preparation activities are completed, until rehabilitation can take place.
- Erosion and sediment controls will be implemented where necessary during site preparation activities, including lease area construction and any upgrades to the existing access track, in accordance with best management practices (such as the Blue Book or IECA Guidelines). These controls will be maintained until disturbed areas of the site are stabilised.
- The site will be rehabilitated in accordance with section 2.6.9 of the REF.
- The quantity of chemicals, fuels and oils stored on site will be minimised, where practicable.
- All additives, chemicals, fuels and oils stored on site will be kept in an appropriately secured, bunded storage shed in accordance with the relevant MSDS.
- An MSDS register of all chemicals used or stored on site will be maintained.
- Maintenance of vehicles, plant and equipment will occur off site at an appropriately licensed facility unless deemed appropriate to conduct such maintenance on site.
- Refueling of plant and equipment will occur in a designated, bunded area, at least 40 metres from the nearest waterway.
- A spill kit will be available on site and personnel will be trained in its use.
- Any spills or leaks will be contained and cleaned up immediately using the spill kit. Contaminated material (such as contaminated soil or absorbent materials) will be placed in a bag and removed from the site for disposal at a licensed waste facility.
- Plant and equipment will be inspected daily to ensure these are properly maintained.

6.1.1.3 [Potential impact category](#)

With the implementation of mitigation measures, potential impacts are likely to be negligible to low adverse.

6.1.2 **Surface water**

6.1.2.1 [Potential impacts](#)

As discussed in section 6.1.1, any vegetation clearing, earthworks and stockpiling activities required for lease establishment will increase the erosion potential of the site. This may result in increased sediment loads in surface runoff, which could increase turbidity and suspended sediment loads of receiving waters including Pig Creek and the Bohena Creek system. Runoff is not expected to be significant given the flat nature of the site and moderate average rainfall.

There is potential for drilling mud to be spilled due to overflow of surface tanks or as a result of tank failure, during the drilling process, or during transit to and from the site. This could result in pollution of Pig Creek or other waterways with sediment and other contaminants.

There is potential for chemicals, fuels or oils used or stored on site to leak or spill and enter drainage lines or Pig Creek and degrade local water quality. Litter from personnel on site may enter waterways and degrade water quality.

Pollutants or wastewater could be discharged to Pig Creek or other waterways during general site activities such as vehicle washing or dust suppression.

The proposed activity is unlikely to significantly affect the distribution or flow of floodwaters. Sediment, contaminants or gross pollutants may be released into waterways as a result of flooding and inundation of the site.

6.1.2.2 [Mitigation measures](#)

The measures identified in section 6.1.1.2 will minimise impacts to surface water and the site will be rehabilitated in accordance with section 2.6.9 of the REF. The following additional measures will be implemented:

- Drilling mud will be contained in surface tanks which will be regularly inspected and maintained.
- Over-balanced drill techniques will be used to prevent formation fluid from rising through the well to the surface.
- Drilling mud will be transported to and from the site by an appropriately licensed contractor as outlined in section 2.7.2 of the REF.
- Wastewater generated through general site activities will be removed by an appropriately licensed contractor for disposal at a licensed facility that is able to accept liquid waste or treated to an appropriate quality prior to discharging.
- A minimum freeboard of 300 millimeters will be maintained for any tanks or pits containing liquid waste.
- Weather forecasts will be monitored and in the event that prolonged, severe wet weather or flooding is predicted, works will cease and plant, machinery and any chemicals will be secured and banded.

6.1.2.3 [Potential impact category](#)

Given the temporary duration of the proposed activity, potential impacts to surface waters are expected to be negligible to low adverse provided that the identified mitigation measures are implemented. Any impacts on the existing flood regime will be negligible.

6.1.3 **Groundwater**

6.1.3.1 [Potential impacts](#)

Due to the type of activity proposed, water from the targeted coal seams is not proposed to be lifted. Potential impacts to groundwater associated with drilling and well installation may result from drilling, well installation or abandonment if not carried out correctly.

Potential impacts of drilling in mixed multi-aquifer systems include:

- creating an artificial connection between water-bearing formations that bypasses aquitards or aquicludes resulting in cross contamination of aquifers
- contamination of the aquifers by drilling fluids or mud if these are lost in the formation
- groundwater discharging to the surface, which might cause flooding or impact on surface water quality depending on the discharge and receiving water qualities.

Groundwater contamination could occur due to spills of oil, fuels or chemicals if not cleaned up appropriately.

6.1.3.2 [Mitigation measures](#)

The measures identified in section 6.1.1.2 will minimise potential impacts to groundwater. In addition, the following mitigation measures will be implemented to minimise potential impacts on groundwater sources:

- The well will be designed and constructed in accordance with the *NSW Coal Seam Gas Code of Practice Well Integrity* (DTIRIS 2012b).
- A driller that holds a license under the National Water Drillers Licensing Accreditation Scheme will be on site during drilling of the top hole and until the surface casing is set, cemented and pressure tested. During this time, there will be 24 hour coverage by one person working the day shift and on call at site during the night.
- A NOW hydrogeologist will be notified at least 28 days prior to the commencement of drilling.
- Drilling operations, well control, waste management and abandonment procedures for the core hole will be in accordance with accepted industry practices and in accordance with the processes outlined in this REF.
- Prior to commencing drilling, Santos will seek permission (from landowners) to access registered groundwater monitoring bores within two kilometers of the site to undertake groundwater monitoring for the purposes of establishing baseline conditions. Where access to bores is granted (and the bore is functioning), monitoring will include water level measurements and quality observations in the field, and sampling for analysis by an accredited laboratory.
- Santos will offer (to landowners) to undertake groundwater monitoring at registered groundwater monitoring bores within two kilometers of the site at the completion of drilling.

- Excessive drilling mud losses will be cured by loss circulation material (cellulose material such as sawdust or other benign naturally occurring substances, as required) to ensure most fluids return to the surface.
- The well will be decommissioned as soon as it is no longer required.
- Data will be collected from the well to measure permeability of the various strata.

6.1.3.3 [Potential impact category](#)

The proposed drilling and well construction and completion method will significantly reduce the risk of impacts to groundwater sources. The risk of groundwater contamination due to spills or leaks on site will be reduced through spill containment and clean up procedures.

Given the temporary duration of the proposed activity, provided that the identified mitigation measures are implemented, a negligible to low adverse impact on groundwater sources is expected.

6.1.4 **Hazardous substance and chemical use**

6.1.4.1 [Potential impacts](#)

The proposed activity will require the use of chemicals, fuels and oils, particularly during drilling activities, as described in section 2 of the REF. While these substances are not highly hazardous, potential impacts may occur due to their improper use, transport or storage, or in the event of an incident. Such impacts could include outbreak of fire, or pollution of land, water or air.

No chemicals with added benzene, toluene, ethylbenzene, and xylenes (BTEX) will be used.

6.1.4.2 [Mitigation measures](#)

The measures identified in section 6.1.1.2 will minimise potential impacts and risks associated with the use of hazardous substances and chemicals. In addition, the following mitigation measures will be implemented:

- Random sampling of drilling mud and drill cuttings will be undertaken to monitor for the presence of BTEX.
- Chemicals and potentially hazardous substances will be used and stored according to regulatory requirements including the *Work Health and Safety Act 2011*.
- Any dangerous goods will be transported according to regulatory requirements under the *Dangerous Goods (Road and Rail Transport) Act 2008*.

6.1.4.3 [Potential impact category](#)

Potential impacts associated with chemical and hazardous substance use can be appropriately managed with the identified mitigation measures. A negligible to low adverse impact from chemical and hazardous substance use is expected.

6.1.5 **Air quality and greenhouse gases**

6.1.5.1 [Potential impacts](#)

Potential air emissions from the proposed activity will include:

- dust generated during clearing, access track and well lease excavation and core hole drilling
- exhaust emissions from vehicle movements to and from the site
- exhaust emissions from plant and machinery operations on site

- venting of CH₄ and carbon dioxide CO₂ from drilling and testing activities.

Dust levels generated by the proposed activity will vary depending on weather conditions.

The main air pollutants associated with vehicle, plant and machinery exhaust emissions include fine particulates (PM_{2.5}), carbon monoxide, oxides of nitrogen, carbon dioxide and hydrocarbons. These pollutants generally dissipate with distance from the source and are unlikely to affect surrounding sensitive receptors given the distance to these receptors.

Direct greenhouse gas emissions from the proposed activity will include:

- exhaust from plant and machinery
- small quantities of CH₄ and CO₂ release during drilling and venting.

6.1.5.2 [Mitigation measures](#)

The following measures will be implemented to minimise impacts on air quality and reduce greenhouse gas emissions:

- The area of disturbance will be limited to the minimum required to carry out the proposed activity safely and efficiently.
- Dust will be suppressed as required by spraying water along the access track and lease area.
- If necessary, the access track will be sealed to prevent excessive dust emissions.
- Site speed limits will be imposed to minimise dust generated by vehicle movements.
- Vehicles, plant and equipment will be regularly maintained to ensure they are in good operating condition.
- Vehicles, plant and machinery will be turned off when not in use rather than left idling.

6.1.5.3 [Potential impact category](#)

Greenhouse gas emissions generated by the proposed activity will not significantly contribute to State or National greenhouse gas emissions given the scale and temporary nature of the proposed activity. Dust and other air emissions can easily be managed with the identified mitigation measures. Therefore a negligible impact on air quality is expected.

6.1.6 Noise

6.1.6.1 [Noise criteria](#)

The assumed RBL for the site is 30dB(A). This is the minimum RBL considered in NSW under the *NSW Industrial Noise Policy* (INP) (EPA, 2000). Noise generating works associated with the proposed activity will occur over approximately three months and will therefore be similar to construction noise. Potential noise impacts of the proposed activity have been assessed according to methodology provided in the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009).

The ICNG recommends the following noise management levels for construction activities:

Time of day	Noise management level	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm and Saturday 8am to	Noise affected RBL + 10 dB(A)	The noise affected level represents the point above which there may be a reaction to noise. Where the predicted or measured noise level (L _{Aeq, 15 minute}) is greater than the noise affected level, all reasonable and feasible work practices should be applied to meet the noise affected level. All potentially impacted residents should be informed of the nature of works to

Time of day	Noise management level	How to apply
1pm		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 reaction to noise. Where noise is above this level, the determining authority may require respite periods by restricting the hours that the very noisy activities can occur.
Outside recommended standard hours	Noise affected RBL + 5 dB(A)	A strong justification would typically be required for works outside the recommended standard hours. All feasible and reasonable work practices should be applied 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 affected receiver.

Source: *Interim Construction Noise Guideline (DECC 2009)*

Drilling and completion activities may occur outside of the recommended standard construction hours. This is considered to be justified as it will make efficient use of remote machinery and workforce, and will shorten the overall duration of the proposed activity.

Based on an assumed RBL of 30 dB(A), the noise affected level for works during standard hours is 40 dB(A) and outside of standard hours is 35 dB(A). The RBL and noise affected levels will be confirmed prior to works commencing.

6.1.6.2 [Potential impacts](#)

The proposed activity will generate noise during site preparation, drilling and completion activities. The noisiest activities will occur during drilling and construction of the well.

Noise consultants, Wilkinson Murray, carried out source noise testing and prediction modelling of drilling/well construction activities to assist Santos in planning works in the Gunnedah Basin. The testing and modelling results are included in Appendix 4. While noise testing occurred on a heavier rig than would typically be used to drill a core hole, and are therefore conservative, the results have been used to determine whether drilling activities at Kiandool 1 can comply with the noise affected level.

The offset distances required to achieve the noise affected level outside of standard hours during still, isothermal meteorological conditions, over flat ground, are provided in Table 6-1.

Table 6-1 Offset distances required to comply with noise affected level

Noise source	Noise affected level	Offset distance
Drilling (including engine noise and mud pump)	35 dB(A)	1200 m
Cementing casing (including high pressure concrete truck)	35 dB(A)	800 m

The results indicate that, during still isothermal conditions, noise levels from drilling activities should achieve 35 dB(A) at the nearest sensitive receiver, which is located approximately 1.3 kilometres from the lease area.

Meteorological conditions at the site will vary and these can affect noise propagation. Temperature inversions during still conditions represent the worst-case meteorological conditions for noise propagation. Temperature inversions usually occur at night.

The modelling carried out by Wilkinson Murray indicates that a temperature inversion of 3°C/100 metre may result in drilling activities exceeding the noise affected level (outside of standard hours) at the three nearest sensitive receivers (being located at distances of 1.3 kilometres north, 1.4 kilometres north-north west and 1.4 kilometres south-east of the proposed lease area). It is important to note however that this result is based

on use of a heavy drill rig. The proposed activity will require use of a smaller rig, which may achieve the noise affected level at the nearest sensitive receiver.

Wilkinson Murray notes that external noise levels of 40 dB(A) would cause little or no interruption to a person's sleep, with windows open.

The nearest sensitive receiver may also be affected by noise from construction vehicles travelling along the access track, or any access track upgrade works. It is unlikely that the next two nearest sensitive receivers would be impacted by noise from construction vehicles or machinery along the access track given the distances from these receivers to the site. Notwithstanding, any impacts will be temporary and will be managed through consultation with the landowner and two next nearest sensitive receivers as identified in section 2.3.1.

6.1.6.3 [Mitigation measures](#)

The noise management strategy outlined in section 2.7.4 will be implemented. The following measures will be implemented to manage potential noise impacts of the proposed activity:

- Consultation with the landowner and two next nearest sensitive receivers will be carried out in accordance with section 2.3.1 of the REF.
- Background noise monitoring will be conducted at the site prior to the commencement of works to confirm the rating background level and noise affected level for recommended standard hours and outside of standard hours.
- Prior to arriving on site, source noise levels of the drilling rig will be confirmed to verify noise impacts and confirm the management approach.
- Noise monitoring will be carried out at the commencement of drilling and cementing activities to confirm noise levels at the nearest sensitive receiver.
- Where noise levels exceed the noise affected level, feasible and reasonable work practices will be implemented to achieve the noise affected level. Further noise monitoring will be carried out to determine the effectiveness of mitigation measures.
- In the event of a noise complaint, the effectiveness of noise mitigation measures will be assessed and additional feasible and reasonable measures will be implemented, where necessary.

6.1.6.4 [Potential impact category](#)

Potential noise impacts from the proposed activity will be temporary and can be managed through the identified mitigation measures and are therefore expected to be low adverse.

6.1.7 **Waste**

6.1.7.1 [Potential impacts](#)

The proposed activity will generate a number of waste streams, as identified in section 2.7.1 of the REF. Potential impacts associated with the generation and disposal of these wastes include:

- leaching of chemicals and other pollutants into groundwater, soils or surface water
- pollution or contamination of land or water due to illegal dumping of waste, lack of suitable containment of waste
- littering of the site, surrounding properties or surface waters due to lack of suitable containment of waste

- odours caused by improper storage or treatment of putrescible waste.

6.1.7.2 [Mitigation measures](#)

The waste management strategy described in section 2.7.2 will be implemented for the proposed activity. In addition, the following measures will be carried out to minimise waste and potential impacts associated with waste generation and disposal:

- Management of waste, including its transport, will comply with the POEO Act and POEO (Waste) Regulation.
- Appropriate waste receptacles will be provided on site including covered rubbish bins for disposal of domestic wastes.
- Waste materials will be separated, classified and managed in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (DECCW 2009).
- Drilling mud will be managed according to the process described in section 2.7.2.
- All wastes will be removed from the site at the completion of drilling for recycling or disposal at an appropriately licensed facility.
- The type and volume of all waste removed from the site will be recorded.
- Portable toilets will be provided on site and will be regularly serviced by a licensed contractor.
- All staff and contractors will be made aware of waste management procedures during the site induction and through toolbox talks.
- Chemical, fuel and oil containers will be managed according to the MSDS or manufacturers' directions to avoid potential impacts to the environment or human health.

6.1.7.3 [Potential impact category](#)

Potential impacts associated with waste generation and management can be appropriately managed with the identified mitigation measures. A low adverse impact is expected.

6.2 Biological

6.2.1 Flora and fauna

6.2.1.1 [Potential impacts](#)

A range of short-term impacts may result from the proposed activity as a result of vegetation removal, topsoil disturbance and other construction activities. These impacts will be temporary and minor. The site is located within an area that has been heavily disturbed by past land clearings.

Flora

Approximately one hectare of 'Ironbark shrubby woodlands of the Pilliga area, Brigalow Belt South' community will need to be cleared to establish the lease area. The vegetation to be removed is considered to be a disturbed remnant of this community and is not commensurate with any TECs listed under the TSC Act or EPBC Act.

Approximately 0.06 hectares of *Angophora floribunda* Forest may need to be cleared for construction of the new access track, if required. This vegetation does is not commensurate with any TECs listed under the TSC Act or EPBC Act.

The proposed activity is unlikely to impact on any threatened flora species. While six threatened flora species were identified as having the potential to occur within the site or surrounds, none were identified during the field survey despite targeted searches for these species being conducted. Given this, and that the proposed activity will result in only the temporary disturbance of a small area of habitat for these species, it is considered highly unlikely that the proposal will result in a significant impact to these species. Therefore, 7-part tests for these species were not considered necessary.

The proposed activity has the potential to introduce weeds to the site or spread existing weeds throughout the site or surrounding area. Soil, seed or vegetation attached to plant, machinery, vehicles or personnel may transfer weeds to or from the site. Activities such as clearing and earthworks may create favourable conditions for weeds and encourage weed growth.

Fauna

The area of vegetation to be removed has little habitat value and does not comprise core habitat for any threatened fauna species or populations.

Noise generated by vehicles, machinery and drilling may deter native fauna from the site or surrounding areas, which may affect the migration and dispersal ability of native fauna. The breeding cycle, roosting, sheltering and foraging behaviour of some fauna species may be impacted by noise, lighting and vehicle traffic. Potential impacts will likely only affect individuals and will be temporary for the duration of construction and drilling activities.

The proposed activity will be unlikely to significantly impact on any threatened or migratory fauna species as the site does not comprise core habitat for these species. The two species with a greater likelihood of occurrence on the site are the Grey Crowned Babbler and the Superb Parrot. These species are highly mobile and are not likely to be significantly impacted by the proposed activity. Seven-part tests were not considered necessary for these species.

The proposed activity does not constitute, and is not part of, a key threatening process under the TSC Act.

6.2.1.2 Mitigation measures

The site will be rehabilitated in accordance with section 2.6.9 of the REF. In addition, the following measures will be implemented to minimise impacts on flora and fauna:

- The site boundary will be clearly demarcated to ensure that plant and vehicles keep within the approved area of disturbance.
- Plant and machinery will be cleaned of any soil, seed and vegetation prior to being transported to the site in accordance with legislative requirements.
- Prior to earthworks, noxious weeds present on the site will be removed or treated with herbicide to help prevent or reduce their spread.
- Clearing will commence in areas of low weed infestation and move towards area of high weed infestation where practicable.
- Weed monitoring will occur throughout site preparation, drilling, completion and rehabilitation activities. Weed removal will be carried out as necessary.
- Cleared weed species will be stockpiled separately and removed off site. Weed material will not be re-used during site rehabilitation.
- The site will be rehabilitated in accordance with section 2.6.9 of the REF.

- In the event that the proposed activity needs to extend outside the site, a qualified ecologist will undertake further inspection.

6.2.1.3 [Potential impact category](#)

Given that construction and drilling activities associated with the proposed activity will be temporary, and that impacts to threatened species, populations or communities are unlikely, potential impacts to flora and fauna will be negligible.

6.3 **Community**

6.3.1 **Community services, infrastructure and sites of importance**

6.3.1.1 [Potential impacts](#)

The proposed activity is unlikely to significantly impact on any community services and infrastructure or any sites of importance to the local or broader community. Contractors and employees required for the proposed activity may be sourced from outside the local area and may require accommodation in Narrabri or other surrounding areas which could provide temporary economic benefits to flow-on businesses.

6.3.1.2 [Mitigation measures](#)

No specific mitigation measures for potential impacts on community services, infrastructure or sites of importance are proposed.

6.3.1.3 [Potential impact category](#)

Potential impacts to community services, infrastructure or sites of importance are considered negligible.

6.3.2 **Economic issues**

6.3.2.1 [Potential impacts](#)

As stated in 6.3.1.1, the proposed activity will provide economic benefits for Narrabri and the surrounding region through the introduction of a temporary workforce, and purchasing of material supplies.

The proposed activity will reduce the amount of agricultural land available to the landowner for farming activities. This may affect the landowner's potential income from farming activities. Any upgrades to the access track will benefit the landowner.

6.3.2.2 [Mitigation measures](#)

The following measures will be carried out for economic issues:

- A land access and compensation agreement will be negotiated with the landowner prior to construction commencing.
- Any upgrades to the access track will be kept for the ongoing use of the landowner.

6.3.2.3 [Potential impact category](#)

The proposed activity will result in economic benefits to the landowner and wider community.

6.3.3 Amenity and public safety

6.3.3.1 [Potential impacts](#)

The proposed activity may temporarily increase dust and noise levels at the landowner and neighbouring residences, though these will be controlled with the measures outlined in sections 6.1.5 and 6.1.6 of the REF respectively.

While the site is not highly visible from any residence, it may be visible from agricultural properties. The presence of plant, equipment and stockpiles during the proposed activity will result in visual clutter and may detract from the scenic qualities of the land. The DAMB and related surface infrastructure may also be visible from agricultural properties but will appear similar to other existing monitoring bores in the area.

Minor increases in traffic will occur along Culgoora Road and the surrounding road network during site preparation, drilling, completion and rehabilitation. This traffic will be unlikely to result in delays or road safety issues.

The proposed activity will introduce a potential hazard to the site, such as moving vehicles, plant and machinery, and chemicals, fuels and oils. This could have safety implications for the landowner or neighbours. While the site is not located within bushfire prone land, the risk bushfire may increase as a result of the proposed activity due to the presence of flammable substances and potential for accidental ignition by vehicles or machinery.

6.3.3.2 [Mitigation measures](#)

The consultation activities outlined in Table 2-2 of section 2.3.1 of the REF will be implemented. The site will be rehabilitated in accordance with section 2.6.9 of the REF. In addition, the following measures will be implemented to minimise amenity and public safety issues:

- The lease area will be fenced for safety reasons.
- Site safety protocols, incident management and emergency procedures will be implemented during the works.
- The site will be kept in a clean and tidy manner during site preparation, drilling activities and operation of the core hole.

6.3.3.3 [Potential impact category](#)

With the implementation of mitigation measures, potential amenity and public safety impacts will be low adverse.

6.4 Natural resources

6.4.1 Agricultural land

An agricultural impact statement was prepared for the proposed activity by RPS and is included at Appendix 5.

6.4.1.1 [Potential impacts](#)

The proposed activity will not impact on any biophysical SAL or Critical Industry Clusters defined under the SRLUP.

The proposed activity will temporarily prohibit agricultural production on up to 1.06 hectares of rural land. This represents a small portion of the total property size (160 hectares) available for agricultural production.

As the property is predominantly used as a lifestyle property, with occasional grazing, the site is not considered a significant agricultural enterprise. The impact on production value of the property is negligible in terms of the gross value of livestock production in the Narrabri Shire. There will be no permanent land capability reduction of agricultural resources as a result of the proposed activity as the site will be rehabilitated in accordance with section 2.6.9 of the REF. Therefore, the proposed activity will not have an unreasonable impact on agricultural resources and production at the site or within the Narrabri Shire LGA.

The proposed activity will not impact on any water supply services or processing facilities required for agricultural enterprises. Personnel and delivery vehicles will need to cross the Walgett Branch rail line, used to haul wheat, to access the site, particularly during site establishment and at the completion of drilling. This has the potential to disrupt rail operations if not planned appropriately.

No existing agricultural jobs will be lost as a direct result on the proposed activity. The current use and carrying capacity of the property is not sufficient to sustain a permanent employment position. Therefore, the proposed activities will not result in a loss of agricultural employment opportunities on the site or in the Narrabri Shire LGA.

As discussed in sections 6.1.1, 6.1.2 and 6.1.3, the proposed activity has the potential to impact on soils, and surface and groundwater sources. Any such impacts could have consequences for agricultural enterprises reliant on these resources. The proposed activity may also contribute to the spread of weeds or plant and soil diseases, particularly *Phytophthora*. These potential impacts will be managed through the measures identified in this REF.

As discussed in section 6.3.3, the proposed activity may be visible from surrounding agricultural properties. These properties do not contain enterprises that are reliant on the landscape values of the area. Therefore, the proposed activity will not affect any agricultural enterprises as a result of visual impacts.

As water requirements for the project will be sourced from Narrabri's town water supply, there will be no impact on agricultural enterprises, as the primary source of water for agricultural purposes is either the Namoi River or aquifers of the Namoi catchment.

6.4.1.2 [Mitigation measures](#)

The mitigation measures identified in section 6.1.1.3, 6.1.2.3 and 6.1.3.3 will be implemented to minimise impacts on soils, surface water and groundwater respectively. Measures to control the spread of weeds and are identified in section 6.2.1.2 of the REF. In addition, the following measures will be implemented to reduce impacts to agricultural enterprises:

- Delivery of plant, equipment and materials to the site will be scheduled to avoid impacts on the Walgett Branch rail line operations. Where necessary, this will include consultation with the NSW Rail Corporation.
- Construction personnel will be trained in pest control and hygiene procedures.
- All plant and machinery delivered to the site will be cleaned of foreign soil and propagative matter prior to arrival on site.

6.4.1.3 [Potential impact category](#)

In the context of the total area of the property and the wider agricultural uses of the region, the temporary and minor loss of agricultural land is considered to be negligible. Potential impacts on agricultural resources will be negligible to low adverse with the implementation of mitigation measures.

6.4.2 Other natural resources

6.4.2.1 [Potential impacts](#)

The proposed activity will not impact on any areas reserved for conservation purposes. Natural resources required for the proposed activity include fill material to build the lease area (approximately 210 m³) and diesel and petroleum fuels for operation of plant and machinery. Fill will be sourced from a local licensed quarry. Quantities of fuel will not be significant.

The proposed activity will not impact on existing coal mining operations. There are no known coal mines planned for the site. The well will pose no threat to future coal mining operations.

6.4.2.2 [Mitigation measures](#)

The following measures will be implemented to minimise potential impacts on natural resources:

- Fuel will be used as efficiently as possible through appropriate work behavior (e.g. switching off equipment when not in use).
- The well will be designed and constructed in accordance with the *NSW Coal Seam Gas Code of Practice Well Integrity*.

6.4.2.3 [Potential impact category](#)

Potential impacts on natural resources will be negligible.

6.5 Cultural heritage

6.5.1 Aboriginal cultural heritage

6.5.1.1 [Potential impacts](#)

The site is located in a highly modified landform and therefore meets the low impact activity criteria under the *National Parks and Wildlife Service NSW 2009* and described in section 7.5 of *2010 Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW 2010).

No Aboriginal objects, sites or culturally modified trees were identified on site during the archaeological survey. It is considered unlikely that any will be located during the works due to past disturbance of the site. Specific mitigation measures will be carried out to limit potential impacts on any unknown Aboriginal sites or objects.

The lease area is located within 75 metres of Pig Creek, however given previous land disturbance, it is reasonable to conclude, in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales 2010*, that there are no known Aboriginal objects or a low probability of objects occurring at the site, and thus unlikely that harm will occur to Aboriginal objects.

The activity will have no impact on areas subject to native title claims, indigenous land use agreements or joint management arrangements as *The Native Title Act 1993* confirms that native title is extinguished over all freehold land validly granted on or before 23 December 1996.

6.5.1.2 [Mitigation measures](#)

The following measures will be implemented to reduce potential impacts on Aboriginal heritage:

- Project staff and contractors will be made aware of their statutory obligations to protect under the NPW Act and the Heritage Act, through the site induction and toolbox talks.

- Where practicable, vegetation will be cut rather than bulldozed to reduce disturbance to the ground surface.
- If any previously unidentified Aboriginal sites are identified during works, then works in the immediate area will cease, the area will be cordoned off and the OEH Enviroline 131 555 will be contacted. A suitably qualified archaeologist will be contacted so that the site can be assessed and managed.
- In the event that skeletal remains are uncovered, then works in the immediate area will cease, the area will be cordoned off and the NSW Police Coroner will be contacted to determine if the material is of Aboriginal origin. If determined to be Aboriginal, the OEH Enviroline 131 555 and relevant Aboriginal stakeholders will be contacted to determine an action plan for the management of the skeletal remains prior to works re-commencing.
- In the event that the proposed activity needs to extend outside the site, a qualified archaeologist will undertake further inspection.

6.5.1.3 [Potential impact category](#)

Provided the identified mitigation measures are carried out, potential impacts on Aboriginal heritage will be negligible.

6.5.2 **European cultural heritage impacts**

6.5.2.1 [Potential impacts](#)

The proposed activity will not impact on any known European cultural heritage items or places. There is some potential for relics or other items of European heritage value to be uncovered during clearing and excavation works.

No vegetation of cultural landscape value is likely to be affected.

6.5.2.2 [Mitigation measures](#)

If any previously unidentified potential European cultural heritage material is identified during works, then works in the immediate area will cease, the area will be cordoned off and the OEH Heritage Branch will be contacted. A suitably qualified archaeologist will be contacted so that the site can be assessed and managed.

6.5.2.3 [Potential impact category](#)

Provided the identified mitigation measures are carried out, potential impacts on European heritage will be negligible.

6.6 **Matters of National Environmental Significance**

The proposed activity will not impact on any MNES as detailed in Table 6-2.

Table 6-2 Matters of National Environmental Significance

MNES	Overview
World Heritage Properties	The proposed activity is not located in or within close proximity to a World Heritage area.
National Heritage Places	The proposed activity is not located in close proximity to a National Heritage Place.
Wetlands protected by international treaty (the RAMSAR convention)	The proposed activity is not located within a RAMSAR listed wetland area.
Nationally listed threatened	Six Threatened Ecological Communities (TECs), listed under the EPBC Act were

MNES	Overview
species and ecological communities:	<p>identified as having the potential to occur within 10 km of the site, including:</p> <ul style="list-style-type: none"> ▪ Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions, listed as endangered ▪ Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions, listed as endangered ▪ Grey Box Grassy Woodlands and Derived Native Grasslands of South-eastern Australia, listed as endangered ▪ Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland, listed as critically endangered ▪ Weeping Myall Woodlands, listed as endangered ▪ White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as critically endangered. <p>One vegetation community was identified at the site, being 'Ironbark shrubby woodlands of the Pilliga area, Brigalow Belt South'. This vegetation community is not commensurate with any TEC listed under the EPBC Act 1999.</p> <p>Six threatened flora species and 14 threatened fauna species listed under the EPBC Act were identified as having the potential to occur on the site. None of these species were identified during the field survey (refer to section 4.3). These species are unlikely to be significantly impacted by the proposed activity as the site does not provide core habitat for these species.</p>
Migratory species	Ten migratory bird species listed under the EPBC Act were identified having the potential to occur on site. None of these species were identified during the ecological field survey. Impacts to these species are considered unlikely.
Commonwealth marine areas	The proposed activity will not impact any Commonwealth marine areas.
Great Barrier Reef Marine Park	The proposed activity will not impact the Great Barrier Reef Marine Park.
All nuclear actions	The proposed activity does not involve a nuclear activity.

6.7 Potential cumulative impacts

6.7.1 Potential impacts

The Narrabri Shire is recognised for its coal seam gas and coal mining resources. There are a number of existing coal seam gas wells within the Gunnedah and Narrabri area, including around 20 wells within 20 kilometres of the site. The nearest of these wells is located at Culgoora, approximately three kilometres west of the site. Existing coal mining operations in the region include the Whitehaven Coal Mine, approximately 28 kilometres south of Narrabri and Boggabri Coal Mine, approximately 15 kilometres north east of Boggabri.

The main adverse cumulative impacts of the proposed activity with existing coal seam gas and mining activities in the area could include pressure on existing community services and infrastructure, depletion of resources and potential impacts to groundwater sources.

CSG extraction can involve pumping water from the coal seam in order to reduce the groundwater pressure that holds the gas in the coal (Schlumberger Water Services, 2012). This can affect the surrounding groundwater system, as groundwater flows into the zone of dewatering (Schlumberger Water Services, 2012). The proposed activity will not result in any produced water and will therefore not contribute to depressurisation or drawdown of shallow aquifers. Wells will be constructed in accordance with industry regulations, therefore no contamination of shallow groundwater sources is expected.

Any community concern over these issues will be addressed through ongoing consultation with affected landowners and the wider community.

Cumulatively, the proposed activity and other coal mining and CSG activities will stimulate the local and regional economies but could also result in adverse effects on increased pressure on labour resources, temporary and permanent accommodation, road infrastructure and telecommunications. Santos is committed to working with local governments to ensure that these issues are addressed appropriately.

6.7.2 Mitigation measures

Santos will work with the relevant local governments, including Narrabri Shire Council for this activity, to ensure issues relating to increased pressure on labour resources, temporary and permanent accommodation, road infrastructure and telecommunications are addressed appropriately at a strategic level.

7.0 Summary of potential impacts

The potential impacts associated with the proposed activity are summarised in Table 7-1.

Table 7-1 Summary of potential impacts

Aspect	Potential impacts	Potential impact category (with mitigation measures)
Soil quality and land stability	<ul style="list-style-type: none"> disturbance of up to 2.2 ha of land soil erosion and loss of topsoil or spoil land contamination in event of a leak or spill 	Negligible to low adverse
Surface water	<ul style="list-style-type: none"> sedimentation of surface waters due to increased erosion contamination of surface waters in event of a leak or spill pollution/contamination of surface waters in event of flooding and inundation of the site 	Negligible to low adverse
Groundwater	<ul style="list-style-type: none"> groundwater contamination due to mixing of aquifers, loss of drilling mud into the formation or inappropriate management of spills 	Negligible to low adverse
Hazardous substance and chemical use	<ul style="list-style-type: none"> land, water or air pollution, or fire, from improper use of hazardous substances or chemicals 	Negligible to low adverse
Air quality and greenhouse gases	<ul style="list-style-type: none"> generation of dust and other particulates generation of greenhouse gas emissions 	Negligible
Noise	<ul style="list-style-type: none"> generation of noise, particularly during drilling activities which may occur up to 24 hours per day 	Low adverse
Waste	<ul style="list-style-type: none"> generation and disposal of various wastes contamination of groundwater, soils or surface water from illegal dumping or leaching of waste litter due to lack of suitable waste containment odours from improper storage or treatment of putrescible waste 	Low adverse
Flora and fauna	<ul style="list-style-type: none"> removal of up to 1.06 ha of non-significant vegetation temporary disruption to breeding cycle, roosting, sheltering and foraging behaviour of fauna species 	Negligible
Community services, infrastructure and sites of importance	<ul style="list-style-type: none"> pressure on temporary accommodation in Narrabri area 	Negligible
Economic issues	<ul style="list-style-type: none"> economic benefits to Narrabri and surrounding region ongoing use of upgraded access track (if undertaken) to benefit of landholder 	Positive
Amenity and public safety	<ul style="list-style-type: none"> temporary reduced amenity for landowner and neighbours from noise, dust and visual impacts minor traffic increases on Culgoora Road and surrounding network introduction of hazard with potential safety implications 	Low adverse
Agricultural land	<ul style="list-style-type: none"> temporary removal of 1.06 ha of land available for agricultural production disruption to Walgett Branch rail line operations impacts on agricultural resources including soil, 	Negligible to low adverse

Aspect	Potential impacts	Potential impact category (with mitigation measures)
	<ul style="list-style-type: none"> surface water and groundwater ▪ spread of weeds or pathogens 	
Other natural resources	<ul style="list-style-type: none"> ▪ use of minor quantities of natural resources including fill material and fuels 	Negligible
Aboriginal cultural heritage	<ul style="list-style-type: none"> ▪ disturbance of unknown Aboriginal objects 	Negligible
European cultural heritage impacts	<ul style="list-style-type: none"> ▪ disturbance of unknown European heritage items 	Negligible

On balance, the proposed activity will have negligible to low adverse impacts on the environment and community. These impacts will be temporary and of a small scale and can be mitigated through the measures identified in this REF.

7.1 Clause 228 Factors

Clause 228 of the Environmental Planning and Assessment Regulation 2000 outlines a number of factors that must be taken into consideration in assessing an activity under Part 5 of the EP&A Act. An assessment of the clause 228 factors is provided in Table 6-2.

Table 7-2 Clause 228 factors

Factor	Impact
<i>Any environmental impact on a community</i>	<p>Minor short term.</p> <p>Impacts will be short term and localised. There are no residential properties within 1km of the site. The nearest residential dwelling is located approximately 1.3 km north of the site. The proposed activity will temporarily reduce the land available for agricultural purposes and the environmental amenity for this residence. The proposed activity will generate additional traffic but this will be unlikely to significantly impact the local road network. Impacts associated with the proposed activity will be virtually imperceptible to the wider community.</p>
<i>Any transformation of a locality</i>	<p>Minor short term.</p> <p>There will be a localised and non-permanent visual impact on the immediate vicinity of the core hole for the duration of the program. This impact will be significantly reduced once the lease area is partially rehabilitated and completely reversed once the DAMB is decommissioned and final rehabilitation of the site is complete.</p>
<i>Any environmental impact on the ecosystems of the locality.</i>	<p>Negligible.</p> <p>The proposal will require the removal of up to approximately 1 ha of 'Ironbark shrubby woodlands of the Pilliga area, Brigalow Belt South' and 0.06 ha of <i>Angophora floribunda</i> Forest. These vegetation communities are not commensurate with any threatened ecological communities listed under either the TSC Act or the EPBC Act. The site will be rehabilitated on completion of the activity.</p>
<i>Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality</i>	<p>Negligible.</p> <p>The proposed activity will reduce the aesthetic values of the site temporarily but will be have no long term effects on the scenic qualities of the landscape.</p>
<i>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</i>	<p>Nil.</p> <p>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 within or near the site.</p>

Factor	Impact
<i>Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974)</i>	<p>Minor short term.</p> <p>The site provides foraging habitat for a range of protected fauna species within the meaning of the NPW Act. While the proposed activity will involve the removal of approximately 1.06 ha of potential habitat the impacts of this will be minor as there is sufficient alternative foraging habitat within the wider locality and the majority of the site will be rehabilitated on completion of the works.</p>
<i>Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air</i>	<p>Nil.</p> <p>The proposed activity will not endanger any species of animal, plant or other form of life, whether living on land, in water or in the air.</p>
<i>Any long-term effects on the environment</i>	<p>Nil.</p> <p>The proposed activity will have no long-term effects on the environment. Well installation will be undertaken in accordance with relevant legislation and best practice guidelines to ensure no impacts on groundwater. Rehabilitation of the site will occur.</p>
<i>Any degradation of the quality of the environment</i>	<p>Minor short term.</p> <p>There is potential for minor short term environmental degradation as a result of air and noise emissions during the works, or from the accidental release of contaminants to the environment.</p>
<i>Any risk to the safety of the environment</i>	<p>Minor short term.</p> <p>The proposed activity may result in short term potential risks to the safety of the environment due to incidents and spills.</p>
<i>Any reduction in the range of beneficial uses of the environment</i>	<p>Nil.</p> <p>The proposed activity will not result in any reduction in the range of beneficial uses of the environment.</p>
<i>Any pollution of the environment</i>	<p>Minor sort term.</p> <p>The proposed activity may result in short term potential risk of pollution of the environment due to incidents and spills or as a result of air or noise emissions.</p>
<i>Any environmental problems associated with the disposal of waste</i>	<p>Nil.</p> <p>All wastes generated by the proposed activity will be collected, classified and removed from site for recycling, disposal or disposal at a licensed waste facility if required. Given the short term nature of the proposed activity, only minor quantities of waste will be produced.</p>
<i>Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply</i>	<p>Minor short term.</p> <p>Resources required for the proposed activity are not in limited supply in the area.</p>

8.0 Conclusion

This REF has been prepared to assess the potential environmental impacts of drilling one core hole, known as Kiandool 1, and undertaking ancillary activities at a property on Culgoora Road, approximately nine kilometres west of Narrabri NSW. The purpose of the proposed activity is to obtain information about coal seam depths, seam thickness, continuity and permeability to assess the coal seam potential of the Gunnedah Basin within PEL 238.

The proposed activity is temporary and minor in scale. The site of the proposed activity has been selected to avoid significant environmental and heritage constraints, and reduce impacts to the surrounding community. The potential impacts of the proposed activity have been assessed and can be managed through the identified mitigation measures. On balance, the proposed activity will have a negligible to low adverse impact on the environment and community.

The proposed activity is not likely to significantly affect the environment or any threatened species, populations or ecological communities, their habitats or critical habitat. The proposed activity does not require preparation of an EIS or SIS.

9.0 Statement of commitments

Table 9-1 provides a statement of commitments for the proposed activity.

Table 9-1 Statement of commitments

Item	Commitment
Activity type and location	<ul style="list-style-type: none"> The proposed activity will be carried out at 545 Culgoora Road, Narrabri, as described in section 2 of the REF and will include: <ul style="list-style-type: none"> using the existing 1.9 km long access track from Culgoora Road to transport materials, equipment and personnel to the lease area upgrading the existing access track, including constructing approximately 100 m of new access track, should this be determined necessary during detailed design establishing a lease area up to one hectare in size drilling Kiandool 1 to a depth of approximately 1,000 m sampling, testing and logging of the core hole installing, operating and maintaining a deep aquifer monitoring bore (DAMB) and supporting infrastructure, similar to existing groundwater monitoring bores operating within the region rehabilitating the majority of the lease area to reduce its size to nine square metres for the DAMB, surface infrastructure and fencing (partial rehabilitation) rehabilitating the remainder of the lease area, including removal of surface infrastructure and fencing, once the DAMB is no longer required for operation (full rehabilitation).
Hours of operation	<ul style="list-style-type: none"> Hours of operation will be negotiated with the landowner and may be up to 24 hours a day, seven days a week.
Activity duration	<ul style="list-style-type: none"> Approximately three months for the drilling, construction, completion and rehabilitation of the core hole and establishment of the DAMB and approximately 30 years for the operation and rehabilitation of the DAMB.
Proposed commencement date	<ul style="list-style-type: none"> Works will commence in the first quarter of 2013.
Maximum area of disturbance	<ul style="list-style-type: none"> 2.2 ha
Rehabilitation commitments and timeframes	<ul style="list-style-type: none"> Partial rehabilitation of the site will occur within six months of completion of the DAMB, where practicable. The site will be rehabilitated to its pre-operational condition or better as agreed with the landowner. Final rehabilitation of the site will occur once the DAMB is no longer required for groundwater monitoring purposes.
Community consultation and complaint management	<ul style="list-style-type: none"> Community consultation and complaint management will be undertaken in accordance with section 2.3.1 of the REF.
Soil quality and land stability	<ul style="list-style-type: none"> Culgoora Road will be closely monitored during the works and where necessary, a street sweeper will be called to clean up any sediment tracked onto the road. Where the lease area is constructed using traditional methods (instead of using industrial matting), topsoil and other soil horizons will be stripped, handled and stockpiled separately. Excess spoil generated during site preparation activities will be stockpiled on site and used as backfill during site rehabilitation. No uncontaminated soil or spoil will be removed from the site. Stockpiles will be managed according to best management practices such as the measures outlined in <i>Managing Urban Stormwater: Soils and Construction</i> (Landcom 2004) ('the Blue Book') or the <i>Best Practice Erosion and Sediment Control Guidelines</i> (IECA, 2008) (IECA Guidelines). This will include: <ul style="list-style-type: none"> Maintaining topsoil stockpiles at a height of no greater than two metres to preserve the seed bank. Stabilising stockpiles using a temporary sterile cover crop or other acceptable materials

Item	Commitment
	<p>once site preparation activities are completed, until rehabilitation can take place.</p> <ul style="list-style-type: none"> ▪ Erosion and sediment controls will be implemented where necessary during site preparation activities, including lease area construction and any upgrades to the existing access track, in accordance with best management practices (such as the Blue Book or IECA Guidelines). These controls will be maintained until disturbed areas of the site are stabilised. ▪ The site will be rehabilitated in accordance with section 2.6.9 of the REF. ▪ The quantity of chemicals, fuels and oils stored on site will be minimised, where practicable. ▪ All additives, chemicals, fuels and oils stored on site will be kept in an appropriately secured, bunded storage shed in accordance with the relevant MSDS. ▪ An MSDS register of all chemicals used or stored on site will be maintained. ▪ Maintenance of vehicles, plant and equipment will occur off site at an appropriately licensed facility unless deemed appropriate to conduct such maintenance on site. ▪ Refueling of plant and equipment will occur in a designated, bunded area, at least 40 metres from the nearest waterway. ▪ A spill kit will be available on site and personnel will be trained in its use. ▪ Any spills or leaks will be contained and cleaned up immediately using the spill kit. Contaminated material (such as contaminated soil or absorbent materials) will be placed in a bag and removed from the site for disposal at a licensed waste facility. ▪ Plant and equipment will be inspected daily to ensure these are properly maintained.
Surface water	<ul style="list-style-type: none"> ▪ Drilling mud will be contained in surface tanks which will be regularly inspected and maintained. ▪ Over-balanced drill techniques will be used to prevent formation fluid from rising through the well to the surface. ▪ Drilling mud will be transported to and from the site by an appropriately licensed contractor as outlined in section 2.7.2 of the REF. ▪ Wastewater generated through general site activities will be removed by an appropriately licensed contractor for disposal at a licensed facility that is able to accept liquid waste or treated to an appropriate quality prior to discharging. ▪ A minimum freeboard of 300 millimeters will be maintained for any pits or tanks containing liquid waste. ▪ Weather forecasts will be monitored and in the event that prolonged, severe wet weather or flooding is predicted, works will cease and plant, machinery and any chemicals will be secured and bunded.
Groundwater	<ul style="list-style-type: none"> ▪ The well will be designed and constructed in accordance with the <i>NSW Coal Seam Gas Code of Practice Well Integrity</i> (DTIRIS 2012b). ▪ A driller that holds a license under the National Water Drillers Licensing Accreditation Scheme will be on site during drilling of the top hole and until the surface casing is set, cemented and pressure tested. During this time, there will be 24 hour coverage by one person working the day shift and on call at site during the night. ▪ A NOW hydrogeologist will be notified at least 28 days prior to the commencement of drilling. ▪ Drilling operations, well control, waste management and abandonment procedures for the core hole will be in accordance with accepted oil industry practices and in accordance with the processes outlined in this REF. ▪ Prior to commencing drilling, Santos will seek permission (from landowners) to access registered groundwater monitoring bores within two kilometres of the site to undertake groundwater monitoring for the purposes of establishing baseline conditions. Where access to bores is granted (and the bore is functioning), monitoring will include water level measurements and quality observations in the field, and sampling for analysis by an accredited laboratory. ▪ Santos will offer (to landowners) to undertake groundwater monitoring at registered groundwater monitoring bores within two kilometres of the site at the completion of drilling. ▪ Excessive drilling mud losses will be cured by loss circulation material (cellulose material such as sawdust or other benign naturally occurring substances as required) to ensure most fluids return to the surface. ▪ The well will be decommissioned as soon as it is no longer required. ▪ Data will be collected from the well to measure permeability of the various strata.

Item	Commitment
Hazardous substance and chemical use	<ul style="list-style-type: none"> Random sampling of drilling mud and drill cuttings will be undertaken to monitor for the presence of BTEX. Chemicals and potentially hazardous substances will be used and stored according to regulatory requirements including the <i>Work Health and Safety Act 2011</i>. Any dangerous goods will be transported according to regulatory requirements under the <i>Dangerous Goods (Road and Rail Transport) Act 2008</i>.
Air quality and greenhouse gases	<ul style="list-style-type: none"> The area of disturbance will be limited to the minimum required to carry out the proposed activity safely and efficiently. Dust will be suppressed by spraying water along the access track and lease area. If necessary, the access track will be sealed to prevent excessive dust emissions. Site speed limits will be imposed to minimise dust generated by vehicle movements. Vehicles, plant and equipment will be regularly maintained to ensure they are in good operating condition. Vehicles, plant and machinery will be turned off when not in use rather than left idling.
Noise	<ul style="list-style-type: none"> Consultation with the landowner and two next nearest sensitive receivers will be carried out in accordance with section 2.3.1 of the REF. Background noise monitoring will be conducted at the site prior to the commencement of works to confirm the rating background level and noise affected level recommended standard hours and outside of standard hours. Prior to arriving on site, source noise levels of the drilling rig will be confirmed to verify noise impacts and confirm the management approach. Noise monitoring will be carried out at the commencement of drilling and cementing activities to confirm noise levels at the nearest sensitive receiver. Where noise levels exceed the noise affected level, all feasible and reasonable mitigation measures will be implemented to achieve the noise affected level. Further noise monitoring will be carried out to determine the effectiveness of mitigation measures. In the event of a noise complaint, the effectiveness of noise mitigation measures will be assessed and additional feasible and reasonable measures will be implemented, where necessary.
Waste	<ul style="list-style-type: none"> Management of waste, including its transport, will comply with the POEO Act and POEO (Waste) Regulation. Appropriate waste receptacles will be provided on site including covered rubbish bins for disposal of domestic wastes. Waste materials will be separated, classified and managed in accordance with the <i>Waste Classification Guidelines Part 1: Classifying Waste</i> (DECCW 2009). Drilling mud will be managed according to the process described in section 2.7.2. All wastes will be removed from the site at the completion of drilling for recycling or disposal at an appropriately licensed facility. The type and volume of all waste removed from the site will be recorded. Portable toilets will be provided on site and will be regularly serviced by a licensed contractor. All staff and contractors will be made aware of waste management procedures during the site induction and through toolbox talks. Chemical, fuel and oil containers will be managed according to the MSDS or manufacturers' directions to avoid potential impacts to the environment or human health.
Flora and fauna	<ul style="list-style-type: none"> The site boundary will be clearly demarcated to ensure that plant and vehicles keep within the approved area of disturbance. Plant and machinery will be cleaned of any soil, seed and vegetation prior to being transported to the site in accordance with legislative requirements. Prior to earthworks, noxious weeds present on the site will be removed or treated with herbicide to help prevent or reduce their spread. Clearing will commence in areas of low weed infestation and move towards area of high weed infestation where practicable. Weed monitoring will occur throughout site preparation, drilling, completion and rehabilitation

Item	Commitment
	<p>activities. Weed removal will be carried out as necessary.</p> <ul style="list-style-type: none"> ▪ Cleared weed species will be stockpiled separately and removed off site. Weed material will not be re-used during site rehabilitation. ▪ The site will be rehabilitated in accordance with section 2.6.9 of the REF. ▪ In the event that the proposed activity needs to extend outside the site, a qualified ecologist will undertake further inspection.
Community services, infrastructure and sites of importance	<ul style="list-style-type: none"> ▪ No specific mitigation measures for potential impacts on community services, infrastructure or sites of importance are proposed.
Economic issues	<ul style="list-style-type: none"> ▪ A land access and compensation agreement will be negotiated with the landowner prior to construction commencing. ▪ Any upgrades to the access track will be kept for the ongoing use of the landowner.
Amenity and public safety	<ul style="list-style-type: none"> ▪ The lease area will be fenced for safety reasons. ▪ Site safety protocols, incident management and emergency procedures will be implemented during the works. ▪ The site will be kept in a clean and tidy manner during site preparation, drilling activities and operation of the core hole.
Agricultural land	<ul style="list-style-type: none"> ▪ Delivery of plant, equipment and materials to the site will be scheduled to avoid impacts on the Walgett Branch rail line operations. Where necessary, this will include consultation with the NSW Rail Corporation. ▪ Construction personnel will be trained in pest control and hygiene procedures. ▪ All plant and machinery delivered to the site will be cleaned of foreign soil and propagative matter prior to arrival on site.
Other natural resources	<ul style="list-style-type: none"> ▪ Fuel will be used as efficiently as possible through appropriate work behavior (e.g. switching off equipment when not in use). ▪ The well will be designed and constructed in accordance with the <i>NSW Coal Seam Gas Code of Practice Well Integrity</i>.
Aboriginal cultural heritage	<ul style="list-style-type: none"> ▪ Project staff and contractors will be made aware of their statutory obligations to protect under the NPW Act and the Heritage Act, through the site induction and toolbox talks. ▪ Where practicable, vegetation will be cut rather than bulldozed to reduce disturbance to the ground surface. ▪ If any previously unidentified Aboriginal sites are identified during works, then works in the immediate area will cease, the area will be cordoned off and the OEH Enviroline 131 555 will be contacted. A suitably qualified archaeologist will be contacted so that the site can be assessed and managed. ▪ In the event that skeletal remains are uncovered, then works in the immediate area will cease, the area will be cordoned off and the NSW Police Coroner will be contacted to determine if the material is of Aboriginal origin. If determined to be Aboriginal, the OEH Enviroline 131 555 and relevant Aboriginal stakeholders will be contacted to determine an action plan for the management of the skeletal remains prior to works re-commencing. ▪ In the event that the proposed activity needs to extend outside the site, a qualified archaeologist will undertake further inspection.
European cultural heritage	<ul style="list-style-type: none"> ▪ If any previously unidentified potential European cultural heritage material is identified during works, then works in the immediate area will cease, the area will be cordoned off and the OEH Heritage Branch will be contacted. A suitably qualified archaeologist will be contacted so that the site can be assessed and managed.
Cumulative	<ul style="list-style-type: none"> ▪ Santos will work with relevant local governments, including Narrabri Shire Council for this activity, to ensure issues relating to increased pressure on labour resources, temporary and permanent accommodation, road infrastructure and telecommunications are addressed appropriately at a strategic level.

Terms and abbreviations

Term/abbreviation	Meaning
Abandonment	Decommissioning the well. A process which involves shutting down the well and rehabilitating the site.
AHIMS	Aboriginal Heritage Information Management System
Annulus	The space between the wellbore and surrounding pipe.
Blow out preventer	One of several valves installed in a wellhead to prevent the escape of pressure either in the annular space between the casing and the drill pipe or in the open hole during drilling, completion and work over operations.
BoM	Bureau of Meteorology
BOP	Blow out preventer
Casing	A pipe placed in a well to prevent the wall of the hole from caving in and to prevent movement of fluids from one formation to another.
Casing collar	Coupling between two joints.
Casing coupling	Tubular section of pipe that is threaded inside and used to connect two joints of casing.
Casing head	A heavy flanged fitting connected to the first string of casing. It provides a housing for slips and packing assemblies.
Cementing	The application of a liquid slurry of cement and water to various points inside and outside the casing.
Cementing assurance swellable packer	Rubber isolation device that swells to form an annular seal.
Cementing head	Component fitted to the bore for the use of cementing.
Cement plug	Portion of cement placed at some point in the wellbore.
Coring	Process of cutting a vertical, cylindrical sample of the formations.
CSG	Coal Seam Gas
DAMB	Deep aquifer monitoring bore
Drill fluid/mud	Circulating fluid that can lift cuttings from the wellbore to the surface and to cool down the drill bit.
DTIRIS	Department of Investment, Trade, Regional Infrastructure and Services
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
LGA	Local government area
ML	Megalitres
MNES	Matter of National Environmental Significance
MSDS	Materials Safety Data Sheets
NV Act	Native Vegetation Act 2003
NOW	NSW Office of Water
OEH	Office of Environment and Heritage
Packer	Piece of down hole equipment that consists of a sealing device. Used to block the flow of fluids through the annular space between the pipe and the wall of the wellbore.
PEL	Petroleum Exploration Licence
Plug	Any object or device that blocks a hole or passageway.

Term/abbreviation	Meaning
POEO	<i>Protection of the Environment Operations Act 1997</i>
REF	Review of Environmental Factors
SEPP	State Environmental Planning Policy
TSC Act	<i>Threatened Species Conservation Act 1995</i>
Surface casing	A drilled and cemented pipe used to provide blow-out protection, to seal off water/hydrocarbon sands and prevent the loss of circulation. Also used to seal off water sands, weak formations and/or lost circulation zones. In some cases surface and intermediate casing requirements are provided by the same string.
Wall cake	Low permeability 'skin' around the wall of the hole.
WMA	Water Management Act 2000
Wellhead	The system of spools, valves and associated adapters that provide pressure control for production.

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Appendix I

Ecological assessment

RPS

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Our Ref: PR113361: LV: MD

Date: 31 October 2012

Attn: Ann Stewart
Santos Limited
Level 12, 40 Creek Street
Brisbane QLD 4000

Via: Email

Dear Ann,

RE: DUE DILLIGENCE ECOLOGICAL APPRAISAL FOR A PROPOSED CSG EXPLORATION SITE, 'KIANDOOL', NARRABRI

RPS Australia East Pty Ltd (RPS) was engaged Eastern Star Gas Pty Ltd to undertake a Due Dilligence appraisal of a proposed CSG exploration corehole on a private property at Lot 2 DP 1037235 on Culgoora Rd, Narrabri, NSW (hereafter referred to as the 'study area').

The proposed exploration corehole (study area) is defined as a 100m x 100m lease pad accessed by an approximately 2km track. This advice is intended to provide constraints and opportunities in relation to the proposal and where relevant provide comment on mitigation measures in realtion to potential ecological impacts.

This advice has been prepared following a recent field inspection which aimed to gather an appreciation of the study areas biodiversity attributes and identify any ecologically sensitive areas (threatened flora, fauna or ecological communities) including the potential occurrence, or likely occurrence, of any threatened species, populations or ecological communities listed within the *Threatened Species Conservation Act 1995* (TSC Act 1995) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

METHODS

The ecological assessment was undertaken over one day on the 20th June 2012 by RPS Field Ecologist Lauren Vanderwyk. The types of methodologies employed across the study area include:

- Desktop Assessment;
 - » State and federal threatened species 10 km searches
 - » EPBC Act Protected Matters Search
 - » Review of regional vegetation community mapping
- Floristic Assessment and delineation of vegetation communities on site;
 - » Targeted flora surveys

- » Delineation of significant features (EEC)
- Habitat assessments; and
- Fauna surveying;
 - » Diurnal Bird searches
 - » Diurnal herpetological surveys
 - » Opportunistic fauna surveys

Where significant ecological features were identified, they were recorded using a Trimble D-GPS capable of sub-meter accuracy following post processing.

RESULTS

The following section provides an overview of the survey results.

Desktop Assessment

A desktop assessment was undertaken to determine potential and previously recorded threatened species on site and within a 10km radius of the study area. The Atlas of NSW Wildlife Database was utilised to assess species listed under the NSW TSC Act 1995 and a Protected Matters Search was used to assess any species listed under the EPBC Act 1999.

The Atlas of NSW Wildlife Database was accessed on the 22nd June 2012 resulting in a total of two threatened fauna (refer to Table 1) species having been recorded within 10km of the study site.

Table 1 - NSW Atlas of Wildlife Search Results

Common Name	Scientific Name	Status TSC Act	No. within 10km
Koala	<i>Phascolarctos cinereus</i>	V	1
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	E	4

Status (TSC Act):

E Schedule 1: Endangered Species

V Schedule 2: Vulnerable Species

An EPBC Protected Matters Report was generated on the 22nd June 2012 via a search of the EPBC Protected Matters Search Tool. The EPBC Protected Matters Report identified 20 threatened species (refer to Table 2 and Table 3) and 10 migratory species with potential to occur within a 10 kilometre radius of the study area.

Table 2 - Protected Matters Search Search Results – Flora

Scientific Name	Common Name	Status EPBC Act	Status TSC Act
<i>Cadellia pentastylis</i>	Ooline	V	V
<i>Digitaria porrecta</i>	Finger Panic Grass	E	E
<i>Lepidium aschersonii</i>	Spiny Pepper-cress	V	
<i>Prasophyllum</i> sp. Wybong (C.Phelps ORG 5269)	A leek orchid	CE	
<i>Pterostylis cobarensis</i>	Cobar Greenhood Orchid	V	V
<i>Tylophora linearis</i>		V	V

Table 3 - Protected Matters Search Results – Fauna

Scientific Name	Common Name	Status EPBC Act	Status TSC Act
<i>Anthochaera Phrygia</i>	Regent Honeyeater	E	CE
<i>Erythrorhynchus radiatus</i>	Red Goshawk	V	E
<i>Geophaps scripta scripta</i>	Squatter Pigeon	V	E
<i>Leipoa ocellate</i>	Malleefowl	V	E
<i>Polytelis swainsonii</i>	Superb Parrot	V	V
<i>Rostratula australis</i>	Australian Painted Snipe	V	E
<i>Maccullochella peelii peelii</i>	Murray River Cod	V	
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat	V	V
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	V	E
<i>Pseudomys pilligaensis</i>	New Holland mouse	V	V
<i>Phascolarctos cinereus</i>	Koala	V	V
<i>Anomalopus mackayi</i>	Five-clawed Worm-skink	V	E
<i>Uvidicolus sphyrurus</i>	Border Thick-tailed Gecko	V	

An assessment of ecological communities with the potential to occur on the study area was undertaken from the locality, resulting in six communities as listed in Table 4 below.

Table 4 - Threatened Ecological Communities

Endangered Ecological Community Name	Status TSC Act	Status EPBC Act
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (TSC). Commensurate with; Brigalow (Acacia harpophylla dominant and co-dominant) (EPBC)	E	E
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	E	E
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia (EPBC) Commensurate with; Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Penplain, Nandewar and Brigalow Belt South Bioregions (TSC)	E	E
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (EPBC) and southern Queensland; Commensurate with; Native Vegetation on Cracking Clay Soils of the Liverpool Plains (TSC)	E	CE

Endangered Ecological Community Name	Status TSC Act	Status EPBC Act
Weeping Myall Woodlands (EPBC) commensurate with: Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Penplain, Murray-Darling Depression, Riverina and NSW South western Slopes bioregions (TSC)	E	E
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	E	CE

Status:

CE Critically Endangered

E Endangered

V Vulnerable

Field Assessment

No regionally significant or threatened flora species or populations listed under the TSC Act 1995 and/or EPBC Act 1999 were detected within the study area during the survey period.

One vegetation community was delineated within the study area, being 'Ironbark shrubby woodlands of the Pilliga area, Brigalow Belt South'. This vegetation community is not commensurate with any listed EEC/TEC under the TSC Act 1995 or EPBC Act 1999. The extant vegetation within the Study Area is considered to be a disturbed remnant of this community, generally presenting with a monoculture of *Callitris glaucophylla* (White Cypress Pine), absent shrub layer and a grassy ground layer (Plate 1 and 2).

Vegetation structure

Upper Stratum – *Callitris glaucophylla* (White Cypress Pine).

Mid Stratum – No mid layer present.

Lower Stratum – *Themeda australis* (Kangaroo Grass), *Sporobolus crebre* (Slender Rat's Tail Grass), *Drosera* sp., *Aristida* sp., *Wahlenbergia* sp., *Chloris ventricosa* (Tall Chloris), *Opuntia stricta* (Prikcly Pear), *Conyza* sp, *Panicum* sp. and *Chrysocephalum* sp.

The access track is comprised of native and non native grasses that have been compressed from regular vehicle movement (Plate 3), grassland (Plate 4) and compacted dirt (Plate 5). One section of the track that may require a small amount of clearing cuts through an *Angophora floribunda* dominated portion of the same vegetation community, which could require the removal of a small amount of *Lomandra species*, one *Acacia deaneii*, possibly one *Allocasuarina* and a dense weed thicket of *Bidens pilosa* (Farmer's Friends) (Plate 6). No significant flora or EEC were detected in this area.

The access track runs parallel with Bohena Creek with the narrowest connection between the two being approximately 15m at one location (Plate 7).

One threatened fauna species listed as Vulnerable under the TSC Act 1995 was recorded in close proximity to the study area during RPS (2012) surveys, namely the Grey Crowned Babbler (*Pomatostomus temporalis temporalis*).

No other threatened fauna listed under the TSC Act 1995 or the EPBC Act 1999 were detected during the survey period. However, one species, the Superb Parrot (*Polytelis swainsonii*), is considered as having the potential to occur within the study area.

The Grey Crowned Babbler could potentially utilise the site for foraging and nesting particularly in the *Callitris* stands, however more suitable foraging habitat preferred by this species occurs in the surrounding vicinity (from which it was heard calling). The Superb Parrot does forage in grasslands similar to that exhibited on site however there are no suitable tree hollows present on site that are required for breeding. Both the Grey Crowned Babbler and Superb Parrot are both highly mobile species and the habitat on site is not considered to be core habitat for both species, therefore an Assessment of Significance (EPBC Act) and Seven Part Test (TSC Act) assessment are deemed unnecessary.

CONCLUSIONS

The field survey resulted in the following:

- No TEC/EEC identified on the study area;
- Identification of one threatened fauna species in close proximity to the study area;
- No hollow bearing trees recorded on the study area;

A total of 10 migratory species listed under the EPBC Act 1999 have been recorded or have suitable habitat within a 10 km radius of the Study Area. The site offers suboptimal foraging habitat for most of the potentially occurring migratory and threatened species due to the absence of an understorey across most of the site where many resources are usually abundant. The monoculture of one tree species (*Callitris glaucophylla*) also limits the availability of fruits, seeds and other foraging requirements brought about by flora diversity. In unison with this fact, there are no hollow bearing trees on site, limiting the breeding resources required for many species. Development of the Study Area is unlikely to substantially modify, destroy or isolate an area of important habitat, result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat or seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

Based on the survey results the proposed drilling activities and access track is considered to have minimal ecological impacts on the study area. Inevitably multiple *C. glaucophylla* trees that persist on the study area will be removed as a result of the proposed drilling activities. No hollows were recorded in any of the *C. glaucophylla* trees and the bird species utilising the trees to be removed are highly mobile having the capability to forage and nest in suitable adjacent habitats such as in the Pilliga State Forest.

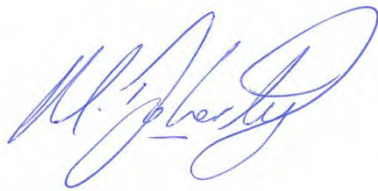
Assessment for potential occurrence of threatened species, populations and ecological communities within the study area known from the locality will be considered under the precautionary principle where a subject species is assumed to be present if there is suitable habitat on site. However it is considered that based on the information provided in relation to the current proposal, this assessment indicates that no significant impact is likely to threatened species, populations or ecological communities such that a local extinction will occur within the study area should a sensible approach to site exploration and lease construction be adopted by Santos during this exploration phase. The following mitigation measures should be considered by Santos during site exploration activities:

- Appropriate nutrient and sediment controls should be implemented to control the flows of sediments into Bohena Creek from the access track in wet weather.
- A qualified ecologist should be present on site during the vegetation clearing works at the commencement of lease build activities to rescue any displaced native fauna.

- Soil stripped for lease build should be stockpiled and stored appropriately to aid in site rehabilitation works.

We trust this information is sufficient for your purposes, however should you require any further details or clarification, please do not hesitate to contact the writer or Lauren Vanderwyk by telephone or email.

Yours sincerely
RPS

A handwritten signature in blue ink, appearing to read 'M. Doherty'.

Matt Doherty
Manager - Ecology & GIS / Technical Director (Ecology)



Plate 1: *Callitris glaucophylla* trees on study area



Plate 2: Absent shrub and ground layer



Plate 3: Compressed grass on access track



Plate 4: Grassland where the access track will be laid



Plate 5: Existing track, compacted ground



Plate 6: Creek and access track in close proximity



Plate 1: Possible access track route through *Lomandra*

Appendix 2

Cultural heritage assessment

RPS



Aboriginal & European Cultural Heritage Due Diligence Report

Kiandool I Core Hole Near Narrabri, NSW

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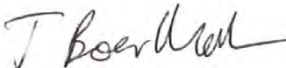
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		Synopsis:	Results of an Aboriginal & European Heritage due diligence investigation

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Revision No.	Author	Reviewer
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2.	SW	DR

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Name	Signature	Date
Tessa Boer-Mah		1/11/2012

FINAL DISTRIBUTION

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We have prepared this report for the sole purposes of Santos Limited ("**Client**") for the specific purpose of a due diligence assessment for Aboriginal and European (historic) cultural heritage of the proposed location of the Kiandool 1 core hole ("**Purpose**"). This report is strictly limited to the Purpose and the facts and matters stated in it and does not apply directly or indirectly and will not be used for any other application, purpose, use or matter.

In preparing this report we have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request or enquiry were complete, accurate and up-to-date. Where we have obtained information from a government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware of any reason why any of the assumptions are incorrect.

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Executive Summary

RPS has been engaged by Santos Ltd to prepare an Aboriginal and European (historic) cultural heritage due diligence assessment for the location of the proposed Kiandool 1 core hole, near Narrabri in the Narrabri Local Government Area (LGA).

This assessment has been undertaken in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects 2010* (DECCW) which requires reasonable and practicable steps be taken to: identify whether or not Aboriginal objects are, or are likely to be, present in an area; determine whether or not their activities are likely to harm Aboriginal objects (if present); and determine if an Aboriginal Heritage Impact Assessment (DECCW 2010:2). This report also considers any potential impacts on European (historic) heritage as a result of proposed activities to determine if a Statement of Heritage Impact is also required.

Investigations under the code have:

- included a search of the Aboriginal Heritage Information Management System (AHIMS) database, which has identified that there were no Aboriginal objects or Aboriginal places in the Project Area;
- considered the landforms: land within 200 metres of water, dune systems, ridge tops, headlands, land immediately above or below cliff faces and/or rockshelters/caves which may give rise to the possibility of Aboriginal objects or sites. Disturbed land within 200 metres of water was identified within the Project Area;
- included a desktop assessment reviewing previous archaeological and heritage studies in the vicinity of the Project Area; and
- included a visual inspection of the Project Area in which no Aboriginal objects were identified.

RECOMMENDATIONS

The numbered recommendation/s have been provided specifically for this Project Area, in addition recommendations A-E must also be followed for undertaking the activity (the construction works).

Recommendation 1

No Aboriginal objects or places have been identified within the Project Area and therefore an Aboriginal Impact Permit (AHIP) is not required for the proposed activity. Likewise no European (historic) heritage sites have been identified within the Project Area, thus a Statement of Heritage Impact is similarly not required for the proposed works.

Recommendations A - E must be followed for undertaking the activity (the construction works). These recommendations provide contingency procedures should unexpected Aboriginal objects, skeletal remains or significant European cultural heritage material be identified during the activity.

Recommendation A

All relevant Santos staff and contractors should be made aware of their statutory obligations for heritage under NSW *National Parks and Wildlife Act 1974* and the NSW *Heritage Act 1977*, which may be implemented as a heritage induction.

Recommendation B

This due diligence report must be kept by Santos Limited so that it can be presented, if needed, as a defence from prosecution.

Recommendation C

If Aboriginal object/s are identified in the Project Area during works, then all works in the immediate area must cease and the area cordoned off. The Office of Environment and Heritage (OEH) must be notified by ringing the Enviroline 131 555 so that the site can be adequately assessed and managed.

Recommendation D

In the event that skeletal remains are uncovered, work must cease immediately in that area and the area cordoned off. Santos must contact the NSW Police with no further action taken until written advice is provided by the Police. If determined to be Aboriginal, OEH must be notified by ringing the Enviroline 131 555 and a management plan prior to works re-commencing must be developed in consultation with the relevant Aboriginal stakeholders.

Recommendation E

If, during the course of development works, suspected European cultural heritage material is uncovered, work should cease in that area immediately. The Heritage Branch, OEH (Enviroline 131 555) should be notified and works only recommence when an approved management strategy is developed.

Terms, Definitions & Abbreviations

Abbreviation/ Term	Meaning
Aboriginal Object	“any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises NSW, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains” (DECCW 2010:18).
Aboriginal Place	“a place declared under s.84 of the NPW Act that, in the opinion of the Minister, is or was of special significance to Aboriginal culture” (DECCW 2010:18). Aboriginal places have been gazetted by the minister.
Aboriginal Culturally Modified Tree	“means a tree that, before or concurrent with (or both) the occupation of the area in which the tree is located by persons of non-Aboriginal extraction, has been scarred, carved or modified by an Aboriginal person by: (a) the deliberate removal, by traditional methods, of bark or wood from the tree, or (b) the deliberate modification, by traditional methods, of the wood of the tree” NPW Regulation 80B (3). Culturally Modified trees are sometimes referred to as scarred trees
Activity	A project, development, or work (this term is used in its ordinary meaning and is not restricted to an activity as defined by Part 5 EP&A Act 1979).
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
DECCW	Department of Environment, Climate Change and Water (is now the Office of Environment and Heritage – OEH)
Disturbed Land	“Land is disturbed if it has been the subject of a human activity that has changed the land’s surface, being changes that remain clear and observable.” (DECCW 2010:18).
Due Diligence	“taking reasonable and practical steps to determine whether a person’s actions will harm an Aboriginal object and, if so, what measures can be taken to avoid that harm” (DECCW 2010:18)
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW)</i>
GDA	Geodetic Datum Australia
Harm	“destroy, deface, damage an object, move an object from the land on which it is situated, cause or permit an object to be harmed.” (DECCW 2010:18)
NPWS	National Parks and Wildlife Service
LEP	Local Environmental Plan
NPW Act	<i>National Parks and Wildlife Act 1974 (NSW)</i>
NPW Regulation	<i>National Parks and Wildlife Regulation 2009 (NSW)</i>
OEH	Office of Environment and Heritage (formerly DECCW)
PAD	Potential Archaeological Deposit
Project Area	Project Area is the area subject to the proposed activity
REF	Review of Environmental Factors
REP	Regional Environmental Plan

Contents

1.0	INTRODUCTION	1
1.1	The Project Area.....	1
1.2	The Proposed Activity.....	1
2.0	LEGISLATIVE CONTEXT.....	2
2.1	<i>National Parks & Wildlife Act 1974</i>	2
2.2	<i>National Parks and Wildlife Regulation 2009</i>	2
2.3	Due Diligence and Codes of Practice.....	3
2.3.1	<i>Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (DECCW 2010)</i>	3
2.3.2	Aboriginal Community Consultation	4
2.4	<i>Heritage Act 1977</i>	4
2.5	Authorship and Acknowledgements	4
3.0	ENVIRONMENTAL AND HERITAGE CONTEXT	7
3.1	Local Environment.....	7
3.1.1	Geology and Soils	7
3.1.2	Topography and Hydrology	7
3.1.3	Climate.....	7
3.1.4	Flora and Fauna.....	8
3.1.5	Environmental Context and Cultural Heritage	8
4.0	HERITAGE CONTEXT.....	9
4.1	Aboriginal Cultural Heritage	9
4.1.1	Aboriginal Heritage Information Management System (AHIMS)	9
4.1.2	Regional Archaeological Literature Review.....	9
4.1.3	Synthesis of Aboriginal Archaeological Context	11
4.2	European (Historic) Heritage	11
4.2.1	World Heritage	11
4.2.2	National Heritage.....	12
4.2.3	Commonwealth Heritage	12
4.2.4	State Heritage	12
4.2.5	Local Heritage	12
4.2.6	Synthesis of European (Historic) Heritage Context.....	13
5.0	VISUAL INSPECTION AND FIELD RESULTS	14
5.1	Visual Inspection.....	14
5.2	Conclusion of Visual Inspection Field Results & Impact Assessment.....	15
6.0	RECOMMENDATIONS.....	16
7.0	REFERENCES	17
8.0	PLATES	18

Figures

Figure 1: Project Area	6
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Plates

Plate 1: Looking 228° South West from proposed lease centre point/core hole location at E 758047.747 - N 6641756.234 toward boundary fence. Note general topography. Scout Party provide scale.....	18
Plate 2: Looking across Project Area from Corner A at boundary fence, facing 136° south east.	18
Plate 3: Project Area looking from Corner D 215° south west into stand of Pine trees.	19
Plate 4: Billabong located adjacent to access track. Looking 3° north.	19
Plate 5: Looking along access track with proposed lease area behind photographer Vehicle for scale. Note general topography and vegetation on track. Looking 41° north east from the lease area.	20

Appendices

Appendix 1: Legislative Requirements
Appendix 2: AHIMS Search Results

1.0 Introduction

RPS has been engaged by Santos Limited (the proponent) to prepare an Aboriginal and European (historic) cultural heritage due diligence report. The purpose of a due diligence report is to demonstrate that reasonable and practicable measures were taken to prevent harm to an Aboriginal object or place and has been undertaken in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (2010) ("Due Diligence Code"). This report however goes beyond the requirements of the Due Diligence Code to assess for potential impacts on European (historic) cultural heritage.

This report has considered the relevant environmental and archaeological information, landforms, disturbances and the nature of the proposed activity in addition to formulating appropriate recommendations.

1.1 The Project Area

This due diligence report has been prepared for the area subject to the proposed activity and herein is referred to as the "Project Area." The Project Area is approximately nine (9) kilometres west of Narrabri in the Narrabri Local Government Area (LGA). The Project Area consists of a core hole location of 100 metres x 100 metres plus a proposed an access track approximately 10 metres (m) wide and 2 kilometres (km) in length running from Culgoora Road along the western boundary fence of the property . The Project Area is situated on a privately owned rural property approximately 156 hectares in size (Figure 1), within Petroleum Exploration Licence (PEL) 238. Santos Limited is the joint title holder and operator of PEL 238.

1.2 The Proposed Activity

The proposed activity is to drill a core hole in the Project Area for the purposes of coal seam gas exploration.

The scope of the proposed activity includes;

- upgrading (if required) and using an existing 1.9 km long access track from the lease area to Culgoora Road
- constructing 100 metres of new access track (if required)
- establishing a one (1) hectare (100 metre x 100 metre) lease area;
- drilling the proposed Kiandool 1 core hole to a depth of approximately 1,000 metres;
- sampling, testing and logging;
- installing and operating a deep aquifer monitoring bore (DAMB);
- partially rehabilitating the lease area; and
- fully rehabilitating the lease area, including removal of the well head and infrastructure, once the DAMB has reached its useful life.

The proposed activity does not include well production, pilot or flow testing.

As the proposed activity includes ground disturbance works, a due diligence assessment is required under S1 and S2a of the Due Diligence Code (DECCW 2010:11). The due diligence assessment was extended to include European (historic) cultural heritage, to determine if this would be impacted by the proposed development works.

2.0 Legislative Context

The following overview of the legal framework is provided solely for information purposes for the client, it should not be interpreted as legal advice. RPS will not be liable for any actions taken by any person, body or group as a result of this general overview, and recommend that specific legal advice be obtained from a qualified legal practitioner prior to any action being taken as a result of the summary below.

Although there are a number Acts protecting and managing cultural heritage in New South Wales (see Appendix 1); the primary ones which apply to this report include:

- *National Parks & Wildlife Act 1974*;
- *National Parks & Wildlife Regulation 2009*; and
- *Heritage Act 1977*.

In brief, the *National Parks & Wildlife Act 1974* protects Aboriginal heritage (places, sites and objects) within NSW; the *National Parks and Wildlife Regulation 2009* provides a framework for undertaking activities and exercising due diligence; and the *Heritage Act 1977* protects European (Historic) heritage.

2.1 *National Parks & Wildlife Act 1974*

The *National Parks & Wildlife Act 1974* (NPW Act) protects Aboriginal heritage (places, sites and objects) within NSW. Protection of Aboriginal heritage is outlined in s86 of the Act, as follows:

- "A person must not harm or desecrate an object that the person knows is an Aboriginal object" s86(1);
- "A person must not harm an Aboriginal object" s86(2); and
- "A person must not harm or desecrate an Aboriginal place" s86(4).

Penalties apply for harming an Aboriginal object or place. The penalty for knowingly harming an Aboriginal object (s86[1]) and/or an Aboriginal place (s86[4]) is up to \$550,000 for an individual and/or imprisonment for 2 years; and in the case of a corporation the penalty is up to \$1.1 million. The penalty for a strict liability offence (s86[2]) is up to \$110,000 for an individual and \$200,000 for a corporation.

Harm: under the NPW Act is defined as any act that; destroys defaces or damages the object, moves the object from the land on which it has been situated, causes or permits the object to be harmed. However, it is a defence from prosecution if the proponent can demonstrate: 1) that harm was authorised under an Aboriginal Heritage Impact Permit (AHIP) (and the permit was properly followed); or 2) that the proponent exercised due diligence in respect to Aboriginal heritage. The '**due diligence**' defence (s87(2)) states that if a person or company has exercised due diligence to ascertain that no Aboriginal object was likely to be harmed as a result of the activities proposed for the Project Area (subject area of the proposed activity); then liability from prosecution under the NPW Act will be removed or mitigated if it later transpires that an Aboriginal object was harmed.

Notification of Aboriginal Objects: under section 89A of the NPW Act, Aboriginal objects (and sites) must be reported to the Director-General (now Chief Executive) of OEH within a reasonable time (unless it has previously been recorded and submitted to AHIMS). Penalties of \$11,000 for an individual and \$22,000 for a corporation may apply for each object not reported.

2.2 *National Parks and Wildlife Regulation 2009*

The *National Parks and Wildlife Regulation 2009* (NPW Regulation) provides a framework for undertaking activities and exercising due diligence in respect to Aboriginal heritage. The NPW Regulation outlines the

recognised due diligence codes of practice which are relevant (see 2.3) to this report, but it also outlines procedures for Aboriginal Heritage Impact Permit (AHIP) applications and Aboriginal Cultural Heritage Consultation Requirements (ACHCRs); amongst other regulatory processes.

2.3 Due Diligence and Codes of Practice

The **advantage of a due diligence** assessment is that:

- it assists in avoiding unintended harm to Aboriginal objects;
- provides certainty to land managers and developers about appropriate measures for them to take;
- encourages a precautionary approach;
- provides a defence against prosecution if the process is followed; and
- results in more effective conservation outcomes for Aboriginal cultural heritage.

One of the benefits of the due diligence provisions are that they provide a simplified process of investigating the Aboriginal archaeological context of an area to determine if an Aboriginal Heritage Impact Permit (AHIP) is required.

Under the s80A NPW Regulation, the following due diligence codes recognised:

- (a) the Due Diligence Code published by the Department of Environment, Climate Change and Water and dated 13 September 2010;
- (b) the Plantations and Reafforestation Code (being the Appendix to the *Plantations & Reafforestation (Code) Regulation 2001*) as in force on 15 June 2010;
- (c) the *Private Native Forestry Code of Practice for Northern New South Wales* approved by the Minister for Climate Change, Environment and Water and published in the Gazette on 8 February 2008;
- (d) the *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects* published by NSW Minerals Council Ltd and dated 13 September 2010;
- (e) the *Aboriginal Objects Due Diligence Code for Plantation Officers Administering the Plantations and Reafforestation (Code) Regulation 2001* published by the Department of Industry and Investment and dated 13 September 2010; and
- (f) the *Operational Guidelines for Aboriginal Cultural Heritage Management* published by Forests NSW and dated 13 September 2010.

This report has been written to meet the Due Diligence Code (DECCW 2010).

2.3.1 Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (DECCW 2010)

This publication sets out a minimum benchmark for acceptable due diligence investigations. The purpose of the Due Diligence Code is to set out reasonable and practical steps in order to:

- (1) identify whether or not Aboriginal objects (and places) are, or are likely to be, present in an area;
- (2) determine whether or not their activities are likely to harm Aboriginal objects (if present); and/or
- (3) determine whether an AHIP application is required. (DECCW 2010:2).

Investigations under the code include the following:

- a search of the Aboriginal Heritage Information Management System (AHIMS) database to identify if there are previously recorded Aboriginal objects or places in the Project Area;

- identification of landscape features including, land within 200 metres of water, dune systems, ridge tops, headlands, land immediately above or below cliff faces and/or rockshelters/caves;
- desktop assessment including a review of previous archaeological and heritage studies and any other relevant material;
- visual inspection of the Project Area to identify if there are Aboriginal objects present; and
- assessment as to whether an AHIP is required.

This report has complied with the requirements of the Due Diligence Code listed above. Other requirements of this code are outlined below.

Aboriginal consultation is not required for an investigation under the Due Diligence Code (DECCW 2010:3). However, if the due diligence investigation shows that the activities proposed for the area are likely to harm Aboriginal objects or likely objects within the landscape, then an Aboriginal Heritage Impact Permit will be required with full consultation.

A record of the due diligence procedure followed must be kept to ensure it can be used as a defence from prosecution (DECCW 2010:15).

Following a due diligence assessment (where an AHIP application was not required) an activity must proceed with caution. If any Aboriginal objects are identified during the activity, then works should cease in that area and OEH notified (DECCW 2010:13). The due diligence defence does not authorise continuing harm.

2.3.2 Aboriginal Community Consultation

Aboriginal community consultation is not a formal requirement of the due diligence process (DECCW 2010:3); therefore the proponent is not obliged to undertake Aboriginal community consultation.

Aboriginal community consultation was not undertaken for this due diligence report.

2.4 Heritage Act 1977

This Act protects the natural and European cultural history of NSW with emphasis on European (historic) cultural heritage (such as a place, building, works, relic, moveable object, precinct, historic shipwreck, or archaeological site) of State or local significance, through protection provisions and the establishment of a Heritage Council and a State Heritage Register. Additionally, Government agencies have special obligations under the *Heritage Act 1977* (NSW). Agencies are required to compile a register of heritage assets (known as a Section 170 Heritage and Conservation Register) and look after their assets on behalf of the community.

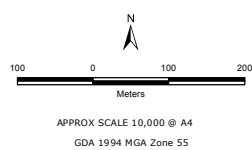
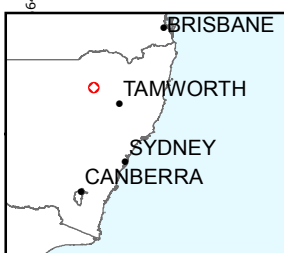
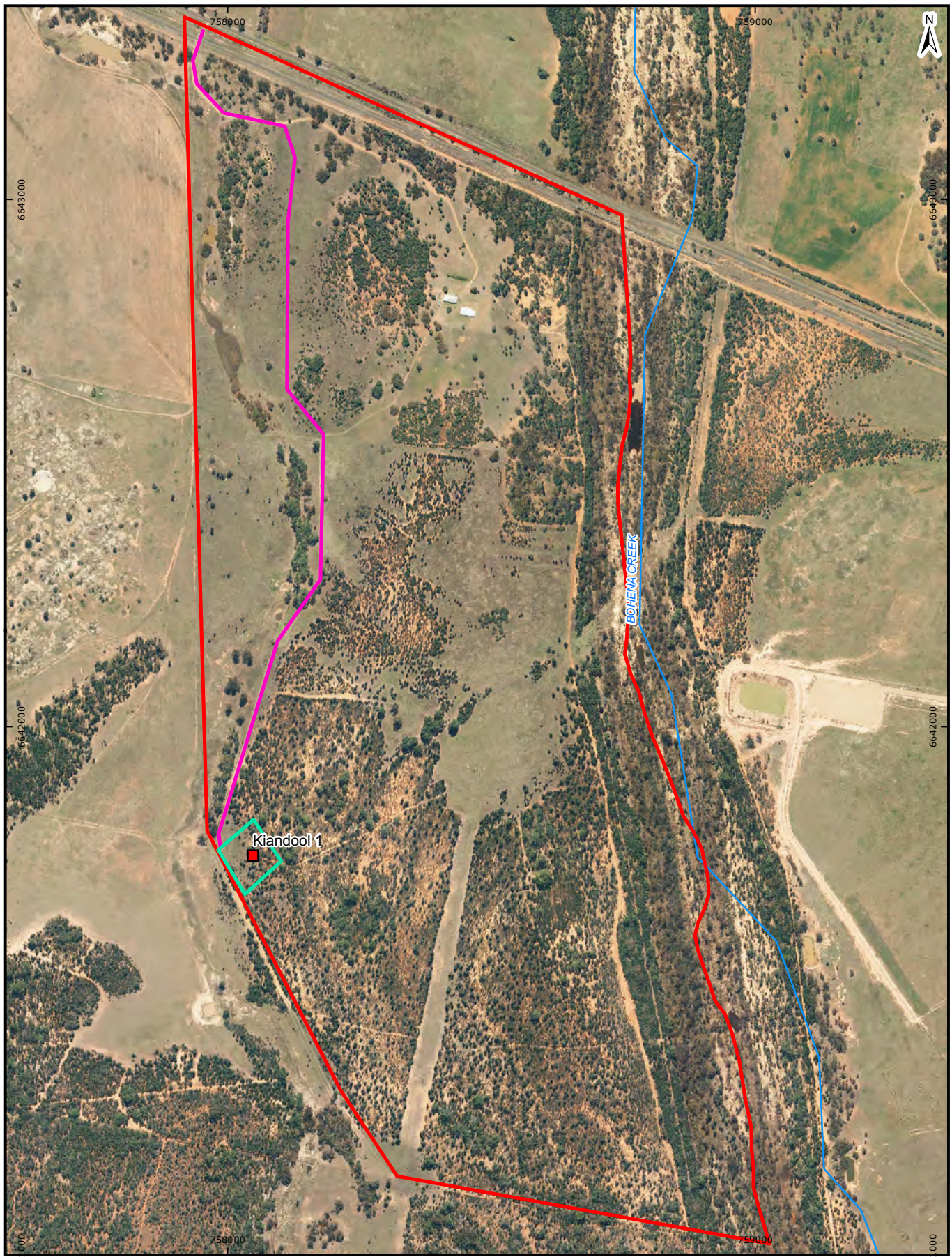
Although Aboriginal objects and places of significance are primarily protected by the NPW Act, if an Aboriginal site, object or place is of State or local significance, it may be protected by a heritage order issued by the Minister subject to advice by the Heritage Council. Penalties of up to \$1.1 million are in place for breaches of the Heritage Act and its Regulations.

2.5 Authorship and Acknowledgements

This report was prepared by RPS Archaeologist, Deborah Farina and RPS Senior Archaeologist, Sarah Ward. Contributions were provided by Thomas Wilson, RPS Senior Spatial Analyst and assistance with report preparation was provided by RPS Business Support Manager, Audrey Churm.

Fieldwork was undertaken on 20 June 2012 by RPS Senior Archaeologist, Sarah Ward who was accompanied by a 'scout party' consisting of: RPS Senior Environmental Scientist, Cassie Hay; RPS Ecologist Lauren Vanderwyk; Santos Senior Land Access Advisor, Wayne Bartesko; Santos Land Access Advisor, Anthony Finlay; and landowners, Mr and Mrs Watson.

The report was reviewed by RPS Senior Archaeologist, Tessa Boer-Mah and RPS Technical Director, Darrell Rigby.



Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

DATA SOURCES

Point features located in field by GPS.

LEGEND

- Kiandool 1
- Proposed Access Road
- Proposed Lease Area
- Site Boundary



FIGURE 1
Kiandool 1 Corehole
Cultural Heritage

3.0 Environmental and Heritage Context

Aboriginal cultural heritage due diligence requires that available knowledge and information is considered and forms part of the desktop assessment required in S4 of the Due Diligence Code (DECCW 2010:12-13). The purpose of reviewing the relevant environmental and heritage information is to assist in identifying whether Aboriginal objects or places are present within the Project Area.

3.1 Local Environment

An understanding of environmental context is important for the predictive modelling of Aboriginal sites and their interpretation. The local environment is understood to have provided natural resources for Aboriginal people, such as stone (for manufacturing stone tools), food and medicines, wood and bark (for implements such as shields, spears, canoes, bowls, shelters, amongst others), along with areas for camping and other activities. The nature of Aboriginal occupation and resource procurement is related to the local environment and it therefore needs to be considered as part of the cultural heritage assessment process.

3.1.1 Geology and Soils

The Project Area is located predominantly on the Jurassic Pilliga Sandstone. This landscape is characterised by quartz sandstone, conglomerate and claystone (Wallis 1971). The soils in the Project Area are duplex soils, being fine, sandy loam topsoil overlaying harsh, clay subsoils. These soils are typical of those derived from the Pilliga Sandstone and are described as highly siliceous. They are characterised by dense growth of trees and shrubs and high species diversity (Norris, 1996).

The geology and soils of the Project Area demonstrate that the landscape prior to European contact was capable of supporting Aboriginal resources suitable for habitation.

3.1.2 Topography and Hydrology

Narrabri is located on the North West Slopes of NSW on the Namoi River in the Brigalow Belt South Bioregion. It is characterised by rolling plains with quaternary sediments in the form of alluvial fans and outwash slopes (OEH 2012a: Online).

The Project Area is located on relatively level (flat) land currently utilised for agricultural purposes. It is approximately 865 metres from Bohena Creek and 75 metres from Pig Creek, an ephemeral tributary of Bohena Creek. Elevation is approximately 200 metres above sea level (asl). The proposed core hole location is on slightly elevated land above the ephemeral tributary.

3.1.3 Climate

Approximately 18,000 years ago, climatic conditions began to alter which affected the movement and behaviour of past populations within their environs. During this time, notably at the start of the Holocene (more than 11,000 years ago), the melting of the ice sheets in the Northern Hemisphere and Antarctica caused the sea levels to rise, with a corresponding increase in rainfall and temperature. The change in climatic conditions reached its peak about 6,000 years ago (Short 2000:19-21). Up until 1,500 years ago, temperatures decreased slightly and then stabilised about 1,000 years ago, which is similar to the temperatures currently experienced. Consequently, the climate of the Project Area for the past 1,000 years would probably have been much the same as present day, providing a year round habitable environment.

The Project Area experiences a warm temperate climate with an average rainfall of 611 millimetres (Australian Bureau of Meteorology 2012: Online). Rainfall is highest over the summer months, with a peak in November, and lowest during the winter months. Temperatures are at their highest in January (34.0°) and February (34.9°) with an average maximum of 26.0° Celsius (Australian Bureau of Meteorology 2011: Online). The coldest month is July with the average maximum temperatures of 17.5°Celsius (Australian Bureau of Meteorology 2012: Online).

3.1.4 Flora and Fauna

The vegetation in the Project Area is described by Keith (2006: 140-141) as Western Slopes Grassy Woodland. It is characterised by native grasses and sporadic stands of trees. This landscape is dominated by plains grass (a native type of spear grass) however grazing has allowed for the introduction of other spear grasses and species such as windmill grass (Keith 2006:110). The Project Area is currently populated by spear grasses, but with scattered trees on the higher ground in the centre of the property. Rat tail grass was evident within the Project Area at the time of the visual inspection, along with a large number of Eucalypt and White Cypress Pine trees.

The native fauna recorded in the vicinity of the Project Area include kangaroo, emu, wallaby, rodents, koala, lizards, snakes and possum (OEH 2012b: Online). None of these were observed within the Project Area during the visual inspection. A full ecological assessment has been prepared by RPS Ecologist Lauren Vanderwyk (RPS 2012) as a companion to this report.

The flora and fauna of the Project Area indicate a) that there were bountiful food and other resources available for exploitation by Aboriginal people; and b) it is a landscape highly disturbed by agricultural pursuits.

3.1.5 Environmental Context and Cultural Heritage

A review of the environmental data shows that the Kiandool 1 Project Area was suitable for Aboriginal and European occupation. Although it is now a highly disturbed, modified landscape, bountiful food sources and other resources would have been available for exploitation by Aboriginal people. This is not borne out by the AHIMS data (below); however this may be due to both the level of disturbance, and the limited previous archaeological/cultural heritage work undertaken in the area.

4.0 Heritage Context

Heritage consists of those objects, sites and places that will be inherited by future generations. Australia has many rich and varied historic places and landscapes, both urban and rural. Identifying and understanding their particular qualities, and what these add to our lives, is central to our engagement with our history and culture.

NSW's heritage is diverse and includes buildings, objects, monuments, Aboriginal places, gardens, bridges, landscapes, archaeological sites, shipwrecks, relics, bridges, streets, industrial structures and conservation precincts.

4.1 Aboriginal Cultural Heritage

Aboriginal and Torres Strait Islander heritage is an important part of Australian heritage. Evidence of the occupation of Australia by Aboriginal and Torres Strait Islander people dates back approximately 60,000 years. As well as being historically important, Aboriginal cultural heritage objects, sites and places provide valuable information about one of the world's oldest living cultures. It has continuing significance, creating and maintaining continuous links with the people and the land.

4.1.1 Aboriginal Heritage Information Management System (AHIMS)

A search was undertaken of the Aboriginal Heritage Information Management System (AHIMS) in accordance with the Due Diligence Code (DECCW 2010:11). The area searched was for Lot 2 in Deposited Plan 1037235 with buffers of 50 metres, 200 metres and one (1) kilometre. All searches revealed that there are no previously recorded Aboriginal sites or previously declared Aboriginal places within the one (1) kilometre of the Project Area.

4.1.2 Regional Archaeological Literature Review

A review of previous archaeological and heritage reports is required as part of the desktop assessment and was undertaken on the 27- 29 June 2012. This was carried out in accordance with the code (DECCW 2010:13). The most relevant publications are described below.

4.1.2.1 [Appleton, J. \(2009\) Narrabri Coal Mine Longwall Stage 2 Project: Aboriginal Heritage Assessment, Archaeological Surveys & Reports Pty Ltd, online.](#)

This investigation was conducted pursuant to an extension to the Narrabri Coal Mine by Whitehaven Coal, located approximately 28 kilometres south of Narrabri, adjacent to the Kamilaroi Highway. The investigation entailed a desktop assessment and a survey over four main areas comprising the impact zones.

The survey identified a total of 121 sites were identified across the four (4) survey areas. The majority of sites were identified in the longwall panels 8-26, followed by the area comprising longwall 1-7. The longwall locations were on a variety of landscapes, but mostly on the eastern slopes of the Pilliga Forest. This area is fed by numerous ephemeral and permanent watercourses, including Pine Creek and Kurrajong Creek.

Overall, the sites comprised low density artefact scatters, with scatters of higher densities being associated with confluences of water courses. A scarred tree and a hearth were also identified in the longwall 1-7 area.

4.1.2.2 [Trindall, E. \(2007\) *Eastern Star Gas: Narrabri Coal Seam Gas Utilisation Project Aboriginal Heritage Assessment*, online.](#)

This investigation was conducted ahead of the proposed construction of a Gas Gathering System, gas flow line and expansion of Wilga Park Power Station. The impact area of that project totalled approximately 36 hectares in the Pilliga East State Forest and open farmland in Narrabri Shire.

The investigation comprised a desktop assessment and a field survey to assess the impact of the proposed operations on the Aboriginal cultural heritage resource. Previous disturbances were variable, with the farmland being moderately disturbed whilst the Pilliga Forest area having been subjected to varying levels of forestry, fires, grazing and mining exploration.

The survey identified one site, a scarred tree located between Dog Fence Road and Pilliga Forest Way. The tree was a Pilliga Box, one of less than 10 in the vicinity of the area surveyed. It was recommended that this tree be avoided by the proposed works.

4.1.2.3 [Silcox, R. & Bowdler, S. \(1982\), *An Archaeological Survey of a Proposed 132 Kv Transmission Line Route from Walgett to Narrabri. Part 1. A Report to the National Parks and Wildlife Service of N.S.W. on behalf of the Electricity Commission of N.S.W.*, unpublished.](#)

This investigation covered the physical examination (visual inspection) of a proposed 132 kv transmission line route from Walgett to Narrabri. This report covers the first 87 kilometres of the 180 kilometre total route, which is proposed to contain an easement 45 metres wide. The second report, containing the Narrabri sector of the route was unable to be located. The aims of the survey were to: identify any signs of 'Aboriginal habitation or activity' within the easement; assess the scientific or cultural significance of any Aboriginal sites or relics found; and to compile a report on the survey and its findings in which management recommendations would be stated for any Aboriginal sites or objects identified during this six (6) day survey, which according to the authors, was the first 'systematic survey of the region'.

Eight (8) sites and seven (7) isolated finds were identified during the course of the survey with visibility averaging 50%. The sites consisted of four scarred trees (two dead both ring barked (WN1 & WN2); two alive, standing, not ring barked (WN3 & WN4)), two surface campsites and two scatters of baked clay 'lumps' (WN7 & WN8). The authors initially suggest that these are from hearths, however concede later in the report that they are likely the result of European clearing and burning of timber.

One campsite (WN5) consists of two chert primary flakes and a backed blade of orange/brown fine-grained chert like material 17 mm x 10 mm x 5 mm with retouch/use wear on the chord, lying on an eroding surface of a brown sandy scald. The second campsite (WN6) consists of a thin scatter of flaked stone material on the surface of several erosional areas on the east bank of a well-timbered ephemeral watercourse. The flaked material included chert (yellow, grey, red, purple, mottled yellow/orange), quartz (pink), and silcrete (grey, red). Most were primary but some flakes showed signs of retouch/use wear including one small scraper of yellow chert. Two small cores; one of grey silcrete and one of red silcrete were noted, along with a fragment of grindstone, possibly basalt, containing two grooves of 2-3mm deep and a larger implement, possible a scraper was noted. It was thought to be ironstone and is 5 centimetres x 5.5 centimetres x 3 centimetres in size.

The isolated finds recorded include a 'creamy-yellow silcrete-like core' (IF1), a grey silcrete primary flake (IF2), a mottled brown/orange primary flake (IF3), a pale orange primary flake (IF4), an irregularly shaped pink/grey banded silcrete flake (IF5), a quartz core (IF6) and a pink quartzitic grindstone (IF7).

With the exception of the second campsite none of the sites were considered significant. The authors recommend that they all be left *in situ* and where necessary, the easement rerouted to avoid them. It was

recommended that the second campsite be recorded in detail and the site removed to the Australian Museum.

None of these sites or objects are in or near to the Project Area, yet point to a fertile landscape for Aboriginal occupation that may have retained cultural evidence of this occupation prior to European disturbance.

4.1.2.4 [Bowdler, S. & Silcox, R. \(1982\), A Salvage Collection from the Walgett-Narrabri Proposed Transmission Line Route: A Report to the National Parks and Wildlife Service of N.S.W. on behalf of the Electricity Commission of N.S.W., unpublished.](#)

This report points to the intended excavation/surface recovery of campsites WN5 and WN6 described above. Site WN5 was not able to be recorded and recovered as the site had been bulldozed prior to the authors return to the area. Site WN6 was recorded and recovered, however it was noted that due to rains and cattle disturbance that since the previous inspection the amount and density of material on site appeared to be extremely low.

The authors suggest that the nature of the site and the material it contained is indicative of 'a certain degree of 'curtage" of stone tools in an area where raw materials are not readily available (Bowdler & Silcox 1982: 4). The report is contains several tables describing the type and style of artefacts recovered.

4.1.3 Synthesis of Aboriginal Archaeological Context

A review of the AHIMS data and previous archaeological work in the area suggest that although the area was utilised by past Aboriginal communities, the availability of water was a crucial factor in the frequency of occupation. Trindall observed the paucity of sites within the Pilliga Forest as being a direct consequence of the lack of reliable water, whilst sites outside the Pilliga, closer to permanent water, contained a variety of site types. However, the potential for sites remaining must be tempered with the previous land disturbances noted in both previous investigations above.

The AHIMS data suggests that artefact sites, such as artefact scatters, isolated finds and non-specified artefact sites appear to be the most frequent site type encountered in the area. This is borne out by the Appleton survey, which found the majority of sites being artefact sites. Appleton also observed the connection between site density/complexity and availability of reliable water.

4.2 European (Historic) Heritage

European land settlement commenced in NSW in 1788 when Governor Phillip claimed possession of the land now known as Australia for a penal colony on behalf of the British Government. The heritage objects, sites and places associated with the European occupation of Australia point not only to the development of Australia as a modern nation, but to the places where people lived and worked.

European (historic) heritage is recorded in a number of ways/places including the Australian Heritage Database, which is an online database of items listed under the Commonwealth Heritage List, National Heritage List and the Register of the National Estate, along with a variety of State and local heritage registers.

4.2.1 World Heritage

The World Heritage List is a register of sites considered to have outstanding universal value. A search of the World Heritage List undertaken on 19 June 2012 revealed there to be 19 World Heritage Sites in Australia, five (5) of which are in NSW. Zero (0) sites are in the Narrabri LGA, and **no items** are within the Project Area itself.

4.2.2 National Heritage

The National Heritage List is now the lead statutory document for the protection of heritage places considered to have national importance. This list comprises Indigenous (Aboriginal), natural and historic places that are of outstanding national heritage significance to Australia. Listed places are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A search of the National Heritage List on 19 June 2012 indicates that there are **no items** in, or near to the Project Area, Bohena Creek or the Narrabri LGA, on the National Heritage List.

Previously the Register of the National Estate was the primary document. While the Register of the National Estate still exists in archival form, items can no longer be registered and since February 2012 no longer has statutory status. However, the Minister is still required to considering the Register when making some decisions under the EPBC Act. A search undertaken on 19 June 2012 revealed three (3) heritage sites within the Narrabri LGA, on the Register of the National Estate (the former Narrabri Gaol, Narrabri Public School and the Narrabri Post Office and former Telegraph Office). **No heritage sites** are in, or near to, the Project Area.

4.2.3 Commonwealth Heritage

The Commonwealth Heritage List is a list of natural, Indigenous and historic heritage places owned or controlled by the Australian Government. These include places connected to defence, communications, customs and other government activities that also reflect Australia's development as a nation. A search of the Commonwealth Heritage List on 19 June 2012 revealed no sites in Bohena Creek on the Commonwealth Heritage List and one (1) site in Narrabri, the Narrabri Post Office and former Telegraph Office, on the Commonwealth Heritage List. The Post Office and former Telegraph Office is located in Maitland Street, Narrabri, outside of the Project Area. As neither the Project Area nor adjacent areas are owned by the Commonwealth, there are **no heritage items** in the Project Area itself. The searches confirm this.

4.2.4 State Heritage

Heritage items in NSW may be registered as important at the State level and/or at the local level. The Heritage Council has developed a set of seven (7) criteria to help determine whether a heritage item is of State or local significance to the people of New South Wales. Items are assessed by the Heritage Council of NSW and if deemed eligible for listing, i.e. are of State significance, they are referred to the Minister for Heritage for Listing on the State Heritage Register, a statutory register of heritage items created by the NSW *Heritage Act 1977*.

The NSW Heritage Inventory database is maintained by the Heritage Branch, Office of Environment and Heritage (OEH) and lists items that have been identified as of State and/or local heritage significance throughout NSW. A search of the State Heritage Register on 10 July 2012 revealed one (1) item of State Heritage Significance on the NSW State Heritage Register (Narrabri Gaol and Residence, Bowen Street, Narrabri) in the Narrabri LGA which is not in, or near to the Project Area. The searches also revealed **no heritage items** in the Narrabri LGA subject to an Interim, or Authorised Interim Heritage Order and no Historic Shipwrecks in Bohena Creek, Kiandool or the Narrabri LGA more broadly.

4.2.5 Local Heritage

Searches of the Heritage Branch, OEH State Heritage Inventory with reference to the *Narrabri Local Environmental Plan No. 2* (current version for 20 April 2012 to date) and were undertaken on 10 July 2012. The searches reveal a nine (9) local heritage items listed on the LEP. A search of the Heritage Branch, OEH State Heritage Inventory on 10 July 2012 reveals 23 items of local significance in the Narrabri LGA, including the nine (9) LEP items. Of these twenty-three (23) local heritage items, no items are in Bohena Creek and **no heritage items** are in or near to the Project Area.

4.2.6 Synthesis of European (Historic) Heritage Context

The search results indicate that there are no known (i.e. reported, recorded or identified) European (Historic) heritage items within the Project Area; it is considered that there are **no European heritage constraints** associated with the project.

5.0 Visual Inspection and Field Results

A visual inspection of the Project Area was undertaken to identify whether Aboriginal objects are present on the ground surface or are likely to be present below the ground surface. In accordance with S4 of the Due Diligence Code a qualified archaeologist undertook the visual inspection (DECCW 2010:12-13).

5.1 Visual Inspection

The visual inspection of the Project Area was conducted on 20 June 2012 and undertaken by RPS Senior Archaeologist, Sarah Ward, together with RPS Senior Environmental Scientist, Cassie Hay, RPS Ecologist, Lauren Vanderwyk, Santos Senior Land Access Advisor, Wayne Bartesko and Santos Land Access Advisor Anthony Finlay. The 'scout party' was accompanied by property owners, Mr & Mrs Watson. The visual inspection was conducted on foot, as a pedestrian survey.

The scout party arrived at the site at 10:00am. The core hole location was identified at position E 758047.747 - N 6641756.234 (altitude 196+/-10m) at approximately 11:00 am. The core hole portion of the Project Area was located on gently sloped, grassed land primarily been used for grazing (Plate 1, Plate 2). The grasses appear to be a mix of native and exotic species which indicates previous land clearance. A stand of pine trees (Plate 3) is located to the west of the 100 metre x 100 metre proposed core hole lease area, along the western boundary of the property.

The access track portion of the Project Area (Plate 5) comprises an existing access track running from Culgoora Road in a roughly south/south west direction, past a billabong (Plate 4) to the proposed core hole location. The existing access track is lightly grassed with light rutting from vehicle tyres. A ten (10) metre wide area, encompassing the existing five (5) metre wide track, was inspected to allow the track to be widened to a size appropriate for a drilling rig.

After the perimeter of the lease area was inspected, the survey was conducted by walking five (5) metre wide transects in a north/south direction across the entirety of the core hole/proposed lease area portion of the Project Area, with particular attention paid to any ground surface exposures. The extensive dense vegetation across the proposed core hole lease area left no such exposures to inspect the natural ground surface, and visibility was assessed as poor, i.e. less than 5%. No Aboriginal objects were identified and the potential for unidentified Aboriginal objects was assessed to be low, for the reasons discussed below.

With regard to the access track portion of the Project Area, this was conducted by walking the entirety of the track, again in five metre transects. Vehicle tracks had left some small, sporadic patches of exposure, however visibility was generally poor. No Aboriginal objects or European (Historic) heritage sites were observed within the access track portion of the Project Area.

With regard to potential for Aboriginal objects to occur within the Project Area, although the core hole location is within 100 metres of a water course, it should be noted that the water course is an ephemeral water course and therefore is not considered to have been suitable for continuous habitation. The land may still have been used for transient or temporary purposes; however evidence of such use would not necessarily be left in the archaeological record. Further, past land uses, such as grazing, land clearance and other agricultural pursuits, may have damaged and/or destroyed what little evidence may have been left by such transient occupation. The RPS description of the landscape conforms with the Office of Environment and Heritage (OEH) definition of disturbed land (2010:18) as:

Land is disturbed land if it has been the subject of human activity that has changed the land's surface, being changes that remain clear and observable. Examples include ploughing, construction of rural infrastructure (such as dams and fences), construction of roads, trails and tracks (including

fire trails and tracks and walking tracks), clearing vegetation, construction of buildings and the erection of other structures, construction or installation of utilities and other similar services (such as above or below ground electrical infrastructure, water or sewerage pipelines, stormwater drainage and other similar infrastructure), substantial grazing involving the construction of rural infrastructure, and construction of earthworks associated with anything referred to above.

Although a watercourse is present within 200 metres of the Project Area it is not within the Project Area boundaries, and the extent to which the area has been previously disturbed is high. Therefore, the archaeological potential for the Project Area is assessed as zero to very low, and an Aboriginal Heritage Impact Assessment is not required for this project.

5.2 Conclusion of Visual Inspection Field Results & Impact Assessment

The purpose of a due diligence report is to identify whether Aboriginal objects are present, or likely to be present, in the Project Area; to determine whether the proposed activity is likely to harm Aboriginal objects (if present) and to determine whether an Aboriginal Heritage Impact Permit (AHIP), or Statement of Heritage Impact (if impacting European heritage) is required.

The proposed activities including the drilling of a core hole for coal seam gas exploration, the clearing and fencing of a 100 metre x 100 metre lease area to secure the core hole location, and the shoring up and extension of an existing track to provide access for the drilling rigs and heavy machinery required to undertake the works. The activities will involve ground disturbing works.

As a result of the visual inspection of both the core hole location and access track, no Aboriginal places or objects were identified within the Project Area. Similarly no culturally modified trees were observed in the Project Area. Whilst vegetation obscured much of the ground surface across the project area, past land uses and distance from permanent water sources lead to the conclusion that the potential for any Aboriginal cultural heritage material to be present within the Project Area is low to zero.

The results of the AHIMS and European (historic) heritage searches together with the visual inspection indicate that there are no identified Aboriginal objects or European heritage sites in the Project Area. As there are no identified Aboriginal objects in the Project Area it is assessed that there is no identified risk of harm to Aboriginal objects and an AHIP is not required for the proposed activity. Similarly, as there are no European (historic) heritage sites identified within the project area, there is no identified risk of harm to European (historic) heritage.

6.0 Recommendations

This report has considered the available environmental and archaeological information for the Project Area, the land condition, as well as, the nature of the proposed activities. The numbered recommendation/s have been provided specifically for this Project Area, in addition recommendations A-D must also be followed for undertaking the activity (the construction works). Recommendations A-D provide contingency procedures should unexpected Aboriginal objects, skeletal remains or significant European cultural heritage material be identified during the activity (construction).

Recommendation 1

No Aboriginal objects or places have been identified within the Project Area and therefore an Aboriginal Impact Permit (AHIP) is not required for the proposed activity. Likewise no European (historic) heritage sites have been identified within the Project Area, thus a Statement of Heritage Impact is similarly not required for the proposed works.

Recommendations A - E must be followed for undertaking the activity (the construction works). These recommendations provide contingency procedures should unexpected Aboriginal objects, skeletal remains or significant European cultural heritage material be identified during the activity (the construction works).

Recommendation A

All relevant Santos staff and contractors should be made aware of their statutory obligations for heritage under NSW *National Parks and Wildlife Act 1974* and the NSW *Heritage Act 1977*, which may be implemented as a heritage induction.

Recommendation B

This due diligence assessment must be kept by Santos Limited so that it can be presented, if needed, as a defence from prosecution.

Recommendation C

If Aboriginal object/s are identified in the Project Area during works, then all works in the immediate area must cease and the area cordoned off. OEH must be notified by ringing the Enviroline 131 555 so that the site can be adequately assessed and managed.

Recommendation D

In the event that skeletal remains are uncovered, work must cease immediately in that area and the area cordoned off. Santos must contact the NSW Police with no further action taken until written advice is provided by the Police. If determined to be Aboriginal, OEH must be notified by ringing the Enviroline 131 555 and a management plan prior to works re-commencing must developed in consultation with the relevant Aboriginal stakeholders.

Recommendation E

If, during the course of development works, suspected European cultural heritage material is uncovered, work should cease in that area immediately. The NSW Heritage Branch (Enviroline 131 555) should be notified and works only recommence when an approved management strategy developed.

7.0 References

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8.0 Plates



Plate 1: Looking 228° South West from proposed lease centre point/core hole location at E 758047.747 - N 6641756.234 toward boundary fence. Note general topography. Scout Party provide scale.



Plate 2: Looking across Project Area from Corner A at boundary fence, facing 136° south east.



Plate 3: Project Area looking from Corner D 215° south west into stand of Pine trees.



Plate 4: Billabong located adjacent to access track. Looking 3° north.



Plate 5: Looking along access track with proposed lease area behind photographer Vehicle for scale. Note general topography and vegetation on track. Looking 41° north east from the lease area.

Appendix I

Legislative Requirements

Summary of Statutory Controls

The following overview of the legal framework is provided solely for information purposes for the client, it should not be interpreted as legal advice. RPS will not be liable for any actions taken by any person, body or group as a result of this general overview, and recommend that specific legal advice be obtained from a qualified legal practitioner prior to any action being taken as a result of the summary below.

COMMONWEALTH

Aboriginal & Torres Strait Islander Heritage Protection Act 1984 (ATSIHIP Act)

The purpose of this Act is to preserve and protect all heritage places of particular significance to Aboriginal and Torres Strait Islander people. This Act applies to all sites and objects across Australia and in Australian waters (s4).

It would appear that the intention of this Act is to provide national baseline protection for Aboriginal places and objects where State legislation is absent. It is not to exclude or limit State laws (s7(1)). Should State legislation cover a matter already covered in the Commonwealth legislation, and a person contravenes that matter, that person may be prosecuted under either Act, but not both (s7(3)).

The Act provides for the preservation and protection of all Aboriginal objects and places from injury and/or desecration. A place is construed to be injured or desecrated if it is not treated consistently with the manner of Aboriginal tradition or is or likely to be adversely affected (s3).

Australian Heritage Commission Act 1975

The *Australian Heritage Commission Act (1975)* established the Australian Heritage Commission which assesses places to be included in the National Estate and maintains a register of those places. Places maintained in the register are those which are significant in terms of their association with particular community or social groups and they may be included for social, cultural or spiritual reasons. The Act does not include specific protective clauses.

The *Australian Heritage Council Act 2003*, together with the *Environment Protection & Biodiversity Conservation Act 1999*, includes a National Heritage List of places of National heritage significance, maintains a Commonwealth Heritage List of heritage places owned or managed by the Commonwealth and ongoing management of the Register of the National Estate.

STATE

It is incumbent on any land manager to adhere to state legislative requirements that protect Aboriginal Cultural heritage. The relevant legislation in NSW includes but is not limited to the summary below.

National Parks and Wildlife Act 1974 (NPW Act)

The NPW Act provides statutory protection for all Aboriginal heritage, places and objects (not being a handicraft made for sale), with penalties levied for breaches of the Act. This legislation is overseen by the Office of Environment and Heritage (OEH), and specifically the Director-General of OEH. Part 6 of this Act is the relevant part concerned with Aboriginal objects and places, with Section 86 and Section 90 being the most pertinent. In 2010, this Act was substantially amended, particularly with respect to Aboriginal cultural heritage requirements. Relevant sections include:

Section 86

This section now lists four major offences:

- (4) A person must not harm an object that the person knows is an Aboriginal object;
- (5) A person must not harm an Aboriginal object;
- (6) For the purposes of s86, “circumstances of aggravation” include:
 - (g) The offence being committed during the course of a commercial activity; or
 - (h) That the offence was the second or subsequent offence committed by the person;
- (7) A person must not harm or desecrate an Aboriginal place.

Offences under s86 (2) and (4) are now strict liability offences, i.e., knowledge that the object or place harmed was an Aboriginal object or place needs to be proven. Penalties for all offences under Part 6 of this Act have also been substantially increased, depending on the nature and severity of the offence.

Section 87

This section now provides defences to the offences of s86. These offences chiefly consist of having an appropriate Aboriginal Heritage Impact Permit (AHIP), not contravening the conditions of the AHIP or demonstrating that due diligence was exercised prior to the alleged offence.

Section 87A & 87B

These sections provide exemptions from the operation of s86; Section 87A for authorities such as the Rural Fire Service, State Emergency Services and officers of the National Parks & Wildlife Service in the performance of their duties, and s87B for Aboriginal people performing traditional activities.

Section 89A

If a person knows of the location of an Aboriginal object or place that has not been previously registered and does not advise the Director-General of that object or place within a reasonable period of time, then that person is guilty of an offence under this Section of the Act.

Section 90

This section authorises the Director-General to issue an AHIP.

Section 90A-90R

These sections govern the requirements relating to applying for an AHIP. In addition to the amendments to the Act, OEH have issued three new policy documents clarifying OEH's requirements with regards to Aboriginal archaeological investigations: *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*, *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* and *Code of Practice for Archaeological Investigations in NSW*. The Consultation Requirements formalise the consultation with Aboriginal community groups into four main stages, and includes details regarding the parties required to be consulted, advertisements inviting Aboriginal community groups to participate in the consultation process, requirements regarding the provision of methodologies, draft and final reports to the Aboriginal stakeholders and timetables for the four stages. The Due Diligence Code of Practice sets out the minimum requirements for investigation, with particular regard as to whether an AHIP is required. The Code of Practice for Archaeological Investigation sets out the minimum requirements for archaeological investigation of Aboriginal sites.

Aboriginal Heritage Impact Permits (AHIP)

OEH encourages consultation with relevant Aboriginal stakeholders for all Aboriginal Heritage Assessments. However, if an Aboriginal Heritage Impact Permit (AHIP) is required for an Aboriginal site, then specific OEH guidelines are triggered for Aboriginal consultation.

Aboriginal Cultural Heritage Consultation Requirements for Proponents

In 2010, the Aboriginal Cultural Heritage Consultation Requirements for Proponents (ACHCR's) were issued by OEH (12th April 2010). These consultation requirements replace the previously issued Interim Community Consultation Requirements (ICCR) for Applicants (Dec 2004). These guidelines apply to all AHIP applications prepared after 12th April 2010; for projects commenced prior to 12th April 2010, transitional arrangements have been stipulated in a supporting document, Questions and Answers 2: Transitional Arrangements.

The ACHCR's 2010 include a four stage Aboriginal consultation process and stipulate specific timeframes for each state. Stage 1 requires that Aboriginal people who hold cultural information are identified, notified and invited to register an expression of interest in the assessment. Stage 1 includes the identification of Aboriginal people who may have an interest in the Project Area and hold information relevant to determining the cultural significance of Aboriginal objects or places. This identification process should draw on reasonable sources of information including: the relevant OEH EPRG regional office, the relevant Local Aboriginal Land Council(s), the Registrar of Aboriginal Owners, Aboriginal Land Rights Act (1983), the Native Title Tribunal, Native Title Services Corporation Limited, the relevant local council(s), and the relevant catchment management authority. The identification process should also include an advertisement placed in a local newspaper circulating in the general location of the project area. Aboriginal organisations and/or individuals identified should be notified of the project and invited to register an expression of interest (EoI) for Aboriginal consultation. Once a list of Aboriginal stakeholders has been compiled from the EoI's, they need to be consulted in accordance with ACHCR's Stages 2, 3 and 4.

Environmental Planning & Assessment Act 1979 (EP&A Act)

This Act regulates a system of environmental planning and assessment for New South Wales. Land use planning requires that environmental impacts are considered, including the impact on cultural heritage and specifically Aboriginal heritage. Within the EP&A Act, Parts 3, 4 and 5 relate to Aboriginal heritage.

Part 3 regulates the preparation of planning policies and plans. Part 4 governs the manner in which consent authorities determine development applications and outlines those that require an environmental impact statement. Part 5 regulates government agencies that act as determining authorities for activities conducted by that agency or by authority from the agency. The National Parks & Wildlife Service is a Part 5 authority under the EP&A Act.

In brief, the NPW Act provides protection for Aboriginal objects or places, while the EP&A Act ensures that Aboriginal cultural heritage is properly assessed in land use planning and development.

Heritage Act 1977

This Act protects the natural and cultural history of NSW with emphasis on non-indigenous cultural heritage through protection provisions and the establishment of a Heritage Council. Although Aboriginal heritage sites and objects are primarily protected by the *National Parks & Wildlife Act 1974*, if an Aboriginal site, object or place is of great significance, it may be protected by a heritage order issued by the Minister subject to advice by the Heritage Council.

Other legislation of relevance to Aboriginal cultural heritage in NSW includes the *NSW Local Government Act 1993*. Local planning instruments also contain provisions relating to indigenous heritage and development conditions of consent.

Appendix 2

AHIMS Search Results

RPS Australia East Pty Ltd Sydney CBD
Level 12 92 Pitt Street
Sydney New South Wales 2000

Date: 21 August 2012

Attention: Sarah Ward

Email: sarah.ward@rpsgroup.com.au

Dear Sir or Madam:

**AHIMS Web Service search for the following area at Lot : 2, DP:DP1037235 with a Buffer of 1000 meters.
conducted by Sarah Ward on 21 August 2012**

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the [NSW Government Gazette](http://www.nsw.gov.au/gazette) (<http://www.nsw.gov.au/gazette>) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

Appendix 3

AHIMS search results

RPS Australia East Pty Ltd Sydney CBD
Level 12 92 Pitt Street
Sydney New South Wales 2000

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Email: sarah.ward@rpsgroup.com.au

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- This search can form part of your due diligence and remains valid for 12 months.

Appendix 4

EDA Rig 1 Source noise level measurements Wilkinson Murray

EDA RIG 1

SOURCE NOISE LEVEL MEASUREMENTS

EDA RIG 1
SOURCE NOISE LEVEL MEASUREMENTS

REPORT NO. 00574
VERSION A

OCTOBER 2011

PREPARED FOR

SANTOS LIMITED
LEVEL 26, 32 TURBOT STREET
BRISBANE QLD 4000

TABLE OF CONTENTS

	Page
1 INTRODUCTION	1
2 DRILL RIG INFORMATION	2
3 NOISE LEVEL MEASUREMENTS	4
3.1 Noise Measurement Equipment	4
3.2 Noise Measurement Results	5
3.3 Noise Level Contours	6
4 NOISE CRITERIA	9
4.1 Background Noise Levels	9
4.2 <i>Interim Construction Noise Guideline</i>	9
5 CONCLUSION	12

APPENDIX A – Noise Prediction Results

APPENDIX B – Noise Emitting Sources

GLOSSARY OF TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph overleaf, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

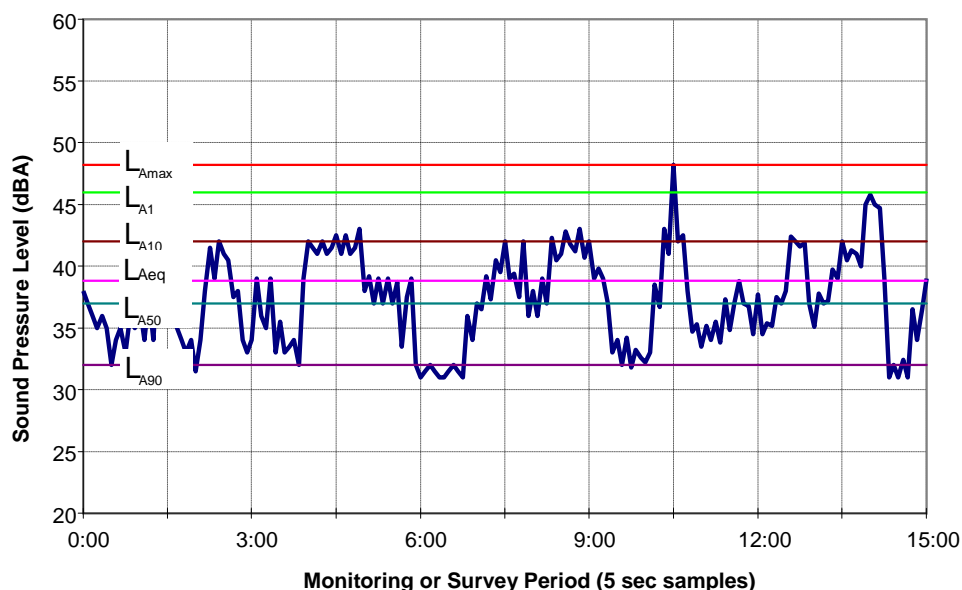
L_{A50} – The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.

L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

Wilkinson Murray has been engaged by RPS Group on behalf of Santos Limited to undertake noise level measurements of Energy Drilling Australia Rig 1 (EDA Rig 1). The purpose of these measurements is to determine the suitability of EDA Rig 1 for use in the Gunnedah Basin.

This report presents the following.

- Results of source noise level measurements of EDA Rig 1 operating in the Fairview, QLD area.
- Discussion of probable criteria for the operation of EDA Rig 1 in the Gunnedah Basin.
- Noise modelling predictions of typical topographic and meteorological conditions to provide guidance on the suitability of EDA Rig 1 for use in the Gunnedah Basin.

This report does not provide a site-specific assessment of noise impacts associated with the operation of EDA Rig 1 in the Gunnedah Basin. The information contained within this report should be used to guide decisions regarding the future use of EDA Rig 1; however we caution that site specific local features, such as topography, can greatly influence the propagation of noise. This is especially so at large distances between the noise source and receiver. In general the scenarios considered in this report present indicative worst-case noise propagation and in many instances the local conditions would serve to reduce the propagation of noise, thus lessening the potential for impacts.

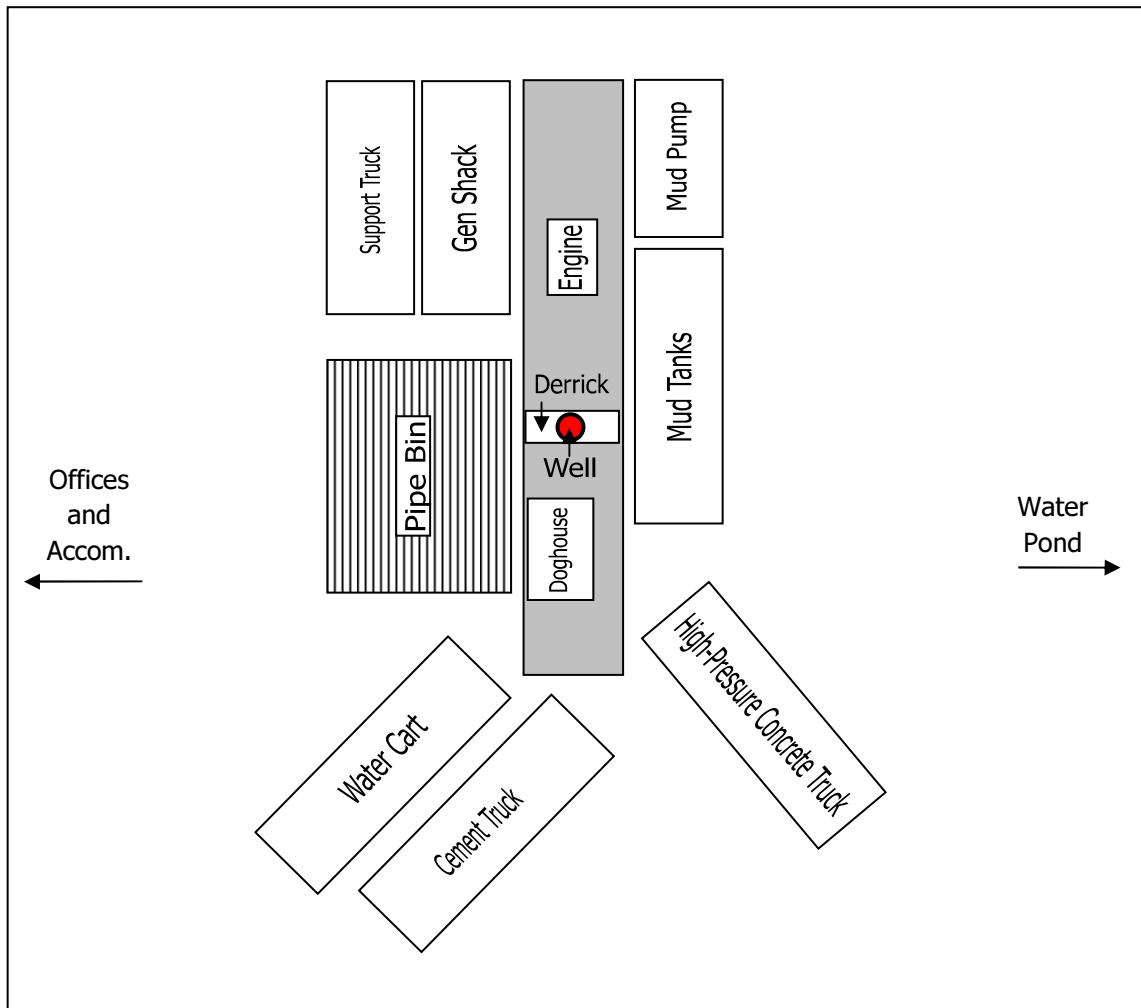
2 DRILL RIG INFORMATION

Well drilling involves the following general stages.

- **Drilling** involves the removal of material to produce the well. The primary noise sources during this operation are the drill rig engine and the mud pump, each of which operates at moderate to high revs. The greatest noise levels are produced when the rig experiences high torque as result of drilling through hard rock. In addition to the above sources, sound can also be radiated from resonances in the drill pipe and/or the derrick. This is most prominent under high torque loads.
- **Tripping** involves the removal of the drill pipe and bit from the well (i.e. making a trip). During this stage the drill rig engine operates at moderate revs and the mud pump operates at low revs. Some banging can occur from the placement of drill pipe onto the pipe bins though this is minimised by the pipe-handler/pipe bin design and can be nullified by careful operation. The noise emissions from this stage are reduced compared with drilling.
- Running **casing** involves inserting metallic casing into the well. The noise emissions from this stage are similar to "tripping".
- **Cementing** the casing involves the injection of high-pressure cement outside the metallic casing to secure the well. Noise emissions from the drill rig during this stage are similar to "tripping", with low-moderate drill rig engine revs and mud pump revs. In addition to the drill rig noise emissions, a high-pressure concrete truck is required during this stage. Noise levels from the concrete truck are significant and thus overall site noise emissions during this stage are similar to drilling, though the directional characteristic differs. The high-pressure concrete truck, cement truck and water cart are only in position adjacent to the rig during the cementing process (i.e. not during drilling etc.).

These stages are repeated multiple times with decreasing drill and casing diameters until the desired well depth is reached. The depth of each cycle, and consequently the duration of each cycle varies, though it is often in the order of several hundred meters for vertical wells, requiring typically in the order of 1-2 days for each cycle.

Figure 2-1 and Figure 2-2 show EDA Rig 1 as it was setup during our survey.

Figure 2-1 Indicative EDA Rig 1 Layout**Figure 2-2 EDA Rig 1**

3 NOISE LEVEL MEASUREMENTS

Detailed noise level measurements of EDA Rig 1 were undertaken on Wednesday 21st and Thursday 22nd September, 2011, whilst the rig was operational at FV16-41 near Fairview in the Bowen Basin, QLD.

Rig noise levels were determined by the following.

- Two "control" locations monitored continuously by unattended environmental noise loggers over the majority of a full drill cycle (approx. 36 hours).
- Six short-term measurement locations in close proximity to the noisiest equipment.
- 16 short-term measurement locations surrounding the drill pad (approximately on the perimeter of the drill pad) capturing the directivity through 360°.

Measurements were undertaken at each of the short-term measurement locations for drilling, running casing and cementing casing stages. The control locations were used to determine if short-term measurements were undertaken at times when the noise emissions were typical for that stage.

3.1 Noise Measurement Equipment

The unattended noise monitoring equipment used for these measurements consisted of an ARL NGARA environmental noise logger set to fast response. This equipment is capable of remotely monitoring and storing both A-weighted and C-weighted noise levels every one-tenth of a second. Additionally the noise monitor is capable of storing wav files for aural analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

Post processing of the one-tenth second noise levels permits the derivation of noise descriptors. L_{A1} , L_{A10} , L_{A90} , L_{Amax} and L_{Aeq} levels of the ambient noise were analysed in 15-minute sampling periods. L_{A1} , L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see GLOSSARY for definitions). The L_{Aeq} level is the Equivalent Continuous Sound Level and has the same sound energy over the sampling period as the actual noise environment with its fluctuating sound levels. The L_{A1} is indicative of regular maximum noise levels due to individual noise events. The L_{A90} level is normally taken as the background noise level during the relevant period.

All attended measurements were conducted using a Bruel and Kjaer Type 2260 Sound Level Meter. This sound level meter conforms to Australian Standard 1259 *Acoustics - Sound Level Meters* as a Type 1 Precision Sound Level Meter which has an accuracy suitable for field and laboratory use. The A-Weighting filter of the meter was selected and the time weighting was set to "Fast". The calibration of the meter was checked before and after the measurements with a Bruel and Kjaer Type 4231 sound level calibrator and no significant drift was noted.

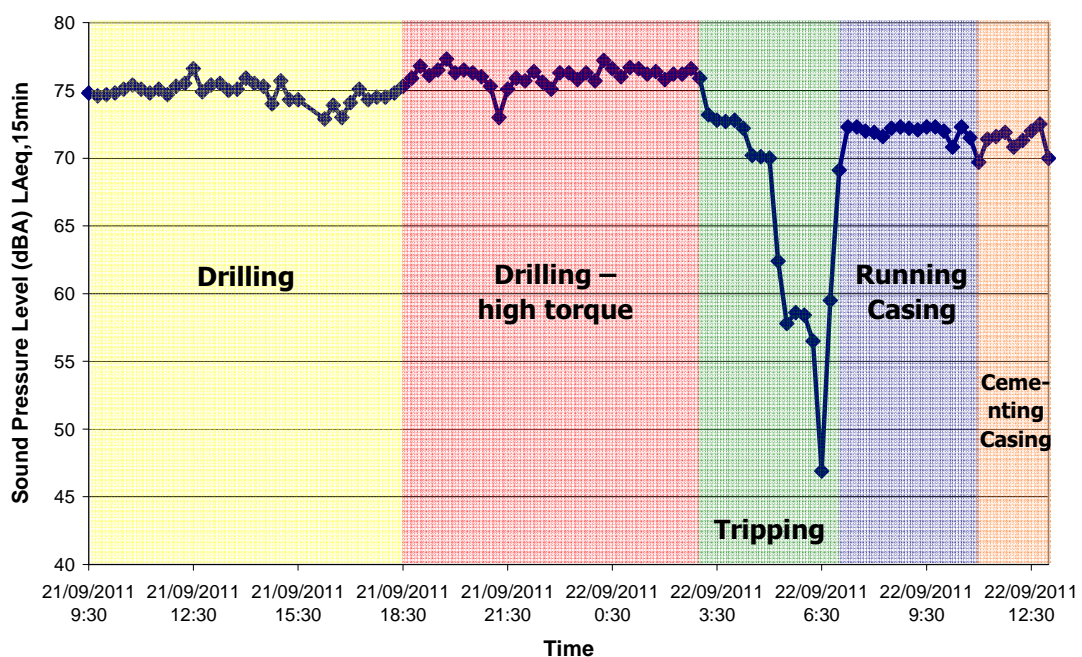
The Bruel and Kjaer Type 2260 and Type 4231 have been laboratory calibrated within the previous two years in accordance with in-house Quality Assurance Procedures.

GPS coordinates of each measurement location and noise source were obtained with a Garmin hand-held GPS and noted for input into the noise model.

3.2 Noise Measurement Results

Figure 3-1 presents a graphical level-history of the drilling cycle at one of the control locations. The figure shows the relative noise emissions from each activity. Drilling is reasonably consistent in noise level, with some elevation whilst drilling harder rock. Tripping produced much lower noise levels than drilling, though a worst-case 15 minute period during tripping was only approximately 5 dB below drilling noise levels. Running casing was 2-5 dB below drilling. Cementing casing was similarly 2-5 dB below drilling at the control location, though greater noise levels were measured at other locations with greater exposure to the high-pressure concrete truck.

Figure 3-1 Noise Level History at "Control" Location



Attended near-field source noise measurements were performed to determine the relative contribution of each noise source associated with the rig. These measurements were taken at varying distances between 7m and 20m from the source.

Table 3-1 presents the sound power levels for each plant item. Note that many of these sources radiate over significant areas and thus cannot be equated by point sources in the near field (less than 20m). Determination of the sound power levels has considered the radiated area of these sources. Near field measurements have been supplemented by more distant measurements (around the drill pad perimeter – approx. 50-70m from noise sources) in order to gain a greater understanding of the total noise emissions.

We note that many of the sources are shielded in some directions. Furthermore, many of the sources are reflected by adjacent items. These sound power levels represent the on-axis (in this instance meaning the loudest direction in the horizontal plane surrounding the rig) equivalent sound power level including reflections (i.e. reflections are accounted for by the source level and need not be incorporated in any predictive calculations).

Other noise sources were present, however the noise sources in Table 3-1 dominated the noise emissions from the site.

Table 3-1 Individual Source Sound Power Levels (SWL)

Plant Item	Operation	SWL dBA	Notes
Drill engine	Typical high load	120	Noise emanates from the engine casing (which is open at both ends for ventilation) and from the exhaust (which is fitted above the engine and discharges vertically).
	Typical low load/idle	116	
Mud pump	Typical high load	120	Noise emanates from the cooling fans at the rear of the pump engine, the engine casing and from the exhaust which is fitted above the engine and discharges vertically.
	Idle	112	
Drill pipe or derrick resonance	High torque drilling	117	We expect that this source could be reduced/avoided with damping and/or improved fitment of items to the derrick – primarily the aluminium cable tray that houses the hydraulic hoses.
High-pressure concrete truck	Cementing casing	122	Noise emanates from the engine, the exhausts and the radiators/fans at the front of the trailer.

Under the tests for annoying characteristics detailed in the *NSW Industrial Noise Policy (INP, EPA 2000)*, the overall emissions from EDA Rig 1 did not exhibit low-frequency, tonal or any other annoying characteristic at the source that would warrant a penalty.

3.3 Noise Level Contours

It is most convenient to express the directional noise emissions of the drill rig using noise level contour plots. These are presented for drilling and cementing casing under a number of propagation scenarios in Appendix A. A description of the noise level predictions follows.

Noise level predictions were made using the Environmental Noise Model (ENM) prediction algorithms. These prediction algorithms have been evaluated and verified by numerous studies and are accepted by regulatory bodies including the NSW Office of Environment and Heritage (OEH) and the Department of Planning & Infrastructure (DP&I).

Directivity of the rig was modelled by representing the geometry of the rig and surrounding items in the noise model. This was calibrated against 16 noise level measurements around the perimeter of the drill pad for each of the operating scenarios. A reasonable verification of the model was obtained with all locations within 2 dB of the (normalised) measured level at each location.

Site specific factors that can affect noise propagation include topography – through shielding and ground attenuation – and also meteorological conditions such as temperature inversions and winds.

The following variables were considered in predictive modelling for this report.

- Ground attenuation is greatest when propagation occurs over relatively flat ground. Truly flat or “tangent” ground is seldom experienced over large distances in the field and as such modelling flat ground can over-predict the attenuation that would occur in reality. Vegetative scattering is another feature that is approximated by a ground absorption terms in noise prediction algorithms. Topographic shielding was not considered by the model but it is expected that at many sites where the receiver is shielded by topography, noise levels would be reduced by 5-10 dB. The range of impact from varying ground attenuation was modelled by a “flat ground” scenario and also a “valley” between source and receiver.
- Winds and temperature conditions can alter the propagation of noise. Wind directions and speeds vary considerably and modelling this with a single “wind” condition is often inappropriate. Temperature inversions increase the propagation of noise and occur most frequently at night, generally under still conditions. Two meteorological conditions were modelled; a still-isothermal condition and a temperature inversion strength of 3°C/100m. This temperature inversion typically represents a 10th percentile noise condition (combined effect of temperature inversions and winds) across sites in NSW and is suitable for many assessment purposes.

Based on the above factors the following scenarios were modelled.

Table 3-2 Summary of Modelled Scenarios

Scenario	Operation	Ground	Met. Condition
A	Drilling	Flat	Still-isothermal
B			3°C/100m temp inversion
C		Valley	Still-isothermal
D			3°C/100m temp inversion
E	Cementing	Flat	Still-isothermal
F			3°C/100m temp inversion
G		Valley	Still-isothermal
H			3°C/100m temp inversion

With regard to the contours presented in Appendix A, Figure A-5 and Figure A-6 – being for cementing with flat ground – require some additional explanation. Within approximately 500m from the source the noise contours for these scenarios show elevated noise levels in the bottom-left, bottom-right and top right quadrants (approximately). This is to be expected because the high-pressure concrete truck is exposed to these locations and is responsible for a significant portion of the total noise emissions. Beyond these distances the areas which are shielded from the concrete truck begin to propagate further. This is due to the way that ground attenuation is handled in the noise prediction algorithms, with the shielded areas propagating from a higher effective source height and thus receiving less ground attenuation. This is effectively an anomaly, though this effect may eventuate in few real situations. In most circumstances the ground is not truly flat and as such the ground attenuation would be more uniform, with less than the predicted attenuation in the exposed directions and more in the shielded directions. For these scenarios it is reasonable to interpret noise levels and offset distances (see below) from the exposed segments.

Similar effects can be observed in Figure A-1 and Figure A-2 which also model flat ground,

though the effect is less pronounced in these scenarios.

It is noted that the above effect does not occur in the scenarios having a “valley” between the source and receiver because there is far less ground attenuation in the exposed directions. In this scenario noise contours appear as expected, with greater noise levels in the exposed directions as compared to the shielded directions.

4 NOISE CRITERIA

4.1 Background Noise Levels

Heggies Pty Ltd Report Number 20-2014-R3 Revision 2 (29 April 2009) presented noise monitoring undertaken on behalf of SANTOS in the Gunnedah Basin. The report concluded that, in the absence of insects and winds the background noise levels were below 30 dBA. This level constitutes the minimum Rating Background Level considered in NSW under the *NSW Industrial Noise Policy (INP, EPA 2000)* and other policies/guidelines that refer to the determination of background noise levels detailed in the *INP*. An RBL of 30 dBA would be expected in rural areas and so this is considered appropriate for derivation of indicative noise level criteria in this instance.

4.2 Interim Construction Noise Guideline

Drilling would typically take three days to one week. In addition to this one to two weeks would be required for earthworks to establish the drill pad. Therefore the duration of works associated with a well site is in the order of weeks, with the greatest noise emissions (drilling) limited to approximately one week. In this context the drilling is akin to construction noise and as such appropriate assessment guidelines are detailed in the *Interim Construction Noise Guideline (ICNG, DECC 2009)*.

The *ICNG* recommends the following **objectives**:

Recommended standard hours of work

- Monday to Friday 7am to 6pm
- Saturday 8am to 1pm
- No work on Sundays or Public Holiday

Management Noise Goals

Noise goals are detailed in Table 4-1.

Table 4-1 Noise at Residences using Quantitative Assessment

Time of Day	Management Level L_{Aeq,15min}	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. <ul style="list-style-type: none"> Where the predicted or measured L_{Aeq,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. <ul style="list-style-type: none"> 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: <ol style="list-style-type: none"> 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) 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	<ul style="list-style-type: none"> 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.

There is a reasonable justification for drilling to occur on a 24 hour basis to make efficient use of remote machinery and workforce. The limited duration of drilling further supports the argument that 24 hour drilling could be permissible.

On the basis of an assumed RBL of 30 dBA, the noise affected level for works outside standard construction hours would be 35 dBA.

The *ICNG* does not require that meteorological conditions are considered in assessments of construction noise. Wilkinson Murray typically considers meteorological conditions in predictions of construction noise occurring over many nights, where receivers are distant from the source.

In this instance however, given that the duration would typically be limited to only a few nights at a time, it is less likely that unfavourable meteorological conditions would be experienced. Therefore we do not consider that meteorological conditions should be considered in predictive

modelling for assessment purposes. A typical worst-case meteorological condition (represented by a 3°C/100m temp inversion) has been modelled and results presented in this report to inform decisions relating to well placement and stakeholder negotiations only.

We note that generally in rural environments, such as that of the Gunnedah Basin, where wind may increase the propagation of noise, this would also increase background noise levels through interactions with trees etc., as noted by Heggies' monitoring survey. Therefore adverse impacts from unfavourable propagating conditions would generally be limited to temperature inversions, when generally close-to-still conditions exist and background noise levels typically remain low.

Based on the noise level contours presented in Appendix A, the following offset distances are predicted to achieve criteria at surrounding receivers. For further information refer to the relevant figures.

Table 4-2 Predicted Offset Distances to Achieve Noise Criteria

Scenario	Operation	Appendix A Figure	Topography	Met. Condition	Criteria (L _{Aeq} dBA)	Offset Distance (m)
A	Drilling	Figure A-1	Flat	Still- isothermal	35	1200
C	Drilling	Figure A-3	Valley	Still- isothermal	35	>1500
E	Cementing Casing	Figure A-5	Flat	Still- isothermal	35	800
G	Cementing Casing	Figure A-7	Valley	Still- isothermal	35	1300- >1500

5 CONCLUSION

Wilkinson Murray has undertaken detailed source noise level measurements of EDA Rig 1. From these measurements noise level predictions have been made for typical generic topographic and meteorological conditions.

The noise level predictions show the variation in noise level and required offset distances due to site specific features, most notably those associated with topography, i.e. shielding and ground attenuation.

The noise level contours suggest that for worst-case topographic conditions, i.e. a line of sight between source and receiver and a valley or similar between the two, offset distances exceeding 1500m would be required to comply with the *Interim Construction Noise Guideline* noise affected level of 35 dBA.

Given the limited duration of drilling, the low probability of experiencing worst-case propagation conditions and the logistical benefits of fully utilising a remote workforce and machinery through 24 hour drilling, it may be possible to negotiate alternative criteria. External noise levels of 40 dBA would likely cause little or no interruption to a persons sleep with windows open, and would almost certainly be acceptable with windows closed. Any such negotiation would need to be undertaken with OEH and other stakeholders (i.e. surrounding residents). Clear communication of drilling timeframes, an all-hours contact number in case of noise complaint and a commitment to actively manage noise emissions upon receipt of a complaint would likely be integral to achieving an agreement of relaxed criteria. Noise monitoring could also be used to manage emissions.

There are opportunities to mitigate some of the noise emissions from EDA Rig 1. Adding damping and/or properly fixing items to the derrick could reduce/eliminate groans from resonances whilst drilling hard rock. The erection of temporary barriers, with absorptive inner facings, in close proximity to noise emitting plant such as the mud pump and drill rig engine would reduce overall noise emissions with gains exceeding 5 dB expected. Scheduling of quieter activities such as tripping and running casing to occur at the most sensitive time periods would be sensible and would help by providing respite from other nights, when drilling might occur.

In summary this report presents noise level measurements and predictions that should serve as guidance on the suitability of EDA Rig 1 for use in the Gunnedah Basin. Gaining approval for these activities would benefit greatly from site specific noise modelling, so that accurate predictions can be made, and also the investigation of mitigation and management measures that can be implemented.

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AAAC

This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Version	Status	Date	Prepared by	Checked by
A	Final	4 October 2011	Adam Bioletti	Ben Lawrence

APPENDIX A

NOISE PREDICTION RESULTS

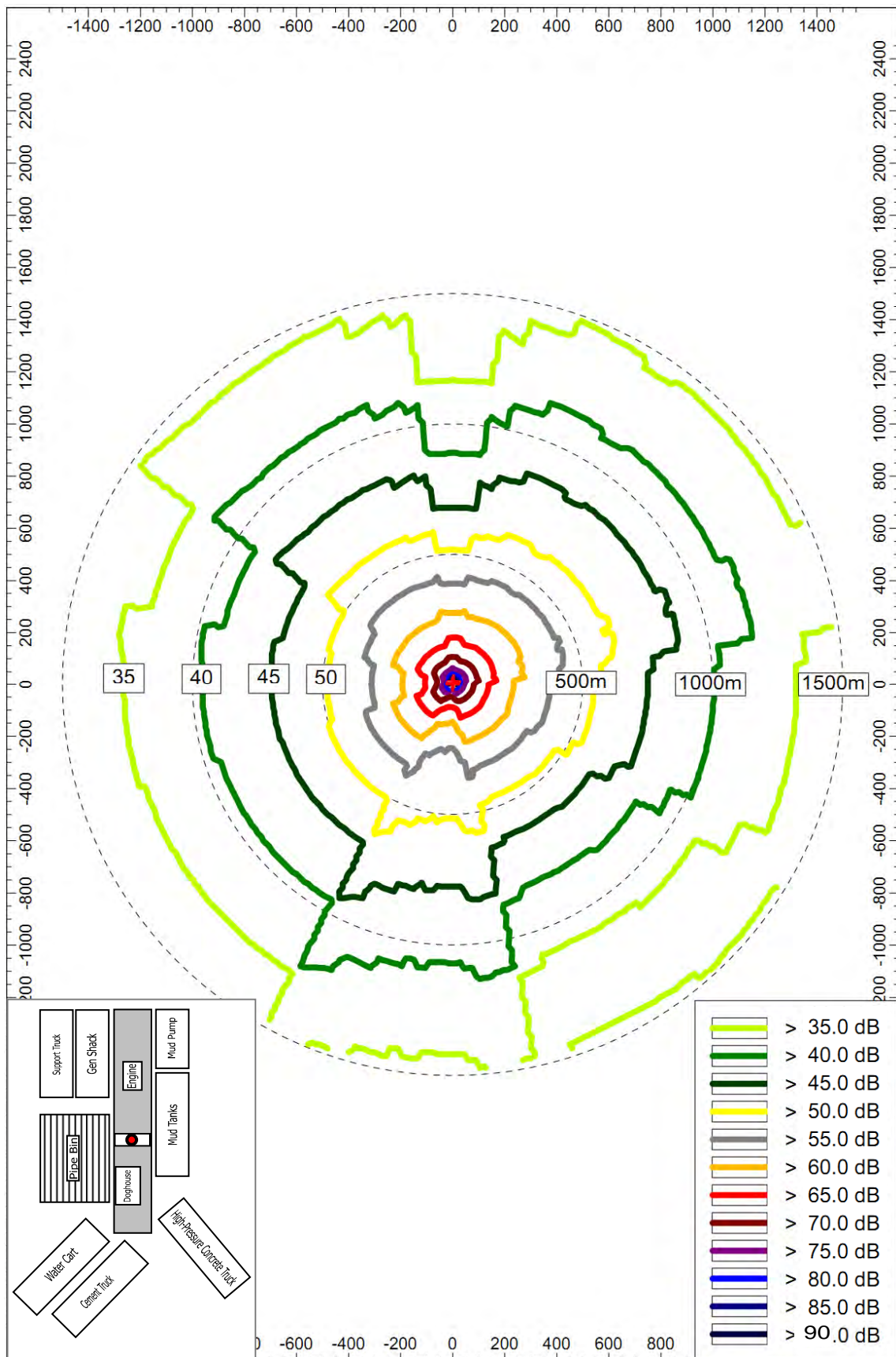
Figure A-1 Scenario A – Drilling, Flat Ground, Still-isothermal – dBA

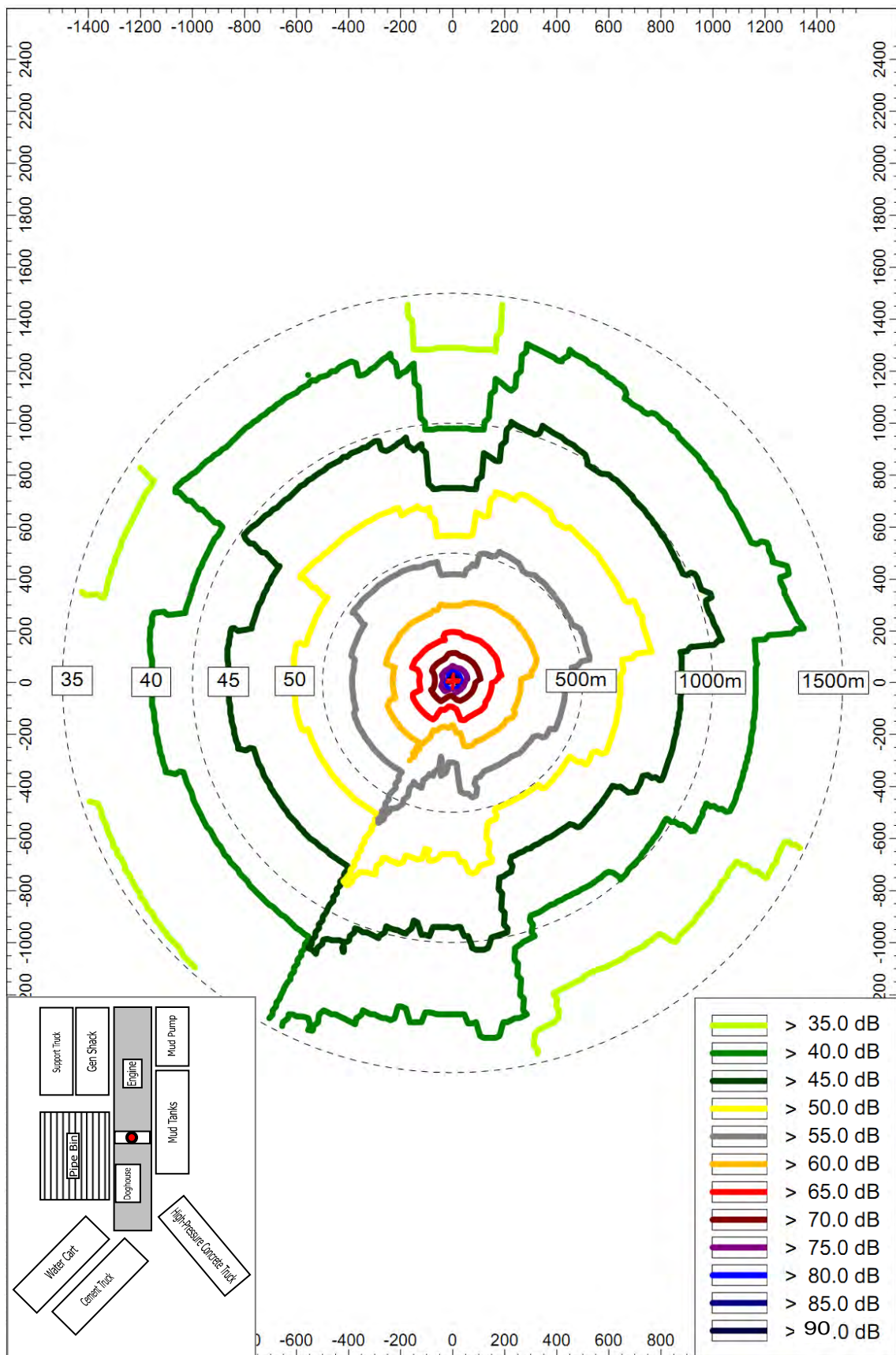
Figure A-2 Scenario B – Drilling, Flat Ground, 3°C/100m Temp Inversion – dBA

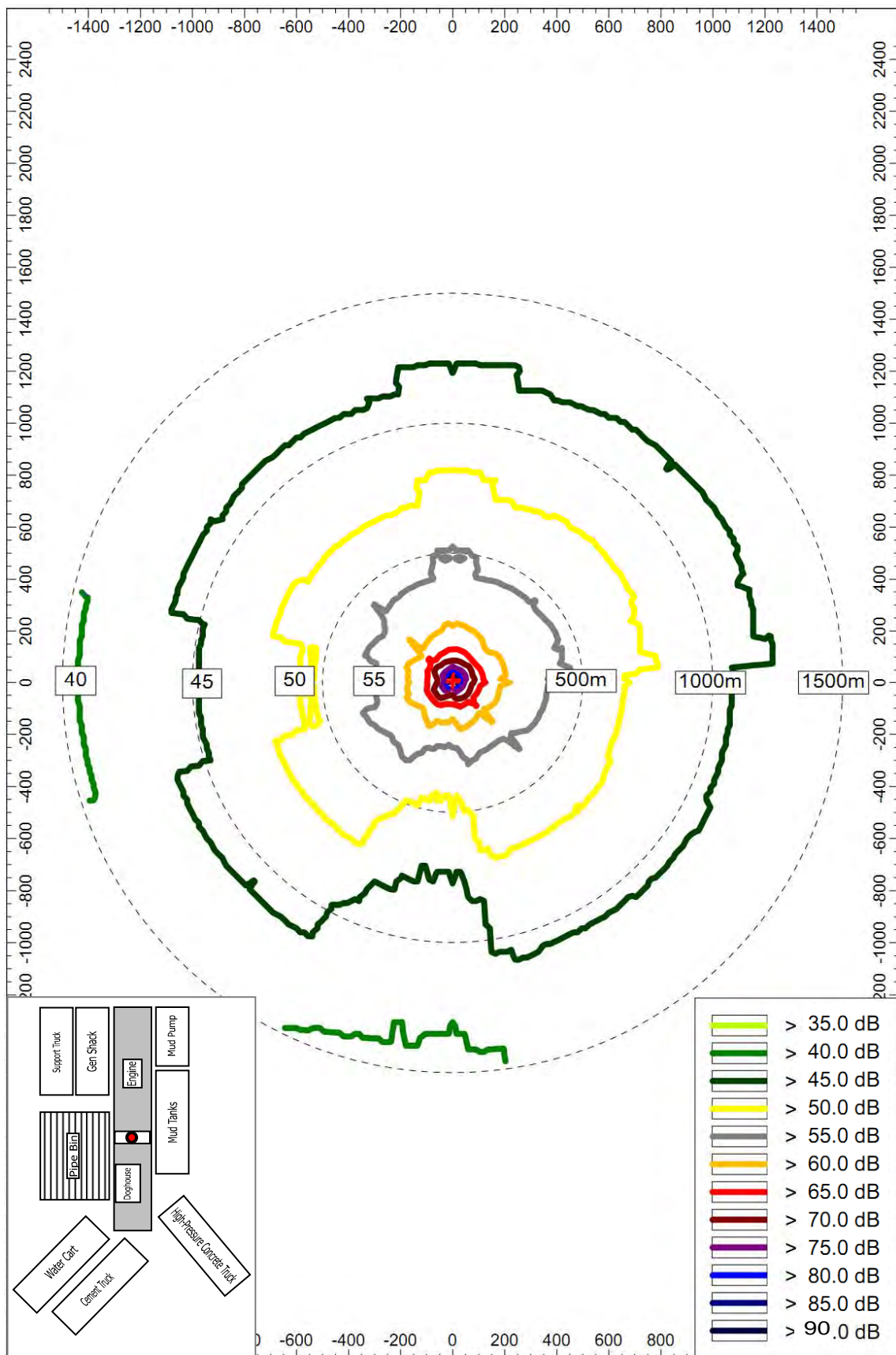
Figure A-3 Scenario C – Drilling, “Valley”, Still-isothermal – dBA

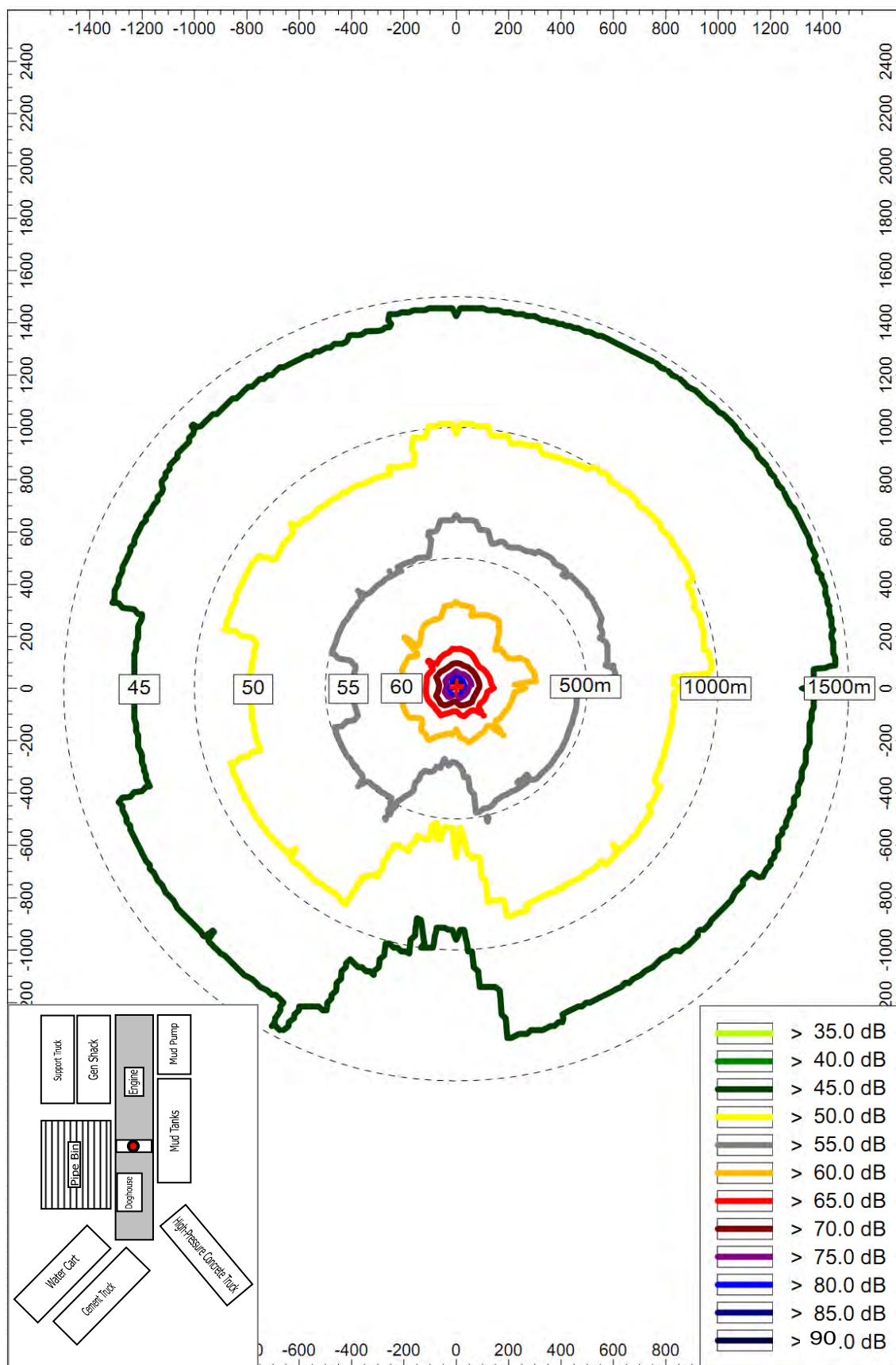
Figure A-4 Scenario D – Drilling, “Valley”, 3°C/100m Temp Inversion – dBA

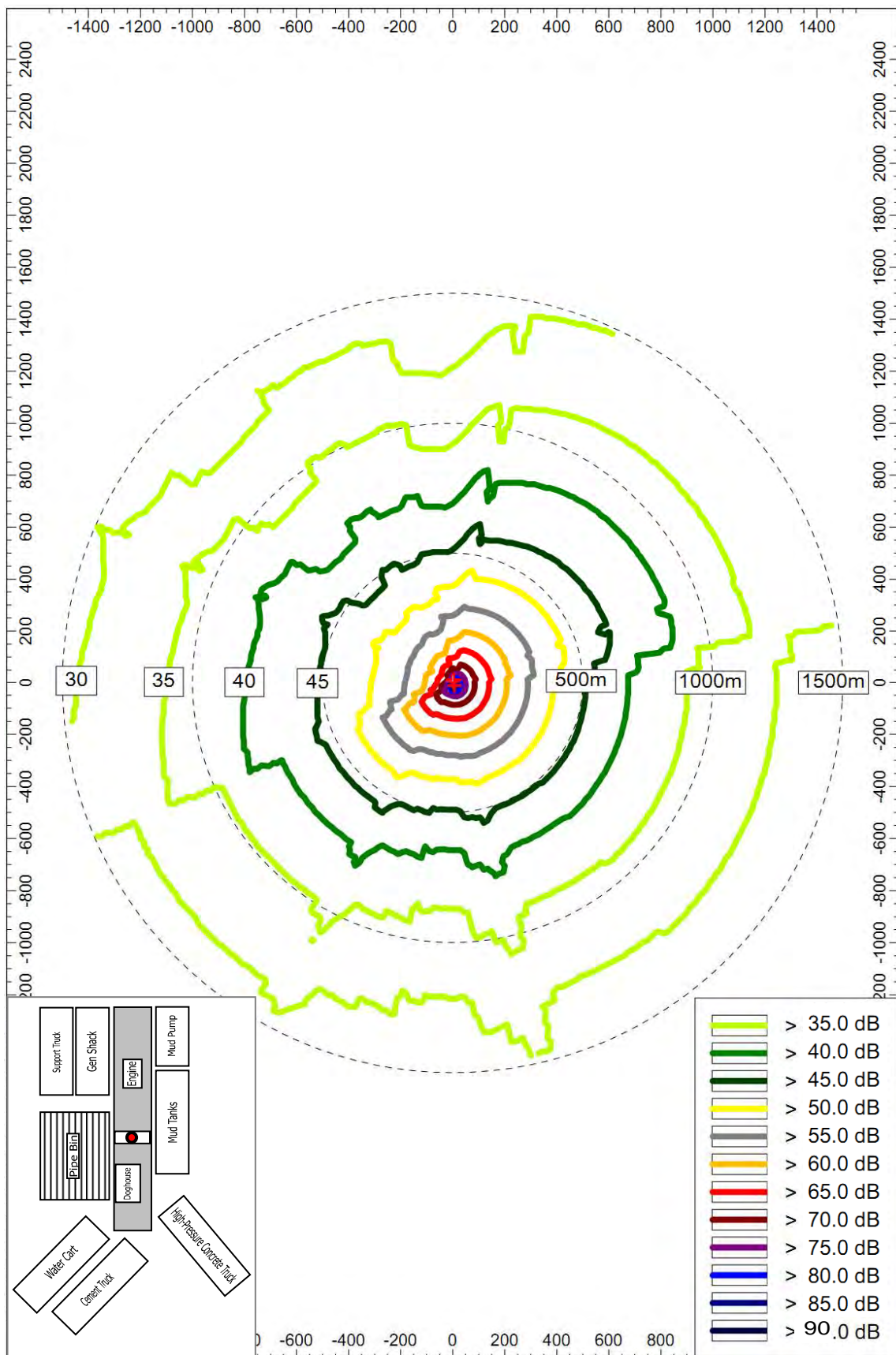
Figure A-5 Scenario E – Cementing Casing, Flat Ground, Still-isothermal – dBA

Figure A-6 Scenario F – Cementing Casing, Flat Ground, 3°C/100m Temp Inversion – dBA

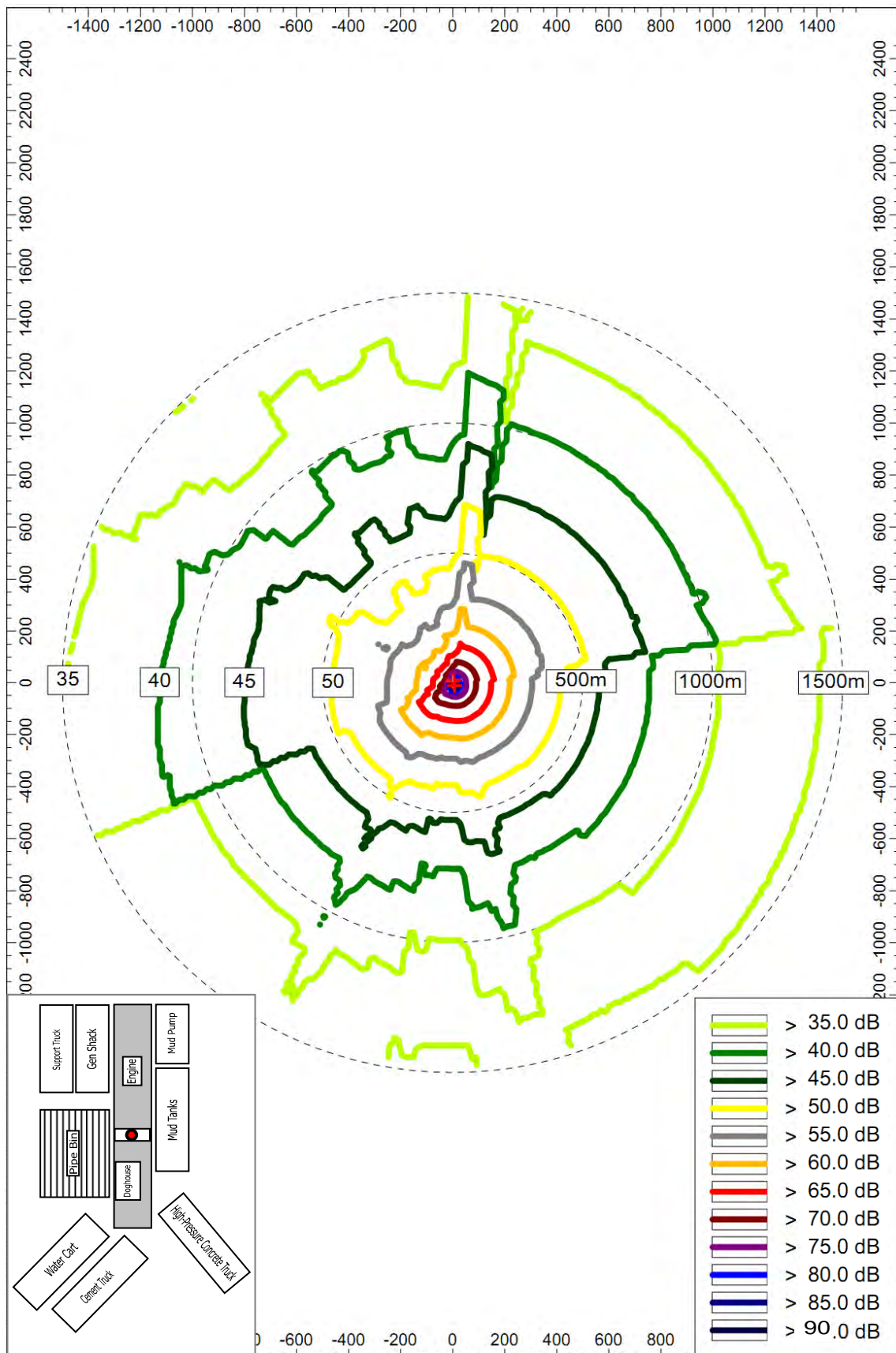


Figure A-7 Scenario G – Cementing Casing, “Valley”, Still-isothermal – dBA

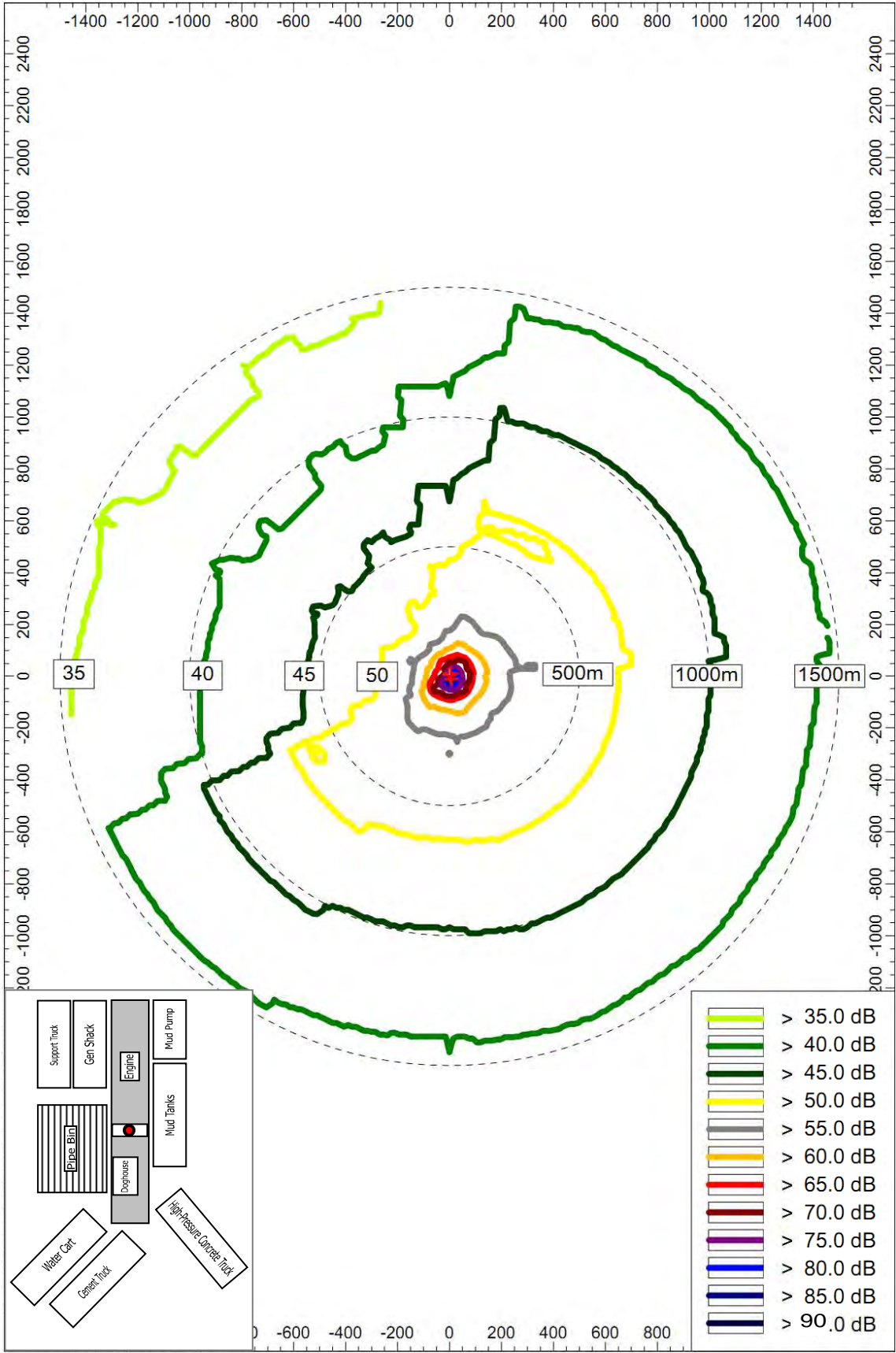
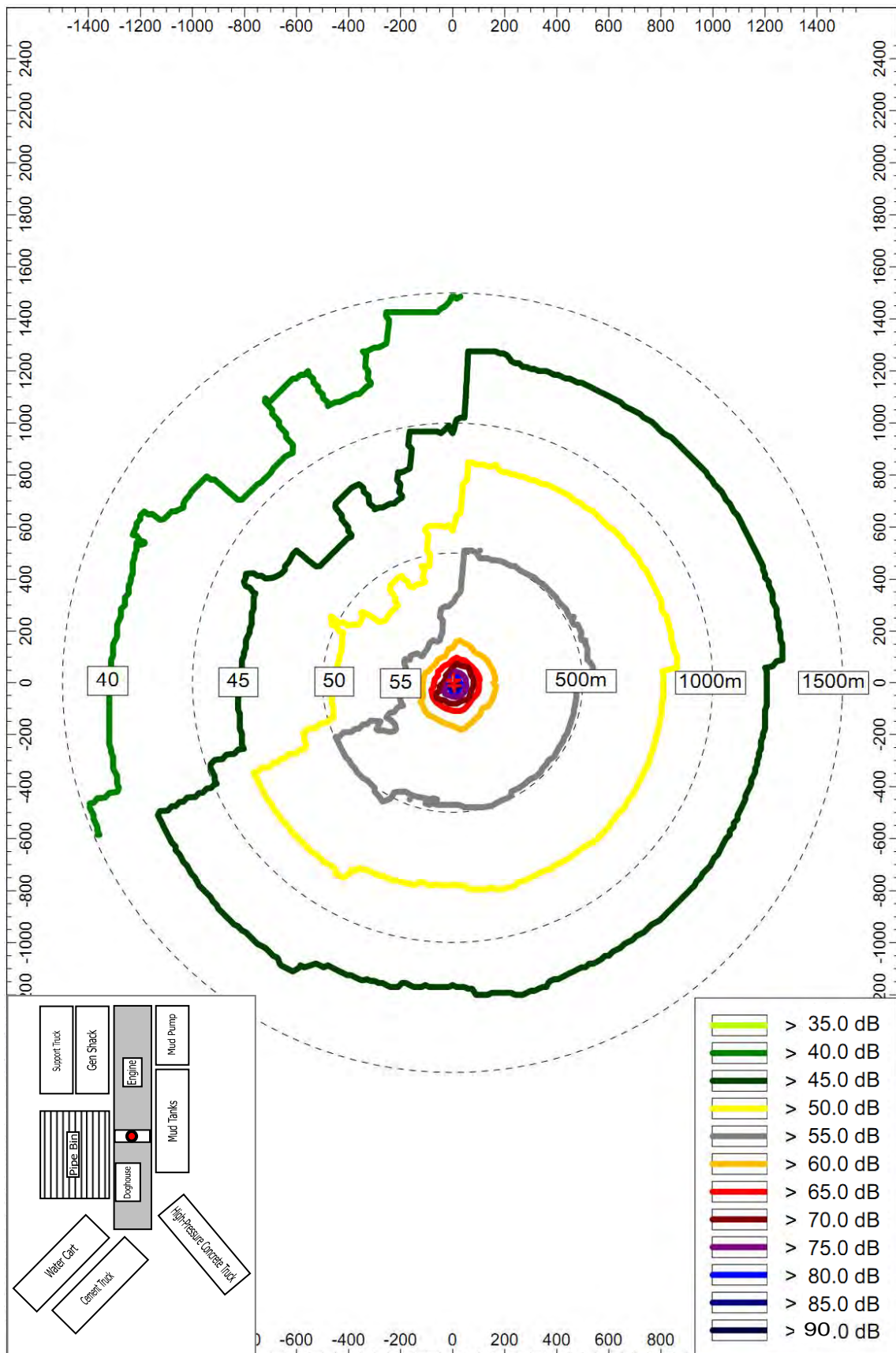


Figure A-8 Scenario H – Cementing Casing, “Valley”, 3°C/100m Temp Inversion – dBA



APPENDIX B

NOISE EMITTING SOURCE

Figure B-1 Drill Rig Engine – Open at Both Ends



Figure B-2 Mud Pump – Unshielded/Exposed



Figure B-3 **Derrick – Resonance during High-Torque Drilling**



Figure B-4 Concrete Truck – Unshielded/Exposed



Appendix 5

Agricultural impact study

RPS



Kiandool I core hole – PEL 238

Agricultural Impact Statement

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
Rev A	Draft AIS for client review	JC/NF	DF	26/09/2012
Rev 0	Final for issue		JC/DF	23/10/2012

Approval for Issue

Name	Signature	Date
David Freebairn		23/10/2012

Contents

1.0	INTRODUCTION	1
2.0	PROJECT DESCRIPTION	2
2.1	Location.....	2
2.2	Site Description.....	2
2.3	Proposed Activities.....	2
3.0	PROJECT DESIGN REVIEW / ALTERNATIVES	6
4.0	AGRICULTURAL ENTERPRISE AND RESOURCES.....	7
4.1	Agricultural Enterprise.....	7
4.1.1	Agricultural Production Value.....	9
4.1.2	Employment.....	9
4.2	Agricultural Support Infrastructure.....	9
4.3	Agricultural Resources.....	10
4.3.1	Climate.....	10
4.3.2	Geology and Topography	11
4.3.3	Soils Landscapes	12
4.3.4	Agricultural Land Use Suitability	17
4.3.5	Water Resources.....	18
5.0	POTENTIAL CONSTRUCTION AND OPERATIONAL PHASE IMPACTS	24
5.1	Agricultural Resources.....	24
5.2	Land Removed from Agricultural Use.....	24
5.3	Socio-Economic Impacts.....	24
5.3.1	Agricultural Enterprises and Support Infrastructure	24
5.3.2	Employment and Economic Development.....	25
5.3.3	Visual Amenity	25
5.4	Agricultural Resource Impacts.....	25
5.4.1	Soils.....	25
5.4.2	Water use.....	26
5.4.3	Surface water	26
5.4.4	Ground water	26
5.4.5	Air and noise	27
5.4.6	Weeds.....	28
5.4.7	Biosecurity	30
6.0	POST OPERATIONAL PHASE IMPACTS / REHABILITATION.....	31
6.1	Agricultural Resource Mitigation Measures.....	31
6.1.1	Land Removed from Agricultural Use	31
6.2	Socio-Economic Mitigation Measures.....	32

6.2.1	Agricultural Enterprises and Support Services	32
6.2.2	Employment and Economic Development.....	32
6.2.3	Visual Amenity	32
6.2.4	Soils	32
6.2.5	Surface water	32
6.2.6	Ground water	33
6.2.7	Air and Noise.....	33
6.2.8	Weeds.....	33
6.2.9	Biosecurity	34
6.2.10	Buffers and Offsets.....	34
7.0	MONITORING AND AUDITING	35
8.0	CONSULTATION	36
9.0	CONCLUSION.....	37
10.0	REFERENCES	38

Tables

Table 4.1: Land use statistics for the Namoi catchment (Green et al., 2011, sourced from 2001/02 Land use mapping of Australia, Bureau of Rural Sciences).....	7
Table 4.2: Climate statistics of the Narrabri Region, station 053030 (BOM 2012).....	11
Table 5.1: Weed Removal Techniques.....	28

Figures

Figure 2.1: NSW petroleum titles and estates in the vicinity of the site.....	4
Figure 2.2: Site Layout.....	5
Figure 4.1: Land use in the Naomi Catchment (Green et al., 2007, sourced from 2001/02 Land use mapping of Australia, Bureau of Rural Sciences).....	8
Figure 4.2: Mean maximum and minimum temperatures (°C) of the Narrabri region (1962 to 2002), and rainfall (1891 to 2012) (BOM 2012).....	11
Figure 4.3: Topography.....	14
Figure 4.4: Soils.....	15
Figure 4.5: Soil fertility.....	16
Figure 4.6: Strategic Agricultural Land.....	20
Figure 4.7: Land and soil capability	21
Figure 4.8: Ground water quality and suitability in the Namoi catchment (Green et al., 2012).....	22
Figure 4.9: Ground water quality and suitability in the Namoi catchment (Green et al., 2012).....	23

I.0 Introduction

The Strategic Regional Land Use Plan New England North West (SRLUP) (DoP&I, 2012a) identifies and protects more than 2 million hectares of strategic agricultural land, valuable water resources and provides greater certainty for companies wanting to invest in mining and coal seam gas projects in regional NSW.

As a result of this policy, all state significant mining and petroleum (including coal seam gas) projects as well as applications for associated state significant infrastructure, such as pipelines which have the potential to affect agricultural resources or industries will be required to submit an agricultural impact statement (AIS) as part of the environmental impact statement (EIS).

Santos Limited is proposing to undertake drilling and ancillary activities at the 'Kiandool 1' site, which is located on Culgoora Road, property, to the west of Narrabri, NSW. The purpose of Kiandool 1 is to investigate the potential coal seam gas resource of the Gunnedah Basin within Petroleum Exploration Licence number 238 (PEL 238). This activity is permissible without consent and is being assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Resources and Energy Division within the Department of Trade & Investment, Regional Infrastructure and Services (DTIRIS) is the determining authority for the activity.

RPS Australia East Pty Ltd (RPS) has prepared a Review of Environmental Factors (REF) to assess the potential environmental impacts of the proposed activity under Part 5 of the EP&A Act. RPS was also engaged to prepare this AIS to support the REF.

The purpose of the AIS is to assess the potential impacts of drilling and ancillary activities at the Kiandool 1 site on agricultural resources and industries. The term 'agricultural resource' is used to describe the land on which agriculture is dependent and the associated water resources (quality and quantity) that are linked to that land. The AIS was prepared as per the requirements of the '*Guidelines for agricultural impacts statements*' (DoP&I 2012a).

2.0 Project Description

2.1 Location

The site is located in the north eastern section of PEL 238 (**Figure 2.1**). PEL 238 covers an area of approximately 7,915 km² and extends across three local government areas (LGAs) including the Narrabri Shire, Warrumbungle Shire and Gunnedah Shire. The site is located within the Narrabri Shire LGA.

The site is located approximately 9 km west of Narrabri and 25 km south east of Wee Waa. The site is not within close proximity to any protected areas, though various State Forests, conservation areas and one National Park are located at distances of greater than 10 km.

2.2 Site Description

The site is located on a rural property of approximately 160 ha in size, predominantly used as a lifestyle property with occasional stock grazing and hence it is not regarded as a significant agricultural enterprise. The nearest residential dwelling to the site is the property owner's residence located approximately 1.3 km north of the lease area. The next nearest dwellings is located approximately 1.4 km to the north-north west and 1.4 km to the south-east of the lease area.

2.3 Proposed Activities

The proposed activity will occur at 545 Culgoora Road, west of Narrabri, within PEL 238. Santos is the joint title holder and operator of PEL 238. For detailed descriptions of proposed activities, refer to the Kiandool 1 Review of Environmental factors (REF), prepared by RPS. The site layout can be viewed in **Figure 2.2**.

The scope of the proposed activity includes:

- Using the existing 1.9 kilometre long access track from Culgoora Road to transport materials, equipment and personnel to the lease area;
- Upgrading the existing access track, including constructing approximately 100 m of new access track, should this be determined necessary during detailed design;
- Establishing a lease area up to one hectare in size;
- Drilling Kiandool 1 to a depth of approximately 1,000 metres;
- Sampling, testing and logging of the core hole;
- Installing, operating and maintaining a deep aquifer monitoring bore (DAMB) and supporting infrastructure, similar to existing ground water monitoring bores operating within the region;
- Rehabilitating the majority of the lease area to reduce its size to nine square metres for the DAMB, surface infrastructure and fencing (partial rehabilitation); and
- Rehabilitating the remainder of the lease area, including removal of surface infrastructure and fencing, once the DAMB is no longer required for operation (full rehabilitation).

The lease area will be a 100 m by 100 m pad and will be established using either, or a combination, of the following methods:

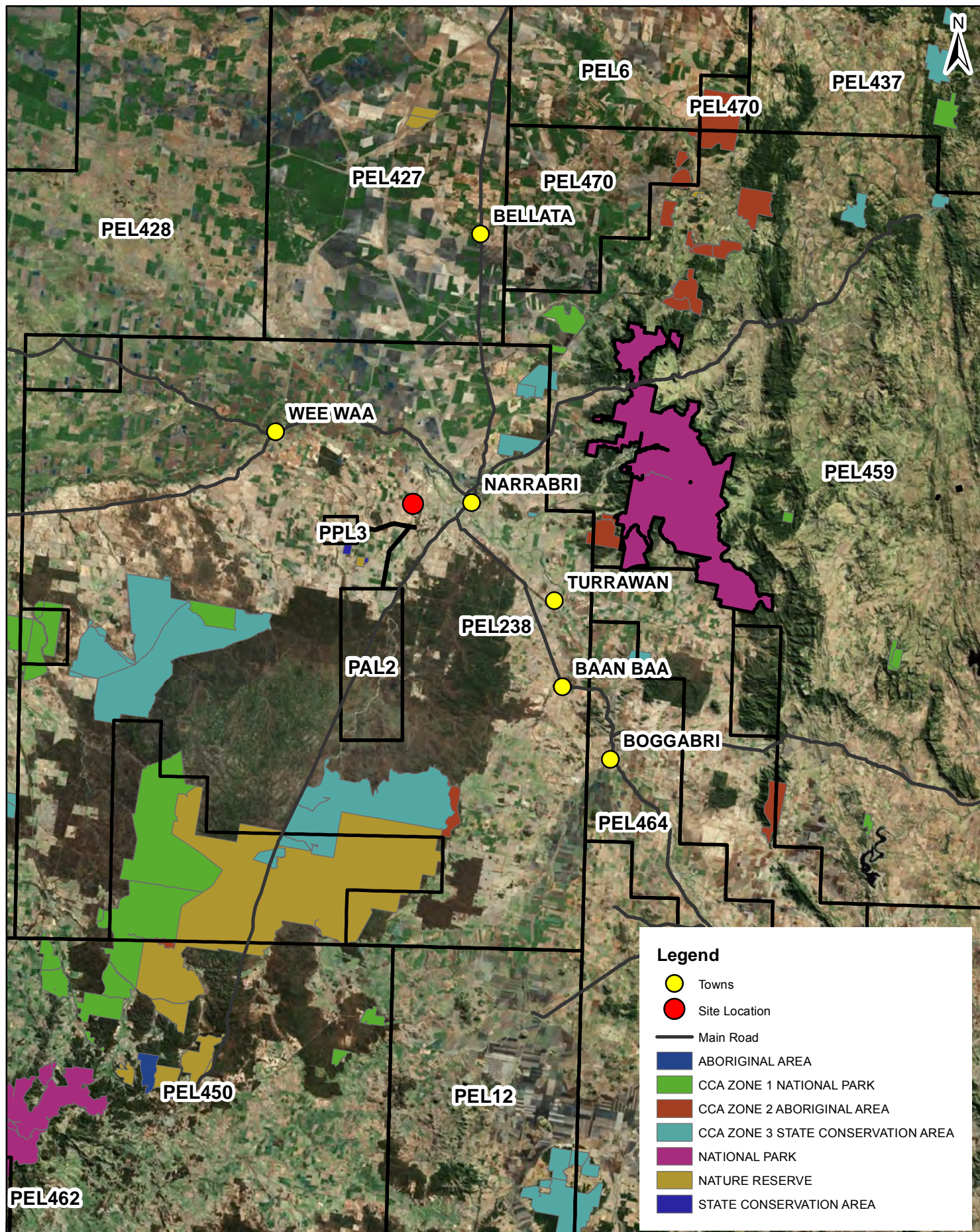
- Slashing grass and vegetation and laying industrial matting over the area; or
- Constructing the lease area with cut and fill. If cut and fill is to be used, estimated volumes are 960 m³ and 210 m³, respectively.

The proposed activity does not include extended production, well production or pilot testing

The duration of the proposed activity will be approximately three months from site preparation until completion of the DAMB. Partial rehabilitation of the lease area will occur within approximately six months of completion of the well as a DAMB, where practicable. Full rehabilitation will occur only once the DAMB has is no longer required for operation, which may be up to approximately 30 years.

The total area of potential disturbance assessed is 1.06 ha. This includes the 1 ha lease area, and 0.06 ha section of new track (100 m long by 6 m wide).

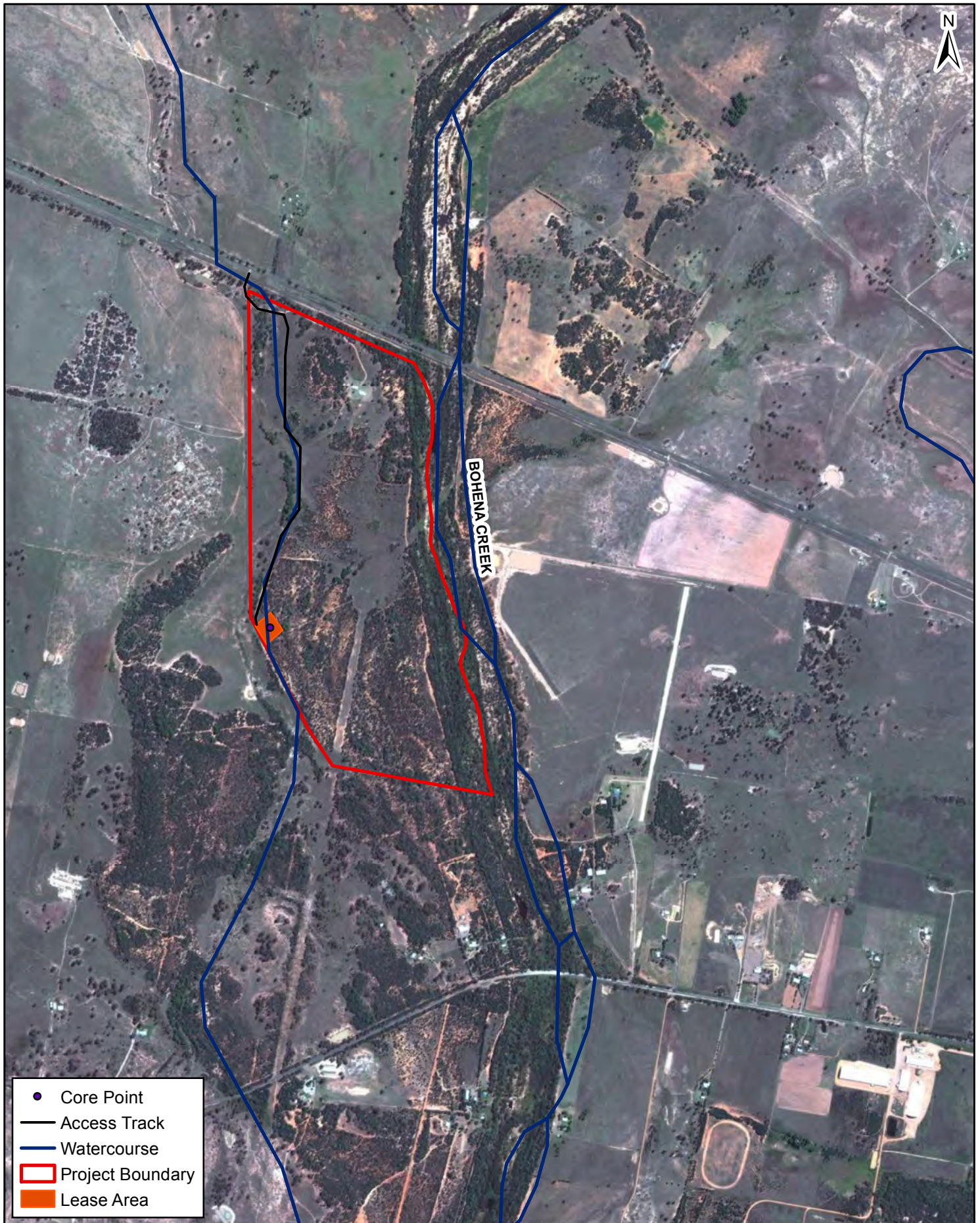
References to 'the site' throughout this AIS includes the lease area, existing access track and new section of track.

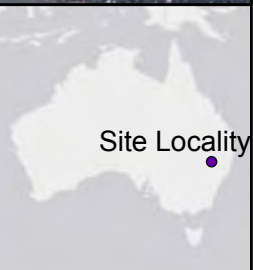
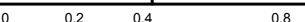



Client: Santos	
Compiled by: JC	Date: 19/09/2012
Approved by: DF	Date: 19/09/2012

NSW petroleum titles and estates	
Figure 2.1	Project: Kiandool AIS
Source: Base topographic data © Bing Aerial Other Data supplied by Santos, Mitchell 2002	





Client: Santos		Site layout		 <p>Site Locality</p>
Compiled by: JC	Date: 19/09/2012	Project: Kiandool AIS		
Approved by: DF	Date: 19/09/2012	Figure 2.2		
 <p>Datum: GDA94</p> 		Source: Base topographic data © Bing Aerial Other Data supplied by Santos, Mitchell 2002		

3.0 Project Design Review / Alternatives

There is limited previous targeted drilling in this area of the Gunnedah Basin that is sufficiently deep for petroleum exploration purposes. Kiandool 1 is essential to gain knowledge of the gas content, composition and detailed stratigraphic data. The proposed activity will include drill core and cutting sampling and testing, which is the only feasible method available to obtain reliable and accurate gas content, composition and permeability data for the local coal seam gas resource. Geophysical methods available, such as seismic, would show the structure of the basin but would not provide the ability to sample and analyse the stratigraphy of the Gunnedah Basin to quantify coal seam gas potential and are therefore not suitable in this instance.

The location of the core hole is a substantial factor in the evaluation of the potential coal seam gas resource. Suitable locations for Kiandool 1 were carefully considered by the project team, in consultation with specialist consultants and taking into account the underlying geology, the biophysical environment and the current land use at each location.

An alternative location to the proposed site was investigated for Kiandool 1. The alternative site was located approximately 1.2 km north of the proposed lease area, close to Culgoora Road. Eastern Star Gas Ltd submitted a review of environmental factors (REF) assessing the impacts of Kiandool 1 at this alternative site to Department of Investment, Trade, Regional Infrastructure and Services (DTIRIS) in July 2011. However, the application was later withdrawn, as it was located approximately 700 m from the nearest sensitive receptor.

The proposed site was selected based on the principles of impact avoidance and harm minimisation. It was broadly identified by Santos' geologists and refined in consultation with the landholder and with the assistance of RPS cultural heritage, ecological and environmental consultants. The site is located 1.3 km from the nearest sensitive receptor so will have reduced noise and amenity impacts compared to the alternative site investigated. It has also been subject to previous disturbance and has few environmental constraints.

4.0 Agricultural Enterprise and Resources

The following section identifies the agricultural enterprises that exist on the site and within the surrounding Narrabri Shire.

4.1 Agricultural Enterprise

In the Northern Plains, cotton is the most significant crop, while beef cattle and wheat production are the other main industries. Moree and Narrabri LGAs produce around 66% of NSW cotton from around 4% of the state's area. These same LGAs also produce 5% of the gross value of NSW beef cattle and the area known as the Golden Triangle (350,000 hectares between Bellata, North Star and Yallaro) produces consistently high yields of prime hard (high protein) wheat (DoP&I, 2012b).

There were an estimated 1,857 businesses registered in Narrabri Shire in June 2007. Agriculture, Forestry & Fishing is the largest industry in terms of business numbers in Narrabri Shire, accounting for 49.8% of the total number of businesses.

The dominant land use in the Namoi catchment is sheep and cattle grazing which accounts for 61 % of land use by area (**Table 4.1** and **Figure 4.1**). Wheat, cotton and other broad acre crops are grown along the alluvial floodplains. Of the 1,120 km² irrigated in the year 2000, around 800 km² (over 70 %) was used for cotton production in the Lower Namoi catchment (CSIRO 2007).

Extensive areas of land for conservation and forestry occur in the middle of the catchment to the south of Narrabri. Together with other native landscapes these land uses account for over 18 % of the catchment. Much of this area comprises the Pilliga Scrub, a significant area of remnant dry sclerophyll forest.

Table 4.1: Land use statistics for the Namoi catchment (Green et al., 2011, sourced from 2001/02 Land use mapping of Australia, Bureau of Rural Sciences)

Land use	Extent (km ²)	Proportion of Catchment (%)
Grazing	25,727	61.2
Dryland cropping and horticulture	6,810	16.2
Forestry	4,339	10.3
Native landscapes	2,136	5.1
Conservation	1,351	3.2
Irrigation	1,259	3
Residential	256	0.6
Lakes, river, dams	139	0.3
Wetland	12	<0.1
Mining	7	<0.1

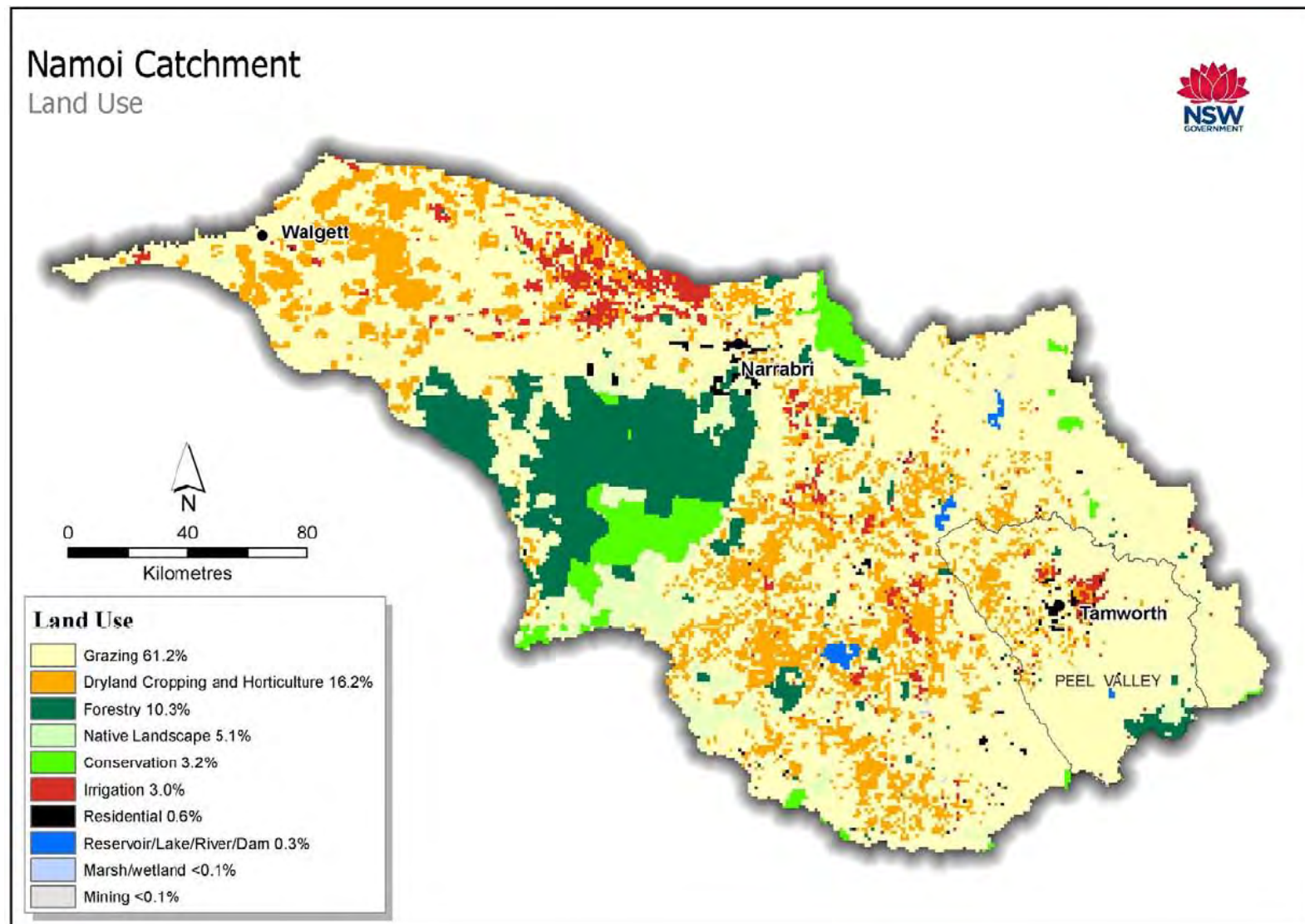


Figure 4.1: Land use in the Naomi Catchment (Green et al., 2007, sourced from 2001/02 Land use mapping of Australia, Bureau of Rural Sciences)

4.1.1 Agricultural Production Value

Agriculture and agribusiness is worth \$1.8 billion annually to the New England - North West regional economy (ABS 2006 Census), which represents approximately 20% of the gross value of agriculture and agribusiness for the entire state. Sheep and cattle grazing, broad acre cereal crops, irrigated cotton, intensive livestock and plant agriculture and poultry production are the main contributors (DoP&I, 2012b).

In 2009 / 2010 the Narrabri Shire recorded a Gross Regional Product (GRP) of \$730 million, with agriculture forestry and fishing contributing \$115.30 million (15.8%) of total GRP (AEC, 2011), resulting in the sector being the second largest contributor to GRP in Narrabri Shire, behind the mining sector.

In 2006, the Narrabri Local Government Area (LGA) reported the gross value of crops in excess of \$215 million, while the gross value of livestock slaughtering and livestock products were \$41 million and \$4 million, respectively (ABS 2006 Census). In 2007, the Agricultural, Forestry and Fishing sector reported a total industry turnover of \$439.5 million, accounting for 50% of the total business by industry and turnover for the Narrabri shire.

No data on the historic production value for the site was available.

4.1.2 Employment

The agriculture and agribusiness sector is currently the most significant employer in the North England - North West region, accounting for almost half of all businesses (ABS 2006 Census). Approximately 12,300 people or 16.8 % of employment in the region is directly related to agriculture (2005-06 ABS). Taking into account flow-on, or multiplier, effects from this sector into other parts of the regional economy, more than 30,000 people are either directly or indirectly employed as a result of agriculture in the New England - North West region – meaning 42 per cent of the region's employment is dependent on agriculture (DoP&I, 2012b).

Agricultural enterprise was the largest employer in the Narrabri Shire (2009 / 10), employing 25 % of the workforce (or 1,527 people), which exceeds the average rate of employment for both the northern statistical district and the New South Wales State average (AEC, 2011). The largest agricultural enterprises in the region are cotton and grain, which employ approximately 47% of the agricultural workforce.

In 2006, the largest industry employer in Narrabri Shire was the Agriculture, Forestry & Fishing sector with 1,450 persons, or 25.2% of the total workforce.

As the site is predominately used as a lifestyle property it does not employ any full time staff for agricultural purposes.

4.2 Agricultural Support Infrastructure

Due to the scale, diversity and productivity of agricultural enterprise within the Narrabri Shire, processing companies, research and development facilities, transport and warehousing and other service industries have established in the Narrabri Shire to support the agricultural industry (DoP&I, 2012b), including:

- Livestock selling center;
- Farm management services;
- Grain and field bean merchant wholesalers; and
- Crop harvesting selling centers.

The Cargill Oilseeds plant in Narrabri processes approximately 250,000 tonnes of cottonseed each year. The Canzac Pulse Processors plant in Narrabri produces high quality pulse seeds for export. Other processing plants in the LGA include seed grading, mixing and packaging operations.

Research establishments are located in the Narrabri district; the I.A Watson Grains Research Centre (operated by the University of Sydney); and the big Australian Cotton Research Institute (ACRI). The Cotton Research and Development Corporation is also located in Narrabri, which is funded by the Federal Government and industry to select and fund suitable research projects.

Kimilaroi and Newell Highway run through Narrabri and provide access to the coast and inland NSW. The Newell Highway which is part of the National Land Transport Network and forms a major linkage between regional centres in North West NSW to Brisbane and Melbourne (DoP&I, 2012b). Approximately half of the traffic which utilises the Newell Highway consists of heavy vehicles carrying freight.

The Walgett railway line is a railway line in north-western New South Wales, Australia. Opening in 1908, it branches from the Main North line at Narrabri and passes through the towns of Wee Waa and Burren before ending in the town of Walgett. The line is used for wheat haulage, and runs adjacent to Culgoora Rd. Walgett railway line needs to be crossed to gain access to the site.

4.3 Agricultural Resources

4.3.1 Climate

Climate in the Narrabri region is regarded as semi-arid, due to the hot summers and mild winters (**Figure 4.2**). Average (1962 -2002) monthly maximum temperatures range 18.0°C (July) to 33.8 (Jan) (**Table 4.2**). Temperatures rarely exceed 35°C. Frost can occur in all low lying parts of the region. Frost events occur mostly between June and August though can begin as early as April. Narrabri has historically recorded frost events as late as October.

Average annual rainfall is 662 mm. Rainfall in the Narrabri region is summer dominate with approximately 40% of annual rainfalls between December and February.

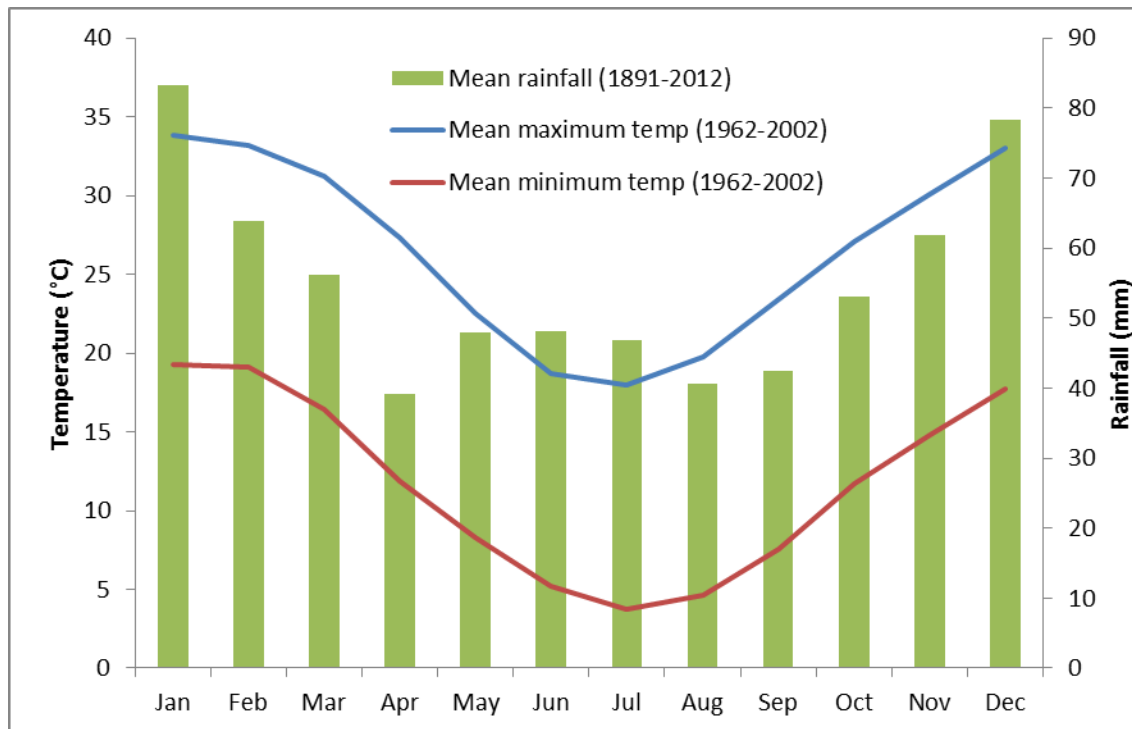


Figure 4.2: Mean maximum and minimum temperatures (°C) of the Narrabri region (1962 to 2002), and rainfall (1891 to 2012) (BOM 2012).

Table 4.2: Climate statistics of the Narrabri Region, station 053030 (BOM 2012).

	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean maximum temp	1962-2002	33.8	33.2	31.2	27.3	22.5	18.7	18	19.8	23.4	27.1	30.1	33
Mean minimum temp	1962-2002	19.3	19.1	16.4	11.9	8.3	5.2	3.7	4.6	7.6	11.7	14.8	17.7
Mean rainfall	1891-2012	83.3	63.9	56.2	39.1	48	48.1	46.8	40.7	42.5	53	61.8	78.4

4.3.2 Geology and Topography

The proposed site is relatively flat. The regional topography is characterised by flat to very flat (approximately 1:1000), gently sloping land with little or no vertical relief. Elevations in the area range between 180 and 220 m AHD.

The NSW landscapes technical manual (Eco Logical 2008) shows that the project area is bisected by two landscape units, with the surrounding area varying in geology and topography. The immediate and surrounding landscapes can be viewed in **Figure 4.3** and are discussed below.

4.3.2.1 The Site

- Barradine – Coghill channels and floodplains:
 - » Sandy incised channels and distributary streams on Quaternary alluvium in fans flowing from the sandstones of the Pilliga forest. General elevation 170 to 210m, local relief of 10m.
- Namoi Channels and Floodplains:

- » Holocene fluvial sediments of channel and meander plain facies of the Namoi River alluvial fan and tributary stream system, relief in the channels 10 to 15m.

4.3.2.2 Surrounding area

- Coghill alluvial plains:
 - » Distal parts of the Quaternary alluvial fans largely derived from Jurassic quartz sandstone on streams draining from the Pilliga forests. Long gentle slopes. General elevation 200 to 280m, local relief of 5 to 9m.
- Namoi Alluvial Plains:
 - » Holocene fluvial sediments of backplain and channelised backplain facies on the Namoi River and its effluent streams, relief 1 to 5m.
- Liverpool Alluvial Plains
 - » Quaternary alluvial plains and outwash fans derived from Tertiary basalts. Permian and Triassic quartz sandstones with minor basalt caps. Undulating hills and sloping plains with alluvial channels and floodplains. General elevation 300 to 350m, local relief <10m.

4.3.3 **Soils Landscapes**

The soils across the region vary depending on the local sediment source. Duplex soils comprising fine, sandy loam topsoil overlaying harsh, clay subsoils are present in the region. These soils are typical of those derived from the Pilliga Sandstone and are highly siliceous (Norris, 1996). A site visit was undertaken on 20 June 2012 whereby the soils were noted to be comprised of red sandy topsoil overlaying sandy loam.

A search of the contaminated land record database maintained by the OEH indicated records of seven contaminated sites within the Narrabri Shire LGA. None of these sites are located near the proposed activity. Given the historical and present use of the site for agricultural purposes, contaminants may be present within the soil as a result of hydrocarbon spills or use of pesticides.

The NSW landscapes technical manual (Eco Logical, 2008) indicated that the project area is bisected by two soils, with the surrounding area dominated by three major soil types. Details of these soils are presented below and in **Figure 4.4**.

- The site is characterised by deep texture contrast soils with deep yellow sand underlain by sodic clays to the south and red brown sands underlain by brown to grey silt to the north;
- 1.7 km to the east and west of the lease area are deep texture contrast soils with harsh clay subsoils, grey clay with gilgai;
- Approximately 5.5 km north east of the lease area are extensive black earths on low angle slopes. Deep black and brown cracking clays, alluvial soils and red or brown texture-contrast soils on slopes below sandstone; and
- 3.5km north of the lease area are dark yellow-brown to silty clays with patches of sand and carbonate nodules deposited from suspended sediment in floodwater, often with gilgai. Slightly elevated areas with red-brown texture contrast soils.

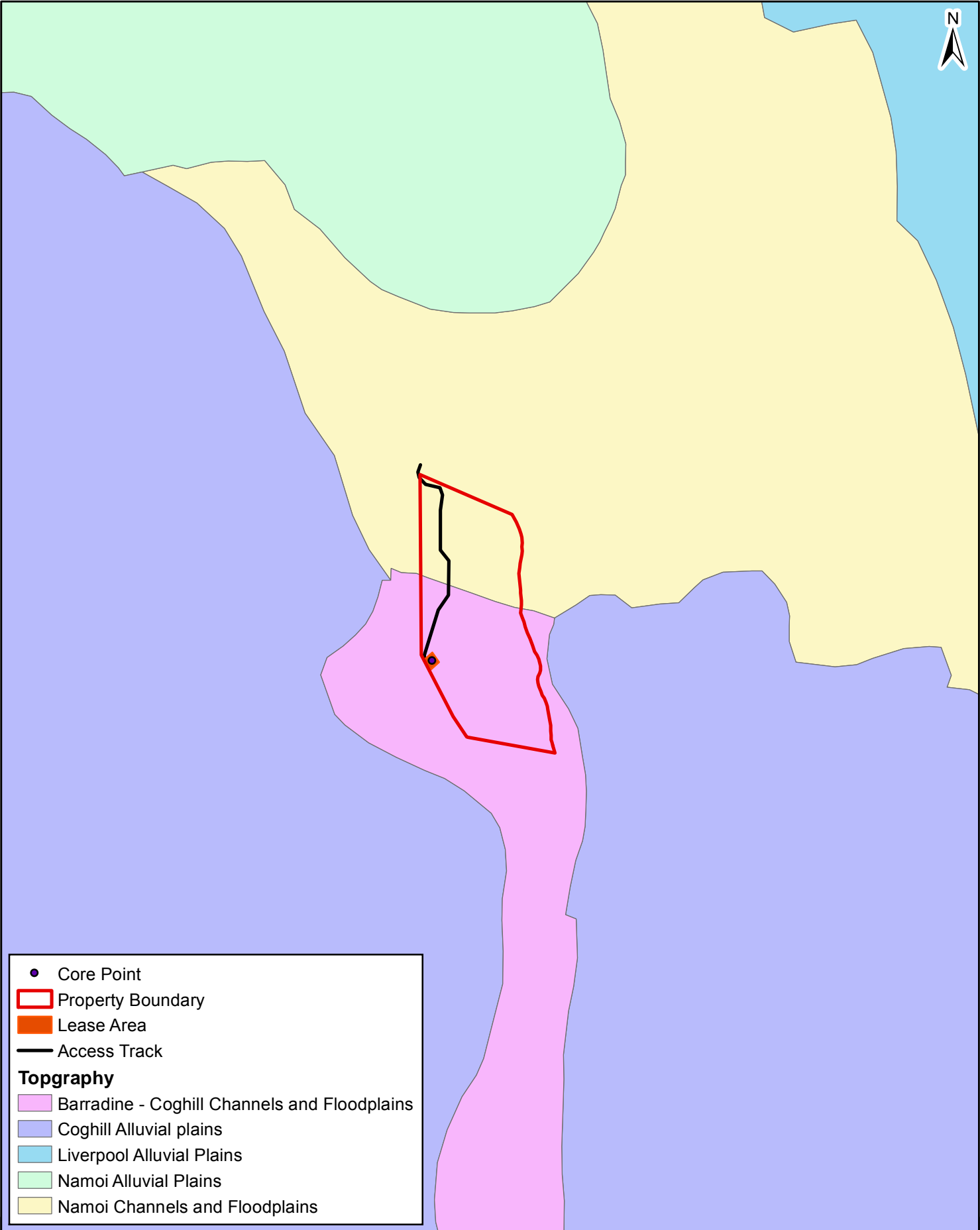
4.3.3.1 Soil Fertility

According to the Draft Inherent Soil Fertility mapping of the New England – North West region (OEH 2012a), the inherent soil fertility of the site is moderately low to moderate (**Figure 4.5**). This broad scale mapping is not suitable for property level assessment; however it was utilised to provide an indication of the suitability of the subject site and surrounding areas for agricultural use.

4.3.3.2 Soil limitations

Soil characteristics of the site indicate that the area is considered to have major limitations (unsuitable for intensive land use activities e.g. agriculture). As the following issues were identified:

- Low plant available water capacity;
- Poor nutrient availability;
- Much of this area is prone to erosion and severe scalding;
- Soils are highly erodible and are easily degraded;
- Runoff can be high when soils are degraded; and
- Effective groundcover can be hard to maintain if areas are continually grazed.



●

Core Point

Property Boundary

Lease Area

Access Track

Topography

Barradine - Coghill Channels and Floodplains

Coghill Alluvial plains

Liverpool Alluvial Plains

Namoi Alluvial Plains

Namoi Channels and Floodplains

Client:
Santos

Compiled by:
JC

Date:
19/09/2012

Approved by:
DF

Date:
19/09/2012

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km

Datum: GDA94

RPS

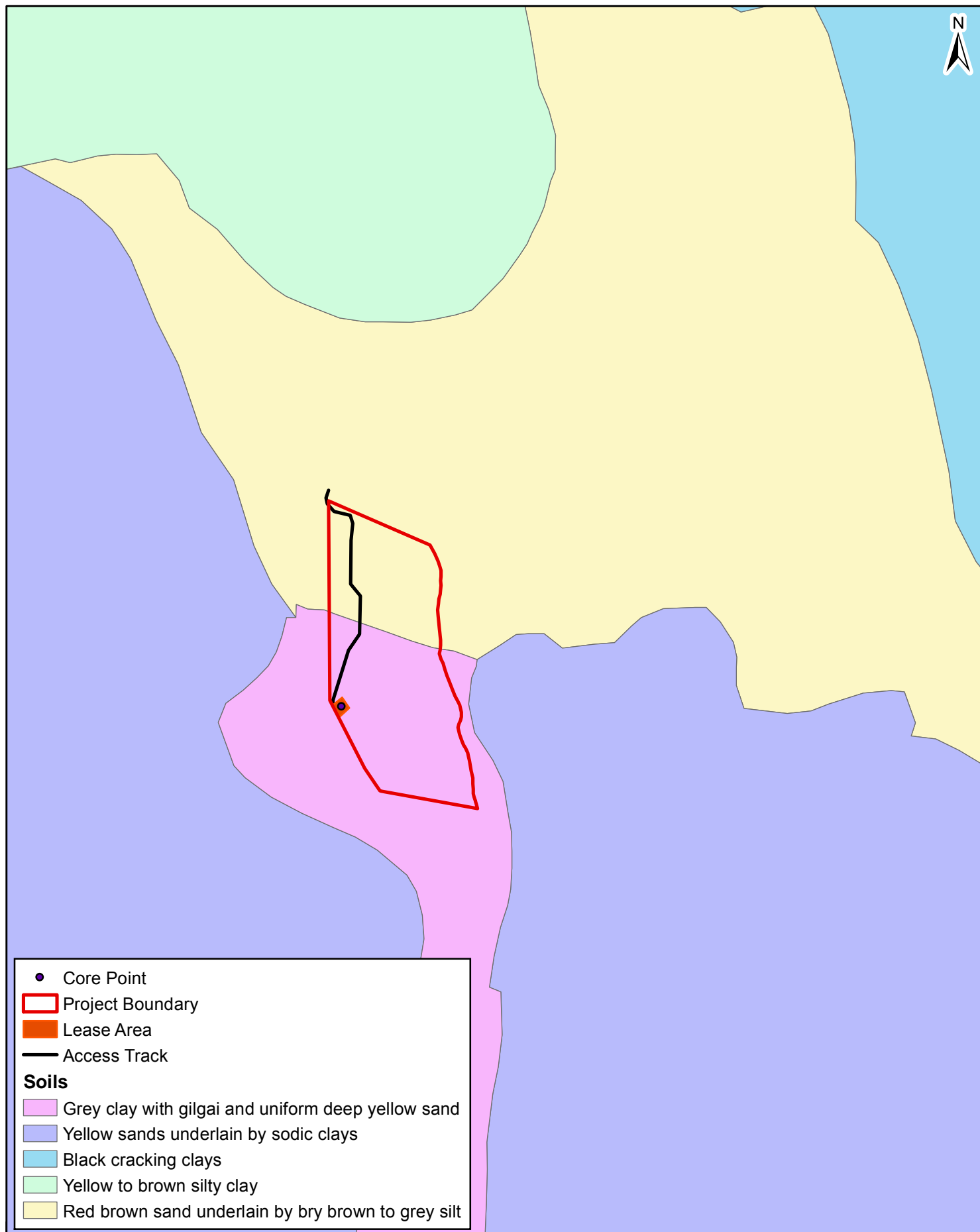
Topography

Figure 4.3

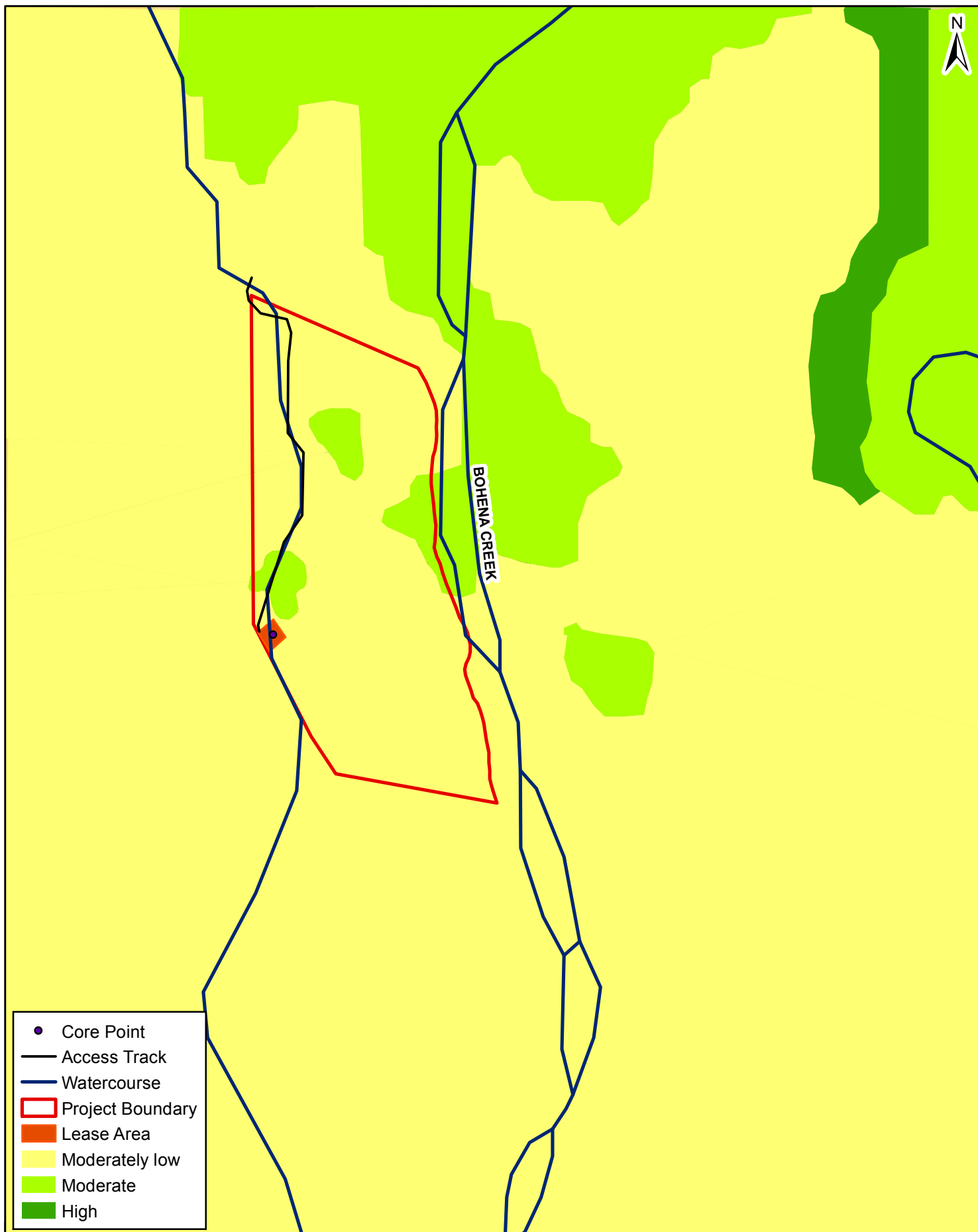
Project:
Kiandool AIS

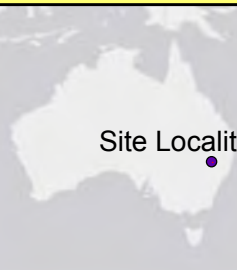
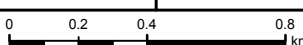

Source: Base topographic data © Bing Aerial
Other Data supplied by Santos, Mitchell 2002

Site Locality



Client: Santos		Soils		 Site Locality
Compiled by: JC	Date: 19/09/2012	Project: Kiandool AIS		
Approved by: DF	Date: 19/09/2012	Figure 4.4		
 Datum: GDA94 		Source: Base topographic data © Bing Aerial Other Data supplied by Santos, Mitchell 2002		



Client: Santos		Soil Fertility		 Site Locality
Compiled by: JC	Date: 19/09/2012	Project: Kiandool AIS		
Approved by: DF	Date: 19/09/2012	Figure 4.5		
 Datum: GDA94 		Source: Base topographic data © Bing Aerial Other Data supplied by Santos, Mitchell 2002 and OEH 2012		

4.3.4 Agricultural Land Use Suitability

4.3.4.1 Strategic Agricultural Land Classification

Strategic Agricultural Land (SAL) is highly productive land that has both unique natural resource characteristics as well as socio-economic value (DoP&I, 2012b). Based on this definition there are two (2) categories of SAL: Critical Industry Clusters (CIC) and biophysical SAL.

A Critical Industry Cluster (CIC) is a localised concentration of interrelated productive industries based on an agricultural product that provides significant employment opportunities and contributes to the identity of the region (DoP&I, 2012b). No CIC's have been identified in the New England - North West Region (DoP&I, 2012b).

According to the Strategic Agricultural Land (SAL) mapping (DoP&I, 2012b), the site is not located on any biophysical SAL for the New England - North West region (**Figure 4.6**). The nearest biophysical SAL polygon is located approximately 3.5 km north east of the site.

4.3.4.2 Land and Soil Capability

In NSW, land and soil capability classes (LSC Classes) have been mapped for the New England - North West region (OEI, 2012b). The mapping is based on an eight class system with values ranging between 1 and 8 which represent a decreasing capability of the land to sustain land use. Class 1 represents land capable of sustaining most land uses including those that have a high impact on the soil (e.g. regular cultivation), whilst class 8 represents land that can only sustain very low impact land uses (e.g. nature conservation).

The majority of the property has been mapped as LSC Class 5 (**Figure 4.7**), while areas along the existing access track and northern and eastern borders of the property are recognised as LSC Class 3.

LSC Class 5 is land associated with severe limitations. These lands are not capable of sustaining high impact land uses unless using specialised land management practices to overcome limitations. Lower impact land uses (e.g. grazing) can be managed by readily available practices. LSC Class 3 is land associated with moderate limitations. These lands are only capable of sustaining high impact land uses via the use of intensive management practices.

Although LSC Class 3 lands are located on the property the area is too small to produce an economically viable crop.

4.3.5 Water Resources

4.3.5.1 Surface water

The site is located within the Namoi River catchment which covers an area of approximately 42,000 km² stretching from Woolbrook in the east to Walgett in the west. The catchment is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south and the Nandewar Ranges and Mount Kaputar to the north.

The Namoi River flows in a westerly direction from its headwaters in the Great Dividing Range. Its main tributary, the Peel River, joins the Namoi near Gunnedah. The Peel River originates in the southeast of the catchment near its border with the Hunter Valley, and flows in a north-west direction towards the Namoi River. The Peel is regulated by Chaffey Dam which provides water for irrigation as well as supplementing the water supply for the city of Tamworth (in addition to Dungowan Dam on Dungowan Creek).

Other major tributaries of the Namoi River include the Manilla and McDonald Rivers upstream of Keepit Dam, Cocks Creek and the Mooki River, which join the Namoi upstream of Boggabri, and Pian, Narrabri, Baradine and Bohena Creeks joining below Boggabri. The Namoi River then flows westerly across the plains and joins the Barwon River near Walgett. The Pian Creek and Gunidgera Creek system is an anabranch of the Namoi River which flows from the northern side of the river near Wee Waa in a westerly direction and rejoins the Namoi upstream of Walgett.

The subject site is located within the Bohena sub-catchment of the Namoi River catchment. The Bohena sub-catchment covers an area of approximately 830 km² south of Narrabri and is the northern extension of the Borah sub-catchment.

The main creek system within the study area is Bohena Creek. Pig Creek, a tributary of Bohena Creek, is located approximately 75 m west of the proposed lease area boundary, within the neighbouring property, and runs adjacent to the existing access track.

Pig Creek has been widened in a section north of the lease area and enters the property in this location. The creek is located 15 m from the access track at its closest point; however, is separated from the access track by a 2 m high earthen bund in this location.

Surface water quality within the catchment is influenced by agricultural runoff, spray drift, and vapour transport (NCMA, 2012). The major water users of the Namoi River are generally irrigators with an annual entitlement of 254, 976 ML.

4.3.5.2 Ground water

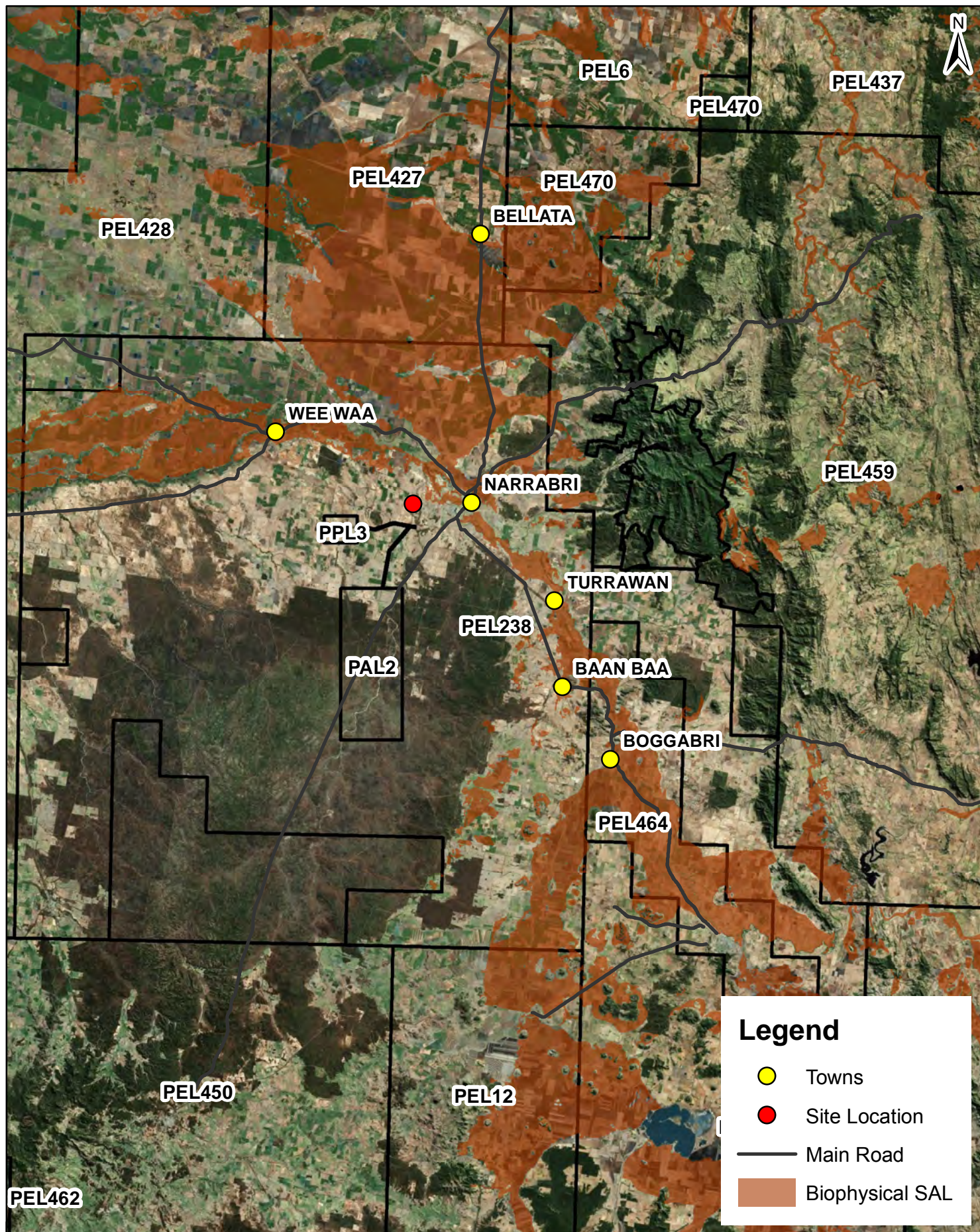
Ground water is contained in the unconsolidated sediments along the Namoi River and its major tributaries. The alluvium of the Namoi River is by far the most important in the state in terms of ground water use, providing water for stock use, domestic supplies, irrigation, industry and town water supplies. There are a total of 700 license holders in the Namoi River catchment.



The high-yielding aquifers of the Namoi catchment are managed as two ground water resources – the Lower Namoi Ground water Source and the Upper Namoi Ground water Source, both of which are managed under a water sharing plan. The Namoi catchment is licensed to provide over 343,000 ML of ground water entitlement per year. In areas not covered by a water sharing plan, the main licensed use of ground water is for irrigation and stock, which represent 50 % and 40 %, respectively, of all ground water entitlement.

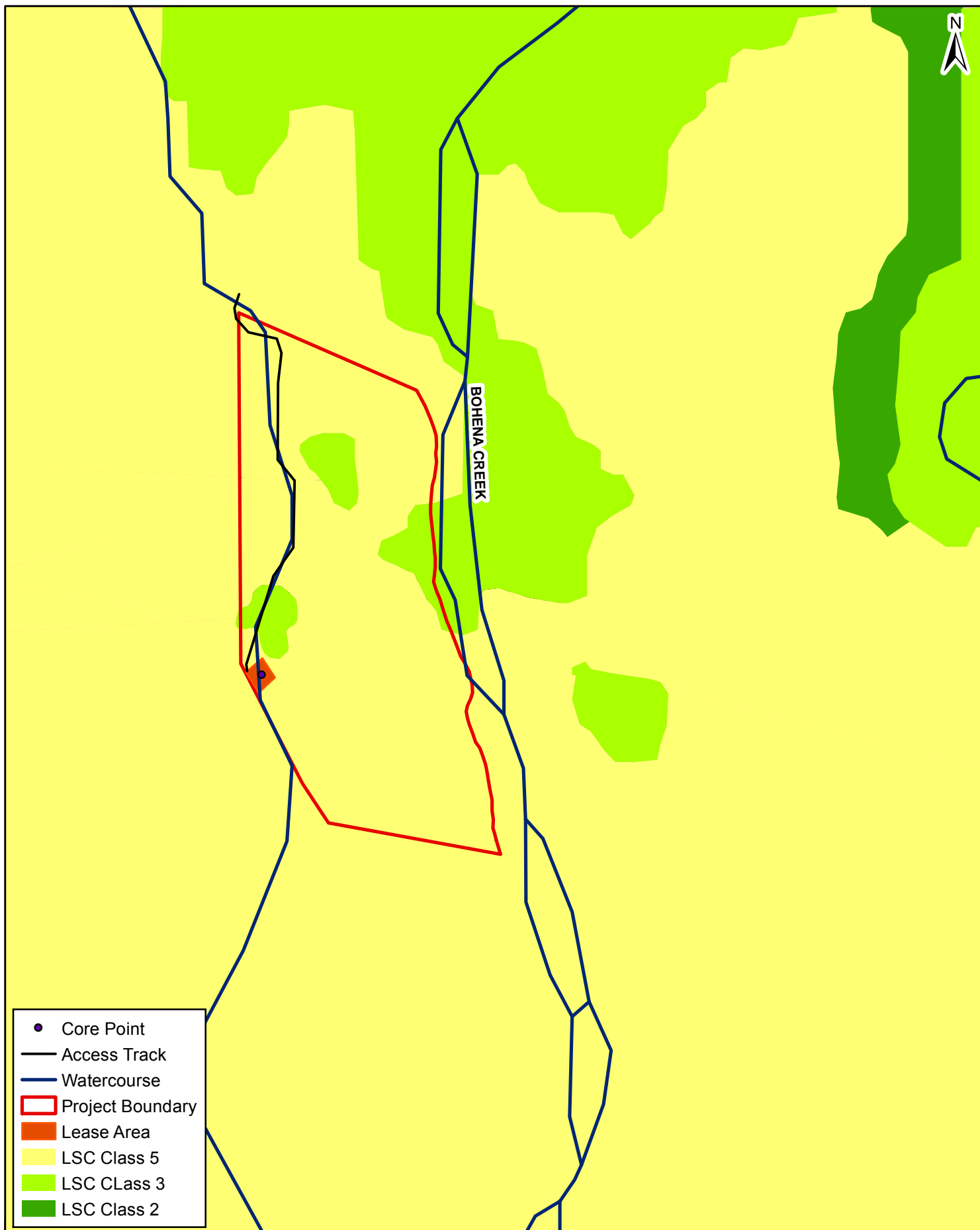
The Lower Namoi Ground water Source extends approximately 160 km west from Narrabri and covers an area of about 7,630 km². The alluvium is up to 120 m deep and some bores yield more than 200 L per second (WRC, 1984).



The Upper Namoi Ground water Sources extend about 175 km south from Narrabri and include the unconsolidated sediments associated with the Namoi River and its tributaries (including Mooki River and Cops Creek) upstream of Narrabri. They cover an area of 3,800 km², and are divided into 12 separate ground water zones based on hydrogeological features.

The lower part of the catchment to the west of Narrabri is underlain by the aquifers of the Great Artesian Basin. This is one of the largest artesian basins in the world covering 1.7 million km² or 22 % of Australia (Crabb, 1997) and containing an estimated 8,700 million ML of artesian water. Groundwater quality and suitability of the Namoi catchment is shown in **Figure 4.9**.



Client: Santos		Strategic Agricultural Land		
Compiled by: JC	Date: 19/09/2012	Figure 4.6		
Approved by: DF	Date: 19/09/2012			
		Project: Kiandool AIS		
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Client: Santos		Soil Fertility		 <div>Site Locality</div>
Compiled by: JC	Date: 19/09/2012	Figure 4.5	Project: Kiandool AIS	
Approved by: DF	Date: 19/09/2012			
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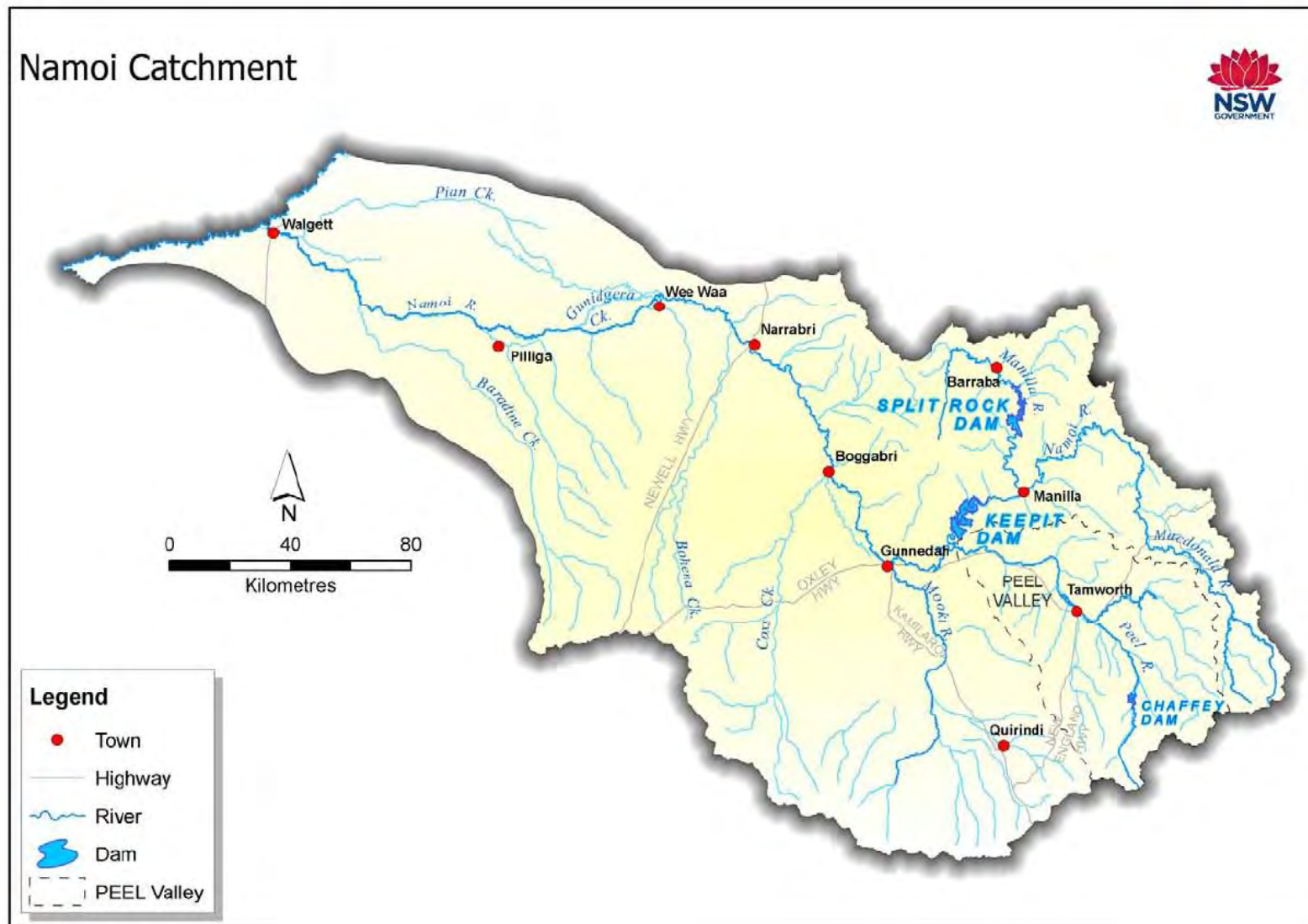


Figure 4.8: Ground water quality and suitability in the Namoi catchment (Green et al., 2012)

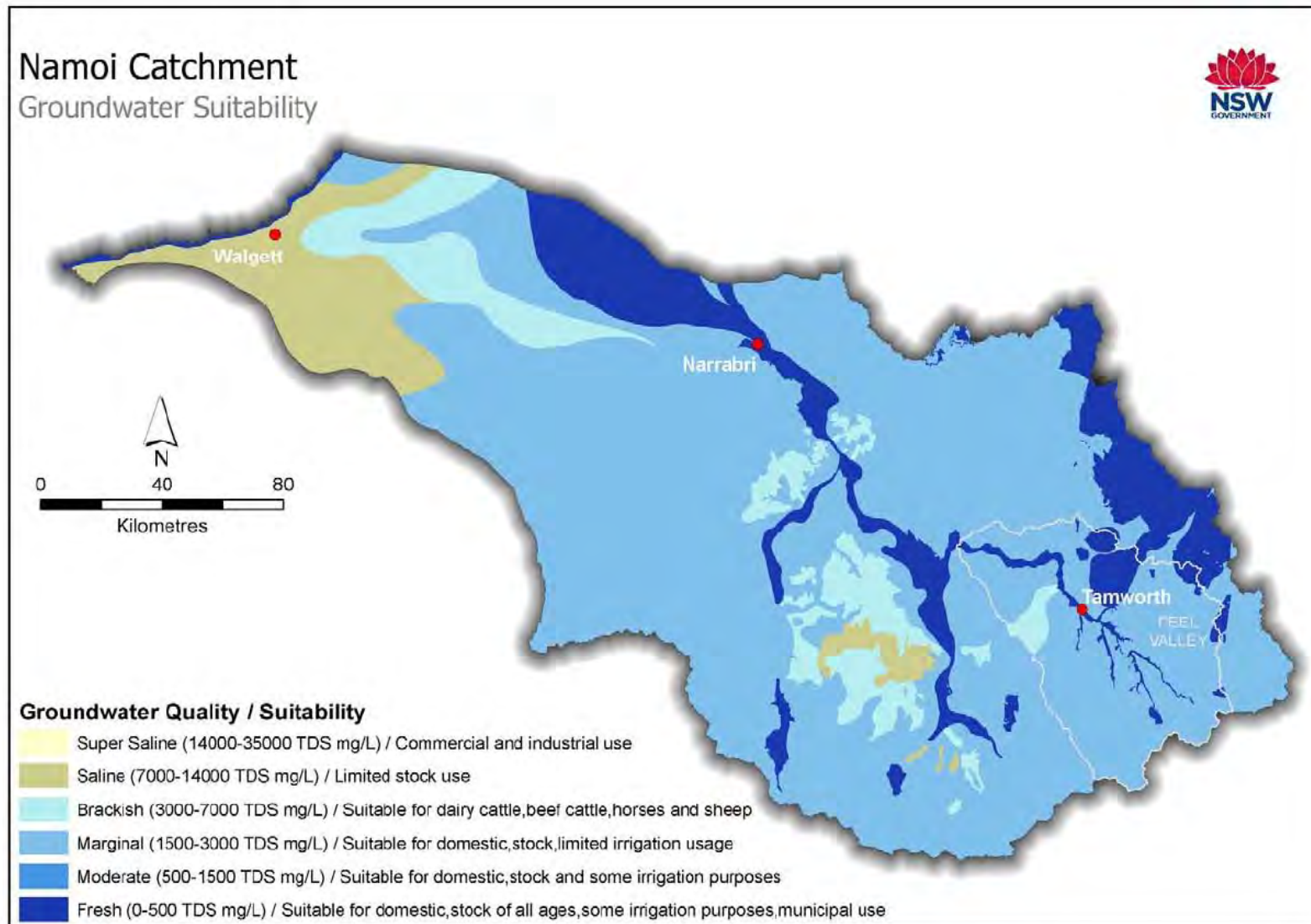


Figure 4.9: Ground water quality and suitability in the Namoi catchment (Green et al., 2012)

5.0 Potential Construction and Operational Phase Impacts

5.1 Agricultural Resources

The term ‘agricultural resources’ is defined in SRLUP (2012) as the land upon which agriculture is dependent and the associated water resources (quality and quantity) which are linked to that land.

5.2 Land Removed from Agricultural Use

The site is located on a rural property of approximately 160 ha in size, which is predominantly used as a lifestyle property with occasional stock grazing. The project will quarantine 1.06 ha of land that could otherwise be utilised for cattle grazing, albeit that cattle grazing on the site itself is not considered to be economically viable due to the quality of the existing unimproved pasture and property size.

There will be no permanent land capability reduction of agricultural resources, though during the construction or operations the site will be excluded from grazing. Once the works are completed, the site will be partially rehabilitated. Partial rehabilitation will aim to be completed within six months of the rig release from the core hole location.

The majority of the lease area will be rehabilitated following completion of the DAMB to its pre-operational condition or better as agreed with the landowner.

5.2.1.1 Mitigation Measures

- The disturbance area will be minimised to reduce unnecessary clearing and earthworks. Additionally, the disturbance area around the lease will be appropriately fenced to ensure machinery is limited to the designated disturbance area;
- Access tracks will be located along existing track routes, where practicable; and
- The temporary loss of land will be mitigated through partial rehabilitation in the short to medium term (approximately 6 months), with full rehabilitation once the DAMB has reached its useful life. Rehabilitation measures are discussed in **Section 6.0**.

5.3 Socio-Economic Impacts

5.3.1 Agricultural Enterprises and Support Infrastructure

In the context of the total area of the property and the wider agricultural uses of the region, the temporary and minor loss of land is considered to be negligible. Further, there will be no pressure on agricultural support infrastructure including:

- Water supply or services;
- Railways; and
- Processing facilities.

The proposed activity will result in minor increases in traffic along Culgoora Road throughout the approximate three month duration of the proposed activity. This level of traffic could easily be accommodated by the existing road network.

5.3.1.1 Mitigation Measures

- No mitigation measures required.

5.3.2 Employment and Economic Development

Approximately 24 employees and contractors may be present on the site each day. No existing agricultural jobs will be lost as a direct result on the proposed activities. Further, the site is used a lifestyle property with occasional grazing, the carrying capacity is not sufficient to sustain a permanent employment position. Therefore, the proposed activities will not result in a loss of agricultural employment opportunities on the site or in the Narrabri Shire region.

5.3.2.1 Mitigation Measures

- No mitigation measures required.

5.3.3 Visual Amenity

The site is not highly visible from any residence or public place. The site may be visible from other agricultural properties; however it does not constitute a key view from any residential property. The nearest sensitive receiver to the site is 1.3 km north of the site. The proposal may detract from the scenic qualities of the land temporarily during construction and drilling (3-6 months) but will be partially rehabilitated following completion of these works, while the lease area will be rehabilitated following completion of the DAMB to its pre-operational condition or better as agreed with the landowner. A negligible to low adverse impact is expected, as there will be no ongoing impacts on scenic quality or visual amenity. Further, no agricultural enterprises are considered to be reliant on the landscape values of the area that would be affected by the addition of the proposed site.

5.3.3.1 Mitigation Measures

- Visual impacts will be mitigated through rehabilitation of the site.
- The site will be kept in a clean and tidy manner during site preparation, drilling activities and operation of the core hole.

5.4 Agricultural Resource Impacts

5.4.1 Soils

The proposed activity will require vegetation clearing and earthworks for establishment of the lease area and upgrading of the access track, if required.

There is potential to impact agricultural resources (soil) at the site due to:

- Soil erosion;
- Chemical spills (e.g. drilling fluid additives, fuels or oil);
- Soil profile inversion; and
- Soil compaction.

However, the risk of adverse impact to the agricultural resources is considered low with the implementation of standard construction site environmental and engineering controls.

5.4.1.1 Mitigation Measures

- Mitigation measures are outlined in the Kiandool 1 REF (RPS 2012).

5.4.2 Water use

Approximately 0.22 ML of water will be required for drilling and general site activities. This will be sourced from Narrabri's potable town water or from water permeate from a reverse osmosis plant, if available. This water will be trucked to the site. There will be no extraction from surface or ground waters during both the construction and operational phases of the project.

As water requirements for the project will be sourced from the Narrabri town water supply there will be no impact on agricultural resources. Further the planned total use of water for the project is 0.22 ML, which is considered low.

5.4.2.1 Mitigation measures

- No mitigation measures required.

5.4.3 Surface water

There is potential to impact agricultural resources (surface waters) at the site and in the local area due to:

- Soil erosion; and
- Chemical spills (e.g. drilling fluid additives, fuels or oil).

However, the risk of adverse impact to the agricultural resources is considered low with the implementation of standard construction site environmental and engineering controls. Further, the sandy loam soils of the site deposit quickly when eroded, meaning eroded sediment is likely to have little off-site (Bohena Creek and Namoi River) impact.

5.4.3.1 Mitigation Measures

- Erosion and sediment controls will be implemented during site preparation activities, including lease area construction and any upgrades to the existing access track, in accordance with best management practices (such as the Best Practice Erosion and Sediment Control Guidelines (IECA, 2008)). These controls will be maintained until disturbed areas of the site are stabilised.
- Further mitigation measures are outlined in the Kiandool 1 REF (RPS 2012).

5.4.4 Ground water

Due to the type of activity proposed, water from the targeted coal seams is not anticipated to be lifted. As ground waters are used by irrigators in the Namoi catchment there is potential to impact agricultural resources (ground water).

Potential impacts of drilling in mixed multi-aquifer systems include:

- Creating an artificial connection between water-bearing formations that bypasses aquitards or aquicludes resulting in cross contamination of aquifers;
- Contamination of the aquifers by drilling fluids or mud if these are lost in the formation;
- Ground water discharging to the surface, which might cause flooding or impact on surface water quality depending on the discharge and receiving water qualities; and
- Ground water contamination could occur due to spills of oil, fuels or chemicals if not cleaned up appropriately.

Given the temporary duration of the proposed activity, provided that the mitigation measures are implemented, a negligible to low adverse impact on ground water quality is expected.

5.4.4.1 Mitigation Measures

- The factors that traditionally contribute to above mentioned impacts include inadequate design, construction and well head completion techniques for the wells, poor planning of drilling programs, inappropriate drilling techniques and/or drilling fluid selection, and inappropriate abandonment methods.
- The proposed bores will be constructed by drillers with recognised technical skills. Where practicable, Santos will use drillers who hold a license under the National Water Drillers Licensing Accreditation Scheme to minimise impacts to aquifers.
- At the completion of the drilling of the surface hole section (and intermediate section where required) of the well, the hole section will be cased with steel pipe and pressure cemented into place and this will provide a solid barrier to prevent any ingress, mixing or discharge of ground water.
- Further mitigation measures are outlined in the Kiandool 1 REF (RPS 2012).

5.4.5 **Air and noise**

The existing noise environment is influenced by birds and insects, occasional vehicles travelling along Culgoora Road and rural activities such as the operation of farming equipment.

Potential air and noise emissions from the proposed activity will include:

- Dust generated during clearing, access track and well lease excavation and core hole drilling;
- Exhaust emissions from vehicle movements to and from the site;
- Exhaust emissions from plant and machinery operations on site;
- Venting of methane (CH₄) and carbon dioxide (CO₂) during drilling; and
- The proposed activity will generate noise during site preparation, drilling and completion activities. The noisiest activities will occur during drilling and construction of the well.

The potential air and noise emissions from the proposed activities may create unfavourable conditions for grazing livestock onsite, while the settlement of dust could reduce the productivity of the surrounding agricultural enterprises, specifically cropping areas. However, given the temporary duration of the proposed activity, provided that the mitigation measures are implemented, a negligible to low adverse impact on air quality and noise is expected.

5.4.5.1 Mitigation Measures

- Mitigation measures are outlined in the Kiandool 1 REF (RPS 2012).

5.4.6 Weeds

The proposed activity has the potential to introduce weeds to the site or spread existing weeds on site throughout the site. Soil, seed or vegetation attached to plant, machinery, vehicles or personnel may transfer weeds to or from the site. Activities such as clearing and earthworks may create favourable conditions for weeds and encourage weed growth.

One listed noxious weed, Prickly Pear, was identified within the site. Prickly pears (includes all *Opuntia* species other than *O. ficus-indica*) are a Class 4 weed under the *Noxious Weeds Act 1993*. As weeds can displace native species, contribute significantly to land degradation, and reduce agricultural productivity they have the potential to impact agricultural resources and must be controlled according to the measures specified in a management plan published by the local control authority. Further, the plant may not be sold, propagated or knowingly distributed.

5.4.6.1 Mitigation Measures

The *Noxious Weeds Act 1993* states that the growth and spread of Class 4 noxious weeds must be controlled. Landowners and occupiers are responsible for the control of noxious weeds according to their Class as specified in the Act. The following weed management procedures will be implemented to prevent the spread of weeds both on and off site:

- Prickly Pear, a Class 4 declared noxious weed will be appropriately controlled within the proposal footprint and along the proposed access road and tracks prior to the construction stage;
- Weed monitoring will occur throughout the construction and operational phase, and weed removal will be carried out as necessary;
- Where plant and machinery are moving from the property, wash down procedures must be implemented;
- All cleared weed species will be stockpiled separately, and removed off site. Weed material is not to be re-used as part of site rehabilitation;
- If practical, clearing will commence in areas of low weed infestation, and move towards areas of high weed infestation; and
- Weed infestations identified within the well lease and proposed new section of access track will be eradicated by hand, with non-residual herbicide, or mechanical removal. Appropriate weed removal techniques are outlined in **Table 5.1**.

Table 5.1: Weed Removal Techniques

Weed Type	Removal Technique	Method
Woody Weeds	Cut and Paint	<ul style="list-style-type: none"> ▪ Make a horizontal cut through the stem close to the ground using secateurs, loppers or a bush saw; and ▪ Immediately apply herbicide to the exposed flat stump surface.
	Stem Injection	<ul style="list-style-type: none"> ▪ At the base of the tree drill holes at a 45 degree angle into the sapwood; ▪ Fill each hole with herbicide immediately; and ▪ Repeat the process at 5 cm intervals around the tree.
	Frilling or Chipping	<ul style="list-style-type: none"> ▪ At the base of the tree make a cut into the sapwood with a chisel or axe; ▪ Fill each cut with herbicide immediately; and ▪ Repeat the process at 5 cm intervals around the tree.

Weed Type	Removal Technique	Method
Small Plants	Hand removal	<ul style="list-style-type: none"> Remove any seeds or fruits and carefully place into a bag; Grasp stem at ground level, rock plant backwards and forwards to loosen roots and pull out; and Tap the roots to dislodge any soil, replace disturbed soil and pat down.
Vines and Scramblers	Hand removal	<ul style="list-style-type: none"> Take hold of one runner and pull towards yourself; Check points of resistance where fibrous roots grow from the nodes; Cut roots with a knife or dig out with a trowel and continue to follow the runner; The major root systems need to be removed manually or scrape/cut and painted with herbicide; and Any reproductive parts need to be bagged.
	Stem Scraping	<ul style="list-style-type: none"> Scrape 15 to 30 cm of the stem with a knife to reach the layer below the bark/outer layer; and Immediately apply herbicide along the length of the scrape.
Weeds with Underground Reproductive Structures	Hand removal	<ul style="list-style-type: none"> Remove and bag seeds or fruits; Push a narrow trowel or knife into the ground beside the tap root, carefully loosen the soil and repeat this step around the taproot; Grasp the stem at ground level, rock plant backwards and forwards and gently pull removing the plant; and Tap the roots to dislodge soil, replace disturbed soil and pat down.
	Crowning	<ul style="list-style-type: none"> Remove and bag stems with seed or fruit; Grasp the leaves or stems together so the base of the plant is visible; Insert the knife or lever at an angle close to the crown; Cut through all the roots around the crown; and Remove and bag the crown.
	Stem Swiping	<ul style="list-style-type: none"> Remove any seed or fruit and bag; and Using an herbicide applicator, swipe the stems/leaves.

5.4.7 Biosecurity

Disease control is required due to the potential for particular plant / soil diseases to be spread, particularly *Phytophthora*. *Phytophthora* can be spread via unregulated exposure and movement of soils between areas of construction. Measures will therefore be implemented to avoid such disease facilitation and hence any potential impact to agricultural resources on and off the site.

5.4.7.1 Mitigation Measures

A variety of mitigation measures will be adapted to minimise and control disease on and off the site:

- Wash down procedures are to be implemented as per **Section 5.4.6.1**;
- Construction personnel will be trained adequately in pest management and hygiene procedures; and
- All machinery to be clean of foreign soil and propagative matter to avoid the importation of *Phytophthora*.

6.0 Post Operational Phase Impacts / Rehabilitation

Once the works are completed, the site will be partially rehabilitated. Partial rehabilitation will aim to be completed within six months of the rig release from the core hole location.

The lease area will be partially rehabilitated following completion of the DAMB to its pre-operational condition or better as agreed with the landowner. Partial rehabilitation may include:

- Removing industrial matting (if used);
- Removing impermeable plastic lining from any pits;
- Beneficially re-using drill cuttings determined to comply with the Protection of the Environment Operations (Waste) Regulation 2001 *Excavated natural material exemption 2008* (the 'excavated natural material exemption') on site;
- Removing temporary buildings;
- Contouring where necessary to prevent water channeling;
- Replacing top soil (if removed);
- Reseeding disturbed ground and planting trees and shrubs (where applicable, as agreed with the landholder) (if required);
- Removing fencing from around the lease area;
- Removing any waste materials for appropriate disposal or recycling; and
- Controlling weeds.

Any improvements to the existing access track will be retained for the benefit of the landowner.

Partial rehabilitation of the lease area will occur within six months of completion of the DAMB where practicable and considering external factors such as the weather and availability of resources.

Once the DAMB has reached its useful life, final rehabilitation will take place. This will include removing surface infrastructure and fencing, revegetation and weed control.

6.1 Agricultural Resource Mitigation Measures

6.1.1 Land Removed from Agricultural Use

At the end of the project life the subject site will be decommissioned and rehabilitated to a condition suitable for livestock grazing.

6.1.1.1 Mitigation Measures

- No mitigation measures are proposed.

6.2 Socio-Economic Mitigation Measures

6.2.1 Agricultural Enterprises and Support Services

Subsequent to on-site infrastructure being decommissioned, the site will be returned to agricultural grazing lands, following removal of surface infrastructure and adequate rehabilitation of disturbed areas.

6.2.1.1 [Mitigation Measures](#)

No mitigation measures required.

6.2.2 Employment and Economic Development

As stated at **Section 5.3.2**, the activities proposed on the subject site will not result in a loss of agricultural employment opportunities in the Narrabri Shire region. Given that the core hole lease is currently used as a lifestyle property with occasional grazing, it will be re-instated to natural grassland to provide site stability and potential agricultural development.

6.2.2.1 [Mitigation Measures](#)

- No mitigation measures required.

6.2.3 Visual Amenity

Following removal of surface infrastructure and adequate rehabilitation to disturbed areas, the presentation of the subject site would be consistent with the existing scenario.

6.2.3.1 [Mitigation Measures](#)

- No mitigation measures required.

6.2.4 Soils

The subject site will be decommissioned and rehabilitated to a condition suitable for livestock grazing. During the course of decommissioning works the potential for adverse impacts to the soil resource are as per **Section 5.4.1**.

6.2.4.1 [Mitigation Measures](#)

- Mitigation measures for potential soil resource impacts during the course of the decommissioning works are as per **Section 5.4.1.1**.

6.2.5 Surface water

During the course of decommissioning and rehabilitation the potential for adverse impacts on surface waters are as per **Section 5.4.3**.

6.2.5.1 [Mitigation Measures](#)

- Mitigation measures for potential surface water impacts during the course of the decommissioning / rehabilitation are as per **Section 5.4.3.1**.

6.2.6 Ground water

The open hole section of this core hole is to be completed as a DAMB with downhole monitoring gauges (subject to NOW licensing) and cemented across all formations to surface. The core hole will be plugged and abandoned with permanent casing installed across the shallowest formations in accordance with current regulatory requirements of the new Well Integrity Code of Practice and specific well design in accordance with that Code of Practice.

Once the DAMB has reached its useful life, final rehabilitation will take place. This will include removing surface infrastructure and fencing, revegetation and weed control.

As ground waters are used by irrigators in the Namoi catchment there is potential to impact agricultural resources (ground water).

Potential impacts during rehabilitation works include:

- Ground water discharging to the surface, which might cause flooding or impact on surface water quality depending on the discharge and receiving water qualities; and
- Ground water contamination could occur due to spills of oil, fuels or chemicals if not cleaned up appropriately.

6.2.6.1 [Mitigation Measures](#)

- Mitigation measures during the course of the decommissioning / rehabilitation are as per **Section 5.4.6.1**.

6.2.7 Air and Noise

During the course of decommissioning and rehabilitation the potential for adverse impacts on surface waters are as per **Section 5.4.5**.

6.2.7.1 [Mitigation Measures](#)

- Mitigation measures during the course of the decommissioning / rehabilitation are as per **Section 5.4.5.1**.

6.2.8 Weeds

Impacts associated with the spread of weeds during the course of decommissioning and rehabilitation are as per **Section 5.4.6**

6.2.8.1 [Mitigation Measures](#)

- Mitigation measures during the course of the decommissioning / rehabilitation are as per **Section 5.4.6.1**
- No weed species will be used to rehabilitate the lease area.

6.2.9 Biosecurity

During the course of decommissioning and rehabilitation the potential for adverse impacts to agricultural enterprises related to the spread of disease, such as *Phytophthora*, are as per **Section 5.4.7**.

6.2.9.1 Mitigation Measures

- Mitigation measures for potential biosecurity impacts during the course of the decommissioning / rehabilitation are as per **Section 5.4.7.1**.

6.2.10 Buffers and Offsets

Due to the low impact nature of the proposed works, buffers and / or offsets are not required for the project and therefore no impact to other agricultural enterprises is predicted.

7.0 Monitoring and Auditing

The mitigation and compliance monitoring strategy for the proposed activity is described in **Section 2.7** of the REF.

8.0 Consultation

Consultation for Kiandool 1 is described in section 2.3 of the REF for the proposed activity.

9.0 Conclusion

- Santos Limited (Santos) is proposing to undertake drilling and ancillary activities at the 'Kiandool 1' site, which is located on Culgoora Road, approximately 9 km west of Narrabri Township.
- The site has a total area of 160 ha, while the lease area is 100 m x 100 m.
- The site and surrounds are not classified as Biophysical SAL. There are no CIC in the New England North West Region.
- The site is characterised by deep texture contrast soils with deep yellow sand underlain by sodic clays to the south and red brown sands underlain by brown to grey silt to the north.
- The site was previously used as a lifestyle property with occasional livestock grazing and is therefore not considered a significant agricultural enterprise.
- The project will quarantine land that could otherwise be utilised for cattle grazing, albeit that cattle grazing on the site itself is not considered to be economically viable due to the quality of the existing unimproved pasture and property size.
- The proposed development will prohibit agricultural production on 1.06 ha at the site during the construction and operational phases of the project. However, the impact on production value is negligible in terms of the total area of disturbance and the gross value of livestock production on the 160 ha property or in the Narrabri Shire. Therefore, the proposed development does not have an unreasonable impact on agricultural resources and production at the subject site or within the Narrabri Shire.
- The main adverse cumulative impacts of the proposed activity could include pressure on existing agricultural infrastructure and depletion of agricultural resources. However, these are considered low, provided that mitigation measures are followed and applied according to best known methods.

10.0 References

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