



Dewhurst 26-29 petroleum wells PEL 238, Gunnedah Basin, NSW

Review of Environmental Factors (REF)

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Report Number: PR113570
Version/Date: Rev0/March 2013

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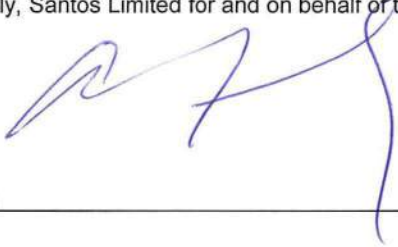
Document Status

Version	Purpose of Document	Orig	Review	Review Date
Rev A	Draft for Client review	KV	BL	01/02/2013
Rev B	Draft for review	PM	CH	15/02/2013
Rev 0	Final	PM	CH	07/03/13

Approval for Issue

Name	Signature	Date
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Executive summary

Overview

Santos NSW (Eastern) Pty Ltd (a wholly owned subsidiary of Santos Limited) (Santos), as a coal seam gas (CSG) operator on behalf of the titleholders of Petroleum Exploration Licence 238 (PEL 238), proposes to drill four petroleum exploration wells, known as Dewhurst 26-29, and carry out ancillary activities within the Pilliga East State Forest, approximately 44 kilometres south of Narrabri, NSW (the proposed activity). The purpose of the proposed activity is to investigate the potential CSG 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 Minister for Resources and Energy (Resources Minister) is the determining authority for the proposed activity by virtue of the need to obtain further approval from the Resources Minister under PEL 238 concerning the proposed activity.

RPS Australia East Pty Ltd (RPS) has prepared this Review of Environmental Factors (REF) as an assessment of 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) and where relevant, the *Additional Part 5 REF requirements for petroleum prospecting: A supplement to ESG2: Environmental Impact Assessment Guidelines* (draft Guidelines)(DTIRIS 2011).

The proposed activity will require a water access licence (WAL) under the *Water Management Act 2000* (WMA). In regards to that WAL, the Minister administering the WMA (Water Minister) is a 'determining authority' within the meaning of section 110 of the EP&A Act. Therefore, duties under Part 5 of the EP&A Act would ordinarily be attached to the Water Minister's grant of the WAL. However, section 110E(c) of the EP&A Act provides an exemption. The effect of that section is that sections 111 and 112 of the EP&A Act will not apply in relation to the proposed activity once it has been approved by the Resources Minister in reliance on this REF. Accordingly, if and when the proposed activity has been approved by the Resources Minister in reliance on this REF, section 111 and 112 of the EP&A Act will not apply in relation to the issue of a WAL for the proposed activity by the Water Minister.

Proposed activity scope

The scope of the proposed activity includes:

Site preparation

- clearing four 10 metre wide service corridors between Beehive Road and the Dewhurst 26-29 lease areas
- constructing access roads within the service corridors
- establishing the Dewhurst 26-29 lease areas each up to approximately one hectare in size
- setting up temporary equipment on each lease area.

Drilling

- drilling two vertical pilots (Dewhurst 26 and 28)
- drilling two tri-stacked lateral pilots (Dewhurst 27 and 29) to intercept Dewhurst 26 and 28.

Gathering system construction

- constructing a gas gathering system parallel to the access tracks and Beehive Road to a proposed flare adjacent to Dewhurst 28
- constructing a water gathering system parallel to the gas gathering system with associated piping and pumps adjacent to Dewhurst 28.

The gathering system will extend from the riser located at the edge of each pilot well lease area to the water transfer tank located adjacent to Dewhurst 28.

Operation

- installing surface infrastructure on the Dewhurst 26-29 lease areas, including separators, metering skids, power generation equipment, telemetry units, motor control centres and drivers
- installing a flare, water transfer tank (capacity 40m³) and pumps adjacent to the Dewhurst 28 lease area
- partially rehabilitating Dewhurst 26-29 to the well head and essential infrastructure
- operating the Dewhurst 26-29 well set for the life of PEL 238 or until critical reservoir data is collected
- continued monitoring of the pilot wells and gathering systems
- maintenance and 'workover' activities as needed.

Post operation

- where pilot testing indicates that commercial gas production is not viable, decommissioning the wells and ancillary infrastructure, and completely rehabilitating the lease areas.

Justification

The proposed activity is necessary for the ongoing exploration and evaluation of the hydrocarbon potential in PEL 238 and will underpin future CSG production in the region. Development of the gas industry will bring capital investment and economic benefits to the region. It will also help to secure supply for domestic gas and alleviate NSW's reliance on imported gas. The proposed activity will be consistent with ecologically sustainable development principles and is therefore justified.

Potential environmental impacts

Potential environmental impacts of the proposed activity during site establishment, drilling and completion activities will be associated with land clearing, noise and dust generation and potential for spills.

Land to be cleared within the Pilliga East State Forest comprises up to approximately 5.755 hectares of narrow leaved ironbark woodland. This habitat provides foraging, breeding, roosting and sheltering resources that is currently utilised by a range of faunal groups. This will result in the displacement of native fauna across the affected area. Displaced fauna will need to relocate into adjacent habitats, which will place short-term pressure on the available resources within these habitats. An ecological assessment prepared for the proposed activity concluded that the proposed activity is unlikely to result in a significant impact on threatened species, populations, ecological communities, or their habitats.

During operation of the proposed activity, water and gas will be extracted and transferred to a facility adjacent to Dewhurst 28. Excess gas will be flared and water will be temporarily stored in a 'balance' tank prior to being transferred to an appropriate facility for treatment. Groundwater modelling was undertaken to determine the impact of CSG water abstraction. This concluded that there will be negligible impact to the

upper aquifers, groundwater dependent ecosystems and registered bore users. A water licence will be required as the proposed activity will result in aquifer interference.

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

Environmental impacts with reference to the ESG2 guidelines are summarised below.

Category	Element	Potential impacts	Potential impact category (with mitigation measures)
Physical and chemical impacts	Soil quality and land stability	<ul style="list-style-type: none"> disturbance of up to approximately 5.755 ha of land soil erosion and loss of topsoil or spoil land contamination in the 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 	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 water abstracted for first 3 years, up to approximately 276 ML, equating to an average of up to 251.6 m³/day negligible change in the volume of groundwater (flux) or aquifer drawdown in the upper layers, no impact to registered bore users or groundwater dependant ecosystems 	Negligible to low adverse
	Flooding	<ul style="list-style-type: none"> site not in flood prone land pollution/contamination of surface waters in event of flooding and inundation of the site 	Negligible
	Coastal process and costal hazards	<ul style="list-style-type: none"> proposed activity not near a coastline 	N/A
	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
	Gaseous, liquid and solid waste and emissions	<ul style="list-style-type: none"> management of groundwater produced during operation of the pilot wells 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 generation of greenhouse gas emissions 	Low adverse
	Dust, noise, odours, vibration and radiation	<ul style="list-style-type: none"> generation of dust and other particulates generation of noise, particularly during drilling activities which may occur up to 24 hours per day 	Negligible to low adverse
Biological	<ul style="list-style-type: none"> removal of up to approximately 5.755 ha of vegetation temporary disruption to breeding cycle, roosting, sheltering and foraging behaviour of fauna 	Medium adverse	

Category	Element	Potential impacts	Potential impact category (with mitigation measures)
		<ul style="list-style-type: none"> species ▪ three threatened fauna species were observed on site; potential impacts to these species are assessed as unlikely 	
Community	Infrastructure and services	<ul style="list-style-type: none"> ▪ pressure on temporary accommodation in Narrabri area ▪ minimal generation of traffic on Beehive Road ▪ introduction of hazard (construction activities, gathering system and flare) with potential safety implications 	Negligible
	Economic issues	<ul style="list-style-type: none"> ▪ economic benefits to Narrabri and surrounding region ▪ ongoing use of upgraded access track to the benefit of Forestry NSW 	Positive
Natural resources		<ul style="list-style-type: none"> ▪ taking of approximately 5.755 ha of land within Pilliga East State Forest ▪ no impact to agricultural land ▪ 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
Historic heritage impacts		<ul style="list-style-type: none"> ▪ disturbance of unknown historic heritage items 	Negligible

Conclusion

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 the community.

The proposed activity is not likely to significantly affect the environment or any threatened species, populations or ecological communities, their habitat or critical habitat, or any Matters of National Environmental Significance. As such, the proposed activity does not require the preparation of an Environmental Impact Statement (EIS) or referral to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC).

1.0 Introduction

1.1 Background

Santos NSW (Eastern) Pty Ltd (a wholly owned subsidiary of Santos Limited) (Santos) as the CSG operator on behalf of the titleholders of Petroleum Exploration Lease 238 (PEL 238) proposes to drill four petroleum exploration pilot wells, known as Dewhurst 26-29, and carry out ancillary activities within the Pilliga East State Forest (the proposed activity). The purpose of the Dewhurst 26 to 29 pilot wells is to investigate the potential coal seam gas (CSG) resource of the Gunnedah Basin within PEL 238.

Petroleum exploration wells are classified as a Category 3 activity under the conditions of PEL 238. Category 3 activities require further approval from the Resources Minister in order to carry out the activity. In this case, a Part 5 approval under the *Environmental Planning and Assessment Act 1979* (EP&A Act) is required.

This Review of Environmental Factors (REF) has been prepared by RPS Australia East Pty Ltd (RPS) at the request of Santos as the CSG operator on behalf of the titleholders of PEL 238 to assess the environmental impact of Dewhurst 26 to 29. The current titleholders for PEL 238 are Santos NSW Pty Ltd (ACN 094 269 780) and EnergyAustralia Narrabri Gas Pty Ltd (ACN 147 609 729).

This REF is an assessment of the potential environmental impacts of the proposed activity and will assist the Resources Minister in fulfilling his 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 the Division of Resources and Energy (DRE) within the Department of Trade & Investment, Regional Infrastructure and Services (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* (Department of Planning and Infrastructure, 2012a) dated July 2011 have also been considered in preparing the REF.

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 involve the drilling and operation of two vertical pilot wells (Dewhurst 26 and 28) and two directional pilot wells (Dewhurst 27 and 29) and the construction of ancillary infrastructure to manage water and gas during operation of the four well pilot set.

The proposed activity can be described in terms of five stages:

- site preparation
- drilling
- infrastructure construction
- operation
- post-operation.

The works proposed during each stage, and timing for these stages, are summarised in Table 2-1.

Table 2-1 Summary of proposed activity by stage

Stage	Proposed works ¹	Timing	Duration
Site preparation	<ul style="list-style-type: none"> ▪ clearing four 10 metre wide service corridors between Beehive Road and the Dewhurst 26-29 lease areas ▪ constructing access roads within the service corridors ▪ establishing the Dewhurst 26-29 lease areas each up to approximately one hectare in size ▪ setting up temporary equipment on each lease area 	Third quarter of 2013	14 days
Drilling	<ul style="list-style-type: none"> ▪ drilling two vertical wells (Dewhurst 26 and 28) to a depth of approximately 1050 mTVD ▪ drilling two directional wells (Dewhurst 27 and 29) to intercept Dewhurst 26 and 28 	Third quarter of 2013	Up to 40 days
Gathering system construction	<ul style="list-style-type: none"> ▪ constructing a gas gathering system parallel to the access tracks and Beehive Road to a proposed flare adjacent to Dewhurst 28 ▪ constructing a water gathering system parallel to the gas gathering system with associated piping and pumps adjacent to Dewhurst 28 (the gathering system extends from the riser located at the edge of each pilot well lease area to the transfer tank located adjacent to Dewhurst 28) 	Third quarter of 2013	Up to 40 days
Operation	<ul style="list-style-type: none"> ▪ installing surface infrastructure on the Dewhurst 26-29 lease areas, including separators, metering skids, power generation equipment, telemetry units, motor control centres and drivers ▪ installing a flare, water transfer tank (capacity 40m³) and pumps adjacent to the Dewhurst 28 lease area ▪ partially rehabilitating Dewhurst 26-29 to well head and essential infrastructure ▪ operating the Dewhurst 26-29 well set ▪ maintenance and workover activities 	Fourth quarter of 2013	For the life of PEL 238 or until critical reservoir data is collected
Post-operation	<ul style="list-style-type: none"> ▪ where pilot testing indicates that commercial gas production is not viable, decommissioning the wells and ancillary infrastructure, and completely rehabilitating the lease areas. 	On completion of pilot testing	30 days

Note 1. mTVD = metres total vertical depth

The total area of potential disturbance assessed in this REF is up to approximately 5.755 hectares. This includes a one hectare lease area for each pilot well, access tracks, and a gathering system right of way. References to 'the site' throughout this REF include the four lease areas, access tracks and right of way.

The proposed activity is described in more detail in section 2.7.

2.2 Regional location context

The site is located in the southern 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): Narrabri Shire, Warrumbungle Shire and Gunnedah Shire. The site is located within the Narrabri Shire LGA.

The site is located approximately 44 kilometres south of Narrabri and 37 kilometres west of Boggabri in the Pilliga East State Forest. The Pilliga East State Forest forms part of a large tract of bushland referred to as the Pilliga Scrub, which encompasses numerous protected areas including the Pilliga East State Forest, Bibblewindi State Forest, Pilliga State Conservation Area, Pilliga Nature Reserve, Jacks Creek State Forest, Rutley State Forest and Kerringle State Forest. The regional context of the site is shown in Figure 2-1.

2.3 Petroleum activity context and wider program of works

2.3.1 50 wells exploration program

Santos commenced CSG exploration NSW in 2008. Santos' CSG acreage in NSW covers approximately 62,000 square kilometres in the areas around Narrabri, Boggabri, Gunnedah, Coonabarabran, Quirindi and Scone.

In 2011, Santos acquired Eastern Star Gas' Narrabri Gas Development Project. This included six existing pilots and associated infrastructure within the area around Narrabri (including within PEL 238).

Santos has recently finalised plans for a 50 well drilling program for the Narrabri and Gunnedah area as part of its exploration of the Gunnedah Basin. The drilling program is scheduled to commence in early 2013 and will take two to three years. The program will include up to six pilots and 10 core holes within PEL 238 and Petroleum Assessment Lease (PAL) 2. These activities are required to gather the vital scientific information that will underpin any future decision to progress towards development and production in the area.

The proposed pilot wells will be located in the southern section of PEL 238. Data collected from the pilot wells will be used to determine the CSG potential within this area of the Gunnedah Basin and whether further exploration or assessment activities are warranted. Any such activities would be subject to further feasibility and environmental assessment, and obtaining the appropriate government approvals.

2.3.2 Water management

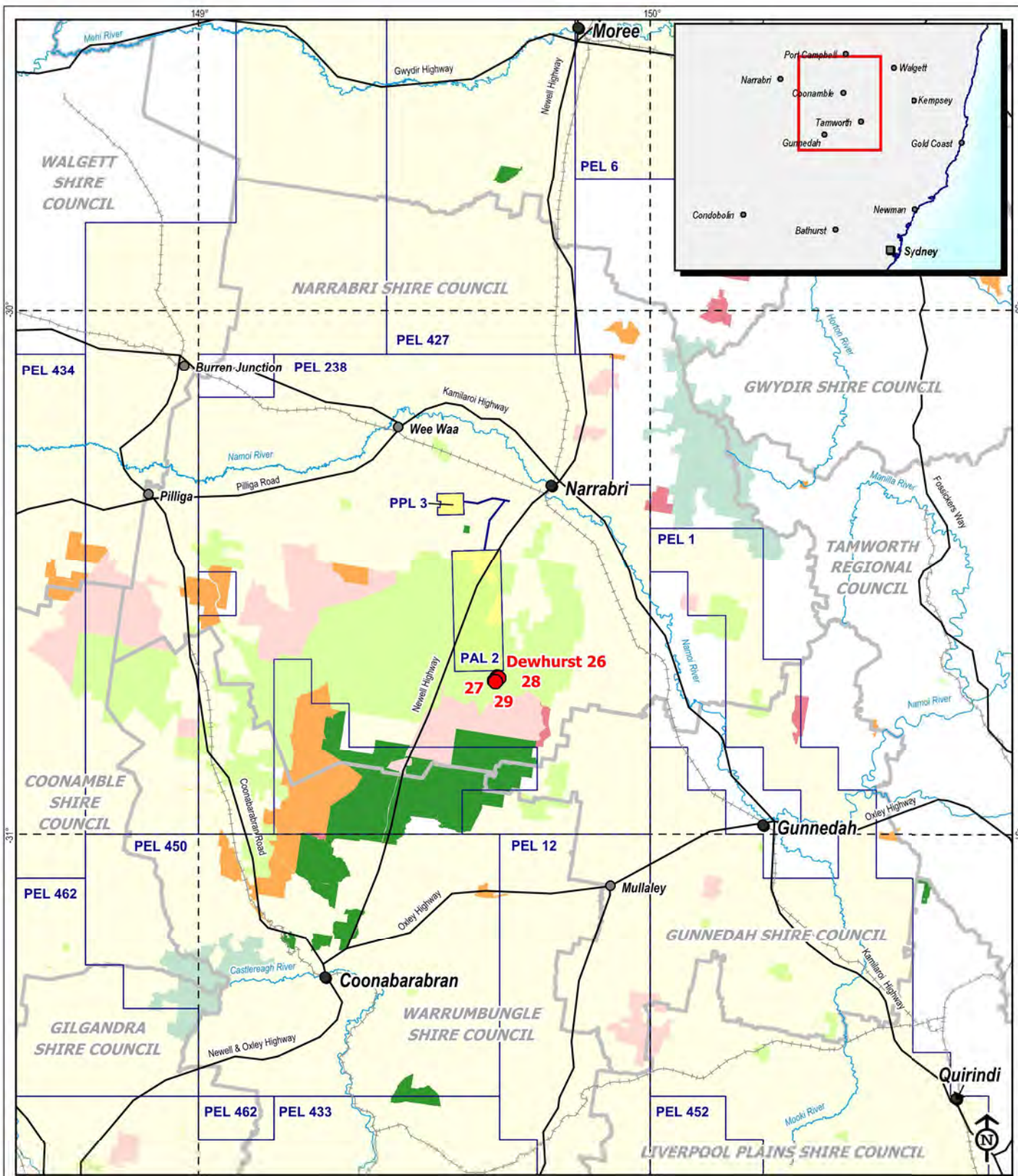
Santos plans to construct a water flowline to link Dewhurst 26-29 to a water storage area, known as the Bibblewindi Water Management Facility, located approximately 7.5 kilometres north of the pilot set. The flowline, known as the Dewhurst Southern Flowline, will be approximately 4.33 kilometres in length and will tie into an existing water flowline that connects back to the Bibblewindi Water Management Facility. The Dewhurst Southern Flowline will be assessed as a separate project under Part 5 of the EP&A Act.

Ultimately, Santos intends to centralise its water handling and treatment operations outside of the Pilliga forest and plans to construct a new water management facility, known as the Leewood Produced Water and Brine Management Facility, on an agricultural property approximately 24 kilometres south of Narrabri. A

16 kilometre water flowline will be constructed between the Bibblewindi Water Management Facility and the Leewood Produced Water and Brine Management Facility.

The Leewood Produced Water and Brine Management Facility will be developed over two phases. The first phase will involve the construction and operation of produced water and brine ponds at Leewood and the water flowlines between Bibblewindi Water Management Facility and Leewood. The second phase will involve the construction and operation of a reverse osmosis (RO) plant and brine treatment plant. Santos prepared a Review of Environmental Factors for Phase 1 of the Leewood Produced Water and Brine Management Facility under Part 5 of the EP&A Act and submitted this to the NSW Department of Investment, Trade, Regional Infrastructure and Services in December 2012.

It is anticipated that the Dewhurst Southern Flowline and Phase 1 of the Leewood Produced Water and Brine Management Facility will be constructed prior to operating the Dewhurst 26-29 pilots. In the event that this infrastructure is not fully operational in time for operation of Dewhurst 26-29, water from the proposed wells will be transported via road to the Bibblewindi Water Management Facility.



- Major Town
- Town
- Site Location
- Major Road
- Rail Line
- River
- Tenements - Production
- Tenements - Exploration
- LGA Area
- CCA Zone 2 - Aboriginal Area
- CCA Zone 1 - National Park
- CCA Zone 3 - State Conservation Area
- National Park
- Nature Reserve
- State Forest

Santos

PEL 238 - New South Wales

Dewhurst 26 - 29 Regional Location

20 0 20 40 km

Figure: 2-1

Date: February 2013
File No: GUNNEDAH 285a

2.4 Stakeholder consultation

2.4.1 Approach

Santos recognises the importance of proactive and effective engagement with communities and stakeholders and is well established within the local community, with a local office and resident employees. Santos has commenced a broad consultation program for planned exploration activities within PEL 238, as well as targeted consultation for the proposed activity.

Through this consultation, Santos aims to:

- increase overall awareness and understanding of the CSG industry
- keep landholders, neighbours, residents, local councils and relevant government agencies informed of its activities
- ensure the interests of stakeholders are considered in the project design and implementation
- identify key issues or concerns for the community and address these through the environmental assessment process
- minimise disputes with landowners or other stakeholders.

2.4.2 Stakeholders

2.4.2.1 Forestry NSW as the landowner/manager

The proposed activity is located entirely on land managed by the Forestry Corporation of New South Wales (Forestry NSW). Santos holds a Permit to Occupy from Forestry Commission of NSW (now Forestry NSW) and the State of NSW. The permit to occupy outlines a range of environmental mitigation strategies that Santos must comply with (see Section 2.8).

Santos' Narrabri Operations Manager holds regular meetings with a representative of Forestry NSW. A schedule of upcoming activities has been provided to Forestry NSW and is updated on a monthly basis. The schedule includes the proposed activity.

2.4.2.2 Other stakeholders

The following additional stakeholders have been identified for the proposed activity:

- Resources Minister through Division of Resources and Energy (DRE) within Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS)
- Office of Environment and Heritage
- NSW Office of Water (NOW)
- Narrabri Shire Council
- Narrabri Local Aboriginal Land Council (LALC)
- Community Consultation Committee – Narrabri Shire (Narrabri CCC)
- General community.

The Narrabri CCC was established by Santos and includes representatives from the Narrabri Shire Council, agricultural groups, local landowners, residents, business owners and other interested parties. The CCC meets monthly to discuss upcoming works on Santos' program and general issues relating to CSG.

There are no relevant infrastructure authorities, service providers, or private landholders that will be affected by the proposed activity.

The site is located within Coal Authorisation 216, held by DTIRIS on behalf of the Crown. No other authorisation or title holders will be affected by the proposed activity.

2.4.3 Consultation activities undertaken to date

Santos has used a wide range of consultation tools to engage with various stakeholders as part of its overall consultation program and during preparation of the REF for the proposed activity. This has covered the full range of exploration activities within the area.

Recent consultation has focussed on engaging with State and local government stakeholders, including the DRE, Narrabri Shire Council and NSW Forestry, and local interest/community groups on Santos' broader activities within the region.

Approximately four meetings with DRE have been held to discuss the exploration program within PEL 238 and, in particular, the regulatory approvals required for this program.

Monthly meetings have been held with the land owner (Forestry NSW) since October 2011.

In conjunction with targeted stakeholder consultation, the wider community has been provided information about the broader project scope, and the environmental assessment process, and invited to contribute their comments and feedback.

Questions and concerns raised by the broader community have been addressed through telephone contact (both through the Santos community 1800 line and by individual telephone calls made to the Narrabri Office staff), formal correspondence and on-site meetings where required. These issues for the broader forest activities have been recorded and considered during preparation of the REF.

This consultation is summarised in Table 2-2.

Table 2-2 Consultation activities

Consultation tool/Activity	Description
Santos project website	Santos maintains a project website which identifies its activities in NSW. The website is regularly updated with general project information, photos and frequently asked questions: http://www.santos.com/exploration-acreage/nsw-csg.aspx
Santos project 1800 number and email address	Santos maintains a free information and enquiries line and project email address: 1800 071 278 http://www.santos.com/exploration-acreage/nsw-csg/contact-our-nsw-team.aspx
Santos Narrabri Office and Project Information Centre	Santos has an office and project information centre at 125 Maitland Street, Narrabri which members of the public can visit and request information about the project. The office is attended from 9am to 5pm Monday to Friday.
Local media advertisements	Santos issues a monthly update through an advertisement in the local Narrabri Courier newspaper that provides information on the upcoming work program. This includes activities associated with decommissioning of wells; work overs, modifications and/or upgrades to existing wells; drilling of exploration core holes; drilling of appraisal or pilot wells; rehabilitation works; and other relevant works.
Community information sessions	Coal seam gas forums This has included open days for the community to discuss the exploration activities occurring within the area. Community members have been invited to community forums

Consultation tool/Activity	Description
	<p>in the township of Gunnedah where senior Santos personnel have presented information on coal seam gas and been available for the day to answer any questions raised by the community.</p> <p>Farmer forums Farmer forums have been held in Narrabri and have been attended by local farmers.</p> <p>Established community forums There have been a number of presentations to the wider community including Narrabri Rotary, Narrabri Chamber of Commerce and several schools in the area. Community information sessions will continue throughout the project.</p> <p>Open evening An open evening was held on 22 January 2012 at the Santos Narrabri Office. Attendees at the event included several landowners from the Narrabri area, Narrabri Shire Council members, media and several stakeholder groups.</p>
Scout	A scout was undertaken by Santos and a contract surveyor. Forestry NSW was advised of the scout in advance but did not have a representative attend the scout.
Stakeholder meetings	<p>Narrabri Local Aboriginal Land Council (LALC) Regular meetings have been held with the Narrabri LALC throughout 2012. Since November 2012 consultation with this group has increased with the cross flow of information occurring more regularly.</p> <p>Gomeri native title applicants A forum was held on 17 January 2013 to discuss the activities occurring within PAL 2 during 2013 and CSG exploration more generally. Thirteen of the nineteen applicants were in attendance as well as NTSCORP (the Native Title Service Provider for Aboriginal Traditional Owners in NSW) and the Narrabri LALC. Santos has agreed future meetings will take place with this group. Santos also met with the elders of the Red Chief LALC on 13 February 2013 and escorted this group on a tour of the Pilliga East State Forest on 25 February 2013.</p> <p>Narrabri Shire Council A regular monthly meeting is held with the Narrabri Shire Council. Santos has also provided a six month look-ahead schedule to the council for comment. Senior council staff are generally advised of media releases prior to any release being made.</p> <p>Forestry NSW Monthly meetings have been held with the Forestry NSW since October 2011. Weekly reports are emailed to Forestry NSW outlining weekly activities and proposed activities for the following week. Forestry NSW is consulted when a scout is to be conducted at a site within the Pilliga Forest. Forestry NSW and all other permit to occupy holders are invited and have attended site tours of Santos' facilities and operations with the Pilliga forest (which is part of PEL 238). Forestry NSW has a relationship owner with the Narrabri Operations Centre and regularly telephones to discuss particular items.</p> <p>Division of Resources and Energy(DRE) Approximately four meetings with DRE have been held to discuss the exploration program within PEL 238 and the regulatory approvals required for the overall exploration program.</p> <p>NSW Office of Water (NOW) Approximately three meetings with NOW have been held to discuss the exploration program within PEL 238 and in particular, water licensing requirements for pilot activities.</p>
Targeted mail outs	Affected landholders receive correspondence advising of the future exploration drilling activities in their area, and closer to the date of commencement activities receive a personal telephone call from the locally based land access team.
Advertisements	Advertisements will be placed in the local media (after advising the Narrabri Shire Council) of the upcoming exploration drilling activities at Dewhurst 26-29
Fact sheets	Fact sheets have been developed explaining the CSG business in NSW and regularly

Consultation tool/Activity	Description
	update. These are made available on the project website.
Narrabri CCC	The Narrabri CCC meets monthly to discuss upcoming activities on Santos' program of works. Meetings to date have focused on providing an overview of planned petroleum activities and in particular exploration drilling activities. The proposed activity will be discussed at the Narrabri CCC meeting the month before the commencement of the activity.

2.4.4 Consultation outcomes, including influence on design and management of proposed activity

Table 2-3 identifies key outcomes of consultation activities undertaken to date.

Table 2-3 Consultation outcomes

Stakeholder	Issues raised during consultation	How issues have been addressed
Forestry NSW	Santos' activities must comply with regulatory requirements. Santos must manage the impact to the forest.	The location of the lease areas and access tracks were influenced by the Forestry NSW's requirements. Santos holds a permit to occupy within the Pilliga East State Forest within PEL 238. A land access and compensation agreement has been negotiated with Forestry NSW. At the monthly meetings held with Forestry NSW feedback is sought with modifications to activities made in accordance with the conditions of the permit to occupy. Operational issues are addressed locally as required.
Narrabri CCC	Concerns about bushfire, impacts to groundwater and how produced formation water is going to be managed. Particular topics should be discussed at each monthly meeting to inform the committee on the CSG activities being conducted by Santos How is coal seam gas extracted from the ground? How is the drill hole cemented and re-enforced to protect cross flow from aquifers? In what ways is Santos supporting the local community?	Santos will continue to consult with the Narrabri CCC. A tour of Santos' operations within PEL 238 is scheduled for 27 February 2013 to increase the community's understanding of groundwater issues associated with CSG and the exploration and appraisal activities in the area. Santos has a response procedure to assist the local Country Fire Brigade if there is a bush fire outbreak in the local area. Santos participated in bush fire management under a request from the local community.
Narrabri Shire Council	Requested continued consultation and a schedule of upcoming events.	The Narrabri Shire Council will continue to be consulted and provided with a six monthly look ahead schedule.
Narrabri LALC and Gomeri native title applicants	Requested more interaction with Santos.	Following the meeting in January 2013, Santos is working with the Aboriginal community to establish a process of assessing Aboriginal cultural heritage beyond legislative requirements.

2.4.5 Future and ongoing consultation activities

Santos will continue to consult with Forestry NSW, the community and stakeholders leading up to and during the proposed activity. This consultation will include:

- newspaper advertisements

- community updates and newsletters
- fact sheets
- community information sessions and display materials
- stakeholder meetings
- email updates to a registered list of interested stakeholders
- continued operation of the project information line, website and email address
- regular project website updates
- written notification to the landowner
- traffic management notifications
- monthly Narrabri CCC meetings
- continued operation of the Narrabri Office and Information Centre.

Table 2-4 identifies specific consultation activities which will be carried out prior to the proposed activity commencing.

Table 2-4 Specific consultation prior to commencement of proposed activity

Stakeholder	Description	Planned timing
Forestry NSW	A formal 'Notice of Commencement of Activities' will be sent to the Forestry NSW Manager prior to construction commencing. The Dewhurst 26-29 activities will also be outlined in the weekly report to Forestry NSW closer to construction commencing.	7 days prior to commencement of construction
Neighbouring landowners	There are no private landowners directly adjoining the site. Ongoing consultation is undertaken with landowners surrounding the Pilliga East State Forest.	Ongoing communication and consultation.
Narrabri Shire Council	Narrabri Shire Council will be notified of the proposed activity.	14 days prior to commencing the proposed activity.
Narrabri CCC and general community	The Dewhurst 26-29 activities will be discussed at a Narrabri CCC meeting prior to commencement of the activity. The proposed activity will be advertisements in the Narrabri Courier Newspaper prior to construction commencing.	Prior to commencement of construction (included in monthly update)
Local police	The local police will be notified of the proposed drilling activities and provided with a road traffic plan specifying the route, time and location of the drilling rig	Ongoing communication and consultation with most recent meeting 21 February 2013.

2.4.6 Stakeholder complaint and conflict management

Santos' primary approach to conflict management is open and proactive communications with all stakeholders.

The project information line will be maintained throughout the proposed activity. This information line is available 24 hours per day, seven days per week and will be widely promoted through all project communication materials including newsletters, community updates, fact sheets and stakeholder and community letters. Santos aims to resolve all enquiries or complaints received via the information line within two business days.

To manage enquiries or complaints 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
- a system to track notes on progress to resolution.

Santos has a documented complaint management procedure which is communicated to all relevant staff members. This procedure requires that complaints be recorded as soon as they are received and notified to the Chairperson of the Santos NSW Business Complaint Management Committee (Complaint Committee). Santos has a policy of ensuring that any reportable complaint is communicated to DRE with a plan for resolution within 24 hours of its occurrence. The complaint management procedure includes the following steps:

- complaint/enquiry received via one of the many methods of communication
- capture enquiry and record details
- details to be recorded include time and date the call/email is received, contact name, phone number, and nature of enquiry/complaint and any response provided
- assess and investigate enquiry by the Complaint Committee and escalate if unable to resolve
- update complainant within 24 hours – during the process of investigation the community member is to be kept informed of the progress of the enquiry/complaint and provided with a timeframe (where possible) for responding to them
- finalise the complaint and update records – close out complaint/enquiry and record all communication actions and responses
- reporting – all issues/contacts are outlined in weekly reports to the Santos senior management.

Santos has well established dispute escalation and resolution processes in place. Where a complaint is not able to be successfully resolved by the Santos NSW Business Complaint Management Committee, the complaint is escalated to Santos senior management for special focus and resolution.

2.5 Justification of the activity

2.5.1 Objectives

The objective of the proposed activity is to drill four pilot wells and undertake ancillary activities to allow operation of a four well pilot set to collect critical reservoir data from this area of PEL 238.

2.5.2 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. Dewhurst 26-29 is part of a wider exploration program within PEL 238 and PAL 2 which will involve up to 10 core holes and six pilot well sets over the next two to three years. The construction and operation of these wells will be subject to separate assessment and approval as the detail and specific locations of the wells and infrastructure is developed. 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-constrained 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 natural environments and agricultural land. Further discussion of potential impacts on biodiversity and agricultural land is provided in sections 6.2 and 6.4 of the REF respectively.

2.5.3 Method and scale

The proposed activity is required as part of Santos' ongoing CSG exploration program within PEL 238. The proposed activity will include two vertical and two directional pilot wells, access tracks and a gas and water gathering system.

The two vertical wells (Dewhurst 26 and 28) will be drilled in order to provide the necessary data on the location of the target coal seams. This will permit the accurate installation of the directional 'in seam' wells.

The two tri-stacked directional wells (Dewhurst 27 and 29) will be drilled to test for methane concentration and deliverability within the pilot, and to assess the technical ability of a triple stacked directional well while pumping and producing from three separate coal seams.

At the completion of the drilling process, subsurface pumps and pressure monitoring equipment will be installed and the pilot operated for the life of the PEL 238 or until critical reservoir data is collected.

2.5.4 Location

The location of the pilot wells is a substantial factor in the evaluation of the potential CSG resource. The pilot well locations were selected based primarily on the results of preliminary geological investigations and CSG content data collected from a core hole to the south of site known as Dewhurst 9.

The data collected from the pilot wells require a minimum distance within the coal seam and have been positioned accordingly. The site selection process is further discussed in section 2.6.3.

The gathering system that links the four wells is located adjacent to Beehive Road to minimise vegetation clearing.

2.5.5 Timing

Drilling of Dewhurst 26 to 29 is scheduled to commence in the third quarter of 2013 due to program commitments. The alternative to carrying out the proposed activity in the third quarter of 2013 is to carry it out later in 2013 or in 2014; however this would result in another well on the overall program being brought forward.

The duration of the operation of the pilot wells at this stage is unknown, but the wells will need to be operated until critical reservoir data is obtained and this could take a number of years.

2.5.6 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.*

In the application of the precautionary principle, public and private decisions should be guided by:

- (i) *careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and*
- (ii) *an assessment of the risk-weighted consequences of various options,*
- (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, such as:*
 - (i) *polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,*
 - (ii) *the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,*
 - (iii) *environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.*

The consistency of the proposed activity with these principles is outlined in Table 2-5.

Table 2-5 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 extent of potential impacts. This included cultural heritage and ecological technical studies, and drawing on information from technical specialists including geologists, drilling engineers and hydrogeologists. Conservative 'worst case' scenarios, such as one hectare lease areas, were considered as part of the environmental assessment process.</p>

Principle	Proposed activity's consistency
	A range of mitigation measures will be put in place to minimise or prevent any environmental degradation. Refer to section 6.
Intergenerational equity	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. Groundwater will be extracted during operation, but modelling indicates that this will have no impact on the upper aquifers, registered bore users or groundwater dependent ecosystems. Following drilling, the lease areas will be rehabilitated back to 5 m x 5 m in size. If testing activities indicate that commercial CSG production is not viable, the wells will be cemented, plugged and abandoned in accordance with the <i>NSW Code of Practice Coal for Seam Gas Well Integrity</i> (DTIRIS 2012b) and the lease areas will be fully rehabilitated.
Conservation of biological diversity and ecological integrity	The lease areas were 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 will not result in significant impacts to any threatened species, population or ecological community, or their habitat, or to critical habitat.
Improved valuation, pricing and incentive mechanisms	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.

2.6 Analysis of alternatives

Alternatives to undertaking the work include:

- do nothing
- reduced scale (less well sets)
- alternative location.

2.6.1 Do nothing option

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 flow rates. The do nothing option would not enable this data to be collected.

2.6.2 Reduced scale

Technical studies investigated opportunities to reduce the number of wells required. The provision of combined vertical and directional wells combined with a tri-stacked option reduced the well sets to a minimum of two sets (four wells) proximate to Dewhurst 9. There are no other lower impact alternatives to the proposed activity available that will adequately assess the potential gas resource.

2.6.3 Alternative location

The site selection process was influenced by:

- the need for a minimum of four wells
- underlying geology
- minimising the length of access tracks and the amount of vegetation to be cleared.

The 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 Forestry NSW and with the assistance of

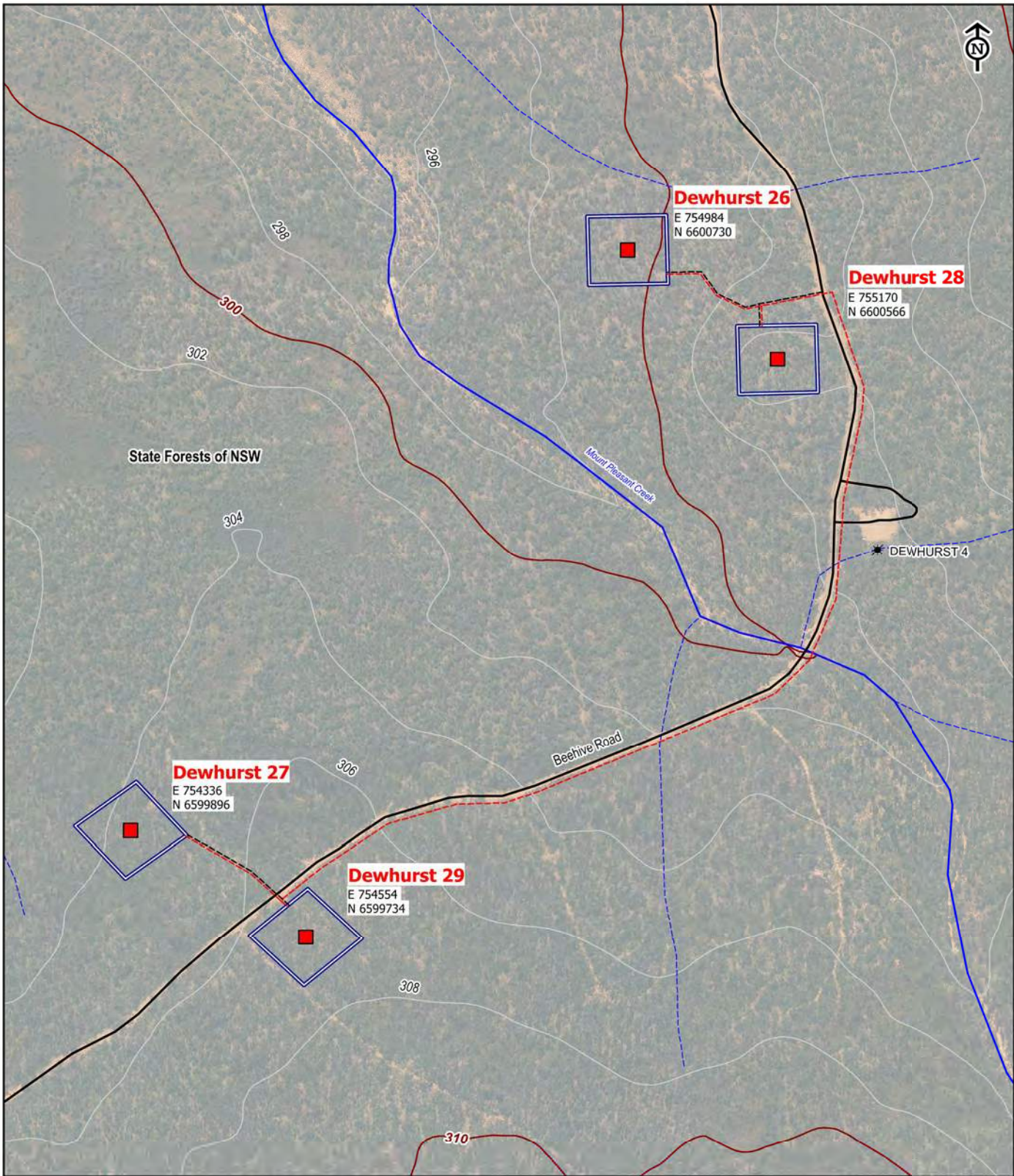
cultural heritage, ecological and environmental consultants. Access tracks were located to avoid hollow bearing trees, targeting areas of greatest disturbance.












A facility adjacent to Dewhurst 28 was selected as the location of the flare and water transfer facility as it provided the most logical tie in to future infrastructure linking the wells to the Bibblewindi Water Management Facility.

2.7 Description of the activity

2.7.1 Overview

The proposed activity can be grouped into five stages: site establishment, drilling, gathering system construction, operation and post-operation. These stages are described in further detail below. Figure 2-2 shows the site plan for the proposed activity, including the corridors for the access tracks and gathering system, topography contours, minor and major drainage lines, the existing well (Dewhurst 4) and existing roads.



-  Site Location
-  Existing Well
-  Proposed Pipeline
-  Unsealed Road
-  Proposed Access Track
-  Major Drainage
-  Minor Drainage
-  Major Contour
-  Minor Contour
-  Well Lease
-  Tenure

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PEL 238 - New South Wales

**Dewhurst 26 - 29
Site Plan**

200 0 200 M





Figure: 2-2 Date: February 2013
File No. GUNNEDAH 285b



2.7.2 Stage I – site establishment

2.7.2.1 Service corridor establishment

Four service corridors will need to be established between Beehive Road and the lease areas to provide vehicular access during drilling/construction and operation, and to accommodate the gathering system infrastructure. This will involve clearing vegetation from within a 10 metre wide corridor between Beehive Road and the lease areas.

The service corridor dimensions are outlined in Table 2-6.

Table 2-6 Service corridor dimensions

Lease Area	Service corridor width	Service corridor length	Total disturbance area
Dewhurst 26	10 m	230 m	2,300 m ² (0.230 ha)
Dewhurst 27	10 m	150 m	1,500 m ² (0.150 ha)
Dewhurst 28 (from Dewhurst 26 service corridor to Dewhurst 28)	10 m	30 m	300 m ² (0.030 ha)
Dewhurst 29	10 m	15 m	150 m ² (0.015 ha)
Total			4,250 m² (0.425 ha)

Construction of the service corridors will involve:

- surveying each corridor by a registered surveyor before any preparatory activities take place
- clearing and stockpiling vegetation at agreed locations determined during negotiation of the access agreement with Forestry NSW.

2.7.2.2 Access track construction

An approximate six metre wide access track will be constructed within each service corridor to allow access to each lease area from Beehive Road. Construction of the tracks will include:

- grading along the access track to produce a six metre wide formed roadway
- top dressing with gravel to reduce dust and provide all weather access.

2.7.2.3 Central gathering system establishment

A 10 metre wide and 1,330 metre long (1.33ha in area) central service corridor to provide vehicular access during drilling/construction and operation, and to accommodate the gathering system infrastructure, will need to be established along the eastern side of Beehive Road. The central gathering system will span from the proposed Dewhurst 26 service corridor to the proposed Dewhurst 27, 28 and 29 service corridors.

2.7.2.4 Lease establishment

The lease areas will be up to approximately 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.

Given the flat nature of the site, the Dewhurst 26, 27 and 29 lease areas could be established using industrial matting. The Dewhurst 28 lease area will need to be a cleared, constructed area so that it can

accommodate a water tank, flare and associated surface infrastructure for the duration of pilot testing.

The industrial matting consists of impervious, non-absorbent material which could be placed directly onto slashed vegetation. This will reduce the need for topsoil removal and earthworks.

Using the industrial matting method will involve the following activities for each lease area:

- marking out the extent of the lease area
- slashing and rolling groundcover
- excavating an environmental pit (54 m³ in size) and lining with heavy grade impermeable plastic sheeting at the natural low point on the lease area, for use as secondary containment in the event of a spill
- excavating a standard cellar pit (13.5 m³) in the location of the well
- stockpiling spoil from the cellar pit and environmental pit in a designated stockpile area
- laying industrial matting down to create a continuous solid surface to stand plant, machinery and storage areas on
- fencing the lease area.

Traditional lease construction methods will be used to establish Dewhurst 28 and at the other lease areas if an issue arises with the industrial matting once on site. This will involve the following activities:

- marking out the extent of the lease area
- installing silt fencing down slope of the lease area
- installing silt fencing down slope of a designated stockpile area
- removing topsoil and groundcover using a bulldozer
- removing subsoil
- grading the lease area, laying and compacting fill
- laying gravel
- building a drainage diversion bund upslope of the lease area
- excavating an environmental pit (54 m³ in size) and lining with heavy grade impermeable plastic sheeting at the low point on the lease area, for use as secondary containment in the event of a spill
- excavating a standard cellar pit (13.5 m³) at the well location
- fencing the lease area.

The assessment undertaken as part of this REF is based on the higher impact option of traditional lease construction methods being used. The estimated levels and cut and fill volumes for each lease area (based on traditional construction methods) are identified in Table 2-7.

Table 2-7 Estimated levels and cut/fill volumes

Lease area	Level	Cut	Fill	Excess to be stockpiled
Dewhurst 26	RL 300.21 m AHD	820 m ³	715 m ³	105 m ³
Dewhurst 27	RL 305.00 m AHD	270 m ³	110 m ³	160 m ³
Dewhurst 28	RL 305.33 m AHD	1900 m ³	1600 m ³	300 m ³
Dewhurst 29	RL 307.40 m AHD	640 m ³	400 m ³	240 m ³

Other activities during establishment of each of the lease areas will 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 and buildings on site
- installing and cementing a 14" conductor casing (typical) from eight to 20 metres depth ahead of the rig arriving on site
- excavating a cuttings pit and lining with heavy grade impermeable plastic sheeting.

2.7.3 Stage 2 – drilling

2.7.3.1 Drilling rig and equipment set up

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 drilling mud tanks
- metal bins, baskets, skids and sea containers to house equipment
- mechanical vibrating screens
- power generator units
- lighting towers
- site offices
- satellite communication trailers
- containers
- sheds
- vent tank to capture any fluids and gas vented
- flaring facilities.

The plant, equipment and temporary buildings will be set up prior to drilling activities and will remain in place for the duration of the drilling. This is estimated to be between 20 to 40 days (depending on the well profile). A heavy drill rig will move between lease areas followed by a smaller work over rig to run completion equipment into the well.

The vent 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 tracks as required.

The conceptual lease layout during drilling is shown in Figure 2-3.

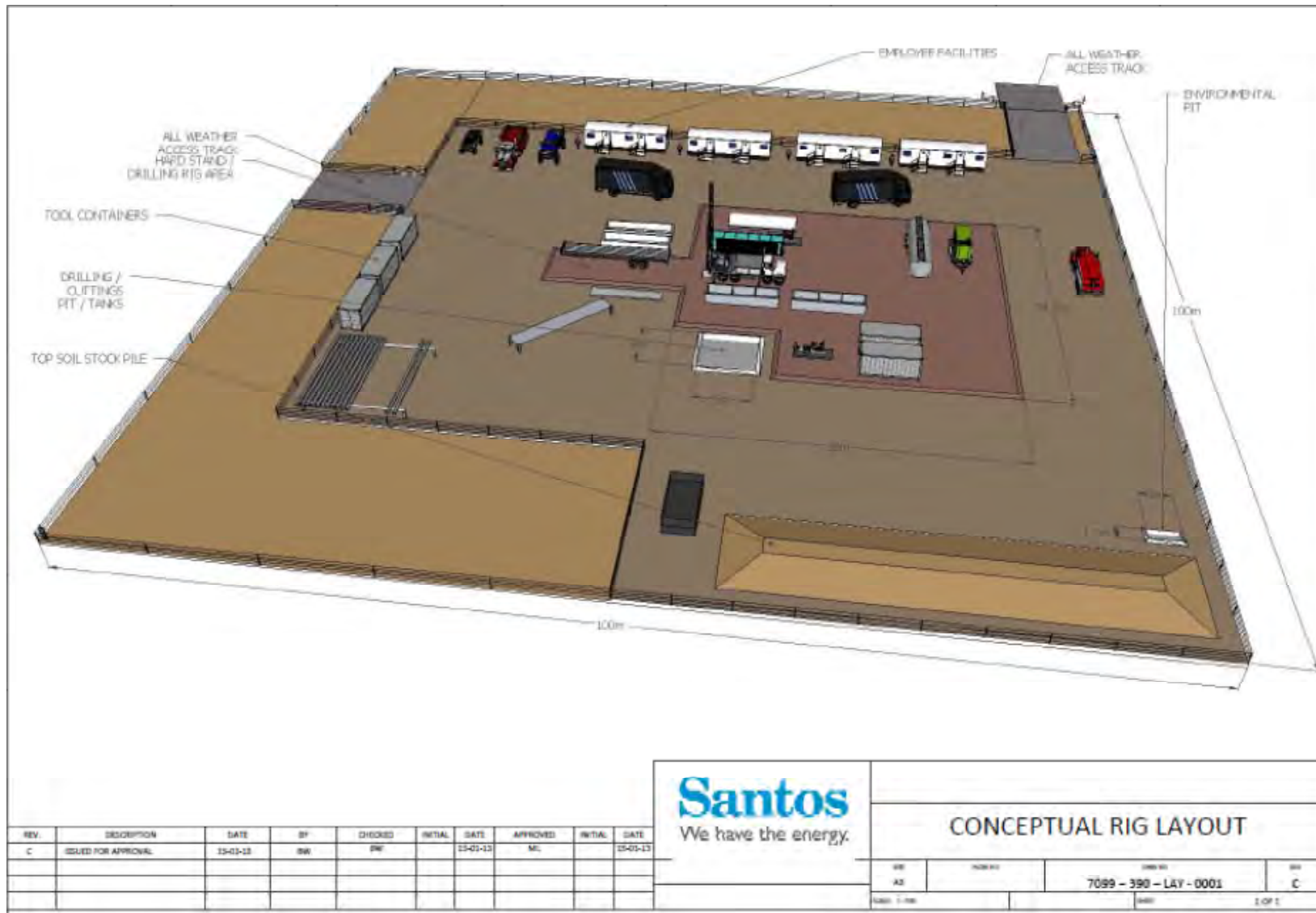


Figure 2-3 Conceptual lease layout during drilling

2.7.3.2 Well design

The wells will be designed and constructed in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012b). Table 2-8 summarises the key design criteria for each of the wells.

Table 2-8 Well design parameters

Design criteria	Dewhurst 26	Dewhurst 27	Dewhurst 28	Dewhurst 29
Direction	Vertical	Directional	Vertical	Directional
Approximate Depth	1050 m TVD ¹	940-1000 m TVD 2100 m MD ²	1050 m TVD	940-1000 m TVD 2100 m MD
Well type	Pilot	Pilot	Pilot	Pilot
Target coal seam	Bohena, Namoi and Rutley	Namoi, Bohena and Rutley	Namoi, Bohena and Rutley	Namoi, Bohena and Rutley
Drilling technique	coring	rotary drilling	rotary drilling	rotary drilling
Well pair	NA	Dewhurst 26	NA	Dewhurst 28
Number of directional lateral wells	NA	3	NA	3
Well head pump	progressive cavity pump	electrical submersible pump	progressive cavity pump	electrical submersible pump

Notes: 1. m TVD = metres True Vertical Depth
2. m MD = metres Measured Depth

2.7.3.3 Drilling process

Drilling and construction of all four wells will involve:

- Drilling an open hole with an approximate diameter of 12-1/4" through alluvial and/or weathered rock material into competent rock (Purlawaugh Formation).
- Installing 9-5/8" steel casing and cementing in place back to surface. The surface casing will be set 260-280 metres below ground level.
- Installing a blow-out preventer (BOP) on top of the casing.
- Drilling out the casing shoe using an 8-1/2" rotary drilling assembly and drilling to the planned depth.
- Installing 7" production casing to the planned total depth.
- Dewhurst 27 and 29 will have +/- 6" holes milled in the casing to facilitate the drilling of the directional wells towards their respective targets of Dewhurst 26 and 28.

At Dewhurst 26 where coring will also be conducted, once the initial core point is reached, the rotary drilling assembly will be pulled from the hole and replaced with an 8-1/2" diameter coring assembly to core through selected coal seams and other formations as determined by the geologists.

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. DRE will be consulted at this time.

Figure 2-4 shows an indicative sub surface cross-section of the wells and Figure 2-5 shows the interaction between a vertical and directional well.

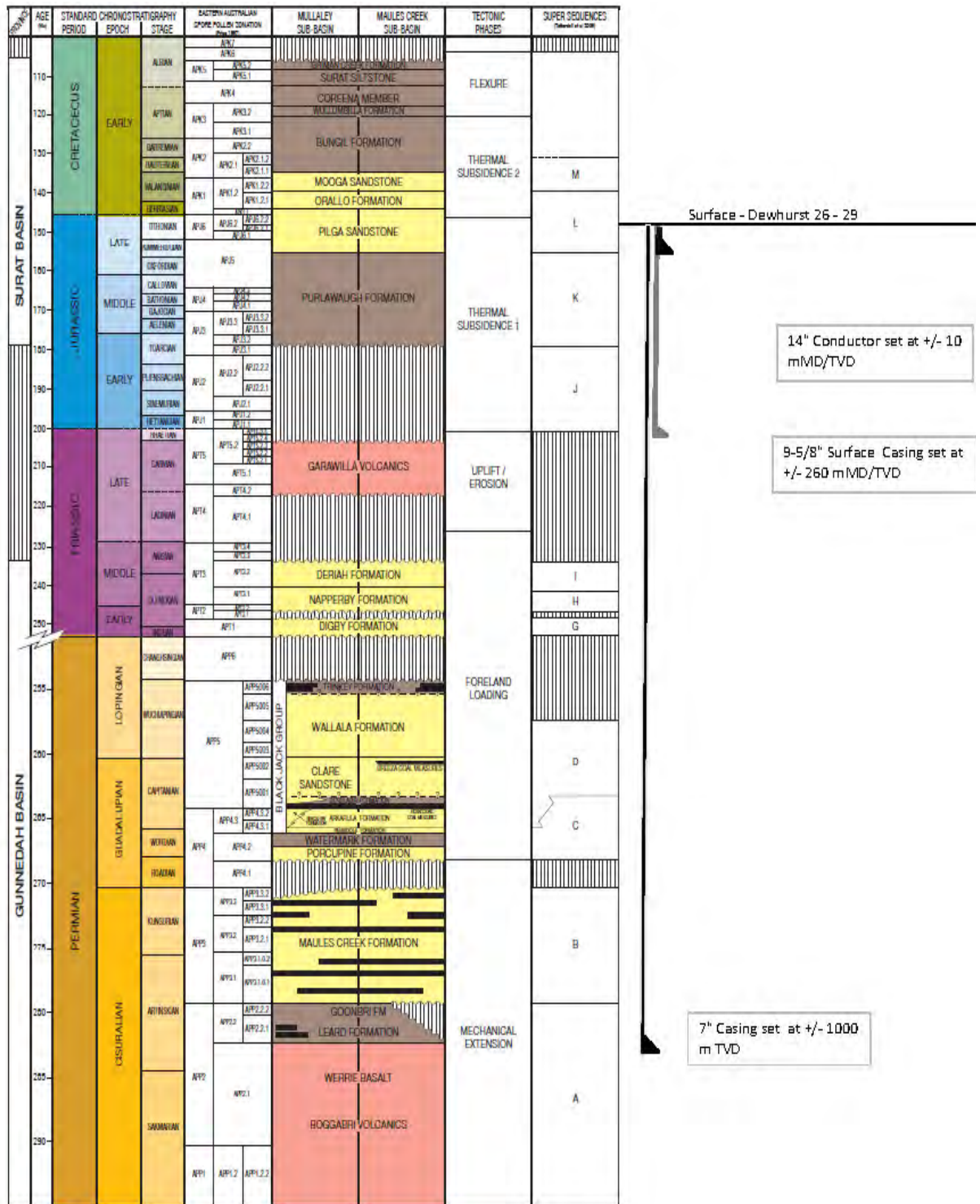


Figure 2-4 Well schematic – indicative sub surface cross section



Figure 2-5 Well schematic – indicative example of directional and vertical pilot well interception

2.7.3.4 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.

The possible chemicals that may be used include:

- K₂S₀₄, also known as Potassium Sulphate
- Calcium Chloride 74-77%, also known as Calcium Dichloride
- Xanthan Gum P, also known as Flowzan
- Quickseal Medium, also known as Kwikseal
- Rheopac, also known as Rheopac-RD, Rheopac-LV, Rheopac-R, Drispac-R, Drispac-SL, PAC-R, PAC-L
- JK – 261/JK-161, also known as CR-650, JK-261 LV, JK-161 LV
- Idcide – 20
- Sodium Bicarbonate
- Citric Acid
- Soda Ash
- Fracseal – Fine
- Defoam – E
- Sodium Formate.

The Material Safety Data Sheets (MSDS) for these chemicals are provided on the Santos website: <http://www.santos.com/exploration-acreage/nsw-csg/reports-and-publications.aspx>. The purpose of use, mass, concentration, chemical composition, chemical abstract service numbers and environmental considerations for each chemical, are included in Appendix 1. A MSDS for potassium sulphate based drilling fluid is included in Appendix 2.

Approximately 0.25 mega litres of water will be required for drilling each well. Potential sources of make-up water for the drilling mud include the Narrabri or Gunnedah town water supply, produced formation water from an operational pilot well in the region, or water permeate from a reverse osmosis plant in the region. The quality of make-up water will depend on the final source. The poorest quality water which could be used is produced formation water from an operational pilot well which would be highly brackish. Formation water quality is further discussed in Section 2.7.5.

Chemicals will be mixed with the drilling mud prior to transporting to site. This will reduce the volume of chemicals required to be stored on site during drilling. 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. Chemicals on site will be stored in an elevated, bunded trailer for protection in the event of heavy rain or site flooding.

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 is complete, drilling mud will be transported to a future 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 Section 2.7.3.

The estimated drilling cuttings and fluid volumes for each well at the start and end of drilling are provided in Table 2-9.

Table 2-9 Drilling fluid volumes

	Dewhurst 26	Dewhurst 27	Dewhurst 28	Dewhurst 29
Drill cuttings generated (m ³)	140	200	140	200
Drilling fluid transported to site (m ³)	225	225	225	225
Drilling fluid transported from rig to Narrabri treatment facility (m ³)	100	100	100	100

2.7.3.5 Cementing

Cementing operations will be in compliance with Section 4.3 of the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012b). 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.

2.7.3.6 Casing the well

Once each well has reached the total depth, geophysical wire-line logs will be run over the entire length of the hole to identify major stratigraphic units, intersected coal seam depth and seam thickness. Additional well tests for down hole evaluation may follow after completion of logging. In the vertical wells, Dewhurst 26 and 28, a combination of steel and fibreglass casing will be run in the hole and pressure cemented ensuring total isolation of the well bore to the surrounding coal seams and any potential aquifers. The combination casing design allows fibreglass to be placed over potential future mineable coal seams whereas steel casing isolates all other non-target rock types in the upper section of the well.

For the directional holes drilled from Dewhurst 27 and 29, the wells will intercept the fibreglass casing in the vertical wells over the target coal seams. Steel 7" casing will be placed over the coal seams in the lateral wells to allow windows to be cut at targeted coal depths which will facilitate the drilling of each lateral section.

2.7.3.7 Well completion

The wells will be completed using a smaller work over rig. This involves installing the downhole pump assembly and hydraulic drive head (wellhead) with additional support equipment.

Well completion will require several days to install the pumping equipment and approximately one day per well to install the pressure monitoring equipment.

2.7.4 Stage 3 – gathering system construction

The proposed water and gas gathering system will comprise separate buried, low pressure flow lines for water and gas linking the pilot wells to a centralised water and gas management facility ultimately located adjacent to Dewhurst 28.

The design parameters of the gathering system are provided in Table 2-10.

Table 2-10 Gathering system design parameters¹

Parameter	Water gathering system design
Flow rate ML/day (water gathering line only)	0.636
Pipe diameter	Up to 250 mm
Material	High Density Polyethylene (PE100)
Static pressure rating	To AS4130
Depth cover	Minimum 1,000mm cover (typical)

Note: 1. Indicative parameters only, based on preliminary engineering design.

The gathering system will be located parallel to the access roads within the cleared service corridors. Construction activities for the gathering system will be wholly located within the service corridor. This will reduce the overall area of vegetation impacted by the proposed activity. The gathering system starts and finishes at the riser within the lease area. The riser is located at the edge of the skid.

Prior to constructing the gathering system, the trench centreline will be surveyed and marked out. Construction of the gathering system will involve ploughing the water and gas gathering pipe into a common trench to a nominal depth of approximately 1,000 millimetres. The ploughing technique will be used as an alternative (or in some cases in conjunction, with traditional trenching. It will minimise environmental impacts compared to traditional trenching by reducing the width of the corridor and top soil disturbance. The technique will also eliminate the requirement to dewater pits and will improve site safety and construction timeframes. The method involves:

- Ripping. The route must be 'ripped' to confirm there is no rock within the gathering system corridor. Where rock is encountered it will be removed and replaced with suitable material that does not present risk of damage to the plough or associated equipment.
- Fusion bonding. HDPE flowlines are joined using fusion bonding. In preparation of the ploughing works the flowline will be bonded and laid out adjacent to the gathering system route. Typically the entire gathering system length will be bonded together before ploughing commences. Up to two kilometres of flowline can be bonded per day.
- Installation. A blade on the plough forms and clears the laying bed. The machine's movement is accurately guided using GPS technology. The plough's ripper and pipe insertion unit is pulled through the ground and the pipe is continuously laid as the machine moves forward.
- Reinstatement. The ground is reinstated instantly following ploughing. Post installation, a small 'hump' may be created which will be lightly compacted using suitable plant.

While the preferred method of construction is ploughing, there may be some instances where the soil is too rocky and the plough is not suitable. If this does occur, a traditional trench construction approach will be utilised for these short sections. These locations will be determined during the construction phase.

2.7.4.1 Creek/waterway crossings

Mount Pleasant Creek and two unnamed watercourses are mapped as intersecting the central gathering line. These tributaries are ephemeral drainage lines, active only in periods of high rainfall.

Facilitating installation of the flowline across ephemeral creeks and waterways will involve:

- Establishing safe access, which may require minor modifications to the banks for access and egress, depending on site specific conditions.
- Installing the flowline using the plough to two metre minimum depth of cover, in accordance with Santos standards.
- Reinstating any bank modifications to the same standard prior to installation, including revegetation.

There is potential for ephemeral creeks to have water flows just below the surface. An investigation of the creek/water line will be carried out prior to construction to determine the presence and depth of any sub-surface flows. The results of this investigation will be used to determine design requirements for creek crossings and further mitigation measures.

2.7.5 **Stage 4 – operation**

The proposed water and operations management strategy to accommodate water and gas production will involve the following elements:

- installation of wellhead and metering skids at each of the pilot well locations with associated power generation and telemetry
- installation of backup diesel generators on each well lease to ensure suitable power generating capabilities
- commissioning of the water and gas gathering system linking the wells to infrastructure located at Dewhurst 28
- installation of facilities at Dewhurst 28 including:
 - » water transfer facilities with a maximum operating capacity of 1,000 barrels (159,000 litres) of water per day per well
 - » installation of a skid flare for the combustion of excess coal seam gas.
- Partial rehabilitation of Dewhurst 26, 27 and 29 lease areas.

Pressures, water volumes, water levels, compositions and gas rates will be monitored during operation of the pilots. These will be reported in accordance with regulatory obligations.

Data collected on site from the well head and gathering system will be transmitted via a Remote Telemetry Unit (RTU) through the Next G network to Santos offices to enable operations personnel to remotely monitor and control the surface facilities. Security measures will also be installed.

The pilot wells will have automated shutdown systems designed to prevent environmental, health or safety risks that are triggered when operating parameters (such as pressure, temperature, gas and water flow rates and separator levels) are exceeded. Figure 2-6 shows the concept layout for Dewhurst 28.

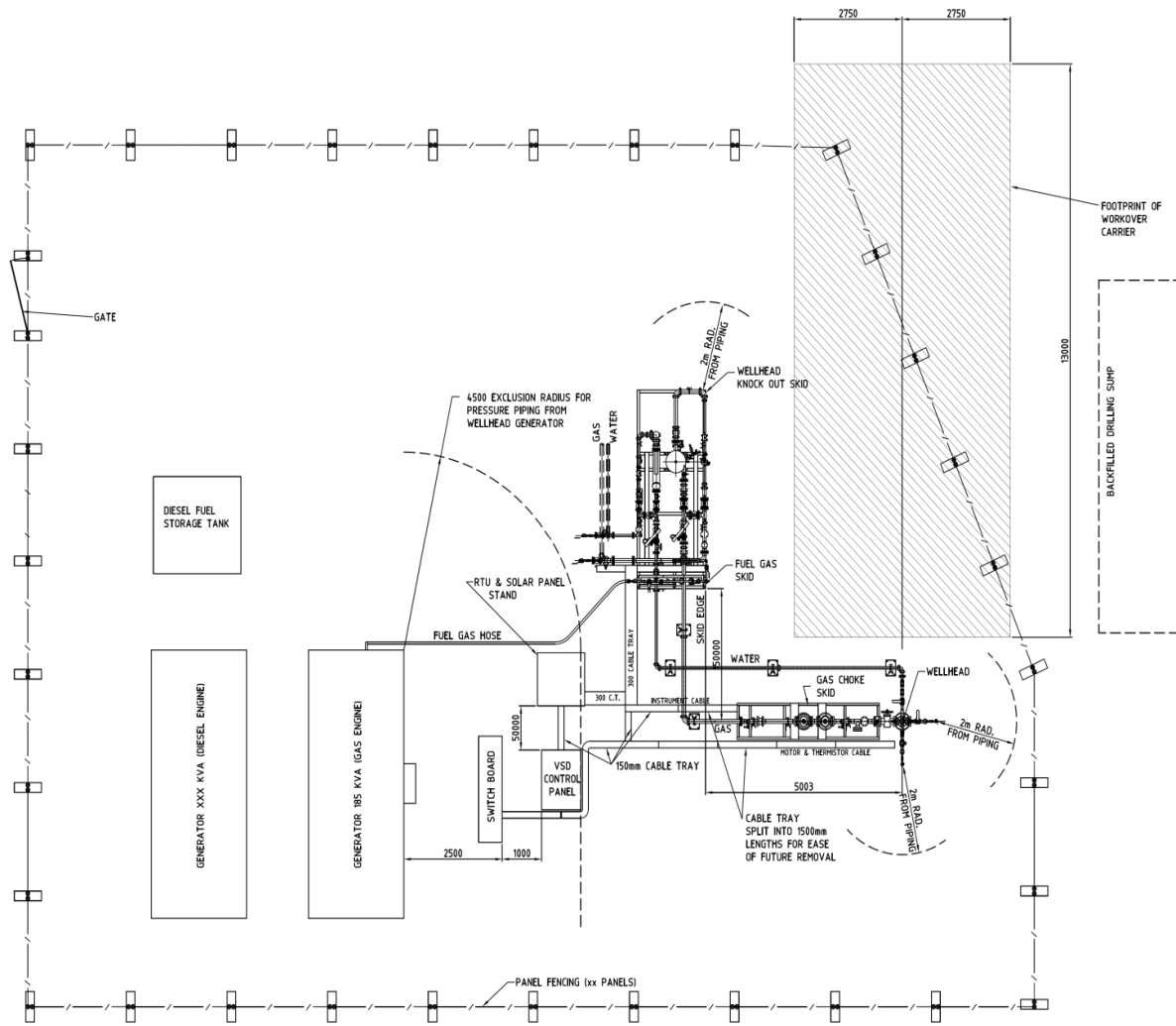


Figure 2-6 Concept arrangement for Dewhurst 28

2.7.5.1 Wellheads and wellhead facilities

The surface facilities at all four wells will be constructed using wellheads similar to the typical arrangement shown in Plate 2-1.



Plate 2-1 Typical wellhead

At the surface, each pilot well will be connected to a small separator, operating at low pressure (approximately 275 kPag) to separate any coal seam gas from the produced formation water. Both the gas and water will be collected from each well and transferred to the gathering systems.

Gas

Recovered coal seam methane gas will flow up the well annulus separate to the water with the gas stream entering the wellhead separator to remove any entrained water. A portion of the produced gas will be diverted to the local fuel gas skid for conditioning, prior to being used within the well site power generators, with the balance flowing to the low pressure gas gathering network to be flared.

It is expected that during periods of high fire danger gas may be vented to atmosphere to minimise the risk of ignition sources within the forest. In the event of a fire, the wells would be remotely isolated.

The maximum gas flow rates expected per well, will be 1,000 million standard cubic feet per day (MMSCFD) at an expected operating pressure of 275 kPag at the wellhead.

Water

For the vertical wells (Dewhurst 26 and 28) a progressive cavity pump (PCP) will be installed just below the coal seam to transfer water to the surface through the well tubing. For the directional wells (Dewhurst 27 and 29), an electrical submersible pump (ESP) will be located at the depth of the target coal seams.

In order to conduct the pilot, water will be extracted from the target seams from both paired pilot wells simultaneously. The lifted water (approximately 251.6 m³/day) will be captured at each well head and transferred via the water gathering system to a transfer tank adjacent to Dewhurst 28.

The water extraction rate is raised steadily over the first 30 days of the trial in order to protect the integrity of the well bore and casing.

Table 2-11 shows the likely produced water composition based on existing water sampling data from existing wells drilled within the Bohena and Namoi coal seams in the Narrabri region. As a background, rainwater typically has 20 milligrams per litre or less total dissolved solids (TDS). Fresh water from lakes, rivers, and groundwater is more variable, with TDS ranging from 20 milligrams per litre to approximately 1,000 milligrams per litre. Brackish water is, by definition, water with TDS exceeding 1,000 milligrams per litre and ranging as high as that of seawater, at approximately 35,000 milligrams per litre. The below results indicate that the CSG water would be considered in the high brackish range and unsuitable for irrigation or drinking water without treatment.

Table 2-11 Quality of formation water from Bohena and Namoi coal seams (based on data taken from existing wells within PEL 238 and PAL 2)

Parameter	Units	Average	Maximum	Minimum
Total Dissolved Solids (TDS)	mg/L	16,095	23,040	8,960
Temperature	° C	22.8	23.4	22.5
pH		7.5	8.0	7.1

The produced water flowing from the wellhead separator will be mixed with the entrained produced water from the PCP/ESP tubing flowline. The combined water stream will then enter the gathering system and flow to facilities at Dewhurst 28.

2.7.5.2 [Water transfer and treatment](#)

Water will be pumped through the gathering system to a transfer tank adjacent to Dewhurst 28. The water storage facilities adjacent to Dewhurst 28 will be connected to the Dewhurst Southern Flowline once constructed. Once operational, the Dewhurst Southern Flowline will transfer water to the Bibblewindi Water Management Facility for storage and eventually to the Leewood Produced Water and Brine Management Facility. The Dewhurst Southern Flowline and Leewood Produced Water and Brine Management Facility projects are subject to separate environmental approvals processes.

In the event that the wider water management network is not fully operational, water will be trucked to the Bibblewindi Water Management Facility. Up to 12 truck movements per day would be required to transfer the water by road.

2.7.5.3 [Flare system](#)

Any gas surplus to the requirements for onsite electricity generation will be flared onsite through a skid mounted or equivalent flare system. This will ensure no direct venting of methane to atmosphere for the duration of the production testing. The flare will be of a size capable of consuming up to two million cubic feet of produced gas per day.

The gas flare will be located within the Dewhurst 28 lease area with a minimum 50 metre setback to mitigate any risk of bushfire. A typical flaring equipment design is shown in Plate 2-2.



Plate 2-2 Typical flare assembly

The operation of the flare in normal operations is expected to occur intermittently as surplus gases become available. The flare is of a type that combusts methane in the absence of any significant quantities of oxygen and therefore burns with a low intensity, with rates of combustion between 90-95 per cent. Additionally, the flare design is robust and can handle fluctuations in gas volumes and composition, and meteorological conditions.

Hazardous area classification

A hazardous area classification has been carried out to determine the acceptable radiation limits at the flare and to enable the proper selection and installation of equipment that could be used safely in the vicinity of the proposed flare.

Acceptable radiation limits for various locations at the flare site were determined based on the American Petroleum Industry (API) 521 standard and are outlined in Table 2-12.

Table 2-12 Radiation design limits

Location	Radiation level kW/m²
Base of flare stack	9.46
Sterile area boundary	6.31
Nearest plant limit	3.15
Areas where operators are continually exposed	1.58

The classification has been carried out using Santos methodology which has been based on the Australian Standard, AS 60079.10.1 – Classification of Areas – Explosive Gas Atmospheres and other relevant standards and codes. The hazardous area classification has been undertaken with consideration of the standards and codes identified in Table 2-13.

Table 2-13 Standards and codes considered in the hazardous area classification

Australian standards	
Australian codes	
AS/NZS 60079.10.1:2009	Classification of areas – explosive gas atmospheres
AS/NZS 60079.20.1:2012	Electrical Apparatus for Explosive Gas Atmospheres. Part 20: Data for flammable gases and vapours relating to the use of electrical equipment
AS/NZS 2381.1:2005	Electrical equipment for explosive atmospheres – Selection, Installation and Maintenance
International codes	
IP 15 (Edition 3- July 2005)	Institute of Petroleum, Model Code of Safe Practice in the Petroleum Industry: Part 15, Area Classification Code for Installations Handling Flammable Fluids
Santos design practices	
1515-67-G002 Rev 1	Design practice for hazardous area classification

Based on the radiation design limits outlined in Table 2-13 above, a 25 metre flare exclusion zone will be established around the proposed flare stack to ensure all personnel movement occurs outside the maximum radiation zone of 1.58 kW/m² and to ensure that the radiant heat intensity at the separator is maintained below this level. A five metre sterile zone surrounding the flare (i.e. 10 metres by 10 metres) will be established.

Table 2-14 summarises the key design features of the proposed flare.

Table 2-14 Design features of proposed flare

Design features	Proposed flare
Average flare height	0.3 to 0.6 metres from top of stack
Design flow rate	2.0 MMSCFD
Average flow rate	0.25 to 0.75 MMSCFD
Stack height	Up to 4 m
Exclusion zone (from stack base)	25 m
Sterile zone (from stack base)	5 m

Flare construction

Following site establishment, a HDPE liner will be laid over the proposed five metre sterile zone surrounding the flare and covered with 300 millimetres of compacted soil and blue metal aggregate. This will ensure protection against heat. No topsoil will be removed.

During construction of the flare the site will be fenced with a 1.6 metre high steel fence to prevent unauthorised entry.

The flare assembly will then be installed and approximately 30 metres of aboveground piping laid to connect the flare to the separator. Pipe supports every seven metres will be installed to keep the piping in place. Pipe hold down lines will also be installed.

Flare operation

A flowmeter will monitor the gas flow rate from the gathering system and gas will then be safely ignited. The settings of the regulators are able to be modified to suit operational requirements.

The flare will ignite automatically to ensure that all gas is burnt rather than vented to the atmosphere. Flaring operations will occur at low levels as required 24 hours a day, seven days per week.

A design feature of the flare installation is a control valve installed upstream of the flare which minimises the pressure drop of the gases in the flare. This design feature reduces noise of the flare operation.

The flare and associated exclusion zone will be fenced with a chain wire fence approximately 1.8 metres high for the duration of operation.

Once the flare is no longer required, infrastructure will be removed and the site rehabilitated to its former state.

2.7.5.4 Partial rehabilitation of Dewhurst 26, 27 and 29

Once the drilling activities are complete, the lease area is proposed to be rehabilitated to an area of approximately five by five metres around each well head with appropriate mitigation measures and environmental safeguards implemented to minimise potential impacts. All rehabilitation works will be undertaken with maximum regard to environmental protection and rehabilitation, vegetation, subsoil and topsoil management, weed control, erosion and sedimentation management and revegetation in accordance with the relevant statutory requirements. In addition, the temporary water load out facilities and water tanker turnaround circle will be decommissioned and removed from site.

2.7.5.5 Maintenance

Work over operations using a smaller rig will be required from time to time for corrosion monitoring, mechanical repairs or other interventions as required.

2.7.6 Stage 5 – post operation

If the decision is made to decommission and rehabilitate the pilot wells post-operation, well abandonment and rehabilitation procedures will be undertaken prior to the expiration of PEL 238 as follows.

2.7.6.1 Well abandonment

The wells will be cemented, plugged and abandoned in accordance with *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012b) and rehabilitated following completion of drilling and testing activities. This will involve:

- sealing the wells from bottom to top by plugging with cement in approximately 200 metre increments
- pressure testing the cement plug across the surface casing shoe to ensure the wells are sealed
- removing the well head at a depth of greater than 1.5 metres below surface and burying.

2.7.6.2 Lease area rehabilitation

The lease areas will be fully rehabilitated within approximately six months of well abandonment where practicable and considering external factors such as the weather and availability of resources.

The following works will be carried out (where applicable) as part of final rehabilitation:

- all plant, equipment, waste materials and temporary buildings will be removed from the site
- plastic lining will be removed from any pits and disposed of at an appropriately licensed facility

- any pits will be backfilled
- subsoil will be replaced across the lease areas, contoured to the landscape and partially compacted
- topsoil will be uniformly placed across the lease areas, graded to natural levels and partially compacted
- perimeter fencing will be removed
- where required, revegetation will occur according to Forestry NSW requirements
- weed control will be undertaken.

2.7.6.3 Gathering system rehabilitation

The gathering system will be flushed, capped at each end and left in the ground. The surface will be rehabilitated, through natural regeneration and planting of suitable native perennial grasses and shrub species that will assist in the stabilisation of the soils as agreed with Forestry NSW.

The rehabilitation will be developed by a suitability qualified ecologist. This plan will include measures to assist in the regeneration of the gathering system corridor, including (but not limited to):

- rehabilitation techniques – native bush regeneration and assisted plantings
- species selection
- seeding and planting techniques
- mulching requirements and techniques
- maintenance and weed control.

2.7.7 **Operational hours and workforce**

The number of employees present on the site at any one time is expected to be up to 40 persons at the well leases during construction and 10 persons during installation of monitoring equipment. Site workers will be accommodated off-site at an approved workers camp or in temporary accommodation in Narrabri.

Construction and drilling hours will be subject to negotiation and agreement with Forestry NSW 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.

Once operational, the wells will pump gas and water continuously for the life of the project. It is anticipated that the site would be visited by operation staff once per day during this time.

2.7.8 **Project timing and duration**

Site preparation and drilling is planned to commence in the third quarter of 2013, subject to approval. The expected duration of the main work phases is identified in Table 2-15.

Table 2-15 Project duration

Activity	Approximate duration
Site preparation	14 days
Drilling	15 – 40 days
Gathering system construction	40 – 60 days

Activity	Approximate duration
Operation	For the life of PEL 238 or until critical reservoir data is collected
Final rehabilitation	30 days

2.8 Mitigation strategy

Santos has developed an extensive understanding of the steps and measures that should be taken to prevent or minimise impacts on the environment, human health and safety when undertaking exploration activities, including drilling activities through their experience developed over 50 years. 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.

An environmental management plan will be developed prior to works commencing. This will detail specific measures and actions to implement the mitigation strategy outlined in this REF. 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 identified in this REF. The statement of commitments in section 9 of the REF will be provided to relevant staff and contractors undertaking the work to ensure compliance with relevant legislation, regulations and the REF.

Climate change is a long-term issue, requiring urgent but informed action to stabilise atmospheric greenhouse gas concentrations. As a global stakeholder in the energy business, Santos recognises its social and environmental responsibility to pursue strategies that address the issue of climate change.

Santos is committed to working with government, industry and the community to address climate change with specific focus on addressing energy efficiency, adaptation strategies, the transition to lower emission technologies and reporting transparency.

Santos' Climate Change Policy outlines the organisations approach to climate change and realisation of the vision to 'lower the carbon intensity of its products'. The policy identifies the following commitments:

- continue to reduce the carbon intensity of Santos' products by focusing on energy efficiency, technology development and by embedding a carbon price in all activities
- use energy more efficiently by identifying opportunities to implement energy efficiency projects and report their progress
- examine the commercial development of low emission technologies, including storage solutions, which will contribute towards long-term emission reduction targets
- pursue no flaring or venting of associated gas, unless there are no feasible alternatives
- continue to publicly disclose Santos' greenhouse emissions profile and carefully examine forecast emissions
- understand, manage and monitor climate change risk and develop appropriate adaptation strategies for our business
- assist governments and engage with other stakeholders on the design of effective and equitable climate change regulations and policy
- inform employees about its commitment to climate change and ensure climate change initiatives continue

to be implemented

- report progress against these commitments to the Board.

Santos has publicly reported its greenhouse gas (GHG) emissions since 2004 with independent assurance provided annually, and as a result has established comprehensive governance processes which will ensure that the emissions associated with the proposed activity will be accurately reported under the *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act). Santos' governance system includes:

- annual independent assurance of GHG emissions
- regular audits in relation to implementation of the Environmental, Health and Safety Management System (EHSMS)
- risk-based internal audits are administered to ascertain conformance with, and effectiveness of the EHSMS Standards
- monitoring and review of energy efficiency opportunities
- other audits of compliance with internal policies and procedures related to GHG reduction through the internal audit program.

Santos holds an Occupation Permit from the Forestry Commission of New South Wales (now Forestry NSW) and the State of NSW. The Occupation Permit outlines a number of requirements for any works, with key environmental requirements including:

- facilities must be secure and fenced
- Santos cannot place, tip or discharge any material
- there is to be no obstruction to any waterway
- Santos must use best endeavours to limit use of power consuming equipment, water and energy consumption and generation of waste
- Santos must take all reasonable precautions to minimise the risk of fire
- any rehabilitation and seed planting is to be agreed with Forestry NSW
- any cleared vegetation with approval from Forestry NSW must be removed and destroyed
- all new access tracks must be properly constructed and drained to a standard that will provide all weather access for four wheel drive vehicles
- all access tracks must be gated
- all vehicles entering the site must be washed down to mitigate the risk of introducing non-endemic species.

Under clause 5.2.1 of the Occupation Permit, consent must be sought from Forestry NSW for any works. This consent can only be sought after the relevant approvals are granted under the EP&A Act.

The mitigation strategy developed addresses all the requirements of the Occupation Permit.

Detailed strategies for water source protection, waste and noise during the construction and operation phases are provided in sections 2.8.1 and 2.8.2 respectively. They are also covered in the Occupation Permit issued under section 31 of the *Forestry Act 1916* (now repealed).

2.8.1 Construction

2.8.1.1 Water source protection strategy

Surface water protection

Mount Pleasant Creek and two unnamed ephemeral watercourses intersect the central gathering system.

Under no circumstances will water be extracted from these waterways or other surface waters as part of the proposed activity. These waterways will be protected through site water management, drainage and erosion and sediment controls. The site water management principles will be based on:

- minimising surface disturbance
- separating clean and dirty water, including minimising surface water running onto the lease areas
- preventing contaminants from running off the lease area.

Minimising surface disturbance

As the first priority, the site establishment and preparation works will seek to avoid ground disturbance. Use of industrial matting is therefore the preferred lease establishment method, as an alternative to clearing and levelling. Grading of the access track will be avoided wherever possible to reduce surface area disturbance. Instead, the access track will be slashed, watered, rolled (to compress the surface), and topped with gravel where necessary. Grading of the gathering system corridor will also be avoided where possible, with the vegetation slashed and rocks cleared as necessary.

Separation of clean and dirty water

Where the lease area is to be constructed using traditional methods, a diversion bund will be constructed on the up-slope side of the lease area to divert clean water around the work area. This will reduce the volume of sediment laden water that needs to be managed.

Spill containment and runoff control

Spill kits will be kept on site and any spills will be contained, cleaned up and reported immediately. Any materials contaminated by a spill, such as absorbent pads or soil, will be removed from the site and disposed of at a licensed waste management facility. The lined environmental pit will act as a secondary control measure to capture spilled liquids and ensure these do not leave the site. Contaminated liquid captured in the environmental pit will be removed and disposed of at a licensed waste management facility.

Where traditional lease construction methods are used, an erosion and sediment control plan will be prepared and implemented to minimise site erosion and sediment loads in runoff. Where industrial matting is used, topsoil and vegetation will remain intact and erosion is expected to be minimal.

Water management, drainage, erosion and sediment control measures

Erosion and sediment control will be undertaken in accordance with industry best practice 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). Prior to commencement of work an assessment of the various site conditions will be undertaken and a progressive erosion and sediment control plan will be prepared.

The assessment will consider the following, as a minimum:

- existing soil types (to determine the most appropriate method of control)
- topography
- water
- vegetation
- ecology
- entry and exit points for both drainage and sediment control.

The specific water management, drainage, erosion and sediment control works for each phase of the proposed activity are identified in Table 2-16.

Table 2-16 Water management, drainage, erosion and sediment control measures

Phase	Control measures
Lease area establishment using industrial matting (preferred method)	<ul style="list-style-type: none"> ▪ The extent of the lease areas will be delineated on site. ▪ Vegetation will be slashed and compacted. The top soil layer will remain intact. ▪ Areas of industrial matting will be placed on the ground throughout the lease areas. ▪ Designated stockpile area(s) will be marked out and silt fencing installed along the down slope perimeter of these areas. ▪ All excavated spoil (from the cellar pit or lined environmental pit) will be stockpiled in a designated area. ▪ The lined environmental pit will be constructed in the low point of each lease area.
Lease area establishment using traditional methods (if required)	<ul style="list-style-type: none"> ▪ The extent of the lease areas will be delineated on site. ▪ Continuous silt fencing will be installed along the down slope perimeter of the lease areas. The silt fencing will extend into the ground surface. ▪ Designated stockpile area(s) will be marked out and silt fencing installed along the down slope perimeter of this area. ▪ A drainage diversion bund will be constructed upslope of each lease area to divert clean water around the lease area. ▪ Vegetation, topsoil and spoil will be stripped separately and stockpiled in a designated stockpile area. ▪ Lease areas will be graded to a low point where the lined environmental pit will be constructed.
Access track and gathering system construction works	<ul style="list-style-type: none"> ▪ Silt fencing will be installed around the area of disturbance as necessary. ▪ The access track will be topped with gravel.
Stockpiling	<ul style="list-style-type: none"> ▪ Silt fencing will be installed and maintained on the down slope perimeter of all stockpile areas. ▪ Topsoil and subsoil material will be stockpiled separately. ▪ Topsoil and subsoil will be stockpiled at the site for a period of up to approximately six months from release of the drill rig, until partial rehabilitation of the lease area can take place. ▪ Stockpiles will be maintained with a slope of no greater than 2(horizontal): 1(vertical). ▪ Stockpiles will be compacted using the back of an excavator bucket or similar to reduce erosion potential. ▪ Topsoil stockpiles will be maintained at a height no greater than two metres.
Drilling activities and operation of lease areas	<ul style="list-style-type: none"> ▪ Water that drains to the cellar pit will be circulated with the drilling mud throughout the drilling process. ▪ Any spilled liquids or contaminated water that is captured in the environmental pit

Phase	Control measures
	<p>will be removed to a licensed waste facility for treatment or disposal.</p> <ul style="list-style-type: none"> ▪ The environmental pit will be maintained with a 300 mm freeboard at all times. ▪ Silt fencing will be regularly inspected and maintained.
Rehabilitation	<ul style="list-style-type: none"> ▪ All plant, equipment, waste materials and temporary buildings will be removed from the site. ▪ Any industrial matting will be removed for re-use at another site. ▪ Plastic lining will be removed from the environmental and cuttings pits and disposed of at an appropriately licensed facility. ▪ The environmental and cuttings pits will be backfilled. ▪ Fencing will be removed from perimeter of lease area. ▪ Where traditional lease construction methods have been used: <ul style="list-style-type: none"> - Subsoil will be replaced across the lease area, contoured to the landscape and partially compacted. - Topsoil will be uniformly placed across the lease area, graded to natural levels and partially compacted. ▪ Weed control will be undertaken.

Groundwater protection

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

The pilot wells will be designed and constructed in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012b). Potential groundwater impacts would also be minimised by having a driller that holds a licence under the National Water Drillers Licensing Accreditation Scheme 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.

2.8.1.2 Waste reduction and management strategy

The proposed activity will generate a number of waste streams. Waste will predominantly be generated during the site preparation and drilling phases including:

- any civil works associated with the lease area construction (if traditional lease construction methods used) and access track upgrade works
- drilling activities
- site clean up
- partial rehabilitation (where traditional lease construction methods used)

- general waste from contractors and personnel on site.

The main waste types and estimated volumes generated by the proposed activity are identified in Table 2-17.

Table 2-17 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	2 m ³ /month
Mud contaminated cement slurry	115 m ³
Drilling mud	400 m ³
Drill cuttings	680 m ³

Note: 1. Sewage waste from toilet facilities provided for workers during their shift. Camp facilities will not be located on site.

The most significant waste types and volumes will be generated during drilling. The management approach for drilling mud and solids (cuttings) has aimed to reduce waste to landfill as much as possible.

Drilling fluids will be mixed off site at an approved and licensed facility and then transported to site. This will reduce wastes associated with mixing chemicals on site (such as chemical containers).

During drilling, used mud will be separated into liquids and solids (cuttings) and mud will be continuously reused throughout the drilling process. At the end of drilling there will be a residual volume of mud which 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, and returned to a licensed treatment facility. The mud will be processed so that it can be reused at the next well to be drilled on the program. There will be a residual amount of waste from the treatment facility in Narrabri which will eventually need to be disposed of at a licensed waste facility.

It is expected that drill cuttings will consist of excavated natural material and can be used in site rehabilitation under the *Excavated Natural Material Exemption 2012* (ENM exemption) issued by the EPA on 19 October 2012.

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 by a licensed contractor for treatment and disposal, as required.

Wastes requiring on-site storage will be placed within a designated waste transfer point within the lease area prior to transportation for disposal. Regulated waste will be collected by licensed contractors for off-site disposal. General and recyclable waste will be transported to local council landfill and recycling facilities.

An indicative summary of the expected waste streams and the proposed management strategy for these is provided in Appendix 3.

Prior to commencement of the proposed activity, a waste management plan will be developed based on the waste reduction hierarchy of avoid, reduce, reuse, recycle, recover, treat and dispose.

The waste management plan will identify:

-
- types of waste generated
 - waste management processes and procedures for each waste stream
 - waste transport requirements
 - monitoring requirements
 - audit and inspection requirements
 - record keeping and reporting requirements.

Other waste management measures are identified in Section 6.1.7.

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, that 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 of offsite at an appropriately licensed waste facility.

2.8.1.3 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. A quantitative noise assessment of similar drilling activities was undertaken by Noise Measurement Services in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC 2009) (refer Appendix 4). The results of the noise assessment are discussed in Section 6.1.8 of the REF.

There are no residential receivers located within five kilometres of the site. Due to its remote location, it is unlikely that noise generated by the proposed activity will be audible at any residences. Users of the forest, such as bushwalkers, picnickers and Forestry NSW staff, may be affected by noise and vibration during the works. Forestry NSW will be notified of the proposed activity prior to commencing works. This will include details of the timing and duration of noise generating activities.

Noise impacts will be managed in accordance with the ICNG and OEH requirements. The management approach will include consultation with potentially affected receivers (i.e. Forestry NSW), implementation of

feasible and reasonable work practices to reduce noise, and complaint management and response. Feasible and reasonable work practices may include:

- training contractors to operate plant and equipment in ways that minimise noise generation
- 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 receiver. If it is determined that noise levels are unacceptable, further feasible and reasonable work practices or mitigation measures will be implemented.

2.8.2 Operation

2.8.2.1 [Water source protection strategy](#)

During operation approximately 251.6 m³ of water will be captured per day (276 mega litres for the first three years) and transferred via the water gathering system to a transfer tank adjacent to Dewhurst 28. Water volumes extracted will be continually monitored.

Water from coal seams abstracted from each well will pass through a separator to a gathering system linking the four wells to surface facilities adjacent to Dewhurst 28.

Pressure gauges will be fitted to both lines and monitored remotely through a Supervisory Control and Data Acquisition (SCADA) system. Should pressure change due to a leak be detected, the pilot wells will be shut down immediately and the affected area investigated.

Under condition 13 of PEL 238, Santos is required to prepare a groundwater monitoring and modelling plan in consultation with NOW. Santos has provided a draft of this plan, titled *Energy New South Wales – Narrabri Gas Project Draft Groundwater Monitoring and Modelling Plan* (draft plan), to NOW. The draft plan identifies a network of shallow and deep aquifer groundwater monitoring bores that will be installed throughout the Narrabri area. The purpose of the shallow aquifer monitoring bore network will be to:

- establish baseline groundwater level and pressure conditions in the Pilliga Sandstone and overlying Namoi Alluvium prior to the commencement of CSG activities
- undertake long-term groundwater level monitoring over the duration of the CSG activities in order to confirm the absence or onset (and magnitude) of any impact to the Pilliga Sandstone and Namoi Alluvium associated with the CSG activities
- collect additional hydrogeological data to confirm the presence of aquitards impeding the vertical flow of groundwater between the Pilliga Sandstone and underlying or overlying formations
- collect water quality samples at select locations.

The purpose of the deep aquifer monitoring bore network will be to:

- establish baseline groundwater level and pressure conditions in the strata belonging to the Gunnedah Basin prior to the commencement of significant CSG activities

- undertake long-term groundwater level monitoring over the duration of the CSG activities in order to assess the migration of de-pressurisation effects within the Permo-Triassic strata and the hydraulic continuity present between different hydrostratigraphic units
- collect additional hydrogeological data including conducting field tests and wireline geophysical logging and collecting core samples for laboratory hydraulic analysis to elaborate the hydraulic properties of the deep strata (including hydraulic conductivity, specific storage and fracturing properties).

These monitoring bores will be installed progressively as the appropriate approvals are obtained. Santos will aim to install groundwater bores as part of this network in time for monitoring during operation of Dewhurst 26-29.

2.8.2.2 Waste reduction and management strategy

The main waste stream during operation will be associated with water produced from the wells. This will be collected at the well heads and pumped to a transfer tank adjacent to Dewhurst 28. Water will then be transferred to a treatment facility for treatment and beneficial reuse or disposal.

2.8.2.3 Noise management strategy

During operation noise will be limited to the occasional combustion of gas through a flare or vehicles visiting the site, and pumping of water between the wells and gathering system. The flare control valve installed upstream of the flare reduces noise of the flare operation.

Cumulative noise levels will be very low and accordingly a specific strategy to manage noise has not been developed.

However, should a noise complaint be received, noise levels will be investigated.

2.9 Access arrangements

The proposed activity is to be undertaken on land dedicated as State Forest and managed by Forestry NSW. Works within the Pilliga East State Forest are undertaken in accordance with the Occupation Permit issued under section 31 of the *Forestry Act 1916*. The Occupation Permit constitutes an access agreement with Forestry NSW under the *Petroleum (Onshore) Act 1991* (Petroleum Act).

2.10 Other approval requirements

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

A water access licence (WAL) under the Water Management Act 2000 (WMA) is also required; refer to section 5.2.8 for further details.

Construction of the gathering system will require crossing of Beehive Road. Consent from the relevant roads authority may be required. Santos will consult with Forestry NSW to determine any additional consent requirements for this component of the proposed activity and will obtain these, prior to construction taking place.

No other approvals are required. Refer to section 5 for further details.

3.0 The site

3.1 Site description and plan

The site is located within the Pilliga East State Forest along Beehive Road, approximately 44 kilometres south of Narrabri and within Crown Land.

The coordinates of the four pilot wells are identified in Table 3-1.

Table 3-1 Coordinates (MGA Zone 55) for the Dewhurst 26-29 Pilot Wells

Pilot well	Easting	Northing
Dewhurst 26	754984.35	6600730.17
Dewhurst 27	754336.17	6599895.59
Dewhurst 28	755170.29	6600565.91
Dewhurst 29	754553.86	6599734.24

Each pilot well will be located in the centre of a one hectare lease area.

The following photographs illustrate the site.



Plate 3-1 Dewhurst 26



Plate 3-2 Dewhurst 27

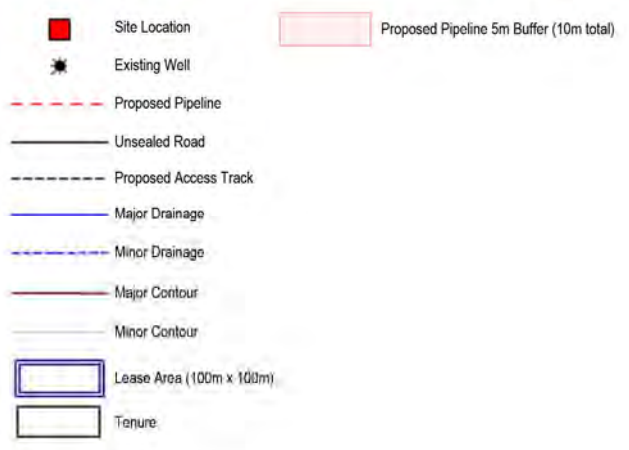
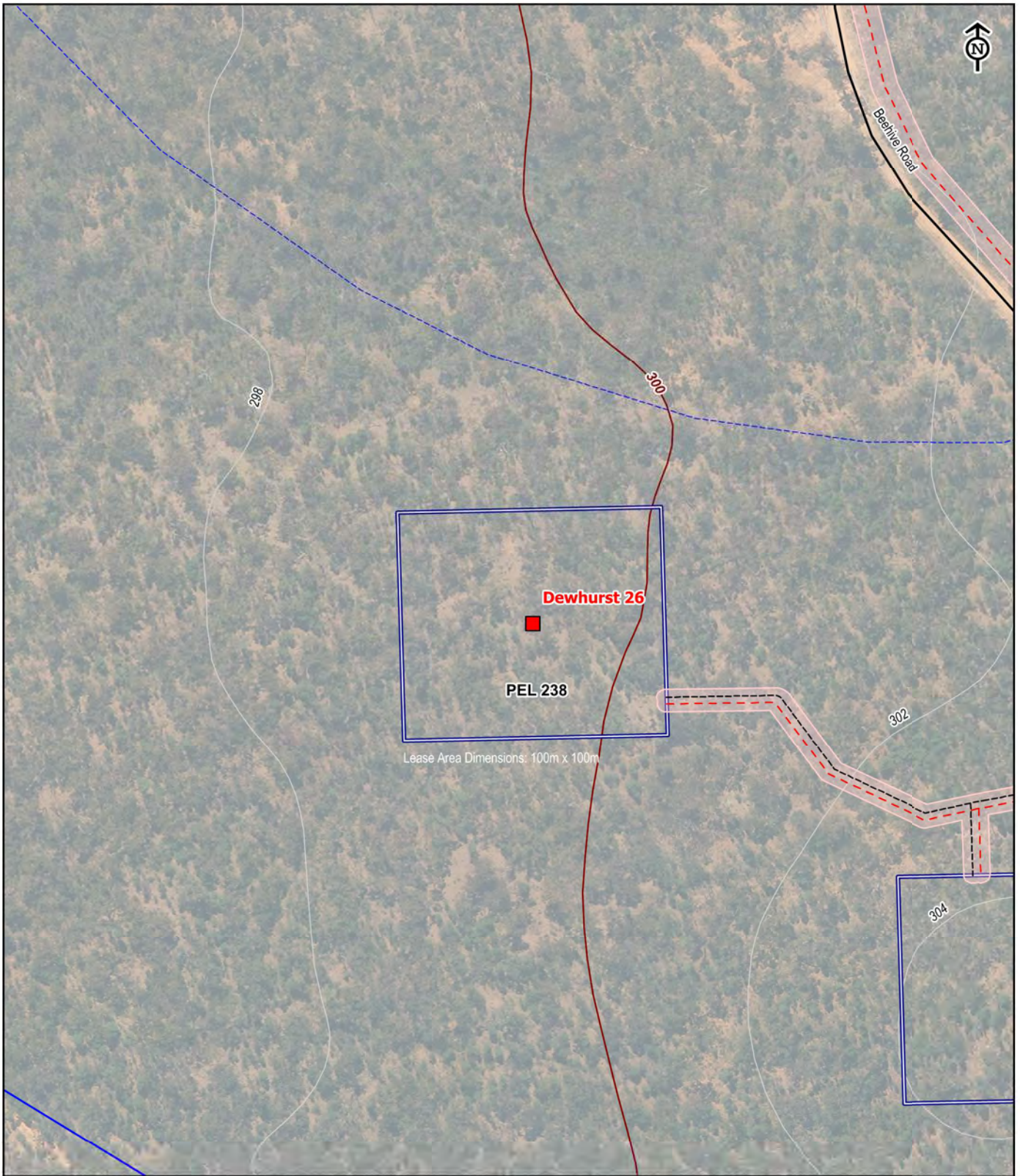


Plate 3-3 Dewhurst 28



Plate 3-4 Dewhurst 29

The site, including topography contours, Lot and DP number and existing forestry roads, are shown at Figure 2-1. The lease areas are shown at Figure 3-1 to Figure 3-4.



Santos

PEL 238 - New South Wales

**Dewhurst 26
Lease Area**

25 0 25 50 75 m

Date: February 2013
File No. GUNNEDAH 285c




Figure: 3-1



- Site Location
- Existing Well
- Proposed Pipeline
- Unsealed Road
- Proposed Access Track
- Major Drainage
- Minor Drainage
- Major Contour
- Minor Contour
- Lease Area (100m x 100m)
- Tenure
- Proposed Pipeline 5m Buffer (10m total)

Santos

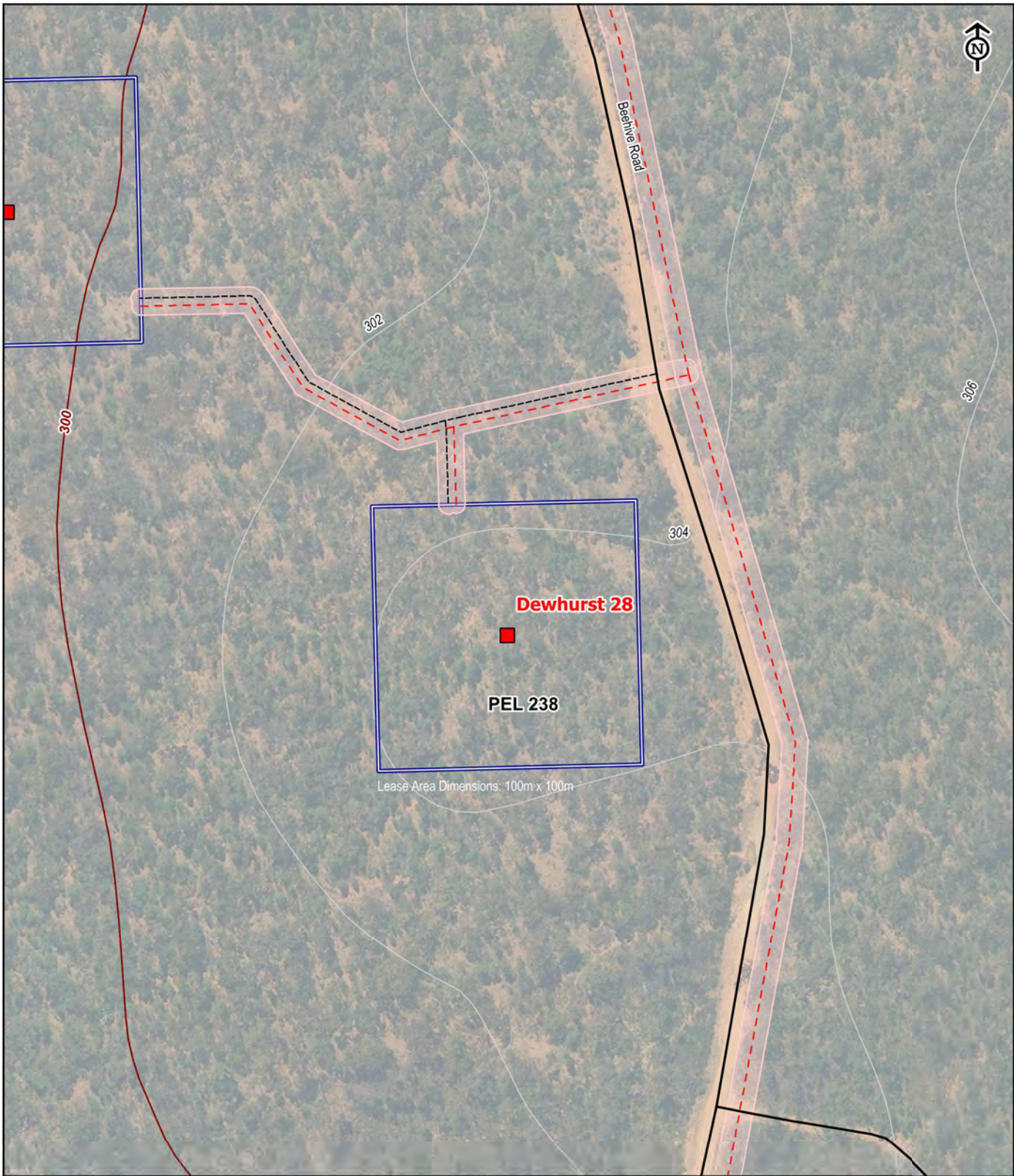
PEL 238 - New South Wales

**Dewhurst 27
Lease Area**

25 0 25 50 75 m

Figure: 3-2

Date: February 2013
File No: GUNNEDAH 265d



- Site Location
- Existing Well
- Proposed Pipeline
- Unsealed Road
- Proposed Access Track
- Major Drainage
- Minor Drainage
- Major Contour
- Minor Contour
- Lease Area (100m x 100m)
- Tenure

Santos

PEL 238 - New South Wales

**Dewhurst 28
Lease Area**

Figure: 3-3

Date: February 2013
File No: GLINNEDAH 28/fe



- Site Location
- Existing Well
- Proposed Pipeline
- Unsealed Road
- Proposed Access Track
- Major Drainage
- Minor Drainage
- Major Contour
- Minor Contour
- Lease Area (100m x 100m)
- Tenure

Santos

PEL 238 - New South Wales

**Dewhurst 29
Lease Area**

25 0 25 50 75 m

Figure: 2-2 Date: February 2013
File No: GUNWEDAH 285f

4.0 Existing environment

4.1 General description

4.1.1 Climate and weather

The closest running weather station is located approximately 16 kilometres west of Boggabri (Boggabri Neotsfield – station 55273). Climate in this area is regarded as semi-arid, due to hot summers and mild winters. Average (1900 – 2013) monthly maximum temperatures range from 16.6°C (July) to 33.4°C (Jan) Table 4-1. Maximum temperatures have not exceeded 40°C. Frost can occur in all low lying parts of the region. Frost events generally occur between June and August though can begin as early as May.

Average annual rainfall at Boggabri (Neotsfield Station) is 594.5 millimetres. Pan evaporation exceeds rainfall throughout the year, indicating the regions reliance on irrigation and soil water storage during fallows.

Table 4-1 Mean climate data

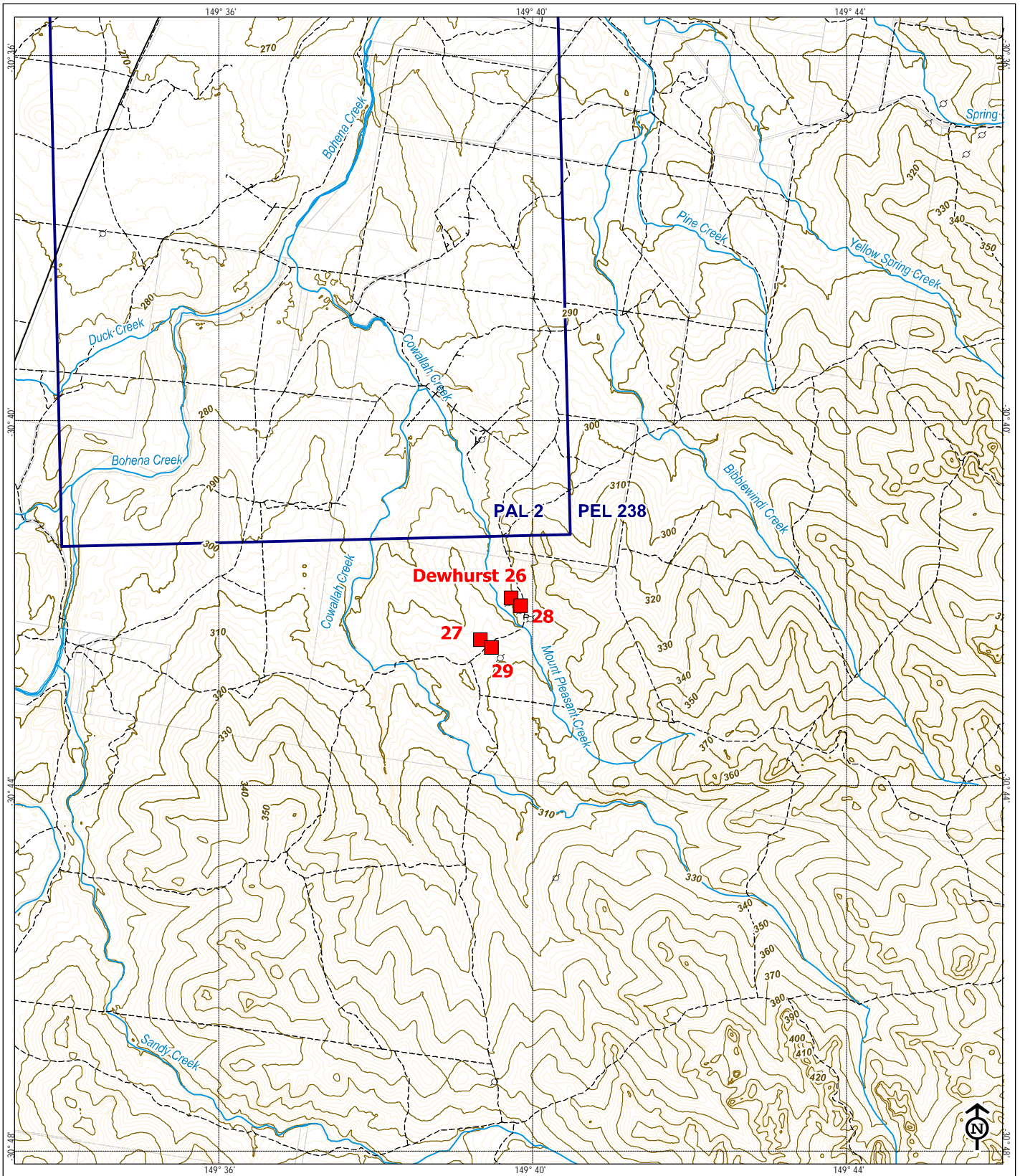
Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	77.9	64.3	45.8	36	43.3	41.8	40.7	35.8	35.6	51.4	58.8	63.1
Maximum Temperature (°C)	33.4	32.5	30.2	25.9	21.1	17.4	16.6	18.6	22.4	26.2	29.7	32.4
Minimum Temperature (°C)	18.1	17.9	15.3	10.7	6.9	4.1	2.8	3.7	6.5	10.5	14	16.6
Pan Evaporation (mm)	272	217	198	133	87.1	59.7	64.4	91.8	131	184	228	273

4.1.2 Topography

The topography of the site is gentle undulating, with no identifying topographic features (refer to Figure 4-1). There are three ephemeral waterways that intersect the central gathering system. One of these watercourses and an additional watercourse is also located within proximity to the lease areas. These waterways are discussed in further detail at Section 4.2.2.

Individual topographic characteristics of each lease area are as follows:

- Dewhurst 26 lease area – generally slopes in a west direction, with elevations ranging between approximately 299.5 and 301.5 metres (AHD).
- Dewhurst 27 lease area – generally slopes in a west direction, with elevations ranging between approximately 304 and 306 metres (AHD).
- Dewhurst 28 lease area – generally slopes in both a northwest direction, with elevations ranging between approximately 303 and 305 metres (AHD).
- Dewhurst 29 lease area – generally slopes in a west direction, with elevations ranging between approximately 306.5 and 308 metres (AHD).



- Site Location
- Sealed Road
- Unsealed Road
- Major Contour
- Minor Contour
- Major Drainage (Line)
- Major Drainage (Region)
- Tenure Boundary
- Santos Tenement

Santos

PEL 238 - New South Wales

Dewhurst 26 - 29 Regional Topography Plan

2 0 2 4 Km

Date: February 2013
File No: GUNNEDAH 285g

Figure: 4-1

4.1.3 Vegetation

An ecological assessment of the site was prepared by RPS and is included at Appendix 5.

Only one vegetation community occurs within the site, Narrow-leaved Ironbark Woodland. The canopy of this community is dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) with Bulloak (*Allocasuarina luehmannii*) commonly occurring. Occasionally, Dirty Gum (*Eucalyptus chloroclada*) and Brown Bloodwood (*Corymbia trachyphloia*) occur. The cover is approximately 45 per cent.

A secondary canopy occurs and is dominated by Bulloak, with Narrow-leaved Ironbark commonly occurring. Black Cypress (*Callitris endlicheri*) and White Cypress (*Callitris glaucophylla*) occasionally occur in this layer. A sparse primary shrub layer also occurs and is dominated by Carol's Wattle (*Acacia caroleae*), with Bulloak occurring as a sub-dominant species. Mudgee Wattle (*Acacia spectabilis*) also occasionally occurs.

A denser, lower secondary shrub layer occurs and is co-dominated by Sticky Hop-bush (*Dodonaea viscosa*), Common Fringe-myrtle (*Calytrix tetragona*), and Broom Bitter-pea (*Daviesia genstifolia*), and occasionally by Cough Bush (*Cassinia laevis*). Sandplain Bitter-pea (*Daviesia acicularis*), Honey Myrtle (*Homoranthus flavescens*), Peach Heath (*Lissanthes strigosa*), and Prickly Beard-heath (*Leucopogon juniperous*) commonly occur, while Mudgee Wattle, Fan-wing Wattle (*Acacia amblygona*) and Carol's Wattle, and Persoonia (*Persoonia cuspidifera*) occasionally occur.

Ground cover is sparse, with native plants species comprising 45% of the total cover. Ground-cover is dominated by Rough Saw-sedge (*Gahnia aspera*), with Blueberry Lilly (*Dianella revoluta*) and Pomax (*Pomax umbellata*), Variable Saw-sedge (*Lepidosperma laterale*), Common Fringe-sedge (*Fimbristylis dichotoma*), Many-flowered Mat-rush (*Lomandra multiflora*), and Serrated Goodenia (*Goodenia cycloptera*), commonly occurring. Grasses are sparse, with Dark Wiregrass (*Aristida calycina*), Plains Grass (*Austrostipa aristiglumis*), Purple Lovegrass (*Eragrostis lacunaria*), Hairy Panic (*Panicum effusum*), and *Eragrostis* sp.

This community is considered to be remnant; however condition varies throughout the study area. Disturbances are generally associated with land management practices due to forestry, such as access tracks and logging. Additionally, CSG activities have occurred in the area, with a disused lease and seismic lines occurring in the study area. This has resulted in disturbances to the understorey, where large open areas are present. Weed cover is considered to be low throughout the study area, with only Prickly Pear (*Opuntia stricta*) observed.

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 described as highly siliceous (Norris, 1996).

The soil landscapes underlying the site and surrounds is designated as 'Cubbo Uplands' according to the NSW (Mitchell) Landscapes (DECC 2002).

The Cubbo Uplands soil landscape is characterised by:

- thin discontinuous soils with stony, sandy profiles and low nutrients on sandstone ridge tops
- texture-contrast soils with harsh clay subsoils down slope
- deep sands with yellow earthy profiles, harsh grey clays, or more texture-contrast soils with a greater concentration of soluble salts in the valley floors.

According to the *Draft Inherent Soil Fertility mapping of the New England – North West region* (OEH 2012), the inherent soil fertility of the overall site is a mix of moderately low to low.

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 development. The site is undeveloped and within the Pilliga East State Forest. As such, it is highly unlikely that there will be any previous uses of the land that will have resulted in contamination.

4.1.5 Land use

The site is located within the Pilliga East State Forest, which is Crown Land managed by Forestry NSW. The State Forest covers an area of approximately 160,000 hectares, and provides publicly accessible roads and tracks which are used for recreational activities such as bushwalking and bird watching.

The *Strategic Regional Land Use Plan New England North West* (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. PEL 238 is overlaid with mining titles, and the site itself is located within Coal Authorisation 216 (AUTH 216) held by DTIRIS on behalf of the crown. Refer to Figure 4-2.

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 of land within the Lower Namoi Catchment irrigated in the year 2000, around 800 square kilometres was used for cotton production (CSIRO, 2007).

The site is not located within land mapped as biophysical strategic agricultural land (SAL) under the SRLUP. Based on the broad scale mapping provided in the SRLUP, the nearest biophysical SAL is located approximately 13 kilometres east of the site (refer to Figure 4-3).

Given the location of the activity within the Pilliga East State Forest, the impact on agricultural land is negligible.

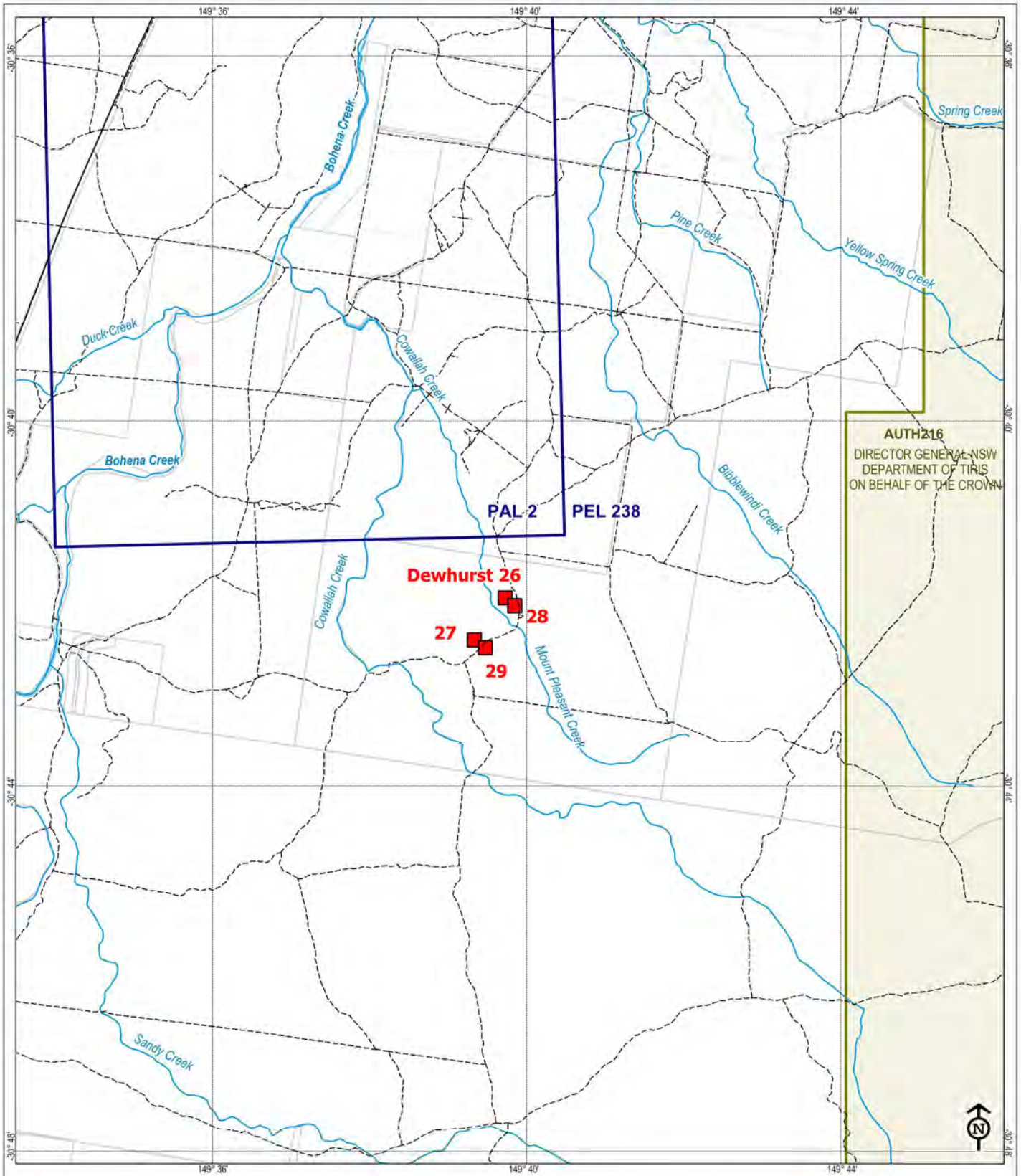
There are two existing petroleum wells within three kilometres of the site known as Dewhurst 4 (adjacent to the site) and Dewhurst 9 (approximately 1.5 kilometres to the south west of Dewhurst 29). Dewhurst 4 was plugged and abandoned in May 2011 and Dewhurst 9 is currently suspended.

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

Table 4-2 Environmental 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

Is the proposed activity located on or within any of the following:	Yes/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
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



- Site Location
- Sealed Road
- - - Unsealed Road
- Major Contour
- Minor Contour
- Major Drainage (Line)
- Major Drainage (Region)
- Tenure Boundary
- Santos Tenement

Santos

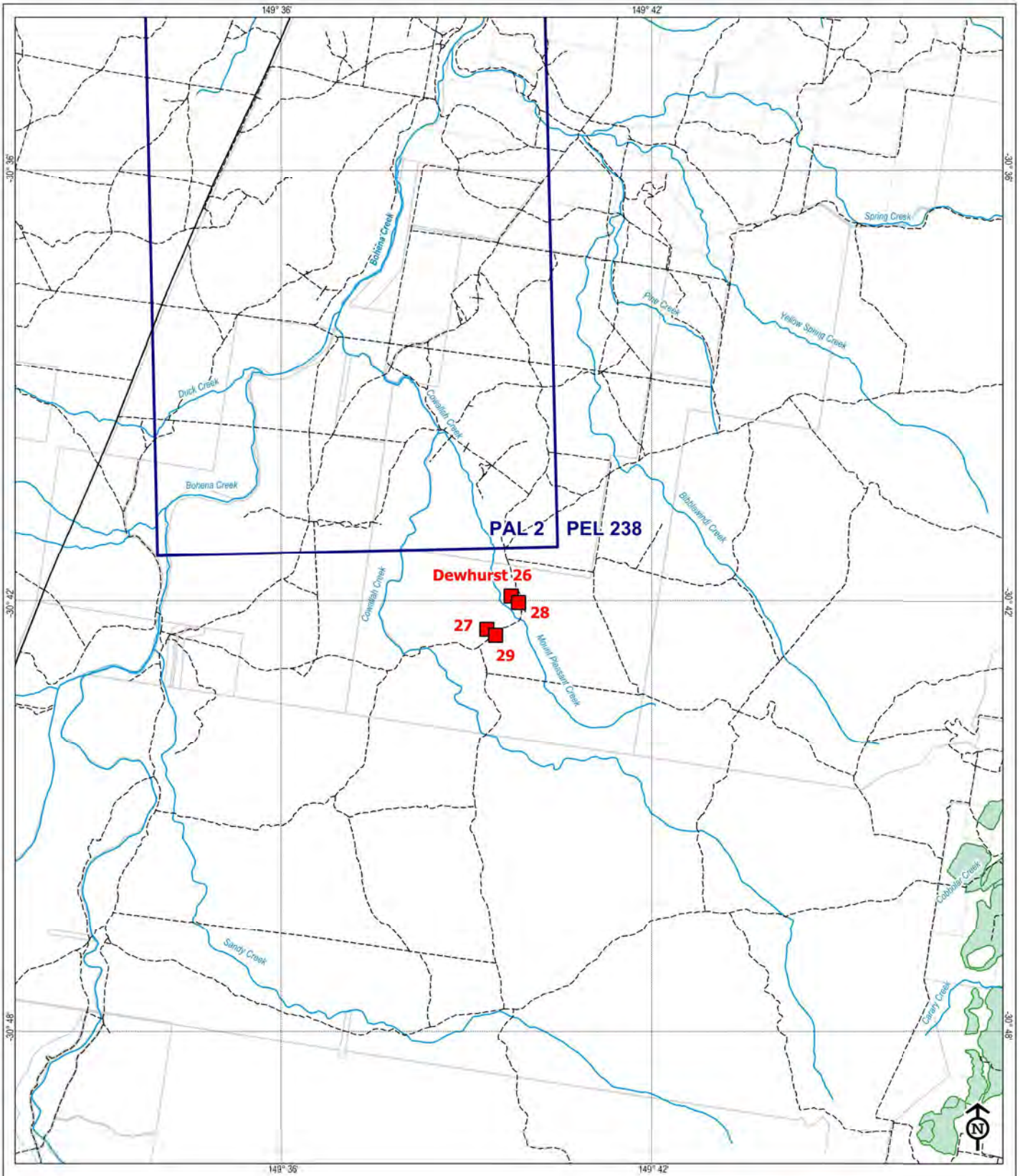
PEL 238 - New South Wales

**Dewhurst 26 - 29
Mining Titles**

2 0 2 4 Km

Date: February 2013
File No: GUNNEDAH 285h

Figure: 4-2



- Site Location
- Sealed Road
- Unsealed Road
- Major Drainage (Line)
- Strategic Agricultural Land
- Major Drainage (Region)
- Tenure Boundary
- Santos Tenement

Santos

PEL 238 - New South Wales

Dewhurst 26 - 29

Strategic

Agricultural Land

Figure: 4-3

Date: February 2013
File No: GUNNEDAH 2351

4.1.6 Availability of services

Beehive Road is an unsealed vehicle track which leads east from Garlands Road and the Newell Highway, which is approximately 12 kilometres east of the site. It provides an east west connection through the Pilliga East State Forest. It is predominantly used by Santos, Forestry NSW staff and some local landowners.

The Newell Highway, National Route 39, is a two-way two lane highway stretching from the Victorian border to the Queensland border. Locally the highway links Narrabri and Coonabarabran.

No known telecommunication, power, water or other services occur at the site or along Beehive Road in the vicinity of the site.

4.1.7 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 Group 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 Group 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 Group 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.

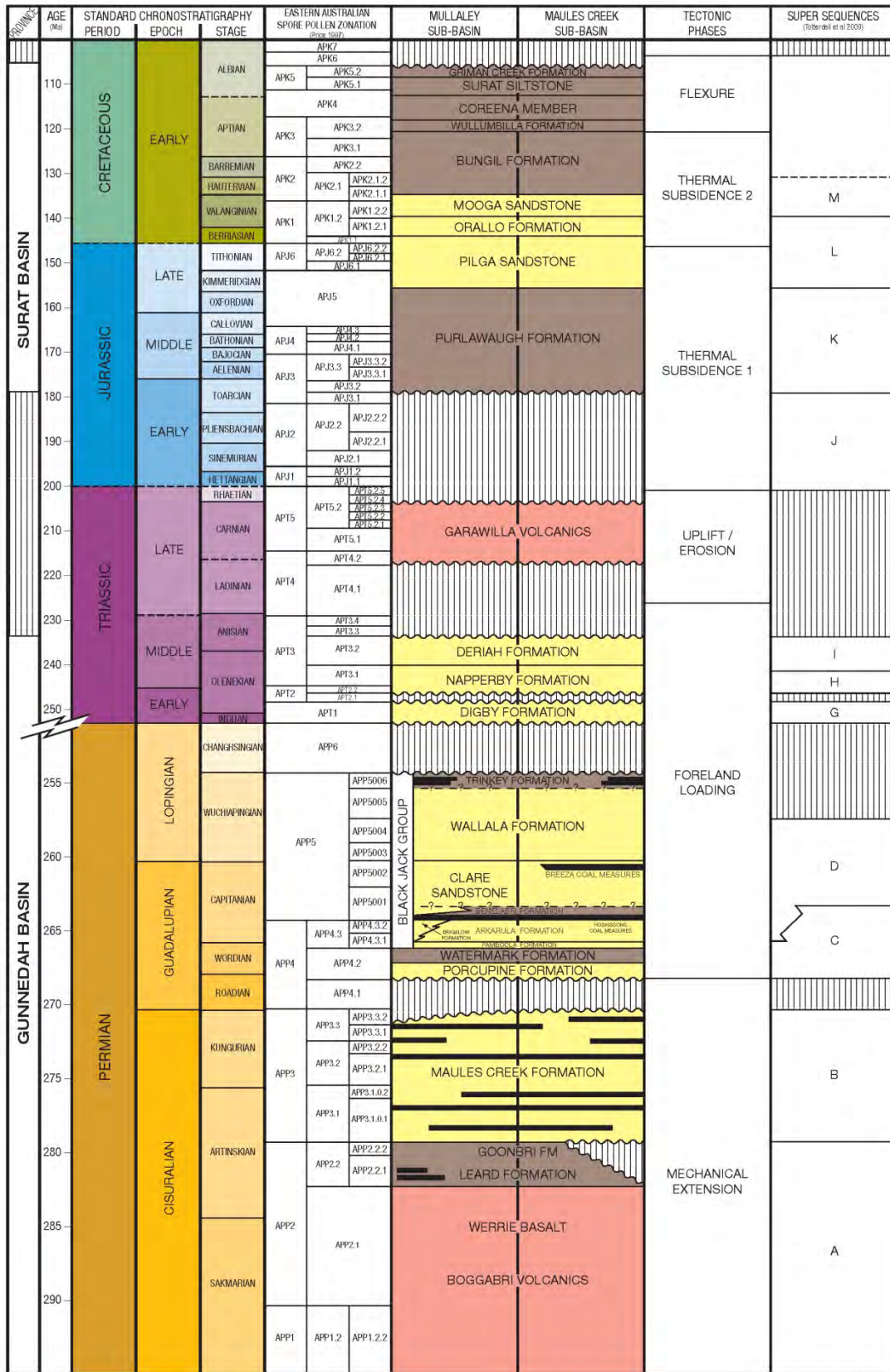
Late Permian volcanic activity and tectonism to the east resulted in renewed deposition of more lithic sediments with an easterly provenance and consequently the upper Black Jack Formation has only limited potential for reservoir development. A period of tectonism, uplift and erosion of variable intensity 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 illustrated in Figure 4-4.



GUNDAH 017

Figure 4-4 Stratigraphy of the Gunnedah Basin

4.1.8 Air and noise

There are no sensitive air or noise receivers located within five kilometres of the site.

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 Beehive Road influence background noise levels at the site.

Baseline noise monitoring conducted in the Pilliga East State Forest indicates that in the absence of insects and wind, the background levels are below 30 dB(A) (refer Appendix 4). This is typical of rural areas and has been assumed for the purposes of noise assessment. It is also the minimum RBL considered in NSW under the *NSW Industrial Noise Policy* (INP) (EPA, 2000).

4.2 Surface and groundwater sources

4.2.1 Surface water catchment

The site is located within the Namoi River catchment which covers an area of approximately 42,000km² 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 with Pian, Narrabri, Baradine and Bohena Creeks joining below 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).

Bohena Creek and its tributaries are ephemeral, generally flowing for short periods following significant rainfall or prolonged wet periods. Baseflow in these creeks are insignificant. Bohena Creek remains dry for extended periods between runoff events, sometimes for periods in excess of 12 months. It contributes little inflow to the Namoi under normal conditions; however during protracted wet conditions, significant flood inflows to the Namoi can be generated.

4.2.2 Site drainage and local surface waters

Figure 4-5 shows the drainage in the vicinity of the site. Mount Pleasant Creek and two unnamed watercourses intersect the proposed central gathering system. Mount Pleasant Creek is located approximately 200 metres to the south of the Dewhurst 26 and 28 lease areas. Another unnamed waterway is located 100 metres to the west of the Dewhurst 27 lease area.

These watercourses flow northwest to Cowallah Creek. Cowallah Creek is located approximately 1.6 kilometres east of Dewhurst 27 and is a tributary of Bohena Creek. Bohena Creek is located approximately 8.1 kilometres northwest of the closest lease area (Dewhurst 26). According to the Strahler

(1957) classification system, the stream order classifications for the major creek systems identified are as follows:

- Stream order 3 – Mount Pleasant Creek
- Stream order 1- The two unnamed watercourses intersected by the central gathering system and the unnamed watercourse adjacent to Dewhurst 27.

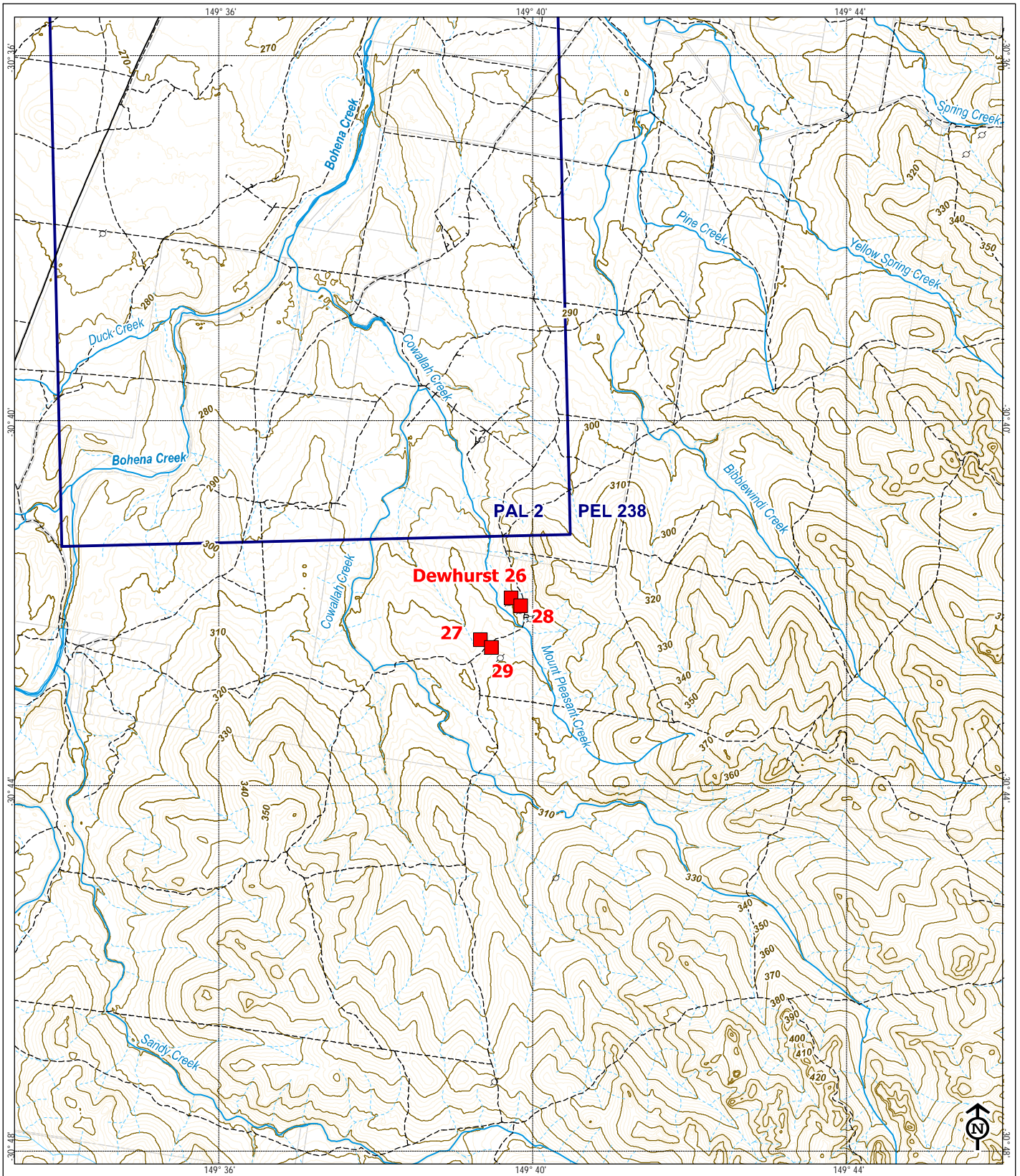
The location of the proposed activity is within the Pilliga Outwash landscape unit as described in Lampert and Short (2004). An aggradational landscape of low lying, undulating alluvial sediments, the outwash is traversed by a number of south to northwest trending drainage lines, many being abandoned paleochannels. Most sediment within the water courses of this landscape is derived from upstream Pilliga Sandstone plateaus or as a result of reworking of the broad outwash plain.

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

The Namoi Water Quality Project 2002-2007 (Mawhinney 2011) incorporated a surface water monitoring station on Bohena Creek at the Newell Highway, downstream of the confluence with Bibblewindi Creek (station number 419905). The frequency of sampling throughout the program's five year life was once a month, however over the course of the five year monitoring period, only five samples were able collected at this site in total, always following heavy rainfall in the catchment area. This reflects the ephemeral nature of the water courses in this area. Details of the water quality measured at this sampling location on Bohena Creek are provided in Table 4-3.

Table 4-3 Water quality measured on Bohena Creek (Station no. 419905) from 2002 – 2007

Parameter	Minimum	Maximum	Median
EC ($\mu\text{S}/\text{cm}$)	148	327	185
Turbidity (NTU)	17	130	76
Total Phosphorus (mg/L)	0.061	0.107	0.073
Total Nitrogen (mg/L)	0.32	0.91	0.62



- Site Location
- Major Contour
- - - Minor Contour
- Major Drainage (Line)
- - - Minor Drainage
- Major Drainage (Region)
- Tenure Boundary
- Santos Tenement

Santos

PEL 238 - New South Wales

Dewhurst 26 - 29 Regional Drainage Plan

2.5 0 2.5 Km

Figure: 4-4

Date: February 2013
File No: GUNNEDAH 285J

4.2.3 Groundwater sources

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 groundwater 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.

According to the relevant water sharing plans for the region, the site does not sit within any mapped Upper Namoi and Lower Namoi Alluvium. However, according to AGE (2006) there are alluvial aquifers associated within Bohena and Bibblewindi Creeks, with minor thin veneers of alluvium in some tributary creeks. The alluvium of Bohena Creek and major tributaries consist of clean, medium to coarse quartz sands which are up to about six metres thick. The alluvial sands form elongated deposits confined to the creek alignment and have an estimated average width of about 60 metres along Bohena Creek.

The water table in the alluvium of Bohena Creek varies from surface level following periods of creek flow, to an estimated two metres below surface level during dryer periods (AGE 2006). It is considered that groundwater in the alluvium is perched on the finer grained sedimentary deposits of the Blythesdale Group, as the water level in the deeper Pilliga Sandstone aquifer is 20 to 30 metres below ground level in the area.

Recharge of the alluvium occurs primarily from infiltration of surface water during creek flow events and to a lesser degree by direct infiltration of rainfall on the sand deposits. Groundwater flow is to the north along the creek channel, with discharge eventually to the Namoi River and/or the major alluvial aquifers associated with the river.

The main aquifers surrounding the site are associated with underlying basement rock units, and include the following:

- Southern Recharge groundwater source, under the Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources.
- Gunnedah-Oxley Basin MDB buried groundwater source, under the Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources.
- Lachlan Fold Belt MDB buried groundwater source, under the Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources.

The Great Artesian Basin (GAB) also underlies the site. The GAB covers 1.7 million square kilometres and contains 8,700 million mega litres of artesian water. It consists of sedimentary sequences with layers of porous and permeable sandstones which alternate with low permeability shales, siltstones and mudstones. Aquifers of the GAB are unsuitable for irrigation use due to high levels of sodium; however, water from these aquifers is generally suitable for domestic and town water supply (GABCC, 1998).

Groundwater recharge takes place chiefly along the south and eastern fringe of the GAB. Groundwater enters the main Pilliga Sandstone aquifer directly through exposed outcrop, or at lesser rates, via overlying strata where there is potential for downward groundwater movement (DWE 2009). The Pilliga Sandstone outcrops in the vicinity of the site, and underlies the area at a relatively shallow depth (20 to 30 metres). The Southern Recharge groundwater source, in which the site lies, is characterised by better quality groundwater than other zones of the GAB.

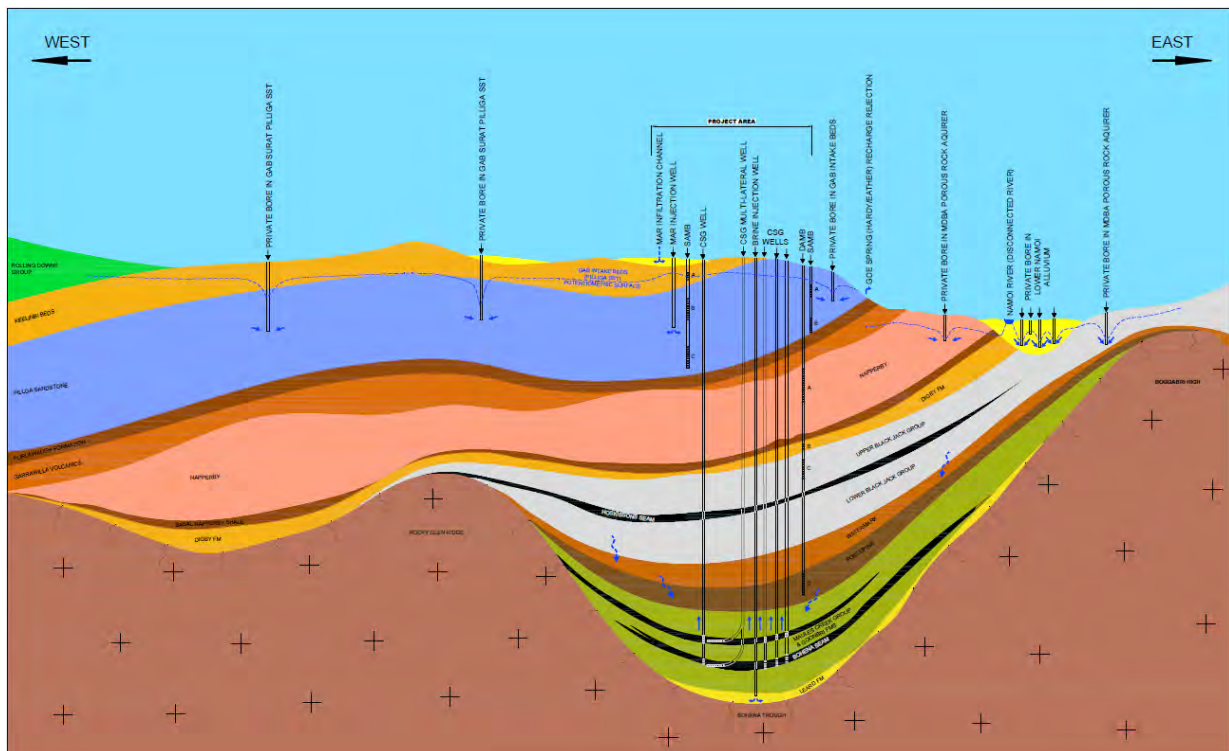
The Gunnedah-Oxley Basin MDB Groundwater Source covers a subcrop area of 2,860,000 hectares. It is the Permian and Triassic rocks associated with the Gunnedah Basin, and the overlying younger Jurassic and Cretaceous rocks associated with the Oxley Basin. The Gunnedah-Oxley Basin extends from the Mount Coricudgy Anticline (separating it from the Sydney Basin), the Hunter-Mooki Thrust to the east (forming the eastern boundary between the Gunnedah-Oxley Basin and the New England Fold Belt), the Lachlan Fold Belt to the west and a structural high to the north of Narrabri (NOW 2012c).

The consolidated formations (e.g. hard rock aquifers) of the Gunnedah Basin comprise interbedded coals, sandstone and siltstones and are not considered major groundwater sources. These formations may be categorised into the following hydrogeological units (AGE 2006):

- hydrogeologically ‘tight’ and hence very low yielding to essentially dry sandstone and lesser siltstone and shale that comprise the majority of the strata
- low to moderately permeable coal seams which are the prime water bearing strata within the Permian sequence.

The primary target CSG bearing formations for this proposed development are the lower Permian coals between the upper Maules Creek formation and lower Maules Creek formation as shown in Figure 4-6.

The Lachlan Fold Belt MDB Groundwater Source covers an area of 16,722,000 hectares. It consists of Cambrian to Lower Carboniferous rock successions, located deeper than the targeted CSG bearing formations. The eastern margin is truncated by the present coastline in the south and is overlapped by the Permo-Triassic succession of the Sydney Basin and its northern equivalents; the northern margin is overlaid by the Mesozoic Great Artesian Basin succession; the southern margin is truncated by the present Tasmanian coastline, and is overlaid by Permian and younger successions. The western margin is largely covered by the mainly Cainozoic Murray Basin successions (NOW 2012b).



Source: Dewhurst 26-29 Technical Pilot, Halcrow (2013)

Figure 4-6 Schematic cross section through the Bohena Trough (not to scale)

There are four licensed groundwater bores within 10 kilometres of the proposed study area:

- GW021998 (maximum depth 73.8 m) – authorised purpose is oil exploration (water bearing zones are located at a depth of 38.7 m to 43.5 m, 46.3 m to 52.0 m and 56.6 m to 69.7 m).
- GW967923 (maximum depth 90.0 m) – authorised purpose is industrial (water bearing zones located at depths 65.0 m to 73.0 m and 75.0 m to 90.0 m).
- GW970010 (maximum depth 47.0 m) – authorised purpose is test bore (water bearing zones located at a depth of 33.0 m to 47.0 m).
- GW967935 (maximum depth 93.0 m) – authorised purpose is industrial (low security) (water bearing zones located at a depth of 53.0 m to 56.0 m, 65.0 m to 81.0 m and 81.0 m to 93.0 m).

4.2.4 Water sharing plans

The *Water Management Act 2000* (WMA) classifies all geological strata underlying the site into Water Sharing Plans. Whilst the majority of water abstracted in the area is derived from high yielding aquifers, there are a number of formations such as the Purlawaugh and Napperby which can be classed as aquitards (i.e. extremely low permeability).

The following Water Sharing Plans apply to water sources within the site and surrounds:

- 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 NSW Murray Darling Basin Porous Rock Groundwater Sources 2011
- Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011.

4.2.5 Drinking water catchment

The site is not located within a drinking water catchment however surface water would filter to groundwater which may be used for drinking water in the surrounding areas. The project will be managed to ensure that there are no impacts on groundwater used for drinking water. These mitigation measures are detailed at Sections 6.1.2 and 6.1.3.

4.2.6 Management controls to mitigate impacts to water sources

During operation, the proposed activity is expected to extract approximately 276 mega litres of groundwater over the first three years from the Gunnedah-Oxley Basin MDB groundwater source under the NSW MDB Porous Rock Groundwater Source WSP. The share allocation of water access licences within the Gunnedah-Oxley Basin MDB groundwater source is 16,197 unit shares. One unit share is currently equal to one mega litre of water. Santos currently holds a 20 unit share aquifer access licence entitlement for this groundwater source and will seek further allocation to cover the expected extraction volume prior to operating the pilots.

The management controls that would be implemented to avoid, minimise or mitigate impacts to water sources; and monitor impacts are outlined in Section 2.8.

4.3 Threatened species, populations and ecological communities

An Ecological Assessment of the proposed activity was prepared by RPS and is attached at Appendix 5. 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
- a detailed ecological assessment between 12 November and 16 November 2012, including detailed flora and fauna surveys.

The findings of the assessment are outlined below.

4.3.1 Ecological communities

Four Threatened Ecological Communities (TEC) listed under the EPBC Act were identified as potentially occurring within 10 kilometres of the site by the EPBC Protected Matters Search Tool, including:

- Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia
- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland
- Weeping Myall Woodlands.

Additionally, three endangered ecological communities (EEC) listed under the TSC Act that are known or predicted to occur within the Namoi catchment have an equivalent TEC listed under the EPBC Act, including:

- EPBC Act – Brigalow (*Acacia harpophylla* dominant and co-dominant).
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland.
- Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions.

An assessment of vegetation communities identified within the study area was undertaken to identify potential TECs. The assessment determined that no TECs listed under the EPBC Act occur at the site.

Nine EEC listed under the TSC Act were identified as potentially occurring within 10 kilometres of the site, based on known or predicted communities occurring within the Namoi catchment (NSW Atlas of Wildlife Search). These include:

- Brigalow within the Brigalow Belt South, Nandewar, and Darling Riverine Plains Bioregions
- *Cadellia pentastylis* (Ooline) community in the Nandewar and Brigalow Belt South Bioregions
- Coolibah-Black Box Woodland of the Darling Riverine Plains and the Brigalow Belt South bioregions;
- Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions
- Inland Grey Box Woodland in the Riverina; NSW South Western Slopes; Cobar Peneplain; Nandewar and Brigalow Belt South Bioregions
- Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions
- Native Vegetation on Cracking Clay Soils of the Liverpool Plains
- Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions
- White Box – Yellow Box – Blakely's Red Gum (Box – Gum) Woodland.

None of these TECs were identified at the site during the ecological survey.

4.3.2 Flora

4.3.2.1 Threatened species

The ecological desktop assessment identified five threatened flora species listed under the EPBC and TSC Acts as potentially occurring in the locality (refer Table 4-4). An assessment of likelihood of occurrence was completed for each species. The assessment identified that the study area provides suitable habitat for four species, namely:

- *Bertya opposens* (Vulnerable);
- Native Milkwort (*Polygala linariaefolia*) (Endangered);
- Cobar Greenhood Orchid (*Pterostylis cobarensis*)(Vulnerable);
- *Rulingia procumbens* (Vulnerable)
- *Tylophora linearis* (Endangered).

Searches did not confirm the presence of any threatened flora species within the study area. However two species, *Rulingia procumbens* and Native Milkwort, have been previously recorded within 10 kilometres of the site and are therefore considered possible occurrences, despite not been recorded during the survey. While the remaining species have not previously been recorded in proximity to the site, habitat considered suitable to support these species occurs at the site.

Table 4-4 Threatened flora species recorded within 10km of site

Species	Listing ¹		Identified during field survey
	TSC Act	EPBC Act	
<i>Bertya opposens</i>	V	V	No
Native Milkwort (<i>Polygala linariaefolia</i>)	E	-	No
Cobar Greenhood Orchid (<i>Pterostylis cobarensis</i>)	V	V	No
<i>Rulingia procumbens</i>	V	V	No
<i>Tylophora linearis</i>	E	E	No

Table Note: 1. E = endangered, V = vulnerable

4.3.2.2 Weeds

The EPBC Protected Matters Search Tool identified five weeds of national significance (WoNS) as potentially occurring at the site, namely:

- African Boxthorn (*Lycium ferocissimum*)
- Radiata Pine (*Pinus radiata*)
- Blackberry (*Rubus fruticosus aggregate*)
- Willows (*Salix spp.*)
- Athel Pine (*Tamarix aphylla*).

None of these WoNS were observed at the site during the field survey.

Prickly Pear (*Opuntia stricta*), which is listed under the *Noxious Weeds Act 1993*, was observed at 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.

Weed cover within the study area is low, with only Prickly Pear observed. No additional listed noxious weeds or environmental weeds were identified within the study area.

4.3.3 Fauna

4.3.3.1 Threatened species

The EPBC Protected Matters database listed 15 threatened fauna species with the potential to occur within a 10 kilometre radius of the site, including seven birds, one fish, five mammals and two reptiles (refer Table 4-5). A total of 12 migratory species were also identified as being potentially present.

The OEH wildlife atlas database search identified a further 17 fauna species listed as threatened under the TSC Act that have previously been recorded within a 10 kilometre buffer of the site.

Table 4-5 Threatened fauna species with potential to occur within 10km of site based on threatened species records and presence of suitable habitat

Scientific name	Common name	TSC Act	EPBC Act	Identified during survey
Birds				
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E Migratory	No
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E	No
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	-	No
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	-	No
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	No
<i>Geophaps scripta scripta</i>	Squatter Pigeon	E	V	No
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-	No
<i>Lathamus discolor</i>	Swift Parrot	E	E	No
<i>Leipoa ocellata</i>	Malleefowl	E	V Migratory	No
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V	-	No
<i>Neophema pulchella</i>	Turquoise Parrot	V	-	No
<i>Ninox connivens</i>	Barking Owl	V	-	No
<i>Polytelis swainsonii</i>	Superb Parrot	V	V	No
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	-	Yes
<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	V	-	No
<i>Rostratula australis</i>	Australian Painted Snipe	E	V	No
<i>Stagonopleura guttata</i>	Diamond Firetail	V	-	No
<i>Tyto novaehollandiae</i>	Masked Owl	V	-	No

Scientific name	Common name	TSC Act	EPBC Act	Identified during survey
Fish				
<i>Maccullochella peelii</i>	Murray Cod	-	V	No
Mammals				
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	-	No
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat, Large Pied Bat	V	V	No
<i>Chalinolobus picatus</i>	Little Pied Bat	V	-	Yes
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat, Corben's Long-eared Bat	V	V	No
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E	V	No
<i>Phascolarctos cinereus</i>	Koala (combined populations of Qld, NSW and the ACT)	V	V	No
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	V	V	No
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	-	Yes
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	-	No
Reptiles				
<i>Aprasia parapulchella</i>	Pink-tailed legless lizard	-	V	No
<i>Uvidicolus sphyrurus</i>	Border Thick-tailed Gecko	V	V	No

No species protected under the EPBC Act were recorded at the site during the field survey. Three species listed as threatened under the TSC Act were recorded at the site or within the near vicinity, including: Grey-crowned Babbler (*Pomatostomus temporalis*), Little Pied Bat (*Chalinolobus picatus*) and Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*). Another threatened microbat species; the Bristle-faced Free-tailed bat (*Mormopterus eleryi*) may also have been recorded however its calls could not be confirmed.

4.3.3.2 Migratory species

The EPBC Protected Matters Search Tool identified 12 migratory species as potentially occurring at the site. An assessment of likelihood of occurrence was completed for each species, based on habitat preference and known species distribution. This assessment confirmed that four species potentially occur at the site, including:

- White-throated Needletail (*Hirundapus caudacutus*)
- Swift Parrot (*Lathamus discolor*) – Endangered
- Rainbow Bee-eater (*Merops ornatus*)
- Regent Honeyeater (*Xanthomyza phrygia*).

No migratory species were observed during the ecological field survey.

4.3.3.3 Introduced species

During the ecological field survey, one feral animal was recorded in the study area; the Red Fox (*Vulpes vulpes*). An additional five pest species were recorded opportunistically within the broader Pilliga forest including the Goat (*Capra hircus*), Rabbit (*Oryctolagus cuniculus*), Brown Hare (*Lepus europaeus*), Cat (*Felis catus*) and Pig (*Sus scrofa*).

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 **Error! Reference source not found.**). This investigation included a desktop review of the environmental and archaeological context 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 14 November 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 6 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.

The flowline crosses a number of ephemeral drainage lines, likely to be active only in periods of high water. The land may still have been used for transient or temporary purposes, though evidence of such use would not necessarily be left in the archaeological record. Further, past land uses such as vegetation clearance, track grading and forestry may have damaged and/or destroyed any remnant evidence of such transient occupation. The archaeological potential for the site was therefore assessed as very low to nil.

During the archaeological field survey, no Aboriginal sites or objects were identified in or near to the site, and no historic heritage items or sites were identified. Additionally, no trees exhibiting evidence of cultural modification/scarring were observed and no vegetation with natural heritage significance was identified. No archaeologically sensitive landscape features, including dune systems, caves/rockshelters, ridge tops, headlands, or cliff faces were identified in or immediately near to the site.

4.5 Native title

A search of the National Native Title Tribunal (NNTT) registers on 9 October 2012 identified one native title claimant, being the Gomeroi People. Their claim extends over an area of 111,340 km² and includes the Narrabri LGA.

As PEL 238 was granted prior to the commencement of the *Native Title Act 1993* (Cth), there is no further need to comply with the *Native Title Act 1993* for the conduct of the proposed activity.

4.6 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 historic heritage items listed under the *Narrabri Local Environmental Plan 2012* (Narrabri LEP) occur in, or near to the site. Several historic 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 historic heritage value were recorded within 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, approval is required from the Australian Government Minister for 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 an action that may be a controlled action must refer the proposal to the Minister for determination as to whether the proposed action is a controlled action. A person proposing to take an action that the person thinks is not a controlled action may nevertheless refer the proposal to the Minister for the Minister's decision on whether or not the action is a controlled action. If the Minister determines that the proposed action is a controlled action, the action is subject to the assessment and approval processes under the EPBC Act. If the proposed action is not a controlled action, approval under the EPBC Act is not required and the action may be undertaken in accordance with the referral.

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. The ecological assessment is contained in Appendix 5.

An assessment of the proposed activity against MNES is provided in Section 6.7. 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.

5.1.2 Native Title Act, 1993

The objectives of the *Native Title Act 1993* are to:

- recognise native title rights and set down basic principles in relation to native title in Australia

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- provide for the validation of past acts which may be invalid because of the existence of native title
 - provide for a future regime in which native title rights are protected and conditions imposed on acts affecting native title land and waters
 - provide a process by which native title rights can be established and compensation determined, and by which determinations can be made as to whether future grants can be made or acts done over native title land and waters
 - provide for a range of other matters, including the establishment of a National Aboriginal and Torres Strait Islander Land Fund.

A search of the National Native Title Tribunal (NNTT) registers on 9 October 2012 identified one native title claimant, being the Gomeroi People. Their claim extends over an area of 111,340 km² and includes the Narrabri LGA.

Santos is currently undertaking preliminary discussions with the Gomeroi Native Title Applicants to identify the interests and issues in the lead up to formalising the negotiation process.

It is noted however that as PEL 238 was granted prior to the commencement of the Native Title Act 1993 (Cth), there is no further need to comply with the Native Title Act for the conduct of the proposed activity.

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.

Santos is the holder of an exploration licence PEL 238 granted under the Petroleum Act and 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. Under PEL 238, the following categories of prospecting operations can be undertaken:

Category 1

- development to which clauses 10(1) and 10(2) of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) apply.

Category 2

- development to which clause 10(2) of the Mining SEPP applies that is not on land to which clause 10(1) applies
- construction of an access way such as a track or road
- construction and use of boreholes
- seismic surveys.

Category 3

- construction and use of petroleum wells
- prospecting operations and water management infrastructure required to be carried out in accordance with an approved Produced Water Management Plan
- fracture stimulation

-
- installation of gas gathering and pipeline infrastructure
 - any prospecting operation resulting in a cumulative surface disturbance exceeding a total of five hectares within the exploration licence area
 - any other prospecting operations not listed in Category 1 prospecting operations or Category 2 prospecting operations.

The proposed activity falls under Category 3 prospecting operations. Under Condition 2 of PEL 238, the licence holder must obtain approval from the Resources Minister prior to carrying out any Category 2 or Category 3 prospecting operations on the exploration licence area. The licence holder is required to comply with the conditions of any approval granted by the Resources Minister. A Surface Disturbance Notice, REF and Agricultural Impact Statement are required for all Category 3 prospecting operations.

Under PEL 238, a Surface Disturbance Notice, REF and Agricultural Impact Statement (Appendix 8) are required for all Category 3 prospecting operations.

This REF is being submitted in accordance with Condition 2 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
- the development is not exempt development
- the development is either carried out by a determining authority or requires the approval of a determining authority
- the development has not previously been approved under Part 4 of the EP&A Act.

The proposed activity falls within the Narrabri Shire LGA. The site is zoned RU3 (Forestry) under the *Narrabri Local Environmental Plan 2012* (Narrabri LEP). The proposed activity is permissible without development consent under the Narrabri LEP as the activity is authorised under the *Forestry Act 2012*.

The Mining SEPP aims, amongst other things, 'to provide for the proper management and development of mineral, petroleum and extractive material resources for the purpose of promoting the social and economic welfare of [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 Narrabri LEP. Condition 2 of PEL 238 requires the licence holder to obtain further approval from the Resources Minister prior to carrying out a Category 3 prospecting operation. The Resources Minister is the determining authority for the purposes of Part 5 of the EP&A Act. As discussed at Section 4.1.5, two petroleum wells are located within three kilometres of the site however one of these has been abandoned and the other suspended. The proposed activity results in five petroleum wells within three kilometres of any other petroleum wells (other than an abandoned petroleum well) within PEL 238 and therefore clause 7 of the Mining SEPP which relates to development that is permissible with consent does not apply.

The proposed activity will not be carried out on an environmentally sensitive area of State significance or land on which the following instruments apply: *State Environmental Planning Policy (Major Developments)*

2005, *State Environmental Planning Policy No 14 – Coastal Wetlands and State Environmental Planning Policy No 26 – Littoral Rainforests*.

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 (section 111 duty).

The determining authority must consider, among other things, the effect of the proposed activity on critical habitat and any protected fauna or protected native plants within the meaning of the *National Parks and Wildlife Act 1974*, and in the case of threatened species, populations or ecological communities, and their habitats, whether there is likely to be a significant effect on those species, population or ecological communities or those habits.

The determining authority is also required 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 its obligations under section 111 of the EP&A Act. In particular, the 'seven part' test has been applied to the proposed activity in Appendix 5 of the REF. This 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 2012

For the reasons discussed above, the proposed activity does not require development consent under Part 4 of the EP&A Act. However, consideration has nevertheless been given to the relevant RU3 Forestry zone objectives under the Narrabri LEP.

The natural resource base relied upon by the industry within the area will not be significantly affected by the proposed activity. The proposed activity will not affect the development of forestry or forestry-related enterprises in the area nor will it result in the fragmentation or alienation of resource lands. The proposed activity will not result in conflict between land uses within the RU3 Forestry zone or land uses within adjoining zones. Therefore, the proposed activity is considered to be a suitable activity within the RU3 Forestry zone.

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 a 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.

As discussed above, 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 proposed activity identified a number of threatened species and ecological communities as having the potential to occur on the site.

While no threatened flora species were recorded in the study area, five species have the potential to occur based on habitat available. An assessment of significance was not considered necessary, as targeted searches for these flora species did not record these species within the study area, and an initial assessment of potential for impact determined that significant impacts are considered unlikely.

Twenty-eight threatened fauna species were identified as potentially occurring within the study area as part of the desktop assessment, including 18 birds, nine mammals, and one reptile. Of these 28 species, three were recorded in the study area, namely, Grey-crowned Babbler, Yellow-bellied Sheathtail-bat, and Little Pied Bat. Bristle-faced Freetail Bat was also potentially recorded, but could not be confirmed. An assessment of significance for each of the fauna species whose occurrence is considered to be 'likely' was undertaken in accordance with the EPBC Act and *EPBC Act Policy Statement 1.1 – Significant Impact Guidelines Matters of National Environmental Significance* (DEWHA, 2009) (refer to Appendix 5). The assessments concluded that no significant impact is anticipated for fauna species.

5.2.4 Forestry Act 2012

The purpose of this Act, which commenced on 21 December 2012, is to:

- provide for the dedication, management and use of state forests and other Crown-timber land for forestry and other purposes
- constitute the Forestry Corporation of New South Wales as a statutory State owned corporation and to specify its objectives and functions
- repeal the Forestry Act 1916 and the Timber Marketing Act 1977 and to amend certain other legislation; and for related purposes.

The Savings and Transitional Provisions in Schedule 3, clause 9 provide that , *'any licence, permit or lease granted under the former Act and in force immediately before the repeal of the former Act is taken to be a licence, permit or lease of the corresponding kind (as determined by the Corporation) in force under this Act'*.

Section 31 of the Act states that an Occupation Permit may be granted for land within a state forest *'for any purpose approved by the commission and specified in the permit'*.

Proposed works within the state forest will be undertaken in accordance with the existing Occupation Permit held by Santos and administered by Forestry NSW.

5.2.5 National Parks and Wildlife Act 1974

5.2.5.1 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).

5.2.5.2 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.

5.2.6 Native Vegetation Act 2003

The *Native Vegetation Act 2003* (NV Act) 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 NV Act 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 NV Act does not apply to any clearing authorised under the Petroleum Act.

5.2.7 Protection of the Environment Operations Act 1997

One of the primary objectives 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'.

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.

5.2.8 Fisheries Management Act 1994

One of the objectives of the *Fisheries Management Act 1994* is to 'conserve key fish habitats'. A policy definition of the term 'Key Fish Habitat' (KFH) was developed to guide the compilation of key fish habitat maps. KFH is defined to include all marine and estuarine habitats up to highest astronomical tide level (that is reached by 'king' tides) and most permanent and semi-permanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank.

The Department of Infrastructure and Investment (I&I NSW) uses the Strahler stream classification system to give waterways an 'order' according to the number of additional tributaries associated with each waterway (Strahler, 1952). This system provides a measure of system complexity and therefore the potential for fish habitat to be present. I&I NSW recognises third order streams and above as likely to display valuable fish habitat, and hence could support viable fish populations.

Small headwater creeks and gullies (known as first and second order streams), that only flow for a short period after rain are generally excluded from the definition of 'key fish habitat', as are farm dams constructed on such systems. Unmapped gullies and first and second order streams (based on the Strahler method of stream ordering) are determined from the largest scale topographic map produced for the area concerned (ie use 1:25,000 rather than 1:50,000 and use 1:50,000 rather than 1:100,000 and include all depicted streams).

As there are no marine or estuarine habitats present within the site, aquatic ecology has not been assessed in detail.

5.2.9 Heritage Act 1977

One of the main objectives 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 2012 or on the NSW State Heritage Register occur on the site. A number of items of local and State heritage significance are present within the Narrabri LGA, however these are not located in close proximity to the site.

5.2.10 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. As water sharing plans are in place for the surface and groundwater sources at or surrounding the site, the WMA applies to the proposed activity.

5.2.10.1 Aquifer interference approval

Under section 91F of the WMA, it is an offence to carry out an aquifer interference activity without an aquifer interference approval. An aquifer interference activity includes the penetration, interference or obstruction of flows within an aquifer or to take or dispose of waters from an aquifer.

However, section 91F of the WMA does not currently apply. This is because the provisions contained in Divisions 1 and 1A of Part 3 of Chapter 3 of the WMA (including section 91F) have not become operative under section 88A. Section 88A provides that Part 3 of Chapter 3 applies to each part of the State or each water source and each type or kind of approval that relates to that part of the State or that water source that is declared by proclamation.

At the time of this REF, no proclamation has been made declaring that Part 3 of Chapter 3 of the Act applies in relation to aquifer interference approvals.

Accordingly, an aquifer interference approval will not be required for the proposed activity.

5.2.10.2 Water sharing plans

WSPs are designed to provide long-term environmental protection and sustainability of the surface water and groundwater resources as well as directing how water will be allocated and shared among the various water users. WSPs apply the goals and principles of the *NSW State Groundwater Policy* at a local and regional level.

The WMA provides for a system of assessment and licensing and approvals relating to the equitable take of water from water sources, in addition to works and activities occurring within or affecting these water sources. Each WSP sets out Water Sharing Rules and Management Rules for aquifer interference activities within each water source that operate under these water management principles.

The proposed activity will have to comply with the rules developed for the affected water sources within the relevant water sharing plans outlined above.

5.2.10.3 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). A water licence is required (unless an exemption applies) where any aquifer interference activity causes:

- the removal of water from a water source
- the movement of water from one part of an aquifer to another part of an aquifer
- the movement of water from one water source to another water source.

Water used for the construction and operation of the proposed activity will be sourced from Narrabri's potable town water supply or local industrial licensed water bores and trucked to the site. Alternatively, production water from pilot wells will be used when available for the preparation of drilling mud.

A WAL is also required for the taking of groundwater, whether for consumption or incidentally, unless an exemption applies. Any new mining and petroleum exploration activities that take more than three mega litres per year from groundwater sources will need to hold a WAL.

The volume of water extracted from the Gunnedah-Oxley Basin MDB Buried Groundwater Source by Dewhurst 26-29 is predicted to be approximately 276 mega litres over the first three years (averaging 251.6 m³/day). Santos will need to obtain a WAL to account for this water take.

5.2.10.4 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.

There are a number of floodplains declared under the Water Act located nearby but not on the site. The closest is the Namoi River: Carroll to Boggabri floodplain located approximately 30 kilometres to the south east. 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.

5.2.10.5 Controlled activity approval

Under sections 91 and 91E 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. Clause 16 of 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

Likely impact on soil quality or land stability

Erosion

The proposed activity may require vegetation clearing, top soil removal and earthworks for establishment of the lease areas and construction of the access tracks. The total area of disturbance will be 5.755 hectares for the lease areas and service corridors. 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. A large part of the gathering system follows existing roads in areas that are already disturbed.

The proposed disturbance to the ground surface is greater than the current nature and condition of the site and surrounding landscape, and as such it may be sensitive to disturbance. However, historically the site has been subject to varying disturbances including forestry activities, mining exploration, and disturbances from feral pigs as noted at section 5.2 of Appendix 5.

While each of the lease areas are 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. 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 sites may track sediment onto Beehive Road. Erosion and sedimentation will be reduced through the measures identified in Section 6.1.1.2.

Potential erosion impacts are greatest during the site establishment, drilling and construction phases of the activity. During operation, the site will be rehabilitated to reduce erosion potential.

Contamination

During site establishment, construction and drilling, 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.

During operation, the groundwater lifted from the coal seam will flow to a water transfer (or balance) tank adjacent to Dewhurst 28 for temporary storage prior to transfer to the water treatment facility. The water transfer tank will be bunded to 100 per cent capacity to minimise impacts of any spillage. Water from the balance tank will be transferred via flowline to the water treatment facility. In the event that the flowline is not fully operational, water will be transported to the treatment facility via road.

There is potential for an uncontrolled discharge to the environment during road water transport. Although unlikely, if this were to occur, there could be localised contamination impacts. It is expected however that these impacts would be minor (largest water truck capacity 23 m³), localised and short term.

There is also a risk that a line failure could occur within the gathering system that transfers lifted groundwater between the wells to the transfer tank adjacent to Dewhurst 28. Water pressure within the pipes is monitored remotely and should this occur, operation of the well will be suspended until the problem is rectified. The extent of the impact will also be small, localised and short term.

Impacts to structural integrity, land instability or subsidence are not expected.

6.1.1.2 Mitigation measures

The management process for drilling mud and cuttings, described in section 2.7.3 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:

Site establishment and construction

- 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).
- 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.

- A diversion bank will be constructed to direct water around the disturbance area.
- A sediment fence will be installed at the downstream limit of the disturbance area.

Drilling

- 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 necessary and appropriate to conduct such maintenance on site.
- Refuelling 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.
- A vacuum truck will be on standby 24 hours a day to travel to the site if required.
- 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.

Operation

- Ongoing management and maintenance of remaining infrastructure on site will occur, including water transfer area and well heads.
- The gathering system water pressure will be monitored.
- The site will be rehabilitated in accordance with sections 2.7.5.4 and 2.7.6 of the REF.

6.1.1.3 Impact categorisation

Table 6-1 provides an analysis of the potential impacts on soil quality and land stability.

Table 6-1 Soil quality and land stability impact categorisation

Analysis of impact	Comment
Size	Up to approximately 5.755 hectares will initially be cleared with top soil stockpiled. The Dewhurst 26, 27 and 29 lease areas will reduce following completion of initial drilling activities from 1 hectare to 0.0025 hectares and topsoil will be used to rehabilitate the site. The entire lease area at Dewhurst 28 will be retained during operation as this lease area will contain the ancillary surface infrastructure required for operation. Following construction of the gathering system, the surface area will be rehabilitated and natural overland flow restored.
Scope	Erosion of stockpiles and the lease area surface may occur. Soil contamination from chemical or oil spills during site establishment and drilling activities.
Intensity	Site is relatively flat and soil erosion impacts are expected to be minimal. Any water leakage from the gathering system will have only a small localised impact.
Duration	Stockpiled topsoil could remain in place for approximately 6 months until partial rehabilitation take place.

Analysis of impact	Comment
	Site establishment and drilling activities approximately 54 days per well.
Level of confidence in predicting impacts	High, provision of erosion controls including drainage bunding, controls on the size and slope of the stockpiles and controls to manage any spills will minimise any impact to soil quality and stability.
Level of reversibility of impacts	Impacts are likely to be minimal with mitigation measures in place and reversible
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above.
Ability of the impacts to comply with standards, plans or policies	The following standards, plans and policies will be adhered to: <i>Managing Urban Stormwater: Soils and Construction</i> (Landcom 2004) ('the Blue Book') <i>Best Practice Erosion and Sediment Control Guidelines</i> (IECA, 2008) (IECA Guidelines)
Level of public interest	Low, soil quality and stability has not been raised through consultation activities undertaken to date
Requirement for further information on the impacts of the activity or mitigation	None
Impact category	Negligible to low adverse

6.1.2 Water body, watercourse, wetland and natural drainage systems

6.1.2.1 Potential impacts

Likely effect on a waterbody, watercourse or wetland or natural drainage system

Impacts to water bodies can be grouped as follows:

- Redirection of flow – this is likely to be minor but will occur during site establishment and drilling when drainage bunding will be put in place to manage surface run off from the lease area or impacts from any spills. The levelling of the site will also impact overland flows.
- Changes to the area, volume or flow of a water body – unlikely for surface water as construction of waterway crossings would only occur during dry periods, groundwater is assessed separately in Section 6.1.3.
- Actual or likely pollution of waters – possible as a result of spills.

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 Mount Pleasant Creek and the Bohena Creek system. Runoff is not expected to be significant given the flat nature of the site and moderate average rainfall.

Erosion and sediment controls will be utilised to minimise the potential for sediment migration to drainage lines. Erosion and sediment control structures may include silt fences, diversion drains, and maintenance of down slope buffer zones. Contour banks around the proposed sumps minimise any overland flow entering the sumps.

In the case of the proposed drilling sump, a plastic liner will be used to ensure there is no leakage to the surrounding environment. The liner will be removed after drilling with the water re-used or taken to a licensed facility for disposal.

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 nearby waterways, including Mount Pleasant Creek, with sediment and other contaminants.

Water for the drilling, access track and lease area construction activities will be sourced from town water or a producing well, rather than a natural/local surface water body.

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

Additionally, as outlined in Section 4.2.2, three ephemeral watercourses are mapped as intersecting the proposed flowline. The two unnamed watercourse have an OEH water classification of Class 4 and are considered unlikely fish habitats. Although the named watercourse (Mount Pleasant Creek) is mapped as key fish habitat, it is unlikely to support the endangered Murray cod (*Maccullochella peelii*), as this species prefers slow flowing deep systems. The ephemeral nature of these creeks would likely support common fish species during migration and breeding and potentially provide feeding areas for some aquatic fauna (e.g. fish, yabbies). No permanent aquatic vegetation was identified along the proposed flowline during the ground-truthing efforts.

As the construction of the flowline across these watercourses will be carried out during dry periods with no waterflow occurring and will be carried out inline with the relevant guidelines, the impact on any potential fish/aquatic habitats would be negligible.

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

Surface runoff will be captured through site bunding along the lease area.

During operation the groundwater lifted from the coal seam will need to be stored temporarily and disposed of in accordance with the proposed water management strategy. An uncontrolled discharge to the environment could occur during road water transport. If this were to occur, there could be localised impacts to surface water. The extent of the impact will be small, localised and short term.

Potential surface water impacts are greatest during the site establishment, construction and drilling. During operation, potential surface water impacts would be limited to any leakage from the gathering system.

Water Quality and River Flow Objectives have been defined for uncontrolled streams within the Namoi catchment. The relevant objectives and how the proposed activity will achieve these objectives are outlined in Table 6-2.

Table 6-2 Relevant water quality and river flow objectives

Relevant water quality and river flow objective	Description of objective	How proposed activity will meet objective
Aquatic ecosystems	<i>Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term</i>	The site will be managed to ensure that no 'dirty' water is discharged to drainage lines and that existing salinity, turbidity and pH levels of surface waters are maintained.
Visual amenity	<i>Aesthetic qualities of waters</i>	The site will be managed to ensure that no 'dirty' water, oil/fuel or debris is discharged to drainage lines. The proposed activity is unlikely to introduce aquatic pests or weeds. Vehicle

Relevant water quality and river flow objective	Description of objective	How proposed activity will meet objective
		cleaning procedures will ensure that other weed species are not introduced to waterways.
Livestock water supply	<i>Protecting water quality to maximise the production of healthy livestock</i>	The Groundwater Impact Assessment (Appendix 7) determined that the aquifers which may be used for livestock water supply would not be impacted upon by the proposed activity. The wells will be constructed in accordance with industry standards and will isolate aquifers.
Irrigation water supply	<i>Protecting the quality of waters applied to crops and pasture</i>	The Groundwater Impact Assessment determined that the aquifers which may be used for irrigation water supply would not be impacted upon by the proposed activity. The well will be constructed in accordance with industry standards and will isolate aquifers.
Homestead water supply	<i>Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing</i>	The Groundwater Impact Assessment determined that the aquifers which may be used for domestic water supply would not be impacted upon by the proposed activity. The well will be constructed in accordance with industry standards and will isolate aquifers.
Drinking water – Disinfection only, or Drinking water – Clarification and disinfection Drinking water – Groundwater	<i>Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment</i>	The proposed activity does not involve the drawing of drinking water from raw surface or groundwater sources.
Protect pools in dry times	<i>Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows</i>	The proposed activity will not involve extraction from any surface waters.
Protect natural low flows	<i>Protect natural low flows</i>	The proposed activity will not involve extraction from any surface waters.
Maintain wetland and floodplain inundation	<i>Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems</i>	The proposed disturbed area is only approximately 5.755 hectares in size and will not alter flooding patterns.
Manage groundwater for ecosystems	<i>Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems</i>	The Groundwater Impact Assessment determined that the aquifers which may feed groundwater dependent ecosystems and baseflows would not be impacted upon by the proposed activity. The well will be constructed in accordance with industry standards and will be isolated from intercepting aquifers.

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 2.7.6 of the REF. The following additional measures will be implemented:

Site establishment and construction

- Contaminated waters will be contained and where necessary disposed of at an appropriate facility.
- Sediment fences and traps will be installed so as to prevent soil loss or sedimentation.
- Where applicable maintenance of roads, drains, bund walls, contour and diversion banks to occur. All drainage structures will be maintained for the life of the development.
- The crossing of Mount Pleasant Creek will be designed to minimise up and downstream erosion of the bed and banks, and changes to flow velocity.
- Waterway crossings will be undertaken during periods of no flow.

Drilling

- 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 2.7.3 of the REF.
- Fuel and lubricants will be stored on site only when necessary and maintained off site whenever possible.
- 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.
- All areas storing or handling fuel, fuel using equipment, and chemicals will be banded in accordance with *Australian Standard 1940 – 2004; The Storage and Handling of Flammable and Combustible Liquids*.
- The maintenance and cleaning of vehicles and other equipment or plant will be carried out in areas from where the resultant contaminants cannot be released into any waters.

Operation

- Proposed rehabilitation (Section 2.7.6) will ensure pre-operational quality or better, to minimise sediment erosion.

6.1.2.3 Impact categorisation

Table 6-3 provides an analysis of the potential impacts on waterbodies, watercourses, wetlands and natural drainage systems.

Table 6-3 Surface water impact categorisation

Analysis of impact	Comment
Size	Small – No watercourses intersect the lease areas or surface infrastructure. Mount Pleasant Creek is located approximately 300m from Dewhurst 26 and Dewhurst 28. An unnamed watercourse is located approximately 100m from Dewhurst 27.
Scope	Localised – Surface water quality could be impacted by spills or sediment erosion
Intensity	Low – Water contamination, if it occurs will be as a result of small spills or leaks that will be relatively contained. Changes to overland flows are minimal as existing area is relatively flat.
Duration	Short term – The likelihood of impact will only occur during site establishment and drilling
Level of confidence in predicting impacts	High, all contaminated water will be captured on site before entering natural water systems.

Analysis of impact	Comment
Level of reversibility of impacts	Any impact to water quality is likely to be small, localised and could be treated.
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above. Measures proposed to address soil quality will also have a positive impact on water quality.
Ability of the impacts to comply with standards, plans or policies	The following standards, plans and policies will be adhered to: <ul style="list-style-type: none"> ▪ Australian Standard 1940 – 2004; The Storage and Handling of Flammable and Combustible Liquids. ▪ Fairfull, S. and Witheridge, G. (2003) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla.
Level of public interest	Water quality is a major issue for the general community and has been consistently raised at a number of forums and communication activities.
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Negligible to low adverse.

6.1.3 Groundwater

An Exploration Groundwater Impact Assessment has been undertaken by Halcrow and is provided in Appendix 7. The key findings are outlined below.

6.1.3.1 Potential impacts

Likely effect on a water body, watercourse or wetland or natural drainage system

Groundwater impacts apply partially during drilling (aquifer interference) but mostly during operations.

During drilling groundwater aquifers will be intersected, however these will be cased off and cemented to isolate any water transfer between aquifers. During operation lifting of water is proposed from the Bohena, Namoi and Rutley seams.

Impacts during drilling

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 (low permeability layers which restrict groundwater flow) or aquicludes (geological formations through which no groundwater flows) 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.

The key risk associated with drilling and well installation include creating an artificial connection between water bearing formations that bypasses aquitards and aquicludes and loss of drilling fluid into the formation resulting in the degradation of water quality. Potential impacts associated with improper drilling, well

installation or well abandonment include depressurisation and/or cross contamination of groundwater resources due to leakage within the borehole and also impacts on groundwater quality from drilling fluid. Human consumptive uses and aquatic ecosystems are at risk from these potential impacts. These impacts are rated as minor and are considered unlikely to occur due to commitment to proper well installation technique.

Impacts to upper layers during operation

Due to the limited extent of basalt in the Bohena sub-basin and as such it is considered unlikely that the proposed activity would result in depressurisation of water sources associated with the Water Sharing Plan (WSP) for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011.

Great Artesian Basin (GAB) Surat Pilliga Sandstone (WSP for the NSW GAB Groundwater Source 2008) are considered to be highly productive in the context of the Aquifer Interference Policy (AIP). Groundwater modelling during operation has indicated that there will be no decline in the water table or change in the volume of water (flux) as a result of the proposed activity.

The porous rock groundwater source of the Gunnedah Basin (WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011) is considered a less productive porous rock groundwater source in the context of the AIP. As the targeted coal seams fall within the lower parts of this water source, changes in flux at the lower levels will result in some impact however recovery of water pressures and return of fluxes to pre-CSG pilot conditions will occur slowly over time.

Registered users

There are four registered bores within nine kilometres of the proposed activity. These bores abstract water from the lower Namoi alluvium and the Pilliga Sandstone. The Pilliga Sandstone of the Surat Basin is considered the lowest (and most easterly) intake beds of the Great Artesian Basin (GAB). None of these layers will be impacted by the proposed activity (construction and operation).

Groundwater dependant ecosystems

Two high priority groundwater dependant ecosystems (GDEs), Hardys Spring and Eather Spring, are located approximately 15 kilometres and 20 kilometres from the proposed activity respectively. These are hydrogeologically associated with the Pilliga sandstone. As there is no impact to the Pilliga sandstone, there is expected to be no impact on the GDEs.

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:

Site establishment and construction

Nil

Drilling

- The wells 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 hydro geologist will be notified at least 28 days prior to the commencement of drilling.
- Drilling and installation operations, well control, waste management and abandonment procedures for the pilot wells will be in accordance with accepted industry practices and in accordance with the processes outlined in this REF.
- 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.

Operation

- The wells will be decommissioned as soon as they are no longer required.
- Data will be collected from the wells to measure permeability of the various strata.
- Pressure gauges will be installed adjacent to the pilot wells with monitoring points to assess impacts on overlying formations.
- The quality of incidental water lifted during proposed activities will be monitored daily and the results provided to the relevant authorities on a weekly basis.
- Santos will make reasonable endeavours to establish a network of groundwater monitoring bores to monitor the impacts of Dewhurst 26-29 and other pilots planned as part of the 50 well program on groundwater sources.

6.1.3.3 Impact categorisation

Table 6-4 provides an analysis of the potential impacts on groundwater.

Table 6-4 Groundwater impact categorisation

Analysis of impact	Comment
Size	The total water likely to be abstracted is 276 ML for the first three years, equating to approximately 251.6 m ³ /day.
Scope	There is negligible change in flux or drawdown in the upper layers. GDEs and registered bore users will not be impacted. Refer to the Groundwater Impact Assessment at Appendix 7.
Intensity	Low – impacts are negligible
Duration	Short term – Water extraction will occur over a sufficient period to provide three months continuous data at stabilised extraction rates. This requires the pilot to be active for up to three years.
Level of confidence in predicting impacts	High confidence and knowledge based on detailed groundwater modelling that has been undertaken, as well as previous exploration activities, including drilling activities, undertaken by Santos over a 50 year period.
Level of reversibility of impacts	Medium, any movement of groundwater between aquifers will naturally rebalance over time
Ability to manage or mitigate the impacts	The proposed mitigation measures at section 6.1.3.2 have been developed based on Santos' prior experience with similar activities. These measures would be effective in minimising impacts on groundwater and have been included within the statement of commitments for the proposed activity at section 9.0.
Ability of the impacts to comply with standards, plans or policies	The following standards, plans and policies will be adhered to: <i>NSW Coal Seam Gas Code of Practice Well Integrity (DTIRIS 2012b)</i>

Analysis of impact	Comment
Level of public interest	The level of public interest relating to potential impacts on groundwater is considered to be moderate, particularly as registered bore users will have an interest in impact to groundwater. The general public maintains an interest in ensuring that the works would not result in adverse impacts on the environment.
Requirement for further information on the impacts of the activity or mitigation	Additional modelling as water production data becomes available will be undertaken. This will further refine impacts to the deeper targeted aquifers.
Impact category	Although the activity will occur within a sensitive area (i.e. groundwater recharge area), given the small scale of the proposed activity, provided that the identified mitigation measures are implemented, a negligible to low adverse impact on groundwater is expected.

6.1.4 Flooding

6.1.4.1 Potential impacts

Likely change on flood or tidal regimes, or activity to be affected by flooding

The proposed activity is unlikely to significantly affect the distribution or flow of floodwaters. Some grading will occur at the lease areas however given the existing topography is relatively flat, changes are minimal.

The site is not located within a flood plain.

Sediment, contaminants or gross pollutants may be released into waterways as a result of localised flooding and inundation of the site.

The site is not located near the coast and therefore would not affect tidal regimes.

6.1.4.2 Mitigation measures

Site establishment and construction

- 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. This will also occur during drilling

Drilling

- A minimum freeboard of 300 millimetres will be maintained for any tanks or pits containing liquid waste.

Operation

Nil

6.1.4.3 Impact categorisation

Table 6-5 provides an analysis of the potential impacts that could be caused by flooding.

Table 6-5 Flooding impact categorisation

Analysis of impact	Comment
Size	Site is not located within a floodplain, any flooding that will occur will be the result of localised heavy rains.
Scope	Impacts will be localised .

Analysis of impact	Comment
Intensity	Small – any impacts will be small and short term.
Duration	Short term – site will only be impacted in heavy rains.
Level of confidence in predicting impacts	High, site is not within a flood plain.
Level of reversibility of impacts	High, impacts will be minimal.
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above.
Ability of the impacts to comply with standards, plans or policies	Nil.
Level of public interest	Low.
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Negligible.

6.1.5 Coast process and coastal hazards

Likely effect on coastal processes and coastal hazards, including those under projected climate change conditions

The site is not located near the coast and therefore would not affect coastal processes or hazards, including tidal regimes.

6.1.5.1 Mitigation measures

Nil

6.1.5.2 Potential impact category

Nil. Coastal processes and coastal hazards would not be affected by the proposed activity.

6.1.6 Hazardous substances and chemicals

6.1.6.1 Potential impacts

Use, storage or transport of hazardous substances or use or generation of chemicals which may build up residues in the environment

The proposed activity will require the use of chemicals, fuels and oils, particularly during drilling activities, as described in Section 2.0 of the REF. While these substances are not highly hazardous at the volumes which they are proposed to be used, 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. Moving vehicles, plant and machinery may also introduce a potential hazard to the site, which may have safety implications due to the accidental ignition by vehicles or machinery.

Drilling mud, containing a number of chemical additives, will be used during drilling as described in Section 2.7.3.4 of the REF. A chemical fact sheet, identifying environmental considerations for each of the chemicals to be used during drilling, is included in Appendix 1. The majority of chemicals would have no impact on the

environment. Some of the chemicals to be used may have consequences to the environment if not used, stored or disposed of appropriately. However, the risk to the environment is considered to be low as chemicals will be stored on site in small quantities. Chemicals will be stored off the ground in an elevated trailer. The proposed activity will be short term and all chemicals will be used and disposed of in accordance with the relevant MSDS.

The risk to human health as a result of the chemicals is also considered to be low as site workers will wear and use the appropriate personal protective equipment and no members of the public will be able to enter the work area. Waste will be disposed of appropriately in accordance with relevant legislation.

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

Dangerous goods will be transported according to regulatory requirements under the *Dangerous Goods (Road and Rail Transport) Act 2008*.

The impacts associated with spills and associated mitigation measures are covered in the discussion on soil quality (Section 6.1.1) and surface water quality (Section 6.1.2)

6.1.6.2 [Mitigation measures](#)

The measures identified to address soil quality and surface water quality will minimise potential impacts and risks associated with the use of hazardous substances and chemicals. In addition, the following mitigation measures will be implemented:

Site establishment and construction

Nil

Drilling

- 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*.

Operation

Nil.

6.1.6.3 [Impact categorisation](#)

Table 6-6 provides an analysis of the potential impacts from the use of hazardous substances and chemicals.

Table 6-6 Hazardous substances and chemicals impact categorisation

Analysis of impact	Comment
Size	The amount of hazardous chemicals stored on site is minimal.
Scope	Localised, spills will be managed through the provision of spill kits on site and associated training in their use.

Analysis of impact	Comment
Intensity	Small – any impacts will be small and short term.
Duration	Short term – chemicals will only be on site during drilling (up to 40 days).
Level of confidence in predicting impacts	High, chemicals stored on site will be small and likely to have a minimal impact if spilled.
Level of reversibility of impacts	High, impacts will be minimal.
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above. Any chemicals stored on site will be minimal, a spill kit will be available, vacuum trucks will be on standby.
Ability of the impacts to comply with standards, plans or policies	The following standards, plans and policies will be adhered to: <i>Work Health and Safety Act 2011.</i> <i>Dangerous Goods (Road and Rail Transport) Act 2008.</i>
Level of public interest	High – hazardous chemicals whilst not specifically raised in association with this project, does generally have a high level of public interest.
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Negligible to low adverse.

6.1.7 Gaseous, liquid and solid waste and emissions

6.1.7.1 Potential impacts

Generation or disposal of gaseous, liquid or solid wastes or emissions.

Waste

The proposed activity will generate a number of waste streams, as identified in Section 2.8.1.2 of the REF. Where possible waste will be reduced or recycled with waste separated into bins on the lease area to facilitate transfer to appropriate treatment facilities. Specific reuse activities will be put in place for drilling fluids and cuttings.

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.
- addition to landfill.

It is expected that drill cuttings will consist of excavated natural material and can be used in site rehabilitation under the ENM exemption issued by the EPA on 19 October 2012. Drill cuttings will be tested to determine whether they comply with the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Waste) Regulation 2005* and the ENM exemption and whether they can be reused or require off-site disposal.

During operation, saline water abstracted from the aquifer will be captured at the wellhead and transferred through the water capture system to Dewhurst 28. The water will then be stored in a transfer tank and

transferred either by flowline to an appropriate treatment facility (Bibblewindi Water Management Facility or the Leewood Produced Water and Brine Management Facility) for beneficial use.

Emissions

Emissions include greenhouse gases (GHG) and other pollutants that may impact on localised air quality.

The main air pollutants that impact air quality are associated with vehicle, plant and machinery exhaust emissions impacting on air quality including 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.

Scope 1 air emissions (direct GHG) from the proposed activity will include:

- Flaring of coal seam gas.

Flaring will be the primary source of GHG emissions for the proposed activity. It is estimated that around 90 per cent of the produced CSG will be flared (the remainder will be used for on-site power generation). Flaring of gas will result in a net reduction of the GHG emissions when compared to venting. When the gas is flared methane is consumed in the process resulting in a significantly lower emission than from direct release to the atmosphere (methane has 21 times the global warming potential (GWP) of carbon dioxide). Consistent with Santos' Climate Change Policy, venting and flaring will only be employed where there is no feasible alternative.

- Fugitive emissions associated with the gathering system and drilling activities.

Minor amounts of gas will be lost to the atmosphere during well development and operation, as well as from the gas gathering pipeline network and associated equipment.

When drilling, venting and flaring may be required when:

- » disposing of air and any produced CSG (when air drilling)
- » production testing the well
- » drill stem testing
- » in an emergency well control situation.

Venting and flaring rates, durations and volumes can vary significantly and depend on whether the well is drilled with air or mud, the number of gas zones and the distance between the zones. Air drilled holes require flaring once the top gas zone has been penetrated. If mud drilling is adopted, no gas is flared or vented except in an emergency or if gas is unexpectedly produced during drill stem testing. Santos intends to drill all the wells using water based drilling mud which will minimise venting and flaring requirements during this phase of the operation.

Fugitive emissions have been calculated based on:

- » 1.2×10^{-3} tonnes of carbon dioxide equivalent (CO_{2-e}) per tonne gas throughput for the gathering system, in accordance with the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*
- » 0.2 tonnes methane (CH₄)/drilling day for mud degassing (converted from 70 per cent methane and accounting for GWP of 21), in accordance with the *API Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry*.

These emissions are expected to be incidental however have been included in the estimate for completeness.

- Emissions from on-site power generation.

Some of the produced CSG will be used for electricity generation at the drill sites. This will reduce the sites dependence on diesel fuel for generation, and reduce the amount of gas sent to flare.

- Exhaust emissions from site-based vehicle movements, plant and machinery

GHG are emitted when fuel is combusted in vehicles, plant and machinery. These emissions are expected to be negligible.

- Clearing of vegetation.

Trees and other vegetation metabolise carbon and store a portion of it as permanent, woody biomass as they grow. When vegetation is cleared the stored carbon is typically lost to the atmosphere as carbon dioxide (CO₂) along with small amounts of carbon monoxide (CO) and CH₄. Vegetation clearing has been minimised where possible as discussed in Section 6.2.

Scope 2 (indirect GHG) emissions will not occur as there will be no purchases of electricity from the grid.

Scope 3 emissions have not been considered at this time.

Table 6-7 provides a summary of estimated emissions. These values have been calculated based on estimated gas flow rates for the first twelve months. The calculation for the flare is based on the design capability of the equipment (refer to Table 2-14) rather than the expected generated gas levels and is therefore conservative.

Table 6-7 Estimated GHG Emissions

Component	Tonnes / CO ₂ e / day
Flare ¹	17.6 – 52.9
Mud degassing ²	4.5
On-site power generation	1.6 – 4.8
Fugitive emissions	0.08 – 0.25
Plant and equipment	Negligible
Vegetation clearing	Negligible
Estimated maximum per day	19.3-58.0

Notes

1. Emissions associated with the flare will not occur until after the gathering system is operational and drilling has finished.
2. Per drilling days up to 40 days.

The REF has assessed overall impacts for the proposed activity based on operation for the life of PEL 238. However, it is expected that the flare would not operate for the same period in line with Santos policy to pursue no flaring or venting of associated gas unless there are no feasible alternatives.

Emissions will be monitored and reported in accordance with legislative requirements.

The primary risk associated with GHG emissions are their potential contribution to New South Wales and Australian GHG profiles.

Australia's GHG Inventory for 2010 (<http://ageis.climatechange.gov.au/>) is provided in Table 6-8. The table shows the maximum expected emissions for the proposed activity over a 12 month period. The potential

GHG contribution of the proposed activity to Australia's existing GHG profile is very minor, being approximately 0.004 per cent and 0.013 per cent of the National and State emissions profiles respectively.

Table 6-8 Comparison to Australian and NSW Emissions

	GHG Emissions Tonnes CO ₂ -e
Australian Emissions (2010)	560,773,000
NSW Emissions (2010)	157,435,000
Estimated Maximum Project Emissions ¹	21,170

Notes

1. Based on most conservative estimate of 44.4 tonnes / CO₂-e / day.

Other air emission associated with the operation of combustion equipment (such as for the flare and the generation sets), are expected to dissipate with distance from the source. As the closest sensitive receiver is in excess of five kilometres from the proposed activity, impacts are expected to be negligible, with no increased risk to health or amenity.

The flare has been designed to ensure that complete gas combustion occurs, and therefore impacts to air quality are minimised. Bushfire risk is discussed in section 6.3.1.

6.1.7.2 Mitigation measures

The waste reduction and management strategy described in Section 2.8 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:

Site establishment and construction

- A waste management plan will be prepared prior to construction.
- 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. These will remain during drilling activities.

Drilling

- 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 2.8.
- 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.

Operation

- Produced water will be transferred to an appropriate water treatment facility to be treated for beneficial reuse or disposal.

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

Site establishment and construction and drilling

- All wells to be drilled using water based mud that will minimise venting and flaring requirements
- The area of disturbance will be limited to the minimum required to carry out the proposed activity safely and efficiently.
- 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.
- Use energy efficient equipment and processes where possible.

Operation

A portion of the captured CSG will be diverted for on-site power generation, reducing the need to use diesel on the site, and reducing gas to flare.

6.1.7.3 [Impact categorisation](#)

Table 6-9 Table 6-10 provides an analysis of the potential impacts from the production of gaseous liquids, solid waste and emissions.

Table 6-9 Gaseous, liquid and solid waste and emissions categorisation

Analysis of impact	Comment
Size	Estimated waste during construction/drilling – 20 m ³ general waste, 2 m ³ /month sewage waste, 400 m ³ drilling fluid (to be transferred to a treatment facility in Narrabri) Water produced during operation is estimated to be 251.6 m ³ /day (or 273 ML over 3 years). Emissions – minimal, pollutants generally dissipate with distance from the source and are unlikely to affect surrounding sensitive receptors. Flare designed to ensure that ignition and complete gas combustion occurs. Contribution to state and national GHG emissions approximately 0.004% and 0.013% respectively
Scope	Waste – localised, waste will be sorted on site and transported to the appropriate facilities for treatment and disposal. Drilling fluid will be separated and reused on site where possible. Emissions – localised, closest sensitive receiver located over 5km from source. Greatest proportion of GHG emissions likely to come from flare at Dewhurst 28.
Intensity	With the implementation of the proposed mitigation measures, potential impacts would be low and over a relatively short period. GHG impacts are longer term however the extent of emissions is relatively small.
Duration	Short/medium term – Flare installed at Dewhurst 28 for the life of the pilot wells. Any leakage from the gathering system will be identified immediately and the well shut down. Vehicle and machinery emissions will only occur during drilling (up to 40 days), Waste will only be generated during site establishment and drilling activities.
Level of confidence in predicting impacts	High confidence and knowledge based on previous exploration activities, including drilling activities, undertaken by Santos over a 50 year period.
Level of reversibility of impacts	Low.

Analysis of impact	Comment
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above.
Ability of the impacts to comply with standards, plans or policies	The following standards, plans and policies will be adhered to: <i>POEO Act and POEO (Waste) Regulation.</i> <i>National Greenhouse and Energy Reporting Act 2007.</i> Waste Classification Guidelines Part 1: Classifying Waste (DECCW 2009).
Level of public interest	High – hazardous chemicals whilst not specifically raised in association with this project, do generally have a high level of public interest.
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Potential impacts associated with gaseous liquids, solid waste and emissions can be appropriately managed with the identified mitigation measures. GHG 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. A negligible to low adverse impact is expected.

6.1.8 Dust, noise, odours, vibration and radiation

6.1.8.1 Potential impacts

Dust

Dust will be generated during clearing, access track and well lease excavation and drilling and will vary depending on weather conditions.

Excessive dust from the proposed activities could potentially disrupt the pollination cycle and ability of native plants to regenerate (i.e. germination, revegetation and re-colonisation of existing plants).

Odours

Methane (CH₄) in its natural form is odourless. Carbon dioxide (CO₂) in low concentrations is also odourless. No impact is expected.

Noise

A Noise Impact Assessment for similar activities to the proposed activity was undertaken by Noise Measurement Services and is included in Appendix 4. The key findings are outlined below.

The relevant noise criteria for the project are derived from the intrusive noise criterion and sleep disturbance criterion under the *NSW Industrial Noise Policy (INP)* (EPA, 2000), which is based on the rating background level (RBL) plus 5 dB(A) and is 35 dB(A) for this project.

The proposed activity has the potential to generate most noise during the construction phase, particularly during drilling which may occur up to 24 hours per day. Drilling is only expected to take approximately 40 days.

Noise modelling for a similar project in the Pilliga East State Forest indicates that noise levels are unlikely to exceed noise criteria during drilling at distances of greater than five kilometres from the site during a variety of meteorological conditions. Noise levels from drilling activities during a temperature inversion (which

typically occur at night and tend to propagate noise) were predicted to be 17 dB(A) at 5.7 kilometres from the source for a similar project. Therefore, the proposed drilling activities at Dewhurst 26-29 are highly unlikely to be audible at any residence during the day or night.

Operation of a five well pilot set, under temperature inversion conditions, was predicted to generate noise levels of 18 dB(A) at five kilometres from the source. As there are no receivers within five kilometres from the Dewhurst 26-29 site, operation of the wells is unlikely to be audible at any receiver during the day or night.

Noise as a result of vehicles, machinery and drilling may deter native fauna from utilising the study area and immediate surrounding areas as habitat. The proposed activities could affect the migration and dispersal ability of native fauna particularly in relation to vehicular movements. The proposed activities may result in increased noise and light pollution which has the potential to disrupt the breeding cycle and the foraging and roosting behaviour of some native fauna species.

Vibration

Localised vibration may occur during drilling however this is unlikely to impact sensitive receivers who are located more than five kilometres from the activity.

Radiation

No radiation impacts are expected from the proposed activity.

6.1.8.2 Mitigation measures

The following measures will be implemented to reduce the impact of dust:

Duration of project

- Dust will be suppressed as required by spraying water along the access tracks and lease areas.
- If necessary, the access tracks will be sealed to prevent excessive dust emissions.
- Site speed limits will be imposed to minimise dust generated by vehicle movements.

The noise management strategy outlined in Section 2.8 will be implemented. Further, the following measures will be implemented to manage potential noise impacts of the proposed activity:

Site establishment and construction

- Consultation with Forestry NSW will be carried out in accordance with Section 2.4 of the REF.
- In the event of a noise complaint, the noise source will be investigated and, where necessary, additional feasible and reasonable measures will be implemented.

Drilling

- Prior to arriving on site, source noise levels of the drilling rig will be confirmed to verify noise impacts and confirm the management approach.
- In the event of a noise complaint, the noise source will be investigated and, where necessary, additional feasible and reasonable measures will be implemented.

Operation

Nil.

6.1.8.3 Impact categorisation

Table 6-10 provides an analysis of the potential impacts caused by the generation of dust, noise, odours, vibration and radiation.

Table 6-10 Dust, odours, noise, vibration or radiation categorisation

Analysis of impact	Comment
Size	Dust – dust will occur during site establishment although this is expected to be minimal Noise – generated noise will be within acceptable guidelines (35 dB(A)).
Scope	Dust will be confined to the access tracks and lease areas proximate to construction activities. Sensitive receivers are located in excess of five kilometres from the nearest well.
Intensity	Low – any impacts will be small and short term.
Duration	Short term – noise and dust impacts are greatest during site establishment and drilling.
Level of confidence in predicting impacts	High. Noise modelling has been undertaken by an industry recognised consultant.
Level of reversibility of impacts	High, impacts will be minimal.
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above.
Ability of the impacts to comply with standards, plans or policies	The following standards, plans and policies will be adhered to: NSW Industrial Noise Policy (INP) (EPA, 2000). Interim Construction Noise Guideline (ICNG) (DECC, 2009).
Level of public interest	High – noise is a critical issue for sensitive receivers.
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Negligible to low adverse.

6.2 Biological

6.2.1 Potential Impacts

An ecological assessment has been undertaken by RPS and is provided in Appendix 5. The key findings are outlined below.

6.2.1.1 Vegetation clearing

Construction activities will require the removal of up to approximately 5.755 hectares of vegetation. This will include the clearing of trees with small hollows, removal of old stockpiles of felled vegetation, and disturbances to understorey vegetation and ground cover such as leaf litter and fallen bark.

Some hollow bearing trees will be removed as a result of the proposed activity. These trees provide viable nesting, roosting and/or breeding resources for native birds, arboreal mammals and some reptile species. They provide breeding habitat for a range of threatened species that are known, or potentially occur in the study area, including Little Lorikeet, Masked Owl, South-eastern Long-eared Bat, and Turquoise Parrot.

However, the broader area provides an abundance of hollow bearing trees that contain viable nesting, roosting and/or breeding resources. The potential removal of hollow bearing trees is not considered to be significant as it is considered unlikely that hollow dependant fauna will be adversely impacted by the proposed activities and should be able to relocate successfully into hollow bearing resources that are present throughout the adjacent habitats.

There will be a temporary disruption of nesting, breeding and/or sheltering behaviour of some reptiles and ground dwelling mammals, however, the disruption is likely to be minimal in extent and these habitat resources will be relocated to adjacent habitats within the broader area.

6.2.1.2 Threatened flora and fauna species (impacts under the TSC Act)

Section 5A of the EP&A Act lists seven factors that must be taken into account in the determination of the significance of potential impacts of proposed activities on 'threatened species, populations or ecological communities (or their habitats)' listed under the TSC Act. The 7-part test is used to determine whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats and thus whether a Species Impact Statement (SIS) is required.

On this basis an assessment of significance was completed for the threatened species populations and ecological communities that are known to occur, or considered likely to occur within the study area. A total of 18 assessments of significance were undertaken. The application of the 7-part test concluded that there is not likely to be a significant effect on threatened species, populations, or their habitats arising from the proposed activities. Table 6-11 provides a summary of assessment of significance of potential impacts.

Table 6-11 Summary of assessment of significance for TSC Act listed species

Species	Common name	TSC Act status	Potential impact	Assessment of significance of potential impacts
Fauna species recorded in the study area				
<i>Chalinolobus picatus</i>	Little Pied Bat	V	<ul style="list-style-type: none"> ▪ Loss of woodland habitat ▪ Loss of roosting sites 	Significant impact unlikely
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	<ul style="list-style-type: none"> ▪ Loss of woodland habitat ▪ Disturbance to movement patterns as they are unable to cross open areas ▪ Disturbance or removal of nests 	Significant impact unlikely
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	<ul style="list-style-type: none"> ▪ Loss of woodland habitat ▪ Loss of roosting sites 	Significant impact unlikely
<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	V	<ul style="list-style-type: none"> ▪ Loss of woodland habitat, particularly understorey vegetation ▪ Disturbances to nests, often located on the ground ▪ Potential for increased predation of nest sites 	Significant impact unlikely
<i>Mormopterus eleryi</i> ¹	Bristle-faced Freetail Bat	E	<ul style="list-style-type: none"> ▪ Loss of woodland habitat ▪ Loss of roosting sites 	Significant impact unlikely
Fauna species considered likely to occur				
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	<ul style="list-style-type: none"> ▪ Loss of woodland habitat and flowering Eucalypts 	Significant impact

Species	Common name	TSC Act status	Potential impact	Assessment of significance of potential impacts
			<ul style="list-style-type: none"> Disturbances due to noise and light 	unlikely
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V	<ul style="list-style-type: none"> Loss of habitat Modification to ground habitat 	Significant impact unlikely
<i>Neophema pulchella</i>	Turquoise Parrot	V	<ul style="list-style-type: none"> Loss of habitat, particularly hollow bearing trees and ground covers Potential for increased predation 	Significant impact unlikely
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	<ul style="list-style-type: none"> Loss of habitat Loss of hollow-bearing trees Disturbances due to noise and light 	Significant impact unlikely
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	V	<ul style="list-style-type: none"> Loss of woodland habitat Loss of potential food trees Loss of hollow bearing trees Disturbances due to noise and light 	Significant impact unlikely
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	<ul style="list-style-type: none"> Loss of woodland habitat Disturbances to fallen timber Loss of hollow-bearing trees required for nesting 	Significant impact unlikely
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	<ul style="list-style-type: none"> Loss of habitat Disturbances to nests 	Significant impact unlikely
<i>Lophoictinia isura</i>	Square-tailed Kite	V	<ul style="list-style-type: none"> Loss of habitat 	Significant impact unlikely
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	<ul style="list-style-type: none"> Loss of habitat, particularly riparian habitat Loss of hollow-bearing trees Loss of flowering Eucalypts 	Significant impact unlikely
<i>Ninox connivens</i>	Barking Owl	V	<ul style="list-style-type: none"> Loss of habitat Loss of nesting sites (hollow-bearing trees) 	Significant impact unlikely
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat, Corben's Long-eared Bat	V	<ul style="list-style-type: none"> Loss of woodland habitat and hollow-bearing trees Disturbances due to noise and light 	Significant impact unlikely
<i>Phascolarctos cinereus</i>	Koala	E	<ul style="list-style-type: none"> Loss of secondary food trees Vehicle strike Disturbances due to noise and light 	Significant impact unlikely
<i>Tyto novaehollandiae</i>	Masked Owl	E	<ul style="list-style-type: none"> Loss of habitat Loss of nesting sites (hollow-bearing trees) 	Significant impact unlikely

Species	Common name	TSC Act status	Potential impact	Assessment of significance of potential impacts
			▪ Vehicle strikes	

¹Although the Bristle-faced Freetail Bat has been assessed as if it was recorded within the area of consideration, its presence was not confirmed.

6.2.1.3 Threatened flora and fauna species (impacts under the EPBC Act)

While no listed flora species were recorded in the study area, five species have the potential to occur based on habitat available. An assessment of significance was not considered necessary, as targeted searches for these flora species did not record these species within the study area, and an initial assessment of potential for impact determined that significant impacts are considered unlikely.

No threat listed fauna species were recorded within the study area; though it is considered possible that one bird species and two mammal species are likely occur. An assessment of significance for each of the fauna species whose occurrence is considered to be 'likely' has been undertaken in accordance with the EPBC Act and *EPBC Act Policy Statement 1.1 – Significant Impact Guidelines Matters of National Environmental Significance* (DEWHA, 2009). The assessments concluded that no significant impact is anticipated for fauna species. Table 6-12 provides a summary of the significant impact assessments.

Table 6-12 Summary of EPBC Act impact assessment for threatened fauna species

Species	Common name	EPBC Act status	Potential impact	Assessment of significance of potential impacts
Considered to likely occur				
<i>Phascolarctos cinereus</i>	Koala	V	<ul style="list-style-type: none"> ▪ Loss of potential resting habitat ▪ Vehicle strike ▪ Disturbances due to noise and light 	Significant impact unlikely
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat, Corben's Long-eared Bat	V	<ul style="list-style-type: none"> ▪ Loss of woodland habitat and hollow-bearing trees ▪ Disturbances due to noise and light 	Significant impact unlikely
<i>Anthochaera phrygia</i> / <i>Xanthomyza phrygia</i>	Regent Honeyeater	CE	<ul style="list-style-type: none"> ▪ Loss of woodland habitat and flowering Eucalypts ▪ Disturbances due to noise and light 	Significant impact unlikely

6.2.1.4 Key threatening process

The EPBC Act and TSC Act provide for the identification and listing of key threatening processes (KTPs). KTPs are defined as a threatening process 'if it threatens or may threaten the survival, abundance, or evolutionary development of a native species or ecological community' (SEWPaC, 2012).

KTPs under the EPBC Act and TSC Act that are relevant to the proposed activities are discussed in Table 6-13.

Table 6-13 Summary of key threatening processes

Key threatening process	Relevance to proposed activities
EPBC Act/TSC Act	
Competition and land degradation by feral European Rabbits	Rabbits were not observed in the study area, but are considered likely to occur. However, it is not anticipated that the proposed activities will increase opportunities for increase to the Rabbit population.
Competition and land degradation by unmanaged goats	Goats were not observed in the study area, but are considered likely to occur. However, it is not anticipated that the proposed activities will increase opportunities for increase to the Goat population. Mitigation measures may be required at the completion of the project to ensure rehabilitation activities are not disturbed by unmanaged goats
Dieback caused by the root-rot fungus (<i>Phytophthora cinnamomi</i>)	There exists the potential for the importation of this pathogen on unclean vehicles and plant machinery.
Land clearance/removal of native vegetation	Vegetation clearing will be required. Approximately 5.755 ha of vegetation will be removed to facilitate the construction of four wells and associated infrastructure.
Predation by European Red Fox	European Red Fox was observed in the study area. It is considered unlikely that the proposed activities will result in increased predation by European Red Fox, given the relatively limited amount of clearing proposed, in comparison to habitat available in the surrounding areas.
Predation by feral cats	Feral Cats were observed in the study area. If waste is not managed on site, there is the potential for an increase in the Feral Cat population.
Predation, habitat degradation, competition and disease transmission by feral Pigs	Evidence of feral pigs was observed in the study area. It is considered unlikely that the proposed activities will result in increased predation, habitat degradation, competition or disease transmission.
TSC Act	
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	The proposed activity will not result in high frequency fires. Fire prevention strategies will be outlined in the REF.
Removal of dead wood and dead trees	Some dead wood in the form of hollow logs and fallen woody debris will be disturbed by the proposed activities, but these habitat resources will be relocated elsewhere in the study area and none will be removed from the study area.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	No works are proposed to occur within any streams or wetlands. It is therefore considered that the proposed works will not alter the natural regimes of any rivers, streams and their floodplains and wetlands.
Predation and hybridisation by feral dogs, (<i>Canis lupus familiaris</i>)	Feral dogs were not observed in the study area, but are considered likely to occur. It is considered unlikely that the proposed activities will result in increased predation from feral dogs.
Loss of hollow-bearing trees	Hollow-bearing trees will be removed to facilitate construction. Where hollow-bearing trees occur adjacent to leases, they will be retained. The hollow bearing trees to be removed will be placed into adjacent habitats as hollow logs and woody debris.
Invasion of native plant communities by exotic perennial grasses	There exists the potential for the invasion of native woodland and grassland communities by exotic perennial grass species, transferred via vehicles and site machinery.

6.2.1.5 Fauna displacement and barriers to movement

The proposed activity will result in the clearing of viable habitat from the affected area (lease area, access track and gathering system). This habitat provides foraging, breeding, roosting and sheltering resources that may currently be utilised by all the faunal groups identified in the study area. This will result in the

displacement of native fauna across the study area. Displaced fauna will need to relocate into adjacent habitats, which will place short-term pressure on the available resources within these habitats.

The degree of displacement within the study area and the intensity of pressure placed on adjacent habitats are minimal based on the percentage of habitats to be lost in comparison to what will be retained in the study area.

The impact on the migration and dispersal ability of native flora and fauna, like most of the other impacts, is species specific. Species, which are less mobile (e.g. reptiles and amphibians), residents (e.g. some birds) or species whereby the habitat to be removed forms an important component of the overall habitat area, are those that will be most likely impacted.

The proposed activity is unlikely to fragment or isolate areas of vegetation or impose a significant barrier to the migration and dispersal ability of native biota. Mobile species such as microbats, medium to large mammals and woodland birds will not be impacted by the proposed activities.

The less mobile smaller species are also unlikely to be significantly impacted, as the area/ extent of habitats to be cleared is small in comparison to the area of habitats to be retained across the study area.

6.2.1.6 Ecological community of conservation significance

The site does not contain any TECs or other communities of conservation significance.

6.2.1.7 Biological diversity

Impacts to biological diversity are negligible as the area impact is relatively small, the activity is temporary in nature and edge effects and severance of fauna corridors will not occur.

6.2.1.8 Noxious weeds, vermin and feral species

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. Weed cover within the impacted area is very low with only one noxious weed (Prickly Pear) observed in very low densities.

6.2.2 Mitigation measures

The site will be rehabilitated in accordance with Section 2.7.6 of the REF. In addition, the following measures will be implemented to minimise impacts on flora and fauna:

Site establishment and construction

- Clearing of habitat trees will be avoided where possible.
- Disturbance areas will be minimised where possible during the design process.
- When clearing or disturbance to vegetation occurs, a fauna spotter/catcher will be on site to supervise works.
- Hollow logs removed from the disturbance areas are to be relocated in habitats adjacent to the lease areas under supervision from the fauna spotter/catcher. Fauna sensitive clearing techniques will be implemented, including vibrating the bucket on large trees (particularly hollow-bearing trees) prior to clearing, and dismantling large trees.

- 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.

Drilling

Nil

Operation

- The site will be rehabilitated in accordance with Section 2.7.6 of the REF.

6.2.2.1 Impact categorisation

Table 6-14 provides an analysis of the potential biological impacts.

Table 6-14 Biological impacts categorisation

Analysis of impact	Comment
Size	Up to approximately 5.755 hectares will be cleared. Potential impacts to identified threatened flora and fauna species likely to occur at the site have been assessed as unlikely.
Scope	Localised – impacts are confined to the local area. It is expected that all affected species will relocate to adjacent vegetated areas. Any hollow logs will also be relocated.
Intensity	Low – any impacts will be small and short term. The area impacted is proportionally small.
Duration	Medium term. Areas will require clearing however during operation of the wells, the Dewhurst 26, 27 and 29 lease areas will be sites will be rehabilitated back to essential well head infrastructure. In the event that gas production is not considered viable, full rehabilitation of all lease areas will occur.
Level of confidence in predicting impacts	High. An ecological assessment has been undertaken by appropriately qualified ecologists.
Level of reversibility of impacts	High, impacts will be minimal with mitigation measures implemented. Any affected fauna will be relocated to adjacent areas. Partial rehabilitation will occur.
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above.
Ability of the impacts to comply with standards, plans or policies	Nil.
Level of public interest	High, a number of environmental stakeholders have raised impacts to flora and fauna as a key issue.

Analysis of impact	Comment
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Medium adverse.

6.3 Community

6.3.1 Potential impacts

6.3.1.1 Community services and infrastructure

The proposed activity is unlikely to significantly impact on any community services and infrastructure. Contractors and employees required for the proposed activity may be sourced from outside the local area. The majority of these workers are likely to be housed in purpose built camps such as a workers camp proposed at 1919 Westport Road, Narrabri for which a development application has been lodged (DA 457/2013). Temporary accommodation may also be required in Narrabri or other surrounding workers. The introduction of this workforce to the area could provide economic benefits to the Narrabri community.

As the number of workers is relatively small (around 40 at its peak) social infrastructure in the local towns will accommodate the temporary workforce.

Traffic volumes will increase on Beehive Road and the southern part of Garlands Road, particularly during site establishment and drilling however these roads are not heavily utilised by the local community and there are no local residents with frontage to the roads.

During operation, the well sites will be visited daily. Traffic may also be generated to remove produced water from the site in the event that the Dewhurst Southern Flowline is not fully operational. In this case, approximately 12 trucks per day would be expected to visit facilities adjacent to the Dewhurst 28 lease area.

Movements associated with operations (inclusive of trucks) will easily be accommodated within the existing infrastructure.

6.3.1.2 Sites of importance

There are no sites of community importance located in the vicinity of the activity.

Lease areas will be fenced during site establishment, drilling and operations, and this will reduce access to some parts of the Pilliga Forest; however, the areas that will be impacted represent less than 0.0025 % of the available Forest.

6.3.1.3 Economic factors

The proposed activity will provide economic benefits for Narrabri and the surrounding region through the introduction of a temporary workforce, and purchasing of materials and supplies which would help support the local economy.

Any upgrades to Beehive Road will benefit Forestry NSW.

The exploration and development of gas reserves will have significant wider economic benefits to the NSW economy and is encouraged through policy guidance. The development of pilot wells is essential in determining the nature and composition of the Narrabri gas field and to inform future production.

6.3.1.4 Safety

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 Forestry NSW forest users.

6.3.1.5 Bushfire risk

Fire plays a major role in the ecology of the Pilliga scrub, with many plant species depending on fire to regenerate. However in unfavourable conditions fire can be extremely intense, destroy entire ecosystems, spread very quickly and threaten nearby properties. The magnitude of historical Pilliga bushfires correlates with the El Nino Southern Oscillation phenomena, with El Nino (dry) years having the most severe fires (NPWS 2006). In 1997 a major fire burned almost half of the Pilliga scrub, while an extremely dry winter and spring in 2006 saw a number of large fires develop. In January 2013, large fires threatened the Pilliga forest.

Bushfire needs to be considered from two perspectives:

- the management activities required should a fire occur
- the risk that the proposed activity contributes to the lighting of a fire.

In the event of a bushfire all activities will cease, wells will be capped (during drilling) or shut in remotely during operation. This includes the wells, flare and gathering system. A bushfire management plan will be prepared prior to operation.

The flare located adjacent to Dewhurst 28 is designed to limit the risk of ignition. Acceptable radiation limits for various locations at the flare site were determined based on the American Petroleum Industry (API) 521 standard and AS 60079.10.1 – Classification of Areas – Explosive Gas Atmospheres.

Within the 10 metre by 10 metre sterile zone, a HDPE liner will be laid covered with 300 millimetres of compacted soil and blue metal aggregate. This will ensure protection against heat and minimise the risk of ignition.

6.3.1.6 Visual or scenic landscape

The site is not visible from private landholder properties adjacent to the State Forest. The presence of plant, equipment and stockpiles during the proposed activity will result in some visual clutter however this is unlikely to be noticeable other than by users of the forest in the immediate area. During operation, the well heads and related surface infrastructure, particularly at Dewhurst 28 and 29, may be visible from Beehive Road.

The flare will not be visible from any private residences.

6.3.2 **Mitigation measures**

The consultation activities outlined in section 2.4 of the REF will be implemented. The site will be rehabilitated in accordance with section 2.7.6 of the REF. Further, the following measures will be implemented to reduce community impacts:

Duration of the project

- Works will be conducted in accordance with landowner requirements as outlined in the Occupation Permit issued under the *Forestry Act 1916*.

Site establishment and construction

- Site safety protocols, incident management and emergency procedures will be implemented during the construction and drilling works.
- The site will be kept in a clean and tidy manner during site preparation, drilling activities and operation of the pilot wells.

Operation

- The lease areas will be fenced and within Dewhurst 28, the flare will have a secondary 1.8 metre high fence.
- A bushfire management plan will be developed prior to construction.
- Hazard classification mapping will be updated prior to commencement of construction.

6.3.2.1 Impact categorisation

Table 6-15 provides an analysis of the potential impacts on the community.

Table 6-15 Community impacts categorisation

Analysis of Impact	Comment
Size	The impact will be minimal; the temporary workforce is small and will be accommodated by existing social infrastructure. Risks to safety including bushfire will be minimised through design.
Scope	Localised – impacts are confined to the local area. Extensive – The proposed activity contributes to the evaluation of gas reserves and the long-term economic benefits to the local and NSW economy.
Intensity	Low – any impacts will be small and short term.
Duration	Short term – the workforce is greatest during site establishment and drilling. During operation, the proposed activity will be visited daily generating one vehicle movement.
Level of confidence in predicting impacts	High. The ongoing consultation program will continue to identify community impacts and appropriate resolution of issues.
Level of reversibility of impacts	High, impacts will be minimal.
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above. Ongoing consultation program will ensure that emerging community issues are addressed.
Ability of the impacts to comply with standards, plans or policies	The following standards, plans and policies will be adhered to: American Petroleum Industry (API) 521. AS 60079.10.1 – Classification of Areas – Explosive Gas Atmospheres. Other standards as outlined in Table 2-13.
Level of public interest	Low – impacts to social and community infrastructure, site safety and visual impact have not featured highly in consultation activities to date.
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Negligible to low adverse.

6.4 Natural resources

6.4.1 Potential impacts

6.4.1.1 Conservation areas

The proposed activity does not impact on any conservation zones. Works will be undertaken within the Pilliga East State Forrest. The impact of this has been considered in biological impacts (Section 6.2) and community uses (Section 6.3).

6.4.1.2 Community use of natural resources

The proposed activity will prohibit forestry activities on up to approximately 5.755 hectares during site establishment and drilling within the Pilliga East State Forest. This area will be reduced significantly during operation and only represents a small portion of the total size of this State Forest (160,000 hectares).

Natural resources required for the proposed activity include fill material to build the lease areas (approximately 2825 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 pilot wells will pose no threat to future coal mining operations.

6.4.1.3 Depletion of natural resources (agricultural land)

An agricultural impact statement has been prepared and is included in Appendix 8.

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

As the proposed activity lies within a State Forest, it will not prohibit any agricultural production within the region, and there will not be any consequent reduction in the permanent land capability of agricultural resources.

The proposed activity will not impact on any transport infrastructure, water supply services or processing facilities required for agricultural enterprises.

No existing agricultural jobs will be lost as a direct result of the proposed activity. Therefore, the proposed activities will not result in a loss of agricultural employment opportunities in the Narrabri Shire LGA.

The proposed activity has the potential to impact on soils, surface and groundwater sources as discussed in previous sections. None of these impacts are expected to 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.

6.4.2 Mitigation measures

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

Site establishment and construction

- All plant and machinery delivered to the site will be cleaned of foreign soil in accordance with legislative requirements with respect to weed management
- Construction personnel will be trained in pest control and hygiene procedures.

Drilling

- Fuel will be used as efficiently as possible through appropriate work behaviour (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* (DTIRIS 2012b).

Operation

- All plant and machinery visiting the site will be cleaned of foreign soil in accordance with legislative requirements with respect to weed management

6.4.2.1 Impact categorisation

Table 6-16 provides an analysis of the potential impacts on natural resources.

Table 6-16 Natural resources impact categorisation

Analysis of Impact	Comment
Size	The impact will be minimal, up to approximately 5.755 hectares of Pilliga East State Forest will be impacted during site establishment and drilling and significantly less during operation. There will be no impact on agricultural land.
Scope	Localised – impacts are confined to the local area.
Intensity	Small – any impacts will be small and short term.
Duration	Short term – Natural resources will be impacted mostly during site establishment and drilling (up to 40 days). Following the initial activities, the site will be fully rehabilitated in accordance with the agreement between Santos and Forestry NSW.
Level of confidence in predicting impacts	High. An Agricultural impact Statement is provided in Appendix 8.
Level of reversibility of impacts	High, impacts will be minimal.
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above.
Ability of the impacts to comply with standards, plans or policies	The following standards, plans and policies will be adhered to: <i>NSW Coal Seam Gas Code of Practice Well Integrity.</i>
Level of public interest	High, impacts to the Pilliga East State Forest have been an area of concern for the community.
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Negligible.

6.5 Aboriginal cultural heritage

6.5.1 Potential impacts

6.5.1.1 Disturbance of ground surface or culturally modified trees

No 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.

6.5.1.2 Known aboriginal objects or places

No Aboriginal objects or sites 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.

6.5.1.3 Landscape features

According to the 2010 *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW 2010) the site possesses sensitive landscape features, as the proposed activity occurs within 200 metres of waters. These sensitive landscape features may indicate the presence of Aboriginal objects.

The central gathering system intersects three ephemeral watercourses and the lease areas of Dewhurst 26, 27 and 28 are located within approximately 200 metres of watercourses. During surveys of the site, two drainage lines were identified however no Aboriginal objects or sites were identified in association with these sensitive landscape features (Appendix 6). Given previous land disturbance and the absence of more permanent water sources and any Aboriginal objects or sites identified during site investigations, 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 within the site and that the archaeological potential of the site is low.

It is therefore unlikely that the proposed activity will harm any Aboriginal objects or places.

6.5.1.4 Avoidance opportunities

No avoidance opportunities are possible.

6.5.1.5 Native title and other agreements

As detailed at Sections 4.5 and 5.1.2, PEL 238 was granted prior to the commencement of the Native Title Act 1993 (Cth), there is no further need to comply with the Native Title Act for the conduct of the proposed activity.

6.5.2 Mitigation measures

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

Site establishment, construction and drilling

- 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.
- All works will be undertaken to comply with Part 6 of the *National Parks and Wildlife Act 1974*.

- 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.

Operation

Nil

6.5.2.1 Impact categorisation

Table 6-17 provides an analysis of the potential impacts on Aboriginal cultural heritage.

Table 6-17 Aboriginal cultural heritage impact categorisation

Analysis of Impact	Comment
Size	Small – no cultural objects, sites or landscapes identified within the site.
Scope	Localised – small area of ground disturbance at each well.
Intensity	Activity is low impact over a short duration. Area of impact is relatively small.
Duration	Short term, potential impacts will only occur during site establishment or initial drilling.
Level of confidence in predicting impacts	High, Aboriginal and Historical Heritage Due Diligence Assessment at Appendix 6.
Level of reversibility of impacts	Low, if a site is disturbed or artefact destroyed impact is not reversible; however it has been assessed that there is low to nil risk of harm to Aboriginal objects or places.
Ability to manage or mitigate the impacts	Possible, specific mitigation measures outlined above.
Ability of the impacts to comply with standards, plans or policies	Mitigation measures include training on statutory obligations under NPW Act and the Heritage Act.
Level of public interest	The level of public interest regarding Aboriginal cultural heritage is moderate. The general public maintains an interest in ensuring that the works would not result in adverse impacts on Aboriginal cultural heritage. A native title claim covers PEL 238 however as PEL 238 was granted prior to the commencement of the <i>Native Title Act</i> there is no further need to comply with the <i>Native Title Act</i> for the conduct of the proposed activity (refer section 4.5).
Requirement for further information on the impacts of the activity or mitigation	None.
Impact category	Provided the identified mitigation measures are carried out, potential impacts on Aboriginal cultural heritage will be negligible.

6.6 Historic heritage impacts

6.6.1 Potential impacts

The proposed activity will not impact on any known historic heritage items or places. There is potential for relics or other items of historic heritage value to be uncovered during clearing and excavation works; however this has been assessed as being very unlikely.

6.6.1.1 Places, buildings, landscapes or moveable items

No places, buildings, landscapes or moveable items will be affected by the proposed activity.

6.6.1.2 Vegetation and cultural landscape

No vegetation of cultural landscape value will be affected by the proposed activity.

6.6.2 Mitigation measures

If any previously unidentified potential historical heritage material is identified during construction or drilling, 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.

6.6.2.1 Impact categorisation

Table 6-18 provides an analysis of the potential impacts on historical heritage.

Table 6-18 Historical heritage impact categorisation

Analysis of Impact	Comment
Size	Small – no places, buildings, moveable items, vegetation or landscapes identified within the site.
Scope	Localised – small area of ground disturbance at each well.
Intensity	Activity is low impact over a short duration. Area of impact is relatively small.
Duration	Short term, potential impacts will only occur during site establishment or initial drilling.
Level of confidence in predicting impacts	High confidence and knowledge based on previous exploration activities, including drilling activities, undertaken by Santos over a 50 year period and the findings of the Aboriginal and Historical Heritage Due Diligence Report at Appendix 6.
Level of reversibility of impacts	Low, if a site is disturbed or artefact destroyed impact is not reversible however site has been identified as low risk of finding any unidentified sites or objects.
Ability to manage or mitigate the impacts	The proposed mitigation measures at section 6.6.2 have been developed based on Santos' prior experience with similar activities and the findings from the Aboriginal and Historical Heritage Due Diligence Report. These measures would be effective in minimising potential impact on natural resources and have been included within the statement of commitments for the proposed activity at section 9.0.
Ability of the impacts to comply with standards, plans or policies	Mitigation measures include training on statutory obligations under NPW Act and the Heritage Act.
Level of public interest	The level of public interest regarding historical heritage is low to moderate. The general public maintains an interest in ensuring that the works would not result in adverse impacts on historical heritage.
Requirement for further information on the impacts	No additional information is required to confirm the predicted level of historical heritage impact.

Analysis of Impact	Comment
of the activity or mitigation	
Impact category	Provided the identified mitigation measures are carried out, potential impacts on historical heritage will be negligible .

6.7 Matters of national environmental significance

The proposed activity is not likely to impact on any MNES, as detailed in Table 6-19.

Table 6-19 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 species and ecological communities:	Vegetation at the site does not comprise any threatened ecological communities. No threatened flora or fauna species listed under the EPBC Act were identified during the ecological survey. Four threatened flora species were considered to have the potential to occur based on the presence of suitable habitat: <i>Bertya opposens</i> , Cobar Greenhood Orchid (<i>Pterostylis cobarensis</i>), <i>Rulingia procumbens</i> , and <i>Tylophora linearis</i> . Significant impacts to these species as a result of the proposed activity are considered unlikely given that none were identified during the survey despite targeted searches. Three threatened fauna species listed under the EPBC Act were identified as having the potential to occur: <i>Anthochaera phrygia</i> (Regent Honeyeater), <i>Phascolarctos cinereus</i> (Koala) and <i>Nyctophilus corbeni</i> (South-eastern Long-eared Bat/Corben's Longeared Bat). However, these species were not recorded during detailed fauna surveys/trapping. Assessments of significance were carried for these species out in accordance with EPBC Act and <i>EPBC Act Policy Statement 1.1 - Significant Impact Guidelines Matters of National Environmental Significance</i> (DEWHA, 2009) and concluded that the proposed activity is unlikely to significantly impact these species.
Migratory species	Two migratory bird species listed under the EPBC Act were identified as having the potential to occur on site; the Rainbow Bee-eater and White-throated Needletail. Significant impacts to these species as a result of the proposed activity 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.

6.8 Cumulative impacts

6.8.1 Potential impacts

The Narrabri Shire is recognised for its CSG and mining resources. A number of mining exploration and production licences cover the area.

Existing mining occurs at the Whitehaven coal mine approximately 28 kilometres south of Narrabri and Boggabri Coal mine, approximately 15 kilometres north of Boggabri. The Whitehaven coal mine has commenced an approval process to support a 20 year mine life with a production of three million tonnes per annum. Expansion plans for both mines include a rail spur and coal handling facility. These will not impact the proposed activity.

A number of existing exploration and production wells are located within PEL 238, PAL 2 and PPL 3, the nearest being Dewhurst 4 (refer Section 4.1.5) adjacent to the proposed activity. These are in varying stages with some active, some suspended and others abandoned and rehabilitated, or awaiting rehabilitation. Existing wells and their purpose within PAL 2, PEL 238 and PPL 3 are summarised in Table 6-20.

Table 6-20 Existing wells within PAL 2, PEL 238, and PPL3

Purpose	PAL 2	PEL 238	PPL 3
Coal	-	66	-
Conventional gas	-	1	11
Conventional oil and Gas	2	2	-
Coal seam gas	48	47	1
Total	50	116	12

Santos is proposing a 50 well drilling program scheduled over three years commencing in 2013 to explore the Gunnedah Basin gas reserve. At this stage, the extent of the project within PEL 238 (inclusive of PAL 2) is expected to include:

- up to 10 core holes
- up to 6 pilot well sets.

The construction and operation of these wells will be subject to approval applications and assessment as the detail and specific locations of the wells and infrastructure is developed. Dewhurst 26-29 is one of the first pilot well sets proposed as part of this program.

The cumulative impacts of the proposed activity with the wider exploration program within PEL 238 are considered in Table 6-21.

Table 6-21 Cumulative impacts

MNES	Overview
Physical and chemical aspects	The proposed activity is temporary and of a minor nature. The lease area will be partially rehabilitated following completion of the pilot wells. The proposed drilling program currently assumes three rigs that have the potential to operate concurrently. No drilling is expected in the vicinity of the proposed activity and cumulative impacts would be minimal.
Biological	The proposed activity will remove trees with small hollows, old stockpiles of felled vegetation and disturbance to understorey vegetation and ground cover. Wells will be located in the Pilliga forest and where possible, these will be located in more disturbed areas. Lease areas have been minimised and access tracks and flow lines located adjacent to infrastructure corridors. Vegetation cleared represents around 2% or less of communities within the area.
Community	The proposed drilling program currently assumes three rigs that have the potential to operate concurrently. The number of employees present within the region associated with construction and drilling works, could be approximately 70-100 personnel. There is the potential for these employees to utilise local community social infrastructure, such as accommodation, retail and other services. The local townships of Narrabri, Wee Waa and Coonabarabran are expected to accommodate the additional short term workforce. Therefore, cumulative impacts on the community are expected to be negligible.
Natural resources	The proposed activity will involve minimal use of natural resources, including agricultural land. Cumulative impacts on natural resources will be negligible.
Cultural heritage impacts	The results of cultural heritage due diligence assessments indicate that the proposed activity is highly unlikely to impact on any cultural heritage. Therefore cumulative cultural

MNES	Overview
	heritage impacts are considered highly unlikely.
Groundwater	A regional groundwater model was developed that includes an assumption of 390 wells inclusive of the four pilot wells proposed in this REF. The modelling indicated that there will be negligible impact to the upper aquifers, GDEs and registered bore users. Wells will be constructed in accordance with industry regulations, therefore no contamination of shallow groundwater sources is expected. As the proposed activity was included as part of the regional modelling, no further cumulative impacts are expected.

There are two existing petroleum wells within three kilometres of the proposed wells, Dewhurst 4 and Dewhurst 9. Dewhurst 4 has been plugged and abandoned, and completely rehabilitated. Dewhurst 9 is currently suspended. There are currently no plans for further works at Dewhurst 9.

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 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.

6.8.2 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 approximately 5.755 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 ▪ water abstracted over 3 years, up to approximately 276 ML equating to an average of 251.6m³/day ▪ negligible change in volume of groundwater (flux) or drawdown in the upper layers, no impact to registered bore users or groundwater dependant ecosystems 	Negligible to low adverse
Flooding	<ul style="list-style-type: none"> ▪ area not within flood prone land 	Negligible
Coastal process and costal hazards	<ul style="list-style-type: none"> ▪ proposed activity not near a coastline 	N/A
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
Gaseous, liquid and solid waste and emissions	<ul style="list-style-type: none"> ▪ management of saline groundwater produced during operation of the pilot wells ▪ 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 ▪ generation of greenhouse gas emissions 	Low adverse
Dust, noise, odours, vibration and radiation	<ul style="list-style-type: none"> ▪ generation of dust and other particulates ▪ generation of noise, particularly during drilling activities which may occur up to 24 hours per day 	Negligible to low adverse
Biological	<ul style="list-style-type: none"> ▪ removal of up to approximately 5.755 ha of vegetation, comprising narrow-leaved ironbark woodland ▪ temporary disruption to breeding cycle, roosting, sheltering and foraging behaviour of fauna species ▪ three threatened fauna species were observed on site; potential impacts to these species are assessed as unlikely 	Medium adverse
Community	<ul style="list-style-type: none"> ▪ pressure on temporary accommodation in Narrabri area ▪ minimal generation of traffic on Beehive Road and Garlands Road. ▪ temporary reduced amenity for neighbours from noise, dust and visual impacts 	Negligible

Aspect	Potential impacts	Potential impact category (with mitigation measures)
	<ul style="list-style-type: none"> introduction of hazard (construction activities, gathering system and flare) with potential safety implications 	
Economic issues	<ul style="list-style-type: none"> economic benefits to Narrabri and surrounding region ongoing use of upgraded access track to benefit of Forestry NSW 	Positive
Natural resources	<ul style="list-style-type: none"> impact to Pilliga East State Forest no impact to agricultural land 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
Historic heritage impacts	<ul style="list-style-type: none"> disturbance of unknown historic heritage items. 	Negligible

On balance, the proposed activity will have negligible to low adverse impacts on the environment and community. There would be moderate adverse impacts on biological aspects. 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 7-2.

Table 7-2 Clause 228 factors

Factor	Impact
<i>Any environmental impact on a community</i>	Minor short term Impacts will be short term and localised. There are no residential properties within 5 km of the site. 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.
<i>Any transformation of a locality</i>	Minor short term There will be a localised and non-permanent visual impact on the immediate vicinity of the pilot wells for the duration of the program. This impact will be significantly reduced once the lease area is partially rehabilitated and completely reversed once the flare and water transfer facility is decommissioned and final rehabilitation of the site is complete.
<i>Any environmental impact on the ecosystems of the locality.</i>	Minor short term One vegetation communities/habitats occur within the site; narrow leaved shrubby ironbark woodland. This community is not commensurate with any TEC listed under the EPBC Act or TSC Act.
<i>Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality</i>	Negligible The proposed activity will reduce the aesthetic values of the site temporarily but will have no long term effects on the scenic qualities of the landscape.
<i>Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or</i>	Nil 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

Factor	Impact
<i>other special value for present or future generations</i>	within or near the site.
<i>Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974)</i>	Medium short term 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 up to approximately 5.755 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.
<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>	Nil 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.
<i>Any long-term effects on the environment</i>	Nil 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 aquifer interference. There will be no impact to the upper aquifers. Rehabilitation of the site will occur.
<i>Any degradation of the quality of the environment</i>	Minor short term 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.
<i>Any risk to the safety of the environment</i>	Minor short term The proposed activity may result in short term potential risks to the safety of the environment due to incidents and spills. The flare will be designed with an appropriate clearance zone.
<i>Any reduction in the range of beneficial uses of the environment</i>	Nil The proposed activity will not result in any reduction in the range of beneficial uses of the environment.
<i>Any pollution of the environment</i>	Minor short term 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.
<i>Any environmental problems associated with the disposal of waste</i>	Nil Drill cuttings will be allowed to dry onsite and re-used in site rehabilitation provided that they comprise excavated natural material. All other wastes generated by the proposed activity will be collected, classified and removed from site for treatment, re-use, recycling, and/or disposal at a licensed facility.
<i>Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply</i>	Minor short term Resources required for the proposed activity are not in limited supply in the area.

8.0 Conclusion

This REF has been prepared to assess the potential environmental impacts of drilling and operating four petroleum exploration pilot wells, known as Dewhurst 26-29, and carrying out ancillary activities within the Pilliga East State Forest along Beehive Road, approximately 44 kilometres south of Narrabri, NSW. The purpose of the proposed activity is to investigate the potential CSG resource of the Gunnedah Basin within PEL 238.

The site of the proposed activity has been selected to avoid significant environmental and heritage constraints, and reduce impacts to the surrounding community.

The proposed activity is unlikely to impact on any Aboriginal sites or objects, or non-Aboriginal heritage items.

Three highly ephemeral creeks will be intersected by the central gathering system. However, crossing will occur during periods of no flow and appropriate bank stabilisation measures will be implemented.

There are no residential receivers within five kilometres of the site and the proposed activity is unlikely to generate noise levels in exceedance of 35 dB(A) at any residences during construction or operation.

Groundwater modelling has indicated there would be negligible change in groundwater volume (flux) or drawdown in the upper aquifers. There would be some impact in the deeper formations, namely the Maules Creek Group, which would recover over time. There would be no impact to registered groundwater bores or groundwater dependent ecosystems.

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 a SIS.

On balance, the proposed activity will have a negligible to low adverse impact on the environment and community.

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	<p>Site Establishment and construction</p> <ul style="list-style-type: none"> ▪ constructing four access tracks from Beehive Road to lease areas ▪ establishing four lease areas up to 1 ha in size each ▪ installing surface infrastructure on Dewhurst 26-29 lease areas, including separators, metering skids, power generation equipment, telemetry units, motor control centres and drivers ▪ constructing a gas gathering system parallel to the access tracks and Beehive Road to a flare adjacent to Dewhurst 28. The gathering system extends from the riser located at the edge of the pilot well lease area to the transfer tank located adjacent to Dewhurst 28 ▪ constructing a water gathering system parallel to the gas gathering system with associated piping and pumps adjacent to Dewhurst 28 <p>Drilling</p> <ul style="list-style-type: none"> ▪ drilling two vertical wells (Dewhurst 26 and 28) to a depth of approximately 1050 m ▪ drilling a tri-stacked horizontal well (Dewhurst 27) to intercept Dewhurst 26 ▪ drilling a single horizontal well (Dewhurst 29) to intercept Dewhurst 28 ▪ operating the Dewhurst 26-29 well sets for the life of PEL 238 or until critical reservoir data is collected. <p>Operation</p> <ul style="list-style-type: none"> ▪ partial rehabilitation of Dewhurst 26, 27 and 29 to well head and essential infrastructure ▪ installing a flare, water transfer tank (capacity 40m³) and pumps at the Dewhurst 28 lease area ▪ continued monitoring of pilot wells and gathering system ▪ maintenance and workover activities.
Hours of operation	Hours of operation will be negotiated with the landowner and may be up to 24 hours a day, seven days a week.
Activity duration	Duration of PEL 238.
Proposed commencement date	Works will commence in the second quarter of 2013.
Maximum area of disturbance	Up to approximately 5.755 ha.
Rehabilitation commitments and timeframes	<p>Partial rehabilitation will occur within six months of completion of the pilot wells for Dewhurst 26, 27 and 29, where practicable. The site will be rehabilitated to its pre-operational condition or better.</p> <p>Final rehabilitation of the site will occur at the expiration of PEL 238.</p>
Community consultation	Community consultation will be undertaken in accordance with section 2.4.1 of the REF.
Complaint management	Complaint management will be dealt with in accordance with Santos protocols outlined in section 2.4.6.
Soil quality and land stability	<p>Site establishment and construction</p> <ul style="list-style-type: none"> ▪ 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

Item	Commitment
	<p>used as backfill during site rehabilitation. No uncontaminated soil or spoil will be removed from the site</p> <ul style="list-style-type: none"> ▪ 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). ▪ 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. ▪ A diversion bank will be constructed to direct water around the area of disturbance. ▪ A sediment fence will be installed at the downstream limit of disturbance area. <p>Drilling</p> <ul style="list-style-type: none"> ▪ 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. ▪ Refuelling 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. ▪ A vacuum trucks will be on standby 24 hours a day. ▪ 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. <p>Operation</p> <ul style="list-style-type: none"> ▪ Ongoing management and maintenance of remaining infrastructure on site will occur, including water transfer area and well heads. ▪ The gathering system water pressure will be regularly monitored. ▪ The site will be rehabilitated in accordance with section 2.7.6 of the REF.
Water body, water course, wetland and natural drainage systems	<p>Site establishment and construction</p> <ul style="list-style-type: none"> ▪ Contaminated waters will be contained and where necessary disposed of at an appropriate facility. ▪ Sediment fences and traps will be installed so as to prevent soil loss or sedimentation. ▪ Where applicable maintenance of roads, drains, bund walls, contour and diversion banks to occur. All drainage structures will be maintained for the life of the development. ▪ The crossing of Mount Pleasant Creek will be designed to minimise up and downstream erosion of the bed and banks, and changes to flow velocity. ▪ Waterway crossings will be undertaken during periods of no flow. <p>Drilling</p> <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 2.7.3 of the REF. ▪ Fuel and lubricants will be stored on site only when necessary and maintained off site

Item	Commitment
	<p>whenever possible.</p> <ul style="list-style-type: none"> ▪ 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. ▪ All areas storing or handling fuel, fuel using equipment, and chemicals will be banded in accordance with <i>Australian Standard 1940 – 2004; The Storage and Handling of Flammable and Combustible Liquids</i>. ▪ The maintenance and cleaning of vehicles and other equipment or plant will be carried out in areas from where the resultant contaminants cannot be released into any waters. <p>Operation</p> <ul style="list-style-type: none"> ▪ Proposed rehabilitation (section 2.7.6) will ensure pre-operational quality or better, to minimise sediment erosion.
Groundwater	<p>Site establishment and construction</p> <p>Nil</p> <p>Drilling</p> <ul style="list-style-type: none"> ▪ The wells 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 and installation operations, well control, waste management and abandonment procedures for the pilot wells will be in accordance with accepted industry practices and in accordance with the processes outlined in this REF. ▪ 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. <p>Operation</p> <ul style="list-style-type: none"> ▪ The wells will be decommissioned as soon as they are no longer required. ▪ Data will be collected from the wells to measure permeability of the various strata. ▪ Pressure gauges will be installed adjacent to the pilot wells with monitoring points to assess impacts on overlying formations. ▪ The quality of incidental water lifted during proposed activities will be monitored daily and the results provided to the relevant authorities on a weekly basis. ▪ Santos will make reasonable endeavours to establish a network of groundwater monitoring bores to monitor the impacts of Dewhurst 26-29 and other pilots planned as part of the 50 well program on groundwater sources.
Flooding	<p>Site establishment and construction</p> <ul style="list-style-type: none"> ▪ 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. This will also occur during drilling. <p>Drilling</p> <ul style="list-style-type: none"> ▪ A minimum freeboard of 300 millimetres will be maintained for any tanks or pits containing liquid waste. <p>Operation</p> <p>Nil</p>
Hazardous substance and chemical use	<p>Site establishment and construction</p> <p>Nil</p> <p>Drilling</p> <ul style="list-style-type: none"> ▪ Random sampling of drilling mud and drill cuttings will be undertaken to monitor for

Item	Commitment
	<p>the presence of BTEX.</p> <ul style="list-style-type: none"> ▪ 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>. <p>Operation Nil</p>
Gaseous, liquid and solid waste emissions	<p>The following measures will be carried out to minimise waste and potential impacts associated with waste generation and disposal:</p> <p>Site establishment and construction</p> <ul style="list-style-type: none"> ▪ A waste management plan will be prepared prior to construction. ▪ 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. These will remain during drilling activities. <p>Drilling</p> <ul style="list-style-type: none"> ▪ 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. ▪ 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. <p>Operation</p> <ul style="list-style-type: none"> ▪ Produced water will be transferred to an appropriate water treatment facility to be treated for beneficial reuse. <p>Site establishment and construction and drilling</p> <ul style="list-style-type: none"> ▪ All wells will be drilled using water based mud to minimise venting and flaring requirements. ▪ The area of disturbance will be limited to the minimum required to carry out the proposed activity safely and efficiently. ▪ 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. ▪ Use energy efficient equipment and processes where possible.
Dust, noise, odours, vibration and radiation	<p>Duration of project</p> <ul style="list-style-type: none"> ▪ Dust will be suppressed as required by spraying water along the access tracks and lease areas. ▪ If necessary, the access tracks will be sealed to prevent excessive dust emissions. ▪ Site speed limits will be imposed to minimise dust generated by vehicle movements. <p>Site establishment and construction</p> <ul style="list-style-type: none"> ▪ Consultation with Forestry NSW will be carried out in accordance with Section 2.4 of the REF. ▪ In the event of a noise complaint, the noise source will be investigated and, where necessary, additional feasible and reasonable measures will be implemented.

Item	Commitment
	<p>Drilling</p> <ul style="list-style-type: none"> ▪ Prior to arriving on site, source noise levels of the drilling rig will be confirmed to verify noise impacts and confirm the management approach. ▪ In the event of a noise complaint, the noise source will be investigated and, where necessary, additional feasible and reasonable measures will be implemented. <p>Operation</p> <p>Nil</p>
Biological	<p>Site establishment and construction</p> <ul style="list-style-type: none"> ▪ Clearing of habitat trees will be avoided where possible. ▪ Disturbance areas will be minimised where possible during the design process. ▪ While clearing or disturbance to vegetation occurs, a fauna spotter/catcher will be on site to supervise works. ▪ Hollow logs removed from the disturbance areas are to be relocated in habitats adjacent to the lease areas under supervision from the fauna spotter-catcher. Fauna sensitive clearing techniques will be implemented, including vibrating the bucket on large trees (particularly hollow-bearing trees) prior to clearing, and dismantling large trees. ▪ 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. <p>Drilling</p> <p>Nil</p> <p>Operation</p> <ul style="list-style-type: none"> ▪ The site will be rehabilitated in accordance with section 2.7.6 of the REF.
Community	<p>Duration of the project</p> <ul style="list-style-type: none"> ▪ Works will be conducted in accordance with landowner requirements as outlined in the Occupation Permit issued under the <i>Forestry Act 1916</i>. <p>Site establishment and construction</p> <ul style="list-style-type: none"> ▪ Site safety protocols, incident management and emergency procedures will be implemented during the construction and drilling works. ▪ The site will be kept in a clean and tidy manner during site preparation, drilling activities and operation of the pilot wells. <p>Operation</p> <ul style="list-style-type: none"> ▪ Any upgrades to the access track will be retained for the ongoing use of Forestry NSW. ▪ The lease area will be fenced and within Dewhurst 28, the flare will have a secondary 1.8m high fence. ▪ A bushfire management plan will be developed prior to construction. ▪ Hazard classification mapping will be updated prior to commencement of construction.

Item	Commitment
Natural resources	<p>Site establishment and construction</p> <ul style="list-style-type: none"> ▪ All plant and machinery delivered to the site will be cleaned of foreign soil in accordance with legislative requirements with respect to weed management. ▪ Construction personnel will be trained in pest control and hygiene procedures. <p>Drilling</p> <ul style="list-style-type: none"> ▪ Fuel will be used as efficiently as possible through appropriate work behaviour (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>. <p>Operation</p> <ul style="list-style-type: none"> ▪ All plant and machinery visiting the site will be cleaned of foreign soil in accordance with legislative requirements with respect to weed management.
Aboriginal cultural heritage	<p>Site establishment, construction and drilling</p> <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. ▪ All works will be undertaken to comply with Part 6 of the <i>National Parks and Wildlife Act 1974</i>. ▪ 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 <p>Operation</p> <p>Nil</p>
Historic heritage	<p>If any previously unidentified potential historic heritage material is identified during construction or drilling, 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</p>
Cumulative	<p>Nil</p>

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.
Aquiclude	Compacted geological formations through which no groundwater flows.
Aquitard	Low permeability formation which restricts the flow of groundwater.
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 steel 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 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 Trade, Investment, 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>
kPag	Kilopascal gauge
LGA	Local government area
ML	Mega litres
MMSCFD	Million standard cubic feet per day
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

Term/Abbreviation	Meaning
Plug	Any object or device that blocks a hole or passageway.
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.
WAL	Water access licence
Wall cake	Low permeability 'skin' around the wall of the hole.
Wellhead	The system of spools, valves and associated adapters that provide pressure control for production.
WMA	Water Management Act 2000
WSP	Water Sharing Plan

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Appendix I

Chemical Fact Sheet

Rheochem Trade Name	Other Trade Names	Material / Chemical Description	Chemical Abstract Service Number/s	Other Industries	HAZCHEM ? (Code)	Toxicity	Environmental Considerations	Independent BTEX Tested	Handling (Consult MSDS for handling and PPE)	Unit Size	Typical Concentration used (kg/m ³)	Max Kept on Site (kg)	Basic Function	Purpose / Use
K2SO4	Potassium Sulphate, K2SO4	Sulphuric Dipotassium Salt, Sulphate of Potash, Potash of Sulfur, Arcanite	7778-80-5	Fertiliser for chloride sensitive crops.	No	Low, moderate if coming into contact with eyes.	None	YES - No detectable levels of BTEX recorded	Avoid Inhaling Dust. Store in well ventilated area.	25 kg Sack	36.0 - 52.0	240	Clay Inhibitor	Helps to keep the drilled clays dry and less sticky.
Calcium Chloride 74-77%	Calcium Dichloride	Calcium Chloride	10043-52-4	Used to de-ice roads. Food grade versions are used in canned vegetables and electrolyte in sports drinks Medicine - Intravenous drips	Yes	Moderate irritant to Eyes, Skin (can cause rash), Inhalation	Salinity	YES - No detectable levels of BTEX recorded	Avoid Skin, Eyes and Lung Exposure.	25 kg Sack	2.80	40	Cement Accelerator	To speed up setting of cement and reduce waiting time.
Xanthan Gum P	Flowzan	Corn Based biopolymer (polysaccharide)	11138-66-2	Food grade version sare used as binders and thickeners.	No	Low	None	YES - No detectable levels of BTEX recorded	Avoid Inhalation	25 kg Sack	1.4 - 5.7	80	Viscosifier	Thickens the mud so it can carry the drilled rock out of the hole.
Quickseal Medium	Kwikseal	Cellophane / Wood / Nutshells	not available	-	No	Low	None	YES - No detectable levels of BTEX recorded	Avoid Inhaling Dust. Store in well ventilated area.	18.1 kg Sack	14.2 - 28.5	50	Lost Circulation Material	Deposits against the wall of the hole to prevent or reduce mud lost down the hole.
Rheopac	Rheopac-RD, Rheopac-LV, Rheopac-R, Drispac-R, Drispac-SL, PAC-R, PAC-L	Poly Anionic Cellulose	9004-32-4, 7647-14-5, 2836-32-0	Poly-anionic cellulose or PAC is derived from Carboxymethyl cellulose (CMC) where the food grade version is used in the manufacture of icecream. Non-food uses include KY Jelly, toothpaste, diet pills etc.	No	Low	Low Biodegradability	YES - No detectable levels of BTEX recorded	Avoid Inhalation	25 kg Sack	1.4 - 3.4	80	Fluid Loss Control	Reduces the amount of fluid seepage from the mud into the ground which can cause the hole to become sticky, unstable and less productive.
JK - 261 / JK-161	CR-650, JK-261 LV, JK-161 LV	PHPA (Partially Hydrolysed Poly Acrylamide)	25085-02-3	Water treatment, paper manufacture, soil treatment material. Food grade version is used in potable water	No	Low	None	YES - No detectable levels of BTEX recorded	Avoid Inhalation	25 kg Sack	1.4 - 3.4	40	Clay Inhibitor	Helps to keep the drilled clays dry and less sticky.
Icdide - 20		Tetrakis Hydroxymethyl Phosponium Sulfate (THPS)	55566-30-8	Biodegradable and non-bioaccumulative microbiocide.	No	Low to Moderate irritant for Skin, to Inhale or Ingest. Severe irritant in contact with eyes.	Toxic to microorganisms in short term, but biodegradable and non-bioaccumulative	YES - No detectable levels of BTEX recorded	Liquid Product. Contain if spilled.	20 kg Drum	0.28 - 0.71	16	Biocide	To prevent micro-organisms from attacking the mud and to stop the sump from going green and starting to smell.
Sodium Bicarbonate	Generic Product	Sodium Hydrogen Carbonate (NaHC03)	144-55-8	Food grade version is a major ingredient of Baking Soda.	No	Low	None	YES - No detectable levels of BTEX recorded	Avoid Inhalation	25 kg Sack	0.71	48	pH Control / Cement Treatment	Treatment against cement contamination of the drilling mud.
CITRIC ACID	Generic Product	-	77-92-9	Food grade version is used for flavouring in beverages, jams, jellies and candy.	Yes (N/A)	Low. Slight irritant to eyes and skin or if inhaled or ingested.	None	YES - No detectable levels of BTEX recorded	Avoid Skin, Eyes and Lung Exposure	25 kg Sack	0.71	40	pH Control / Stuck Pipe	to reduce pH, or to mix in a Citric SAPP pill if the drillpipe gets stuck in the hole.
SODA ASH	Generic Product	Sodium Carbonate (Na2C03)	497-19-8	Food grade version used in water treatment for hardness. Manufacturing of Glass. General cleanser.	No	Slightly Corrosive - Irritant	pH	YES - No detectable levels of BTEX recorded	Avoid Inhalation	25 kg Sack	0.71	48	Hardness Treatment	Control of Calcium Hardness.
Fracseal - Fine		Micronised Cellulose fibre	Not available	Paper	No	Low	None	YES - No detectable levels of BTEX recorded	Avoid Inhaling Dust. Store in well ventilated area.	11.3 kg Sack	14.2 - 28.5	35	Lost Circulation Material	Deposits against the wall of the hole to prevent or reduce mud lost down the hole.
Sodium Formate	Sodium Formate	Formic Acid, Sodium Salt	141-53-7	Food grade version is used as a Preservative and Anti-bacterial ingredient	No	Moderate irritant - The substance is toxic to lungs, mucous membranes. Very hazardous in case of ingestion. Hazardous in case of skin contact of inhalation	Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.	Sample Testing ongoing	Keep away from heat. Keep away from sources of ignition. Do not breathe dust.	25 kg Sack	13.7 - 18.2	240	Weighting Agent, Clay Inhibitor	To provide weight in the fluid and provide some clay inhibition.
DEFOAM - E	-	Polyoxyethylene polyoxypropylene block copolymer	64742-95-6, 64742-88-7	-	No	Low to moderate irritant if in contact with eyes. Over exposure may irritate nose and throat.	Not readily biodegradable	YES - No detectable levels of BTEX recorded	Liquid Product. Contain if spilled.	25 L Drum	0.08	32	Defoaming Agent	Prevent foaming of mud and problems with pumps.
Barite	Rheobar, Aus-Bar	Barite, Barium Sulfate. Naturally occurring, insoluble mineral.	14808-60-7, 7727-43-7	Medical - eg passed through digestive system to X-Ray digestive problems. Used in the manufacture of paper and paint.	No	Low	None	YES - No detectable levels of BTEX recorded	Avoid Inhaling Dust. Store in well ventilated area.	25 kg Sack	142 - 180	Standby	Weighting Material	To prevent hole collapsing and high pressure gas or water from escaping (ie "Blowout"). Legal Requirement for "Well Control".

Appendix 2

MSDS for Potassium Sulphate Polymer Drilling Fluid

Product Name **POTASSIUM SULPHATE POLYMER DRILLING FLUID****1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER**

Supplier Name RHEOCHEM LTD
Address 11 Alacrity Place, Henderson, WA, AUSTRALIA, 6166
Telephone +61 8 9410 8200
Fax +61 8 9410 8299
Emergency 1800 127 406 (Australia); 011 64 3 3530199 (International)
Web Site <http://www.rheochem.com.au/>
Synonym(s) K2SO4 DRILLING FLUID
Use(s) DRILLING FLUID • DRILLING FLUID ADDITIVE
SDS Date 28 Sep 2011

2. HAZARDS IDENTIFICATION

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE

UN No. None Allocated **DG Class** None Allocated **Subsidiary Risk(s)** None Allocated
Packing Group None Allocated **Hazchem Code** None Allocated

3. COMPOSITION/ INFORMATION ON INGREDIENTS

Ingredient	Formula	CAS No.	Content
WATER	H2O	7732-18-5	>85%
POTASSIUM SULPHATE	K2-S-O4	7778-80-5	3-10%
BARITE	Not Available	Not Available	1-5%
NON HAZARDOUS INGREDIENTS	Not Available	Not Available	<2%
CELLULOSE	Not Available	Not Available	0.5-1.5%
XANTHAN GUM	Not Available	Not Available	<0.5%

4. FIRST AID MEASURES

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poison Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

Advice to Doctor Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flammability	Non flammable. May evolve toxic gases if strongly heated.
Fire and Explosion	Treat as per requirements for Surrounding Fires: Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.
Extinguishing	Prevent contamination of drains or waterways.
Hazchem Code	None Allocated

6. ACCIDENTAL RELEASE MEASURES

Spillage	If spilt (bulk), use personal protective equipment. Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal. Prevent spill entering drains or waterways. CAUTION: Spill site may be slippery.
-----------------	--

7. STORAGE AND HANDLING

Storage	Store in a cool, dry, well ventilated area, removed from oxidising agents, heat or ignition sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills. Large storage areas should have appropriate ventilation systems.
Handling	Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

8. EXPOSURE CONTROLS/ PERSONAL PROTECTION

Exposure Stds	No exposure standard(s) allocated.
Biological Limits	No biological limit allocated.
Engineering Controls	Avoid inhalation. Use in well ventilated areas.
PPE	Wear splash-proof goggles and rubber or PVC gloves. When using large quantities or where heavy contamination is likely, wear: coveralls. In a laboratory situation, wear: a laboratory coat.



9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	VISCOUS WHITE TO OFF-WHITE LIQUID	Solubility (water)	NOT AVAILABLE
Odour	CHARACTERISTIC ODOUR	Specific Gravity	1 to 1.2 (Approximately)
pH	8.5 (Approximately) (10% solution)	% Volatiles	NOT AVAILABLE
Vapour Pressure	NOT AVAILABLE	Flammability	NON FLAMMABLE
Vapour Density	NOT AVAILABLE	Flash Point	NOT RELEVANT
Boiling Point	> 100°C	Upper Explosion Limit	NOT RELEVANT
Melting Point	NOT AVAILABLE	Lower Explosion Limit	NOT RELEVANT
Evaporation Rate	NOT AVAILABLE	Decomposition Temperature	NOT AVAILABLE
Autoignition Temperature	NOT AVAILABLE	Viscosity	NOT AVAILABLE
Partition Coefficient	NOT AVAILABLE		

10. STABILITY AND REACTIVITY

Chemical Stability	Stable under recommended conditions of storage.
Conditions to Avoid	Avoid heat, sparks, open flames and other ignition sources.
Material to Avoid	Incompatible with oxidising agents (eg. hypochlorites).
Hazardous Decomposition Products	May evolve toxic gases if heated to decomposition.
Hazardous Reactions	Polymerization is not expected to occur.

11. TOXICOLOGICAL INFORMATION

Health Hazard Summary	Low toxicity - low irritant. This product may present a hazard with direct eye contact or prolonged skin contact. Chronic effects are not anticipated.
Eye	Low irritant. Contact may result in irritation, lacrimation and redness.
Inhalation	Low irritant. Over exposure may result in irritation of the nose and throat, with coughing.
Skin	Low irritant. Prolonged or repeated contact may result in mild irritation, rash and dermatitis.
Ingestion	Low toxicity. Ingestion of large quantities may result in nausea, vomiting and gastrointestinal irritation.
Toxicity Data	POTASSIUM SULPHATE (7778-80-5) LD50 (Ingestion): 6600 mg/kg (rat) LDLo (Ingestion): 750 mg/kg (woman) LDLo (Subcutaneous): 3000 mg/kg (guinea pig) TDLo (Ingestion): 750 mg/kg (woman)

12. ECOLOGICAL INFORMATION

Environment	Limited ecotoxicity data was available for this product at the time this report was prepared. Ensure appropriate measures are taken to prevent this product from entering the environment.
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13. DISPOSAL CONSIDERATIONS

Waste Disposal	For small amounts, absorb with sand, vermiculite or similar and dispose of to an approved landfill site. For larger amounts, contact the manufacturer for additional information.
Legislation	Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE

Shipping Name	None Allocated			
UN No.	None Allocated	DG Class	None Allocated	Subsidiary Risk(s) None Allocated
Packing Group	None Allocated	Hazchem Code	None Allocated	

15. REGULATORY INFORMATION

Poison Schedule	A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP).
AICS	All chemicals listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Additional Information	ABBREVIATIONS: ACGIH - American Conference of Industrial Hygienists. ADG - Australian Dangerous Goods. BEI - Biological Exposure Indice(s). CAS# - Chemical Abstract Service number - used to uniquely identify chemical compounds. CNS - Central Nervous System. EC No - European Community Number. HSNO - Hazardous Substances and New Organisms. IARC - International Agency for Research on Cancer. mg/m ³ - Milligrams per Cubic Metre. NOS - Not Otherwise Specified. pH - relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
-------------------------------	--

Product Name POTASSIUM SULPHATE POLYMER DRILLING FLUID

ppm - Parts Per Million.
RTECS - Registry of Toxic Effects of Chemical Substances.
STEL - Short Term Exposure Limit.
SWA - Safe Work Australia.
TWA - Time Weighted Average.

HEALTH EFFECTS FROM EXPOSURE:

It should be noted that the effects from exposure to this product will depend on several factors including: frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a ChemAlert report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:

The recommendation for protective equipment contained within this ChemAlert report is provided as a guide only. Factors such as method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

Report Status

This document has been compiled by RMT on behalf of the manufacturer of the product and serves as the manufacturer's Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

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SDS Date 28 Sep 2011

End of Report

Appendix 3

Indicative waste inventory

Waste	Regulated / trackable	Action	Reduce	Reuse	Recycle	Landfill
Chemicals						
Chemical waste	Yes	Return excess to supplier wherever possible. Triple rinse containers and empty for recycling.	●		●	
Contaminated soils						
Contaminated soils – hydrocarbons	Yes	Contact environmental professional for advice.	●			
Contaminated soil – other	Yes	Contact environmental professional for advice.	●			
Drilling Wastes						
Drill Cuttings	Both	Sample and classify for reuse or disposal. Where re-used, store in bins and skips or if disposed transfer to licensed waste disposal facility.	●	●		●
Drill Fluids – K2SO4 Based	Yes	Classify and store onsite in tanks for transport to batching facility for re-use and/or licensed disposal.	●	●		
Drill Fluids – KCl Based	Yes	Classify and store onsite in tanks for transport to batching facility for re-use and/or licensed disposal	●	●	●	
Electrical and Electronic						
Electrical - batteries - dry	Yes	Place in recycling container at Council's waste transfer station	●		●	
Electrical – batteries – wet	Yes	Place in recycling container at Council's waste transfer station	●		●	
Electrical – electronic and electrical equipment	No	Place in recycling container at Council's waste transfer station	●	●	●	
Electrical – toner and print cartridges	No	Place toner into original cardboard box for transport to accredited toner cartridge collector.	●	●	●	
General						
General – cardboard	No	Ensure cardboard is clean and has no plastic or other contaminants. Place into receptacle for collection by the waste contractor.			●	
General – litter	No	Place into receptacle for collection by the waste contractor.	●			●
General – paper	No	Ensure paper is segregated disposed into recycling bins.	●		●	
General – paper food packaging	No	Ensure packaging is disposed into general waste bins. If packaging is labelled with recycling symbol, segregate into recycling bins.			●	●
General – food scraps	No	Food scraps are to be disposed of into the designated bin on site. Bin to be emptied into the worm farm for the Narrabri Operations Centre.	●		●	
Glass						
Glass – general	No	Ensure glass jars/bottles are rinsed of contents. Store on site in designated recycle bin.			●	

Waste	Regulated / trackable	Action	Reduce	Reuse	Recycle	Landfill
Glass – fluorescent tubes	No	Place intact tubes in old tube boxes where available prior to delivery fluorescent tube box located within the Narrabri Operations Centre.	●	●	●	
Hazardous						
Hazardous – filters – air, dust, paper	Yes	Air filters vehicles are to be cleaned out using an air pressure hose so that they may be re-oiled and refitted to the vehicle. Return directly to supplier where possible.	●	●		
Metals						
Metals – aerosol cans	No	Ensure aerosol cans are empty and store on site in designated recycle bin prior to disposal			●	
Metals – aluminium cans	No	Store on site in designated recycle bin prior to removal to appropriate recycling facility.	●		●	
Metals – copper and aluminium (other than cans)	Yes	Store on site prior to disposal in metal bin at Councils waste transfer station .			●	
Metals – steel drums – empty - damaged	No	Ensure all steel drums are empty (<1% product), clearly labelled and accompanied with an MSDS if appropriate. Return directly to supplier where possible or place on pallet at waste transfer area	●		●	
Metals – steel drums – empty – good condition	No	Ensure all steel drums are empty (<1% product), clearly labelled and accompanied with an MSDS if appropriate. Return directly to supplier where possible or place on pallet at waste transfer area		●	●	
Metals – steel – scrap	No	Small off-cuts are to be cleaned of any oils/lubricants before being placed in bin, ensure large scrap metal items are removed from any site.			●	
Oils						
Oils – oil filters	Yes	Drain filters of excess oil prior to disposal. Place in oily waste bins prior to disposal off site.			●	
Oils – oily rags	Yes	Ensure oily rags are not mixed with clean rags. Place in oily waste bins prior to disposal off site.			●	
Oils – waste oil	Yes	Ensure waste oil is contained before placing into designated storage tank.			●	
Plastics						
Plastics – drums (empty)	No	Ensure drums are cleaned appropriately and chemical labels are removed for re-use. Return directly to supplier where possible.	●	●	●	
Plastics – packaging	No	Classify into recyclable or general waste and store in appropriate bins prior to disposal at waste transfer station			●	●
Plastics – PET containers	No	Store in recycle bin on site prior to disposal at waste transfer station			●	
Rubber						
Rubber – other	No	Return directly to supplier where possible. Ensure remaining rubber items are placed in container at waste transfer area.		●	●	
Rubber – tyres and tubes	Yes	Ensure that un-usable tyres are returned to supplier, remaining tyres are placed on pallets at waste transfer			●	●

Waste	Regulated / trackable	Action	Reduce	Reuse	Recycle	Landfill
area						
Sewerage						
Septic waste	Yes	Effluent removed by licenced contractor.		●		
Wood and Garden Waste						
Wood/garden – wood – general	No	Place in recycling area at waste transfer area			●	
Wood/garden – wood – pallets	No	Return directly to supplier where possible. Ensure remaining pallets are stored at waste transfer area.			●	
Other						
Other – concrete	No	Place in general waste bins on site.			●	
Other – personal protective equipment	No	Place in general waste bins on site.		●		●

Appendix 4

Noise and Vibration Assessment



NOISE MEASUREMENT SERVICES

Noise and Vibration Assessment

Drilling, Construction and Operation of Pilot Wells

Santos Limited

Pilliga State Forest

Narrabri NSW

Report 2228-DPW 6 February 2013

DOCUMENT CONTROL PAGE

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Revision No	Issue Date	Revision Description	Checked By	Issued By
0	29/11/2012	Draft Report for Review		BT
1	3/12/2012	Report; review additions	MF	BT
2	4/12/2012	Additional well, updates, review comments included		BT
2A	6/12/2012	Sound power table D1		BT
3	6/2/2013	Revised Dewhurst well locations		BT

Copy No(s)	Rev No	Destination
1pdf	3	RPS Australia East
2	3	Noise Measurement Services

REPORT FOR RPS Australia East

CONTACT Sigrid

Signed



Dr Bob Thorne
(Principal)

DISCLAIMER

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EXECUTIVE SUMMARY

Noise Measurement Services Pty Ltd was commissioned by RPS Australia East consulting to Energy NSW - Santos to complete an environmental noise assessment for the drilling, construction and operation of pilot wells which can be used to support the Review of Environmental Factors (REF) for the Dewhurst 6, 22 – 25 pilot wells, as well as REF's for other pilot wells within the Pilliga. The scope of works in this Report is:

- Establishing the existing background sound levels in the vicinity of the proposed Dewhurst 6, 22-25 pilot wells;
- Establishing the environmental noise criteria that would apply to the drilling, construction and operation of the pilot wells;
- Predicting the environmental noise levels due to the construction and operation of the proposed pilot wells at noise sensitive receivers (residences); and
- Assessing the noise related impacts, if any, at noise sensitive receivers (residences).
- Measures for noise mitigation of any noise source are not part of this scope of works.

The noise criteria to be achieved are the Intrusive noise criterion and sleep disturbance criterion under the Industrial Noise Policy. The Rating Background Level plus 5 dB(A) and is established as LAeq 35 dB. 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 similar to short-term construction noise and the appropriate assessment guidelines are detailed in the *Interim Construction Noise Guideline*.

Table ES1: Noise 'Most Likely' Predicted Levels (LAeq), Noise Criteria, and Distances to Residences. Sound levels are rounded and calculated at the residential façade

Residence	Distance	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 'F'
R1	3370	26	36	16	21	24	29	22
R2	3430	25	36	16	21	23	29	22
R3	4070	23	32	<15	19	21	27	21
ML1-R4	5730	16	17	<15	16	<15	18	17
Plant		Drilling	Drilling	1 x well	5 x wells	1 x well	5 x wells	5 x wells
Weather		calm	southerly	calm	calm	southerly	southerly	inversion

Note: 'Distance' is the distance in metres from Dewhurst 24 to the relevant residence

The noise emissions from the operation of the 5 pilot wells together, under temperature inversion 'F' conditions, is calculated at approximately 18 dB(A) LAeq, at 5 km from the wells.

It is concluded that the drilling stages may be audible at night when the background levels drop to around 20 dB(A). The activity, however, is of short duration and noise mitigation to the mud-pump (the main source of noise) will reduce further any audible sound.

It is concluded that the operation of the pilot wells should not be audible at any of the residences identified in this assessment.

Glossary

Ambient sound

All sounds in a locality or "soundscape" from distant and nearby sources or activity including traffic, bird song, vegetation movement in the breeze, and so on.

Assessment Background Level (ABL).

The Assessment Background Level is the single figure background level representing each assessment period (day, evening and night) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (LA90) for each period.

Background sound pressure level (LA90,T), L90

Commonly called the "L90" or "background" level and is an indicator of the quietest times of day, evening or night. The L90 level is calculated as the noise level equalled and exceeded for 90% the measurement time. The level is recorded in the absence of any noise under investigation. The level is not adjusted for tonality or impulsiveness. Also known as the background "noise" level.

Character of the environment

The *character of the environment* is often assessed by third-octave or narrow band analysis of the ambient sound. Sounds may be characterised, for example, as "bangs", "hum noise", "plant sounds", and "high frequency sounds". The assessment is required to determine intrusive noise, tonality or annoying character.

Equivalent Continuous or time average sound pressure level (LAeq,T), Leq

Commonly called the "Leq" level it is the logarithmic average noise level from all sources far and near and is referenced to a specific measurement time interval; e.g. 1-hour. The level can be adjusted for tonality.

LA10.

The LA10 level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the LA10 level for 90% of the time. The LA10 is a common noise descriptor for environmental noise and road traffic noise.

INP

New South Wales Industrial Noise Policy, EPA 2000

NMS

Noise Measurement Services Pty Ltd

Rating Background Level (RBL)

The overall, single-figure, background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24-hour period used for the assessment of background level [in NSW]). This is defined as the median value of all the day evening or night assessment background levels.

1.0 INTRODUCTION

1.1 Project Location

The proposed activity will occur within the Pillaga East State Forest along Monument Road (the Forest), south of Narrabri, within PEL 238. Santos will conduct the activities for and on behalf of the titleholders of PEL 238 and is working with Forests NSW, who manages the Forest, to establish a land access agreement.

Noise Measurement Services Pty Ltd was commissioned by RPS Australia East consulting to Energy NSW - Santos to complete an environmental noise assessments for the drilling, construction and operation of the Dewhurst 6, 22 – 25 pilot wells. The proposed pilot well locations are illustrated in Plates 1.1.1 and 1.1.2. The gathering corridor is 10 metres in width. The initial size of each pilot well drill pad is 100 metres by 100 metres. The area reduces to approximately 10 metres by 10 metres when the pilot well alone is operational. (The gathering system operational works for the wells is calculated as part of the overall noise emissions).

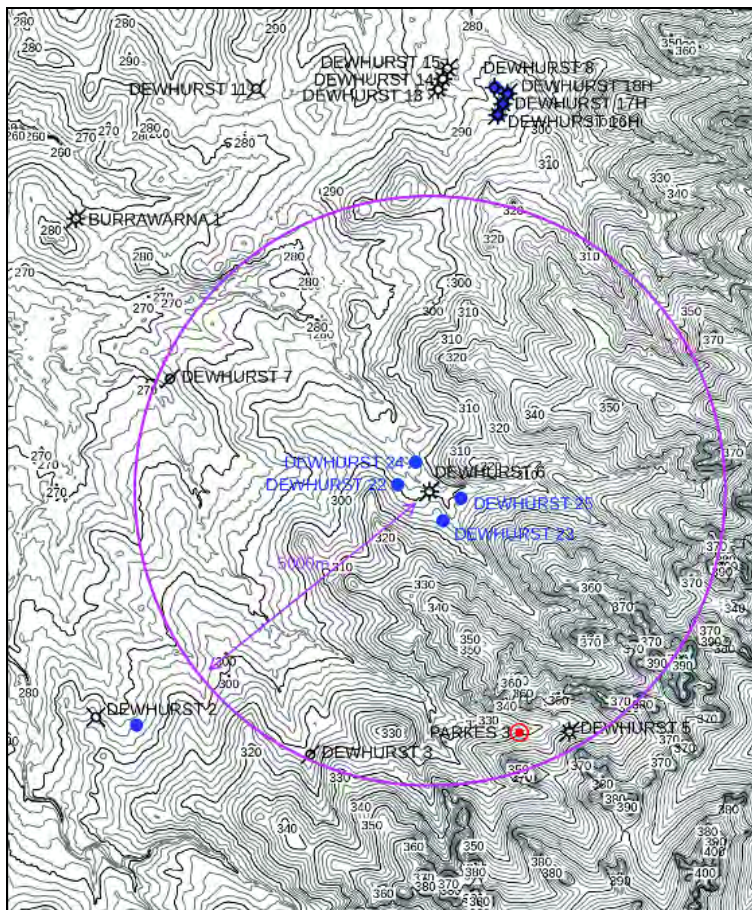


Plate 1.1.1: Location of pilot wells Dewhurst 6, 22 – 25.

The gas flare and water storage facility will be situated at Dewhurst 22. Future infrastructure will link the gathering system to the Bibblewindi ponds.

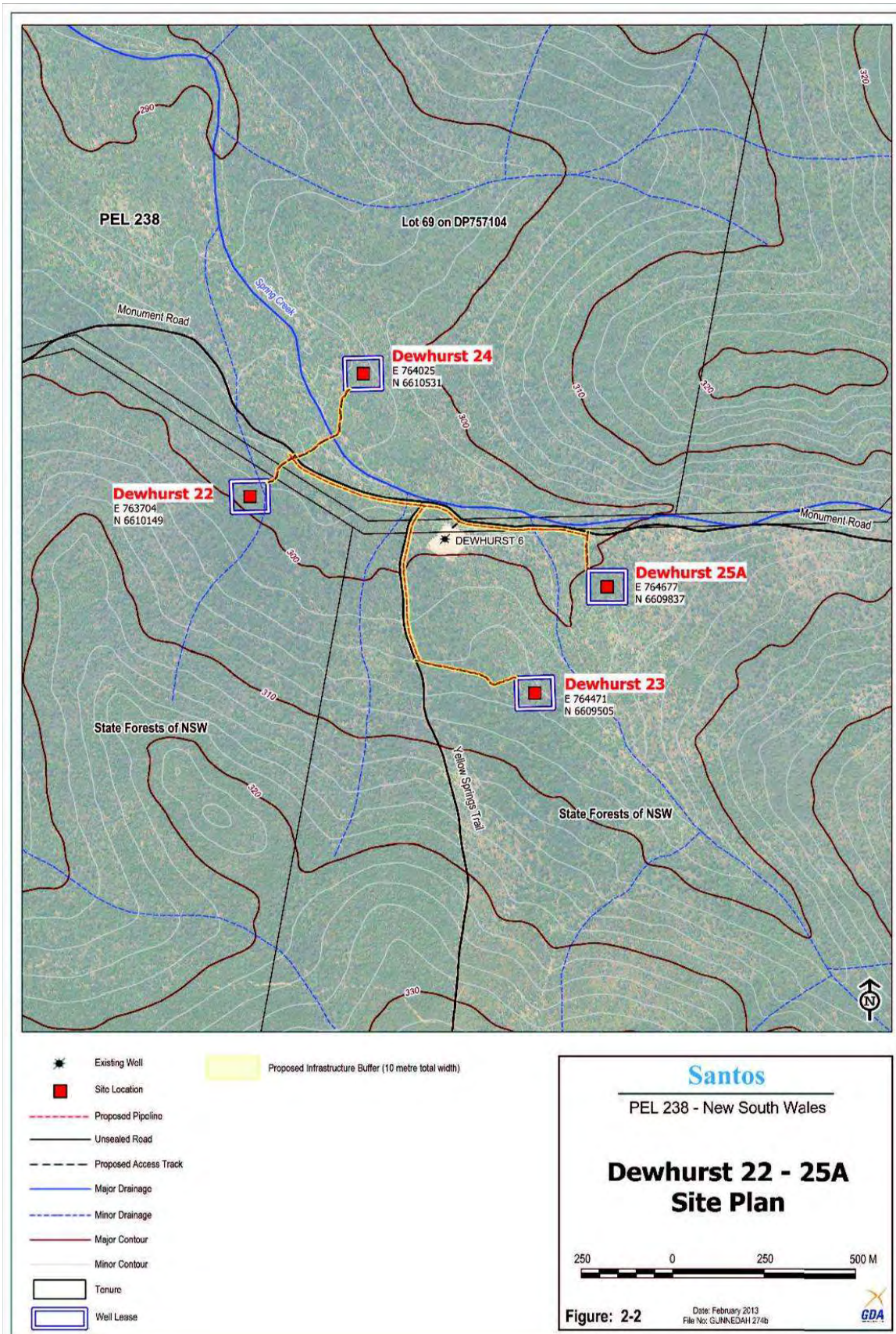


Plate 1.1.1: Location of existing Dewhurst 6 well, pilot wells Dewhurst 22 – 25A and gathering system (red/yellow lines).

1.2 Project Description

This Report considers the noise emissions from coal seam gas (CSG) well development and operation of the pilot wells.

1.2.1 Well development

CSG Well Development is undertaken in stages and operational noise potentially impacting on nearby noise sensitive receivers may include:

- Scouting - a relatively quiet activity, the only noises that should be expected are from vehicles travelling to the site and general conversation.
- Well site preparation – following location of the well site, general construction activities such as excavation and trenching take place to prepare the site, or well pad, for drilling.
- Well drilling – during gas well drilling activities, increases in noise and vibration can be expected in the surrounding area. This noise and vibration is temporary but is generated on a 24 hour continuous basis. Noise emitting equipment used includes the drilling rig, electricity generators for pumps and lighting, pumps, PA system, cementing process, truck and vehicle movements.
- Well completion – site rehabilitation enables the drilled well to be converted into a producing well. Flaring can create a noise for a short period of time. Noise is from the power generator, pump and compressor, and flaring. Trucks remove water and gas with associated vehicle noise. There is some noise during site rehabilitation and periodic well maintenance.
- Installation of the gas and water gathering systems – noises associated with this include the operation of earthmoving and trenching equipment, pipe unloading and lowering pipe into the trenches, backfilling the trench and associated truck engine sounds.

While earthmoving works are undertaken mostly using conventional construction plant such as excavators and graders, drilling processes involve specialised plant such as high-performance compressors and drilling machinery. The equipment used for the mobilisation and powering of the drilling rigs have mufflers installed on their respective power plants and prime movers. Sound from plant and equipment may be audible at night, however, depending on the activities taking place.

1.2.2 Drilling activities

Well drilling involves the following general stages-

- Drilling involves the removal of material by rotary drilling to create the well. The primary noise sources during this operation are the drilling 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 drilling and casing operations are repeated multiple times with decreasing hole 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.

The drill rigs used for coal seam gas wells typically emit noise from the operation of:



Figure 1.2.2.1: Typical drilling rig

- Diesel motor/s for the rig's operation;
- The mud pump that pumps drilling mud through the drill pipe and brings the cuttings to the surface then circulates the mud into tanks or ground sumps for reuse;
- Fitting and uplifting drill stems and fixing with an iron roughneck, that tightens the pieces of drill stem together as the hole is drilled deeper;
- Small pumps for water removal; and
- Generators to power ancillary lighting and office air conditioning equipment.

Noise emissions from the drilling rig encompasses different drilling modes the potential noise impacts are assessed at various distances from the rig. Noise measurements and predictions are generally for four different operational modes:

- Open hole drilling;
- Running casing;
- Cementing; and
- Core drilling.

The sound levels from various items of plant such as the mud pump, lighting rigs, various generators, pumps and items of mobile plant have been included in the noise assessments. The calculated sound power levels and calculated noise emission levels from typical plant are detailed in Annex A and summarised in Part 4.

1.2.3 Wellhead for water and gas extraction

To extract the gas from the coal seam, the gas and CSG water is pumped to the surface, where the CSG water and free and entrained gas is directed to a separator at the well head to reduce the amount of gas going to the water gathering system and minimise the amount of water going to the gas gathering system. Water gathering systems drain to low points in the topography and the collected water goes to tanks or to flow-lines to a water treatment facility. Each wellhead has separation and gas and water metering facilities. Gas and water from the wells is collected by the gathering systems linking the wells to centralised gas production facilities. The typical facilities at a CSG well are illustrated in Figures 1.2.3.1 to 1.2.3.3:

- A wellhead through which the gas and CSG water is brought to the surface;
- A pump that lifts the CSG water to the surface;
- A power supply to drive the water pump; and
- A wellhead separator with CSG control devices.

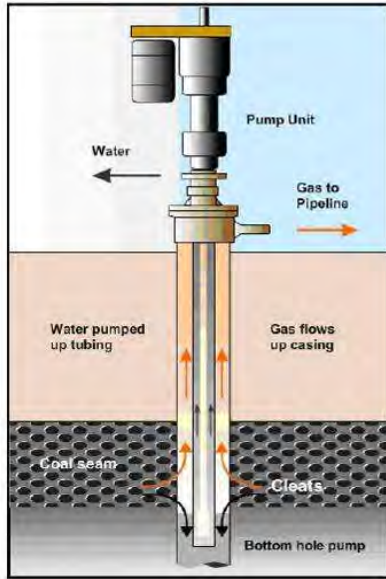
Well head pumping power is generally supplied by a modular gas fired or diesel electric power generation unit located adjacent to the well head. The power generation system and controls provide power for the artificial lift system within the well. As the well pressure declines, a small compressor may be required at the wellhead to ensure that maximum recovery of available gas is achieved. A pump may also be required to maintain water transfer. Flaring happens when there is gas build up and can occur at any time day or night (“24/7”).



Figure 1.2.3.1 - Typical wellhead for extraction of gas and CSG water from coal seams



Figure 1.2.3.2: Typical flare assembly



The on-site plant includes:

- Wellhead with progressing cavity pump (PCP, vertical wells at Dewhurst 6, 22 and 24) or down-hole electric submersible pump (ESP, lateral wells at Dewhurst 23 and 25) installed
- Gas fired gensets (2 x 185 kVa) with diesel backup generators (where applicable)
- Plant control panel
- Wellhead choke skid
- Wellhead knockout skid (includes gas and liquid metering skid)
- Gas flow monitoring device; Vortex Meters or Multivariable Transmitter (MVT) units
- Liquid flow monitoring via a Magnetic Water Flow meter device
- Remote Telemetry Unit
- Flow line risers
- Transfer tank
- Transfer pumps.
- Flare at Dewhurst 22

Figure 1.2.3.3: illustration of coal seam gas extraction pump unit

A portion of the produced gas is diverted to the local fuel gas skid for conditioning prior to being used within the well site power generators, with the balance being sent into the LP gas gathering network and flared. Backup diesel generators and associated diesel storage tanks will be stored onsite to ensure suitable power generation capabilities to the site. Any gas surplus to the requirements for on-site electricity generation will be flared on-site at Dewhurst 22 through a skid mounted or equivalent flare system.

1.2.4 Site preparation and rehabilitation

Site preparation consists of clearing the site (100m x 100m) and installing the various ponds and facilities. On-site plant will include excavators and trucks to move over-burden and to stock-pile soil for rehabilitation. Trucks will bring in metal for base-course and this is spread either by bulldozer or grader or both. Other vehicles will bring in the facilities and small plant. Maintenance vehicles (4WD vehicles) will be on-site at twice per day. Vehicles will travel along the access tracks Monument Road and Yellow Spring Creek Road. A water and gas collection system linking the 5 wells runs parallel to the access tracks.

1.2.5 Timing and Duration of Activities

The overall on-site activities are expected to take approximately 3 months and the main phases of work are identified in Table 1.2.5.1

Table 1.2.5.1 Duration of on-site activities

Activity	Approximate Duration	12hr or 24 hr
Site Preparation	14 days	12
Drilling* and completion	15 – 40 days	12
* drilling and cementing as a stand-alone process	3 – 7 days within the above time	24
Operation of wellhead	12 months	12
Rehabilitation	14 days	12

The number of people on-site at any one time is expected to be 40 staff during construction and 10 staff during installation and operation of the monitoring equipment. Crews will be located in Narrabri and travel to

site. The standard working hours are 7:00 am to 6:00 pm. The number of 4WD vehicle movements is expected to be approximately between 10 and 20 at these hours.

1.3 Sensitive Receptors

Three noise sensitive receptors (i.e. residences R1 to R3) are within 5 km of the Dewhurst 22 – 25 pilot wells and one residence is a little further way, as shown in Plate 1. Plate 1 also shows the ambient noise monitoring locations (ML1 and ML2). There is a residence at location ML1. The location of the Dewhurst 22-25 pilot wells is shown on Plate 1 and in more detail on Plate 2. The location of the residences and measurement locations in this report are given in Table 1.3.1 by latitude and longitude.

Table 1.3.1 Residential and Measurement Locations

Location	Easting	Southing
Residence 1	149°44' 36"	30°34' 55"
Residence 2	149°44' 31"	30°34' 42"
Residence 3	149°45' 05"	30°34' 20"
Residence 4 and ML1	149°41' 38"	30°36' 26"
ML2	149°41' 59"	30°38' 54"
ML3 (to the north of the Project area)	149°41' 07 "	30°21' 49"
ML4 (to the north of the Project area)	149°41' 07 .47"	30°22' 06"

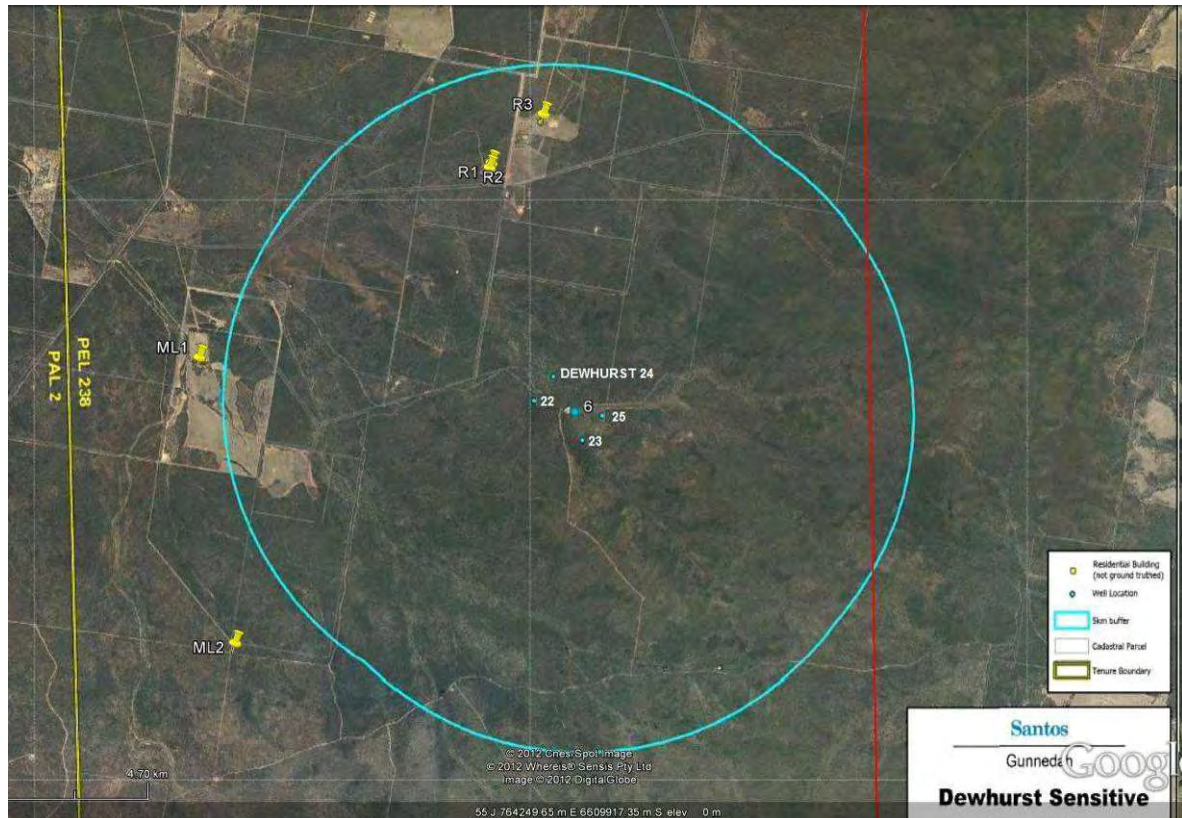


Plate 1.3.1: Residences (R1-R3), noise monitoring locations ML1, ML2) and Dewhurst pilot well locations

1.4 Noise Assessment Method

The basic concept of determining whether or not the noise from petroleum and gas activities is likely to cause intrusive noise impacts is to compare the existing noise levels to the expected noise levels from the proposed activities. The operational noise assessment was conducted in accordance with the Industrial Noise Policy (INP) published by the NSW EPA in 2000.

The determination compared the background sound levels calculated to the Industrial Noise Policy (the average of the minimum sound levels without the petroleum and gas activities) to the measured sound level at a potentially affected sensitive residence when the petroleum and gas activities are being carried out. Further operational noise levels were calculated to other residences potentially affected. Noise modelling creates different scenarios, including a scenario of worst case meteorological conditions. While different scenarios can be calculated through a noise model, it will rarely be possible to factor in all possible situations that may present themselves over time with accuracy. For this reason, assumptions must be made in applying the noise model. The calculation methods are detailed in Annex C.

The model identifies the preparation, drilling and 5 pilot well noise sources that could impact on residences. A residence may be affected by noise emissions from two or more operational wellheads. Therefore multiple noise sources are calculated.

The ambient noise level at a residence consists of the natural sound levels from wind in trees, insects, animal, rural activity, household activity noise. When the drilling occurs or the wellheads are in operation an additional sound is added to the natural environment. This is defined as the intrusive noise (or component noise) and is defined as the source noise only (i.e. without the contribution of background noise).

We conclude that, in the absence of insects and winds the background sound levels are below 30 dBA. This level constitutes the minimum Rating Background Level (RBL) 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. The measured ambient sound levels are recorded in Section 2.

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.

Intrusive Noise

The Intrusive Noise Criterion is determined as the Rating Background Level (RBL) plus 5 dB(A), measured as the time-average LAeq sound level over 15 minutes.

Sleep Disturbance

The Sleep Disturbance Criterion is determined as 40 dB(A), façade-affected per Table 2.1 of the INP measured as the time-average LAeq sound level over 15 minutes.

2.0 Ambient Noise Monitoring

2.1 Noise monitoring locations

In order to establish the existing noise environment within and adjacent to the Project area, ambient noise monitoring was conducted at two locations, ML1 and ML2 in November 2012. The selected locations are considered to be representative of the noise sensitive receptors within the Project area. In addition, two monitoring locations (ML3 and ML4) just to the north of the Project area are included as these give representative rural noise levels for June 2012. The measurement locations are shown graphically in Plate 2.1.1 and 2.1.2. The selection of noise monitoring locations was based on consideration of noise sensitive locations (residential properties) and other noise sources which may influence the noise measurements.

Plate 2.1.1: Aerial photograph showing ML1 and ML2 (November 2012). ML1 is located close to a Residence.

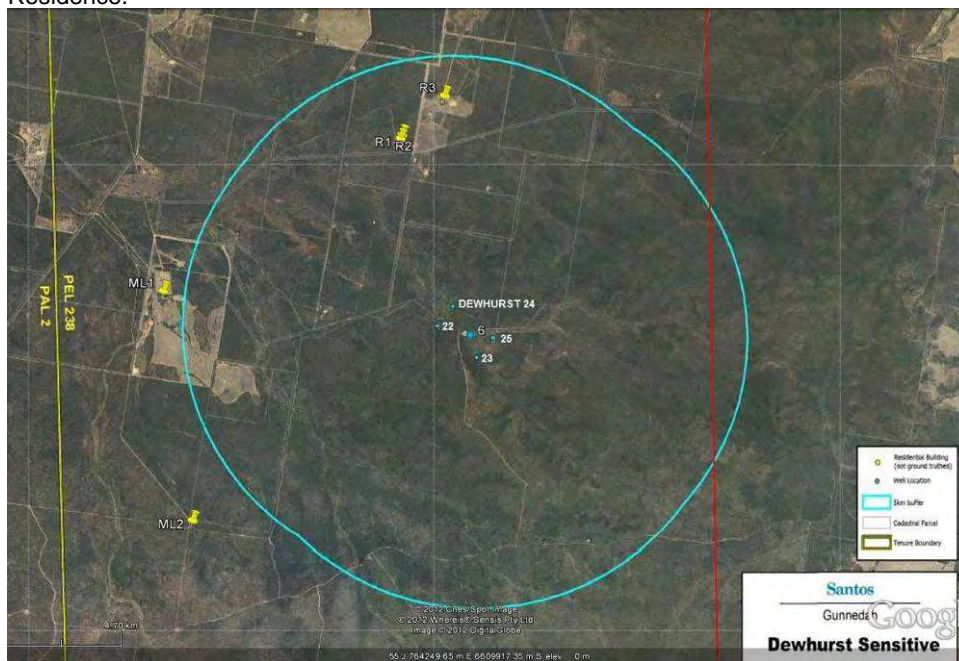
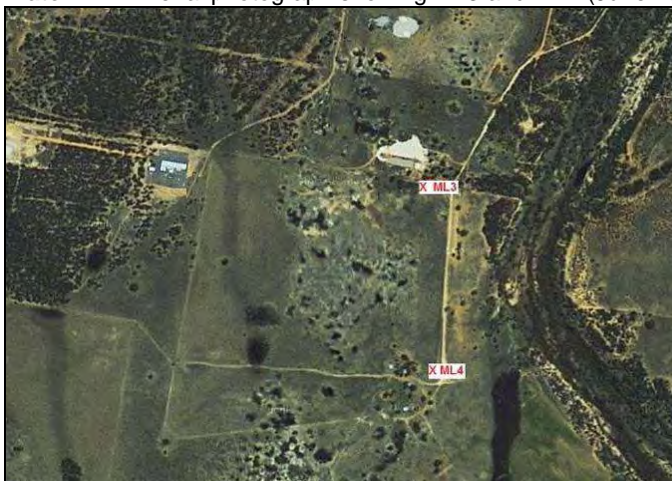


Plate 2.1.2: Aerial photograph showing ML3 and ML4 (June 2012). ML4 is located close to a residence.



The following photographs illustrate the various sound measurement locations for the survey.

Photo 2.1: View of noise logger location ML1 including weather station and residential dwelling behind.



Photo 2.2: View of noise logger ML2.



Photo 2.3: View of noise logger ML3 (June 2012 Survey).



Photo 2.4: View of noise logger ML4 (June 2012 Survey).



2.2 Instrumentation

The two-week unattended noise logging was conducted using Larson Davis 831 sound analyser instruments, designated as Class 1 under Australian Standard AS IEC 61672.1-2004 *Electroacoustics - Sound level meters - Specifications* as having an accuracy suitable for field use. The long-term noise loggers were calibrated before and after the measurements with a drift in calibration not exceeding ± 0.5 dB. Each sound level meter was calibrated before and after the measurements with a Rion NC73 calibrator and the drift in calibration not exceeding ± 0.5 dB. Each sound level meter used for this assessment has current a calibration certificate.

2.3 Meteorological data

Weather data for the area was sourced from the Bureau of Meteorology's Narrabri Airport weather station (Annex C) to wind speed and direction over a 12-month period and during the monitoring. A Davis weather station was installed at one of the measurement locations in order to record ground-level meteorological data. As required by the INP guidelines, extraneous noise events and noise data adversely affected by weather, e.g. rain, were excluded. The recorded weather data was recorded every 15 minutes and the data is summarised in Table 2.3.1. All the 15 minutes samples are displayed in 6-hour blocks. The noise data is unaffected by adverse weather.

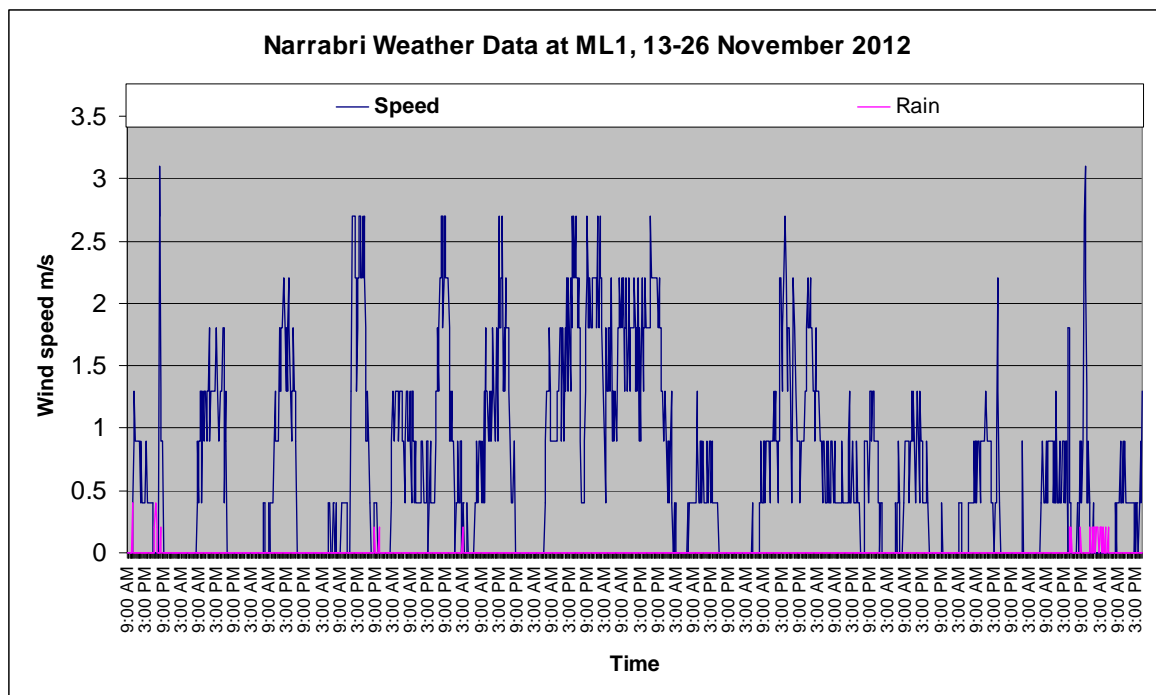


Figure 2.3.1 Weather data at Narrabri during the monitoring in November 2012

2.4 Unattended continuous noise monitoring

In order to assess the background and ambient noise levels at the site, in the absence of plant operating and in accordance with the *NSW Industrial Noise Policy 2000*, a series of surveys were taken on site, generally in accordance with Australian Standard AS1055.1:1997 - *'Acoustics-Description and measurement of environmental noise - Part 1: General procedures'*.

The microphone at each location was 1.35m above ground level. A Davis weather station was also employed during the survey to record wind and rain information, in order that days with excessive wind or rain noise could be identified and excluded. Two loggers were used to continuously measure background noise levels between Tuesday 13 November 2012 and Tuesday 27 November 2012 (refer to Figure 3). The results of the noise monitoring were processed in accordance with the procedures contained in the INP. Additionally, sound levels recorded to the north of the Project area have been reviewed and noted as they relate to different time of year and have different background levels that will be similar to the Dewhurst location.

The noise logger measured the noise level over the sample period and the L_{A1} , L_{A10} , L_{A90} , L_{Amax} and L_{Aeq} sound levels recorded every 15 minutes. The L_{A1} , L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period respectively.

The noise logger at location ML2 failed after 3 days. This was an instrument failure.

2.5 Rating Background Noise Levels

The background sound levels calculated to the Industrial Noise Policy are presented in the following tables. The levels were measured in continuous 15 minute intervals from 14 to 26 November 2012. The data is correlated to 15-minute wind and rain data. There were no events (rain or average wind speeds above 5m/s) requiring data to be excluded. This data is available for a more precise analysis if necessary.

The L_{A90} is taken as the background noise level. The Assessment Background Level (ABL) is established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or Rating Background Level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring duration.

The RBL is representative of the average minimum background sound level (in the absence of the source under consideration), or simply the background level. The L_{Aeq} is the average energy sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

A summary of the calculated RBLs (L_{A90}) and existing ambient noise levels (L_{Aeq}) is presented in the following tables. The calculated ABLs and existing L_{Aeq} ambient noise levels for each noise monitoring location for each assessment period (day, evening and night) are presented following.

Where the rating background level is found to be less than 30 dB(A) the RBL is set to 30 dB(A).

Table 2.1: Ambient noise levels at Residence (ML1); RBL (Median LA90)

	Day	Evening	Night
Wed 14 Nov	33.7	37.2	36.7
Thu 15 Nov	33.7	32.6	37.4
Fri 16 Nov	32.8	35.0	35.5
Sat 17 Nov	28.6	30.6	33.4
Sun 18 Nov	28.4	32.7	32.7
Mon 19 Nov	27.4	35.6	25.7
Tue 20 Nov	33.4	34.8	35.2
Wed 21 Nov	27.9	29.2	27.3
Thu 22 Nov	30.2	30.3	30.2
Fri 23 Nov	28.7	30.0	35.3
Sat 24 Nov	32.1	30.6	41.0
Sun 25 Nov	33.4	59.1	38.5
Mon 26 Nov	35.4	36.3	40.9
Time Period	7am to 6pm	6pm to 10pm	10pm to 7am
Rating Background Level (RBL)	32	33	35

Table 2.2: Ambient noise levels background location (ML2); RBL (Median LA90)

	Day	Evening	Night
Wed 14 Nov	28.0	35.7	16.6
Thu 15 Nov	27.4	30.4	15.6
Time Period	7am to 6pm	6pm to 10pm	10pm to 7am
Rating Background Level (RBL)	28	33	16

Note: the measurements are truncated because the noise logger failed.

Table 2.3: Ambient (2012) noise levels in rural area to north of Project area (W-ML3); RBL (Median LA90)

	Day	Evening	Night
Sat 23 Jun	23.6	24.8	23.7
Mon 25 Jun	21.0	24.1	21.3
Tue 26 Jun	22.2	21.3	20.8
Fri 29 Jun	22.9	29.9	21.7
Sun 8 Jul	22.1	19.3	ND
Mon 9 Jul	22.5	19.2	19.7
Tue 17 Jul	ND	ND	ND
Sun 15 Jul	ND	ND	ND
Sat 30 Jun	24.5	28.6	21.0
Mon 2 Jul	26.3	22.3	22.6
Time Period	7am to 6pm	6pm to 10pm	10pm to 7am
Rating Background Level (RBL)	23	23	21

Table 2.4: Ambient (2012) noise levels at residential property, rural locale north of the Project area (W-ML4); RBL (Median LA90)

	Day	Evening	Night
Sat 23 Jun	25.7	20.0	18.7
Mon 25 Jun	21.4	18.6	20.1
Tue 26 Jun	24.3	18.9	19.1
Fri 29 Jun	23.9	26.0	22.7
Sun 8 Jul	24.5	19.9	19.9
Mon 9 Jul	23.7	19.7	19.5
Tue 17 Jul	25.1	43.0	31.2
Sun 15 Jul	30.3	36.9	33.9
Sat 30 Jun	25.6	23.1	20.5
Mon 2 Jul	27.9	19.5	19.2
Time Period	7am to 6pm	6pm to 10pm	10pm to 7am
Rating Background Level (RBL)	25	20	20

2.6 Ambient Leq Noise Levels

The Leq sound levels calculated to the procedure under the Industrial Noise Policy are presented in the following tables. The levels were measured in continuous 15 minute intervals from 14th to 26th November 2012. Days affected by rain or high winds (average wind gusts over 5m/s) were excluded from assessment, where possible.

Table 2.5: Ambient LAeq noise levels at residence (ML1)

	Day	Evening	Daytime	Night
Wed 14 Nov	47.2	59.8	54.7	53.4
Thu 15 Nov	46.2	51.0	48.1	53.5
Fri 16 Nov	45.9	53.8	49.7	49.3
Sat 17 Nov	46.6	51.4	48.5	51.1
Sun 18 Nov	46.7	58.8	53.7	55.0
Mon 19 Nov	44.4	48.8	46.1	45.4
Tue 20 Nov	45.6	48.1	46.4	47.4
Wed 21 Nov	44.0	54.6	49.8	56.8
Thu 22 Nov	50.7	53.5	51.6	55.9
Fri 23 Nov	45.5	53.1	49.0	55.3
Sat 24 Nov	46.2	49.2	47.2	55.6
Sun 25 Nov	47.3	61.5	56.1	55.5
Mon 26 Nov	49.6	51.1	50.0	55.1
Time Period	7am to 6pm	6pm to 10pm	7am to 10pm	10pm to 7am
Existing Leq	47	56	51	54

Table 2.6: Ambient LAeq noise levels background location (ML2)

	Day	Evening	Daytime	Night
Wed 14 Nov	43	44	44	37
Thu 15 Nov	40	45	42	36
Time Period	7am to 6pm	6pm to 10pm	7am to 10pm	10pm to 7am
Existing Leq	42	44	43	36

Note: the measurements are truncated because the noise logger failed.

This location, ML2, is in the bush and affected by insects, birds and noise in vegetation.

Supplementary Data

The levels were measured in continuous 15 minute intervals from 20 June to 20 July 2012, whilst the gas powered generators at Wilga Park were not operational. Days affected by rain or high winds (average wind gusts over 5m/s) were excluded from assessment, where possible. The data is included as it provides an assessment for mid-year (June) weather conditions.

Table 2.7: Ambient LAeq 2012 noise levels at residential property, rural locale north of the Project area (W-ML3)

	Day	Evening	Daytime	Night
Sat 23 Jun	45	33	44	34
Mon 25 Jun	47	29	45	43
Tue 26 Jun	45	30	44	38
Fri 29 Jun	47	36	46	36
Sun 8 Jul	48	25	47	31
Mon 9 Jul	52	30	51	37
Tue 17 Jul	51	44	50	42
Sun 15 Jul	44	43	44	42
Sat 30 Jun	46	27	45	31
Mon 2 Jul	51	28	49	38
Time Period	7am to 6pm	6pm to 10pm	7am to 10pm	10pm to 7am
Existing Leq	48	37	47	39

Table 2.8: Ambient LAeq 2012 noise levels at rural property boundary north of the Project area (W-ML4)

	Day	Evening	Daytime	Night
Sat 23 Jun	43	32	42	32
Mon 25 Jun	42	29	41	33
Tue 26 Jun	43	29	42	32
Fri 29 Jun	43	36	42	36
Sun 8 Jul	ND	25	ND	ND
Mon 9 Jul	43	26	41	34
Tue 17 Jul	ND	ND	ND	ND
Sun 15 Jul	ND	ND	ND	ND
Sat 30 Jun	44	32	42	34
Mon 2 Jul	43	31	42	33
Time Period	7am to 6pm	6pm to 10pm	7am to 10pm	10pm to 7am
Existing Leq	43	31	42	33

3.0 Noise Assessment Criteria

3.1 Operational noise criteria

Under the provisions of the *Protection of the Environment Act*, any premises that has the capacity to produce more than 5 petrajoules of gas per annum must hold an environmental protection licence. The licence can include noise conditions. While it is not known (to NMS) if the trigger level is reached for this Project element it is 'best practice' to assume that noise conditions may be applied to this part of the Project. Potentially relevant legislation and guidelines include:

- Protection of the Environment Operations Act 1997 (POEO Act),
- Protection of the Environment Operations (General) Regulation 1998,
- Protection of the Environment Operations (Noise Control) Regulation 2000,
- NSW Industrial Noise Policy (INP), DEC January 2000,
- Interim Construction Noise Guideline, 2009
- Environmental Criteria for Road Traffic Noise (ECRTN), DEC, May 1999,
- NSW Environmental Noise Control Manual or ENCM (DEC Ref. 94/31),
- Environmental Noise Management, Noise Guide for Local Government (DEC Ref.2004/59).

Not all of the above need to be considered for this assessment. Noise generated within the Project area, including construction noise, noise from plant, truck movements, loading/unloading activities, mechanical services associated with site buildings, are assessed in accordance with the EPA's Industrial Noise Policy 2000 (INP) guidelines. Noise of the type that would be generated by the Project is classified under the INP as '*industrial noise*'. The INP assessment procedure for industrial noise sources has two components, which are:

- Controlling intrusive noise impacts in the short term for residences; and
- Protecting noise amenity for particular land uses and for residences.

3.2 Intrusive noise impacts

The INP states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15 minute period, does not exceed the background noise level (RBL), measured in the absence of the source, by more than 5 dB. This is termed the *Intrusiveness Criterion*. The RBL is the background noise level to be used for assessment purposes and is determined by the methods given in Section 3.1 of the INP. In accordance with the INP requirements, adjustments are to be applied to the level of noise produced if the noise at the receptor contains annoying characteristics such as tonality or impulsiveness.

3.3 Protecting noise amenity

To limit continuing increases in noise levels, the ambient noise level resulting from industrial type noise sources should not normally exceed the acceptable noise levels specified in *Table 2.1* of the INP. That is, the industrial noise level contribution should not exceed the level appropriate for the particular locality and land use. This is

termed the *Amenity Criterion*. Most applicable to this assessment are the amenity criteria for residential receptors in a 'Rural' area and passive recreation areas. The recommended maximum values provide guidance on an upper limit to the level of noise from industry and industrial type facilities. In all cases, it is expected that all feasible and reasonable mitigation measures would be applied before the recommended upper limit noise levels are referenced.

3.4 Cumulative impact from Drilling and Operation of Pilot Wells

The site specific environmental noise criteria, which are derived based on existing ambient conditions, take into account the cumulative impact from the individual pilot wells within the area adjacent to the proposed Project area. This is achieved by calculating all 5 wells operating together. The predicted levels from the wells are below the RBL of 30 dB(A).

3.5 Sleep disturbance criteria

The INP discusses sleep disturbance and its objective assessment. To reduce the risk of sleep disturbance as a result of industrial type operations during the night-time period, Table 2.1 has a recommended amenity criterion of 40 dB(A) LAeq for night-time at a residence in a rural area. (*Note – in quiet rural areas and a low background level at night an activity level of 40 dB(A) at the outdoor façade will be audible indoors*). The INP application notes recommend that the LA1(1 minute) noise level outside a bedroom window should not exceed the LA90 background noise level by more than 15 dB(A) during the night-time period (10.00 pm to 7.00 am).

3.6 Sound character

The character of the sound emissions from the site construction, drilling, and pilot well operation is different to that the existing environment. Low frequency sound (for example, generator sound), impulsiveness (for example, the clanging of drill pipes) and possible tonal noise (for example, from generators) are the most common sounds noticed at a distance under enhanced propagation conditions. The guidelines suggest a 'penalty' or 'adjustment' based on the degree that the sound may be noticed. A value of +5dB(A) is added to the modelled sound levels to represent "tonal components that are clearly audible and their presence can be detected by one-third octave analysis". If the sound is only just detectable by the observer and is determined by narrow-band analysis an adjustment of 2 to 3 dB is more appropriate.

3.7 Interim Construction Noise Guideline

The Project is considered a mining project for the purpose of this noise assessment. In accordance with the recommendations in the Interim Construction Noise Guidelines (ICNG), the construction activities for mining projects are to be assessed under the INP, therefore the operational noise criteria presented previously will also apply to construction works associated with the Project.

Drilling typically takes 3 - 7 days. 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 short-term construction noise and as such appropriate assessment guidelines are detailed in the *Interim Construction Noise Guideline* (ICNG, DECC 2009).

The Guideline presents noise management levels for use when undertaking a quantitative assessment, such as for major construction projects. The recommended standard hours are-

- Monday to Friday 7am to 6pm
- Saturdays 8am to 1pm
- No work on Sundays or public holidays

Construction Noise Criteria

The noise management level for works during the recommended standard hours is background + 10 dB(A). Above this noise level the proponent needs to implement all feasible and reasonable work practices, as defined in the Guideline, to minimise noise impacts.

For works outside the recommended standard hours, the noise management level is background + 5 dB(A).

The highly noise-affected level of LAeq 75 dB(A) represents the point above which there may be strong community reaction to noise and indicates a need to consider other feasible and reasonable ways to reduce noise, such as restricting the times of very noisy works to provide respite to affected residences.

4.0 Noise Calculations – Impact Assessment

4.1 Environmental noise prediction method

The method of prediction is ideally suited to a combination of both ISO 9613-2 and CONCAWE methods. The calculation programs available for this purpose are (a) SoundPLAN, which has both methods as separate modules, and (b) PEN3D, an environmental noise model developed by Noise Mapping Pty Ltd Queensland. The PEN3D environmental model is the program used in this Report. It is a faithful representation of the Environmental calculation method described in the book by Bies & Hansen “*Environmental Noise Control*”. The program has both propagation methods and is described in Appendix D.

The noise model is based on an assessed flat topography as the land effectively flat within the 5 km of the pilot wells to the nearest residences. Tonality is not allowed for in the models and is added into the calculation tables.

4.2 Meteorological conditions

Meteorological conditions such as the presence of a temperature inversion or light to moderate winds can have a significant effect on sound propagation. Temperature inversions (i.e. when the normal temperature profile of the atmosphere is reversed such that the air temperature increases with increasing height above ground) typically occur at night during winter periods and tend to assist the propagation of noise. Based upon information provided by Heggies (see Appendix C), the occurrence of F class or greater temperature inversions is 22% or less during the winter months. The INP suggests that the effects of temperature inversions on noise levels be assessed in locations where occurrence approaches or is in excess of 30%. An assessment under inversion conditions is not therefore part of this Report. Modelling with a 5m/s breeze from the south blowing towards the nearest residences was conducted as part of this assessment.

4.3 Operational activities

All operational equipment was assumed to be running 24 hours per day, 7 days a week, with similar capacity during the day, evening and night-time periods. All noise sources were modelled as point sources as the distance between source and receptor is large enough to warrant this assumption. Operational activities with the potential to create a noise impact within the Project area are described previously and for prediction purposes consist of:

- Site clearing sound power level of 120 dB(Lin) or 118 dB(A), LAeq 1 hour
- Well drilling sound power level of 120 dB(Lin) or 118 dB(A), LAeq 1 hour
- Pilot well operation sound power level of 114 dB(Lin) or 97 dB(A), LAeq, 1 hour

All residential receptors were modelled at a height of 1.8 m above ground level. Noise predictions were carried out at the three nearest residential receptors to the Dewhurst wells. The distances of the three residential receptors to the Dewhurst locations are shown in the predictions' table, Table 4.3.1, for scenarios 1 to 6. Scenario 'F' is an assessment of the 5 pilot wells in operation at the same time and an inversion layer over the locale. The inversion is stability 'F' and calculated as a temperature gradient of 3.0 °C/100m, 10°C ambient, 50% relative humidity.

The noise criterion to be achieved is established as the Intrusive Noise Criterion under the Industrial Noise Policy. This is the Rating Background Level plus 5 dB(A) and is established as LAeq 35 dB.

As the exact location of the residences are not known (the locations have been estimated as closely as possible from Google Earth) the calculations are predicted in the free-field or nominally 5 metres from the assessed residence location. At the distances involved this assessment will not give rise to a significant variation in activity sound level. Table 4.3.1 gives the predicted free-field values and Table 4.3.2 gives the predicted façade-affected time-average LAeq sound levels at the residences.

Table 4.3.1: Noise 'Most Likely' Predicted Levels (LAeq), Noise Criteria, and Distances to Residences. Sound levels are rounded and calculated to 5 metres from the façade ('free-field')

Residence	Distance	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 'F'
R1	3370	24	34	<15	19	21	26	20
R2	3430	23	33	<15	19	21	26	20
R3	4070	20	30	<15	17	19	24	18
ML1-R4	5730	<15	15	<15	<15	<15	16	15
Plant		Drilling	Drilling	1 x well	5 x wells	1 x well	5 x wells	5 x wells
Weather		calm	southerly	calm	calm	southerly	southerly	inversion

Note: 'Distance' is the distance in metres from Dewhurst 24 to the relevant residence

Table 4.3.2: Noise 'Most Likely' Predicted Levels (LAeq), Noise Criteria, and Distances to Residences. Sound levels are rounded and calculated at the residential façade

Residence	Distance	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 'F'
R1	3370	26	36	16	21	24	29	22
R2	3430	25	36	16	21	23	29	22
R3	4070	23	32	<15	19	21	27	21
ML1-R4	5730	16	17	<15	16	<15	18	17
Plant		Drilling	Drilling	1 x well	5 x wells	1 x well	5 x wells	5 x wells
Weather		calm	southerly	calm	calm	southerly	southerly	inversion

Note: 'Distance' is the distance in metres from Dewhurst 24 to the relevant residence

The noise emissions from the operation of the 5 pilot wells together, under temperature inversion conditions, is calculated at approximately 18 dB(A) LAeq, at 5 km from the wells. The duration of noise from pilot well is taken as being '24/7' and is calculated on a 15-minute or 1-hour basis. This also applies to the operation of the drill rig. All other activities are taken as being 7am to 6pm daily.

The weather conditions in the Table relate to 'calm' conditions where there is no breeze blowing towards a residence; and 'enhanced' conditions when there is a 3 metres/sec breeze blowing towards a residence.

The 'worst case' assessments for noise from the drilling rig (or from similar noisy plant and machinery such as excavators) are given in Table 4.3.3.

Table 4.3.3: Predicted 'Worst Case' LAeq Sound Levels at Various Offset Distances for the drilling rig operation (or similar plant such as excavators) alone

Drill Rig and Operation	Weather Condition	Predicted LAeq Sound Level at Buffer Distances (metres)						
		50m	100m	500m	1000m	1500m	2000m	5000m
Open Hole Drilling	Calm	70	62	45	36	30	25	<10
	Enhanced	70	64	48	39	33	29	<10
Running casing	Calm	70	62	45	36	30	25	<10
	Enhanced	72	64	47	38	32	27	<10
Cementing Casing	Calm	70	62	45	36	30	25	<10
	Enhanced	77	69	51	41	35	30	13
Core Drilling	Calm	64	58	41	33	27	23	<10
	Enhanced	68	61	43	35	29	25	<10

Table 4.3.4 presents an assessment of the Industrial Noise Policy guideline values for Intrusive Noise with respect to the potential noise sources as they affect the residences. The criterion is 35 LAeq.

Table 4.3.4: Compliance with Intrusive Noise Guideline of 35 dB(A) LAeq façade level

Residence	Distance	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 'F'
R1	3370	Pass	+1	Pass	Pass	Pass	Pass	Pass
R2	3430	Pass	+1	Pass	Pass	Pass	Pass	Pass
R3	4070	Pass	Pass	Pass	Pass	Pass	Pass	Pass
ML1-R4	5730	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Plant		Drilling	Drilling	1 x well	5 x wells	1 x well	5 x wells	5 x wells
Weather		calm	southerly	calm	calm	southerly	southerly	inversion

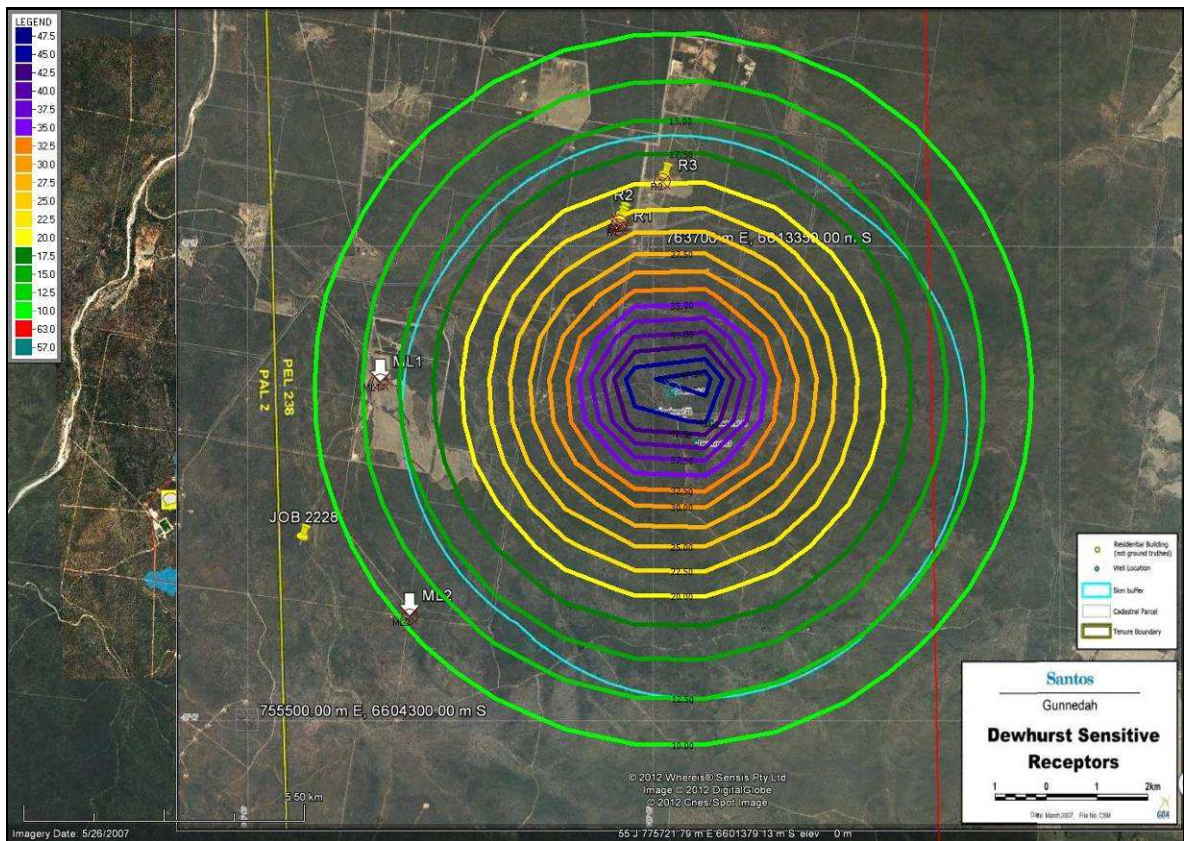
Note: 'Distance' is the distance in metres from Dewhurst 24 to the relevant residence

Table 4.3.5 presents an assessment of the Industrial Noise Policy guideline values for Sleep Amenity (measured outdoors) with respect to the potential noise sources as they affect the residences. The criterion is 40 LAeq.

Table 4.3.5: Compliance with Amenity (sleep) Guideline of 40 dB(A) LAeq façade level

Residence	Distance	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 'F'
R1	3370	Pass	+1	Pass	Pass	Pass	Pass	Pass
R2	3430	Pass	+1	Pass	Pass	Pass	Pass	Pass
R3	4070	Pass	Pass	Pass	Pass	Pass	Pass	Pass
ML1-R4	5730	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Plant		Drilling	Drilling	1 x well	5 x wells	1 x well	5 x wells	5 x wells
Weather		calm	southerly	calm	calm	southerly	southerly	inversion

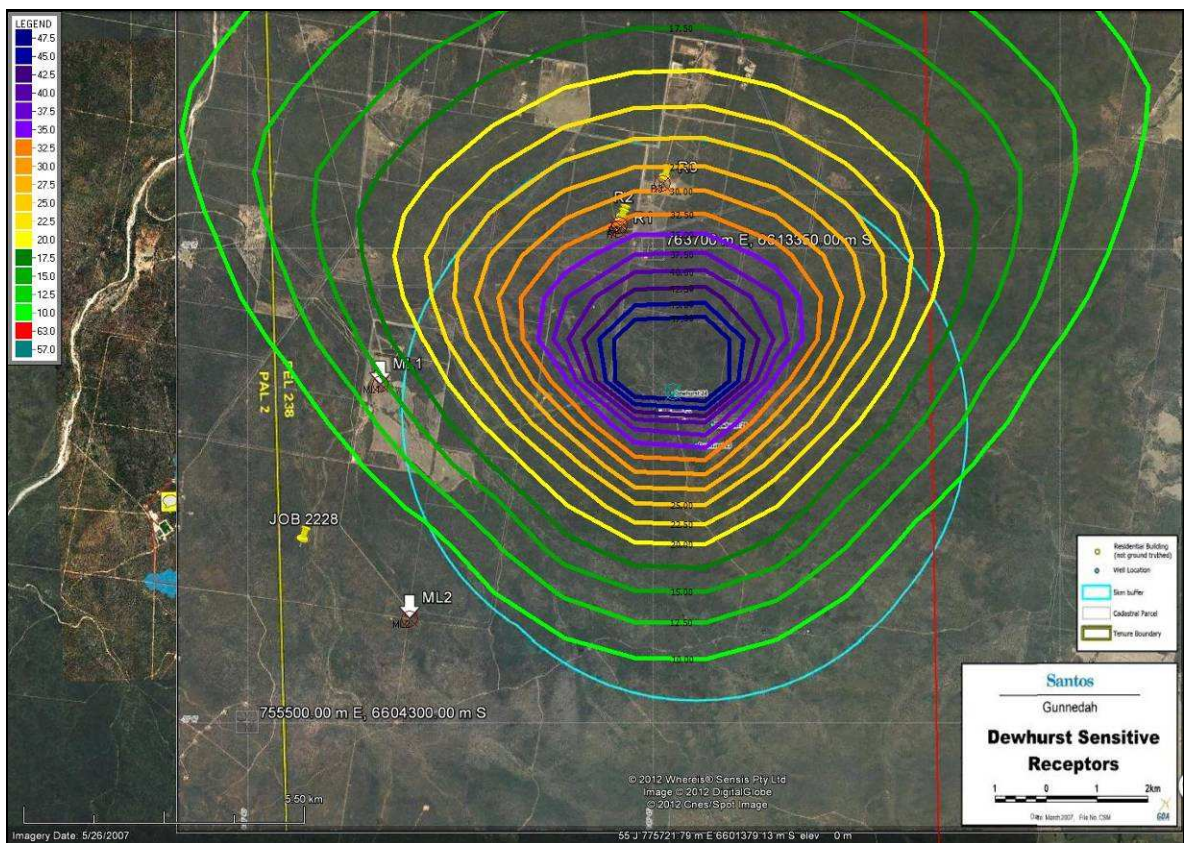
Note: 'Distance' is the distance in metres from Dewhurst 24 to the relevant residence



Scenario 1: site operations or single drilling rig, calm weather

Scenario 1: Point calculations for site operations or single drilling rig

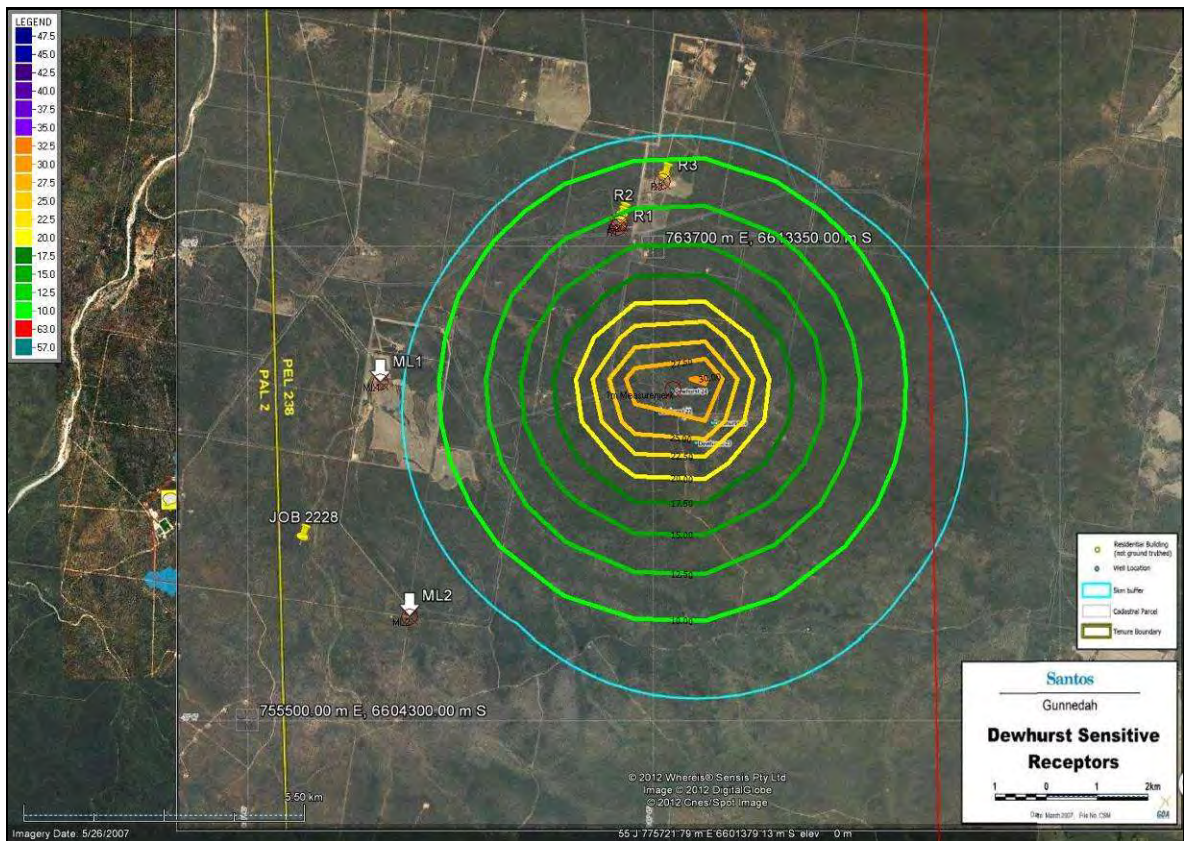
Plant Sound Power Level	dB(Lin)	dB(A)
Excavators or drill rig	120	118
Wind speed (modelled, m/s)	0	
Wind direction (modelled)	calm	
Temperature (modelled, °C)	20	
Humidity (modelled, RH%)	50	
Surface roughness (m)	0.023	
Sound Levels at Residence	dB(A) LAeq, calculated at 5m from residence location	
R1	13.6	
R2	23.8	
R3	23.4	
ML1 – R4	20.1	



Scenario 2: site operations or single drilling rig, wind 3 m/s from south

Scenario 2: Point calculations for site operations or single drilling rig

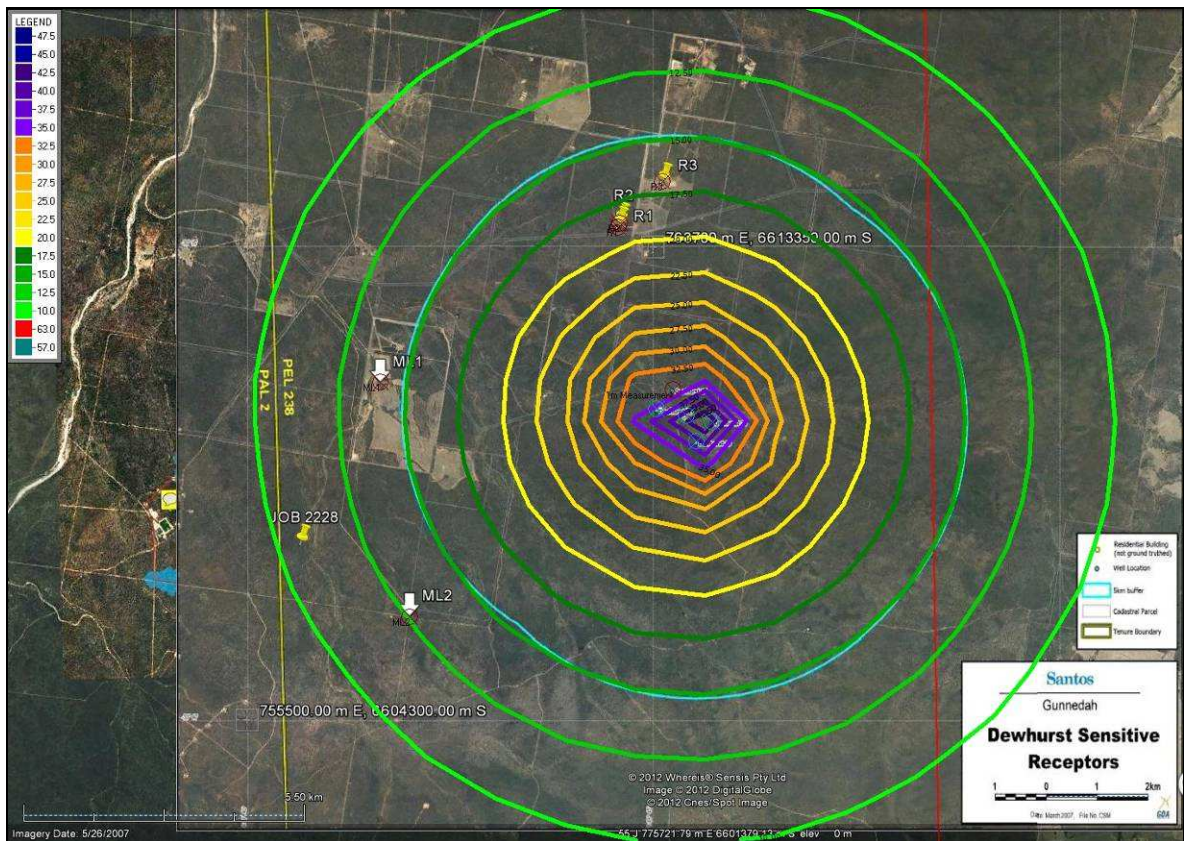
Plant Sound Power Level	dB(Lin)	dB(A)
Excavators or drill rig	120	118
Wind speed (modelled, m/s)	3	
Wind direction (modelled)	southerly	
Temperature (modelled, °C)	20	
Humidity (modelled, RH%)	50	
Surface roughness (m)	0.023	
Sound Levels at Residence	dB(A) LAeq, calculated at 5m from residence location	
R1	15.1	
R2	33.7	
R3	33.3	
ML1 – R4	29.5	



Scenario 3: single pilot well, Dewhurst 24, calm weather

Scenario 3: Point calculations for single pilot well (Dewhurst 24)

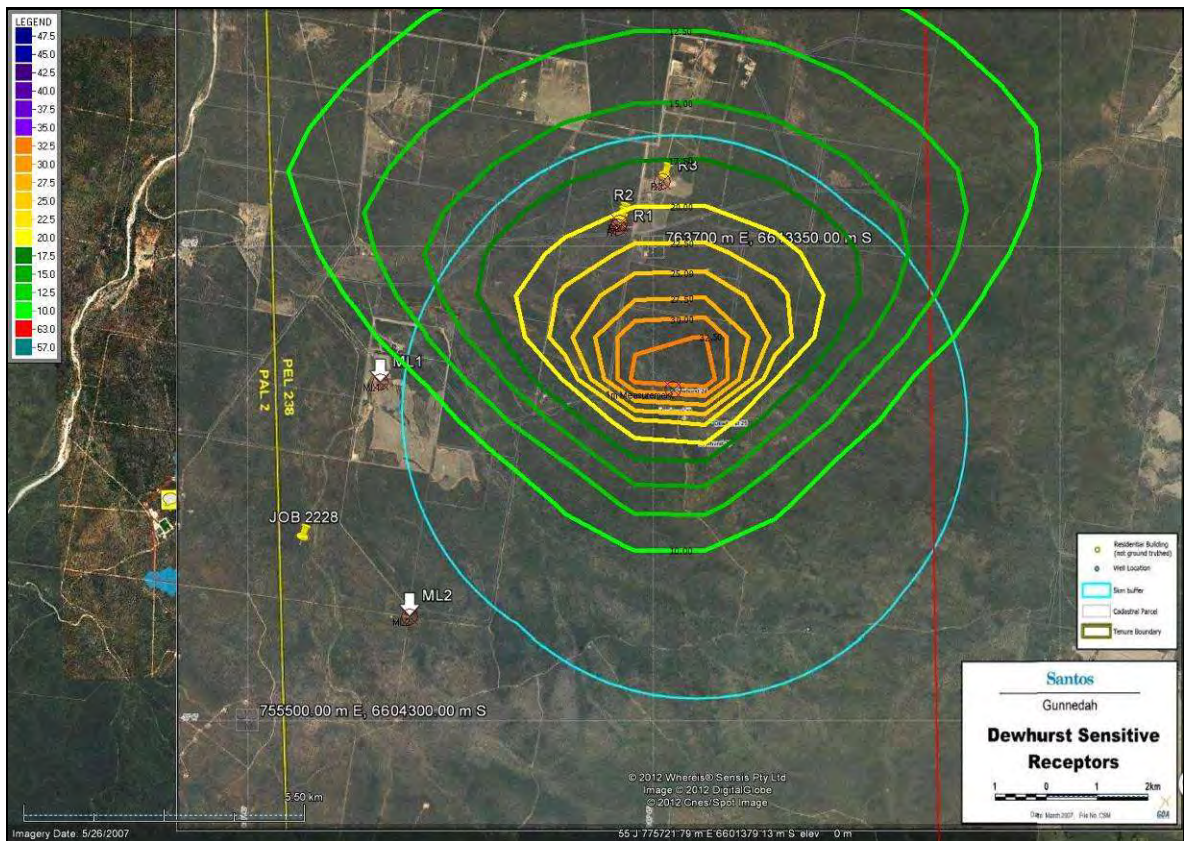
Plant Sound Power Level	dB(Lin)	dB(A)
Pilot well with Cummins generator	114	88
Wind speed (modelled, m/s)	0	
Wind direction (modelled)	calm	
Temperature (modelled, °C)	20	
Humidity (modelled, RH%)	50	
Surface roughness (m)	0.023	
Sound Levels at Residence	dB(A) LAeq, calculated at 5m from residence location	
R1	13.4	
R2	13.2	
R3	11.2	
ML1 – R4	7.4	
Tonality (just detectable)	Add 2 dB(A) to above sound levels	
Level at the residential facade	Add 2.5 dB(A) to above sound levels	



Scenario 4: All 5 wells at Dewhurst 6, 22-25 operating, calm weather

Scenario 4: Point calculations for all 5 pilot wells operating

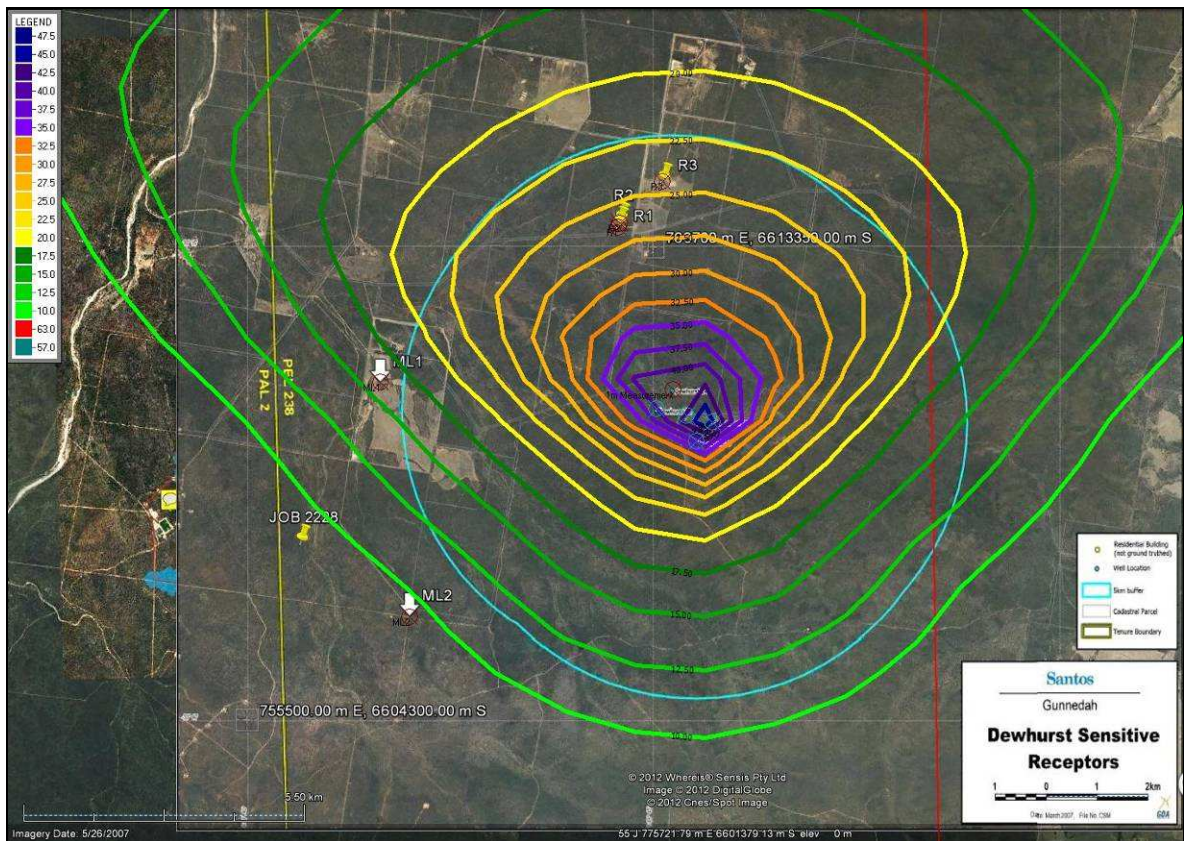
Plant Sound Power Level	dB(Lin)	dB(A)
Pilot well with Cummins generator	114	88
Wind speed (modelled, m/s)	0	
Wind direction (modelled)	calm	
Temperature (modelled, °C)	20	
Humidity (modelled, RH%)	50	
Surface roughness (m)	0.023	
Sound Levels at Residence	dB(A) LAeq, calculated at 5m from residence location	
R1	17.9	
R2	17.7	
R3	16.0	
ML1 – R4	13.0	
Tonality (just detectable)	Add 2 dB(A) to above sound levels	
Level at the residential facade	Add 2.5 dB(A) to above sound levels	



Scenario 5: single well, Dewhurst 24, wind at 3 m/s from the south

Scenario 5: Point calculations for single pilot well (Dewhurst 24)

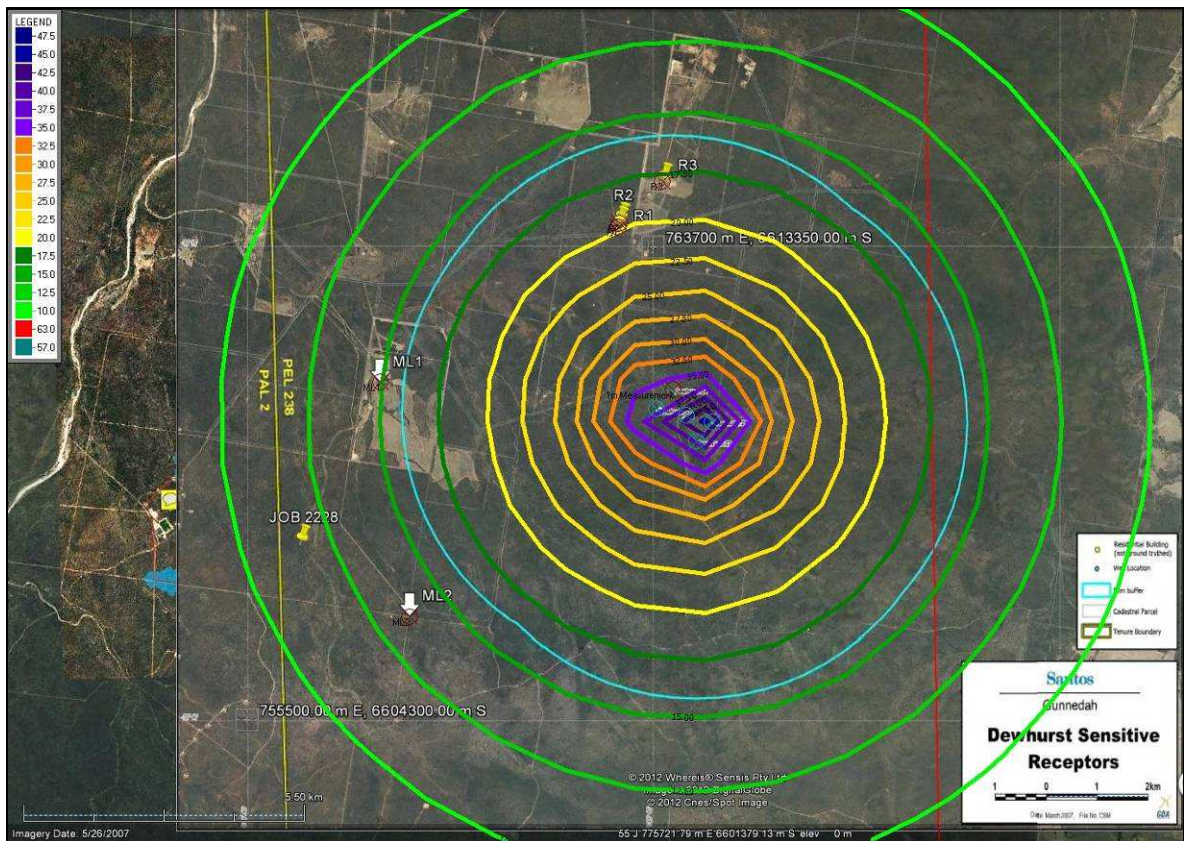
Plant Sound Power Level	dB(Lin)	dB(A)
Pilot well with Cummins generator	114	88
Wind speed (modelled, m/s)	3	
Wind direction (modelled)	southerly	
Temperature (modelled, °C)	20	
Humidity (modelled, RH%)	50	
Surface roughness (m)	0.023	
Sound Levels at Residence	dB(A) LAeq, calculated at 5m from residence location	
R1	21.0	
R2	20.7	
R3	18.7	
ML1 – R4	8.2	
Tonality (just detectable)	Add 2 dB(A) to above sound levels	
Level at the residential facade	Add 2.5 dB(A) to above sound levels	



Scenario 6: All 5 wells at Dewhurst 6, 22-25 operating, wind at 3m/s from the south

Scenario 6: Point calculations for all 5 pilot wells operating

Plant Sound Power Level	dB(Lin)	dB(A)
Pilot well with Cummins generator	114	88
Wind speed (modelled, m/s)	3	
Wind direction (modelled)	southerly	
Temperature (modelled, °C)	20	
Humidity (modelled, RH%)	50	
Surface roughness (m)	0.023	
Sound Levels at Residence	dB(A) LAeq, calculated at 5m from residence location	
R1	25.5	
R2	25.3	
R3	23.5	
ML1 – R4	15.0	
Tonality (just detectable)	Add 2 dB(A) to above sound levels	
Level at the residential facade	Add 2.5 dB(A) to above sound levels	



Scenario 'F': All 5 wells at Dewhurst 6, 22-25 operating, Stability factor 'F' resulting in inversion

Scenario 'F': Point calculations for all 5 pilot wells operating

Plant Sound Power Level	dB(Lin)	dB(A)
Pilot well with Cummins generator	114	88
Wind speed (modelled, m/s)	0	
Wind direction (modelled)	Inversion 'F' with temperature gradient 3°C/100m	
Temperature (modelled, °C)	20	
Humidity (modelled, RH%)	50	
Surface roughness (m)	0.023	
Sound Levels at Residence	dB(A) LAeq, calculated at 5m from residence location	
R1	19.0	
R2	18.8	
R3	17.0	
ML1 – R4	14.0	
Tonality (just detectable)	Add 2 dB(A) to above sound levels	
Level at the residential facade	Add 2.5 dB(A) to above sound levels	

5.0 Conclusions

The noise criteria to be achieved are the Intrusive noise criterion and sleep disturbance criterion under the Industrial Noise Policy. The Rating Background Level plus 5 dB(A) and is established as LAeq 35 dB. 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 similar to short-term construction noise and the appropriate assessment guidelines are detailed in the *Interim Construction Noise Guideline*.

Table 5.1: Noise 'Most Likely' Predicted Levels (LAeq), Noise Criteria, and Distances to Residences. Sound levels are rounded and calculated at the residential façade

Residence	Distance	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 'F'
R1	3370	26	36	16	20	24	28	22
R2	3430	25	36	16	20	23	28	21
R3	4070	23	32	<15	19	21	26	20
ML1-R4	5730	16	17	<15	16	<15	18	17
Plant		Drilling	Drilling	1 x well	5 x wells	1 x well	5 x wells	5 x wells
Weather		calm	southerly	calm	calm	southerly	southerly	inversion

Note: 'Distance' is the distance in metres from Dewhurst 24 to the relevant residence

The noise emissions from the operation of the 5 pilot wells together, under temperature inversion 'F' conditions, is calculated at approximately 18 dB(A) LAeq, at 5 km from the wells.

Table 5.2 presents an assessment of the Industrial Noise Policy guideline values for Intrusive Noise with respect to the potential noise sources as they affect the residences. The criterion is 35 LAeq.

Table 5.2: Compliance with Intrusive Noise Guideline of 35 dB(A) LAeq façade level

Residence	Distance	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 'F'
R1	3370	Pass	+1	Pass	Pass	Pass	Pass	Pass
R2	3430	Pass	+1	Pass	Pass	Pass	Pass	Pass
R3	4070	Pass	Pass	Pass	Pass	Pass	Pass	Pass
ML1-R4	5730	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Plant		Drilling	Drilling	1 x well	5 x wells	1 x well	5 x wells	5 x wells
Weather		calm	southerly	calm	calm	southerly	southerly	inversion

Note: 'Distance' is the distance in metres from Dewhurst 24 to the relevant residence

Table 5.3 presents an assessment of the Industrial Noise Policy guideline values for Sleep Amenity (measured outdoors) with respect to the potential noise sources as they affect the residences. The criterion is 40 LAeq.

Table 5.3: Compliance with Amenity (sleep) Guideline of 40 dB(A) LAeq façade level

Residence	Distance	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 'F'
R1	3370	Pass	+1	Pass	Pass	Pass	Pass	Pass
R2	3430	Pass	+1	Pass	Pass	Pass	Pass	Pass
R3	4070	Pass	Pass	Pass	Pass	Pass	Pass	Pass
ML1-R4	5730	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Plant		Drilling	Drilling	1 x well	5 x wells	1 x well	5 x wells	5 x wells
Weather		calm	southerly	calm	calm	southerly	southerly	inversion

Note: 'Distance' is the distance in metres from Dewhurst 24 to the relevant residence

5.1 Summary of Conclusions

1. It is concluded that the drilling stages may be audible at night when the background levels drop to around 20 dB(A). The activity, however, is of short duration and noise mitigation to the mud-pump (the main source of noise) will reduce further any audible sound.

2. It is concluded that the operation of the pilot wells should not be audible at any of the residences identified in this assessment.

5.2 Noise Management Measures

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.

Noise generated by the proposed development is unlikely to be audible at any residential receivers due to its remote location. Users of the Forest, such as bushwalkers, picnickers and Forests NSW staff, may be affected by noise and vibration during the works. Forests NSW 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 receiver. If it is determined that noise levels are unacceptable, further feasible and reasonable work practices or mitigation measures will be implemented.

ANNEX A DRILLING RIG SOUND POWER LEVELS

Noise Measurement Services (NMS) has surveyed the potential for noise from a drilling rig referenced as 'Brigalow 1200-1'. This Annex covers different drilling modes and assesses the potential noise impacts at various distances from the rig. Noise measurements and predictions have been taken during four different operational modes:

- Open hole drilling;
- Running casing;
- Cementing; and
- Core drilling.

The sound levels from various items of plant such as the mud pump, lighting rigs, various generators, pumps and items of mobile plant have been included in the noise assessments.

The noise criterion reported as a reference point is the time-average level of 35 dB(A) for night-time operation. It is predicted that this level is achieved at a distance of 1100 metres (open hole drilling and running casing); 1250 metres (cement casing) and 800 metres (core drilling). These distances will vary, of course, if a different noise limit is applied. Cementing is completed relatively quickly (in around 30 minutes) from the time the cement vehicles arrive onsite and until the cementing process is complete. The other processes are of a longer time period lasting for a number of days.

Noise modeling has been made using SoundPLAN v7.0 and the prediction methodologies *ISO 9613-2 Acoustics-Attenuation of sound during propagation outdoors-Part 2: General method of calculation* (for 'neutral' conditions) and CONCAWE (for 'worst-case' conditions) with calculated sound power levels from field measurements taken in accordance with *AS1217.7-1985 Acoustics-Determination of sound power levels of noise sources* and *ISO 3744:1994 Acoustics-Determination of sound power levels of noise sources using sound pressure-Engineering method in an essentially free field over a reflecting plane* to derive sound power values for the activities. The calculations are made with an estimated uncertainty of ± 3 dB(A) at 1000 metres. The sound levels calculated in this report are cross-checked with measured levels at 50 metres and with a variation of approximately 1 dB(A) this allows confidence in the prediction methodology and assumptions.

Sound, however, is not consistent in its propagation and is affected by wind and inversion conditions, especially under cold clear nights with little or no wind movement. Under these circumstances enhanced propagation can occur and the sound of the drilling rig can be heard further than under 'optimum' conditions. As a general rule an allowance of 5 dB(A) needs to be included to allow for these effects. The allowance includes the prediction uncertainty referred to previously. The criterion level then becomes the distance at which a time-average sound level of 30 dB(A) can be reasonably predicted.

The prediction model is referenced to ISO 9613-2 for the noise contours and to ISO 9613-2 and CONCAWE for offset distances, and to AS1217.7 for the sound power calculations used in the model. Broadly, the establishing the sound power levels of the operational plant involved taking measurements at 2 metre intervals around the equipment. The distance from the microphone(s) to the plant was set at 1.0 metres. Two measurement heights were employed at each measurement location; one at 1.35 metres above ground and one at 3.0 metres above ground. Six 10-second measurements of the A-weighted sound pressure levels were

taken at each measurement location. The sound levels were recorded in a variety of forms including A-weighted Slow response and the A-weighted time-average level, LAeq. The AS1217.7 standard refers to measurements as A-weighted Slow response. The standard, however, has been withdrawn and this Report references the time-average level, LAeq, as this is now the most common descriptor for sound power measurements and compliance assessments.

The measurements are then ascribed to the noisiest pieces of plant and the parallelepiped method employed to calculate the sound power levels. The plant noise was then cross-checked to the measurements locations in order to confirm the calculation process. A slight variation of ± 1 dB(A) is expected in the calculation process as the different plant measurements are influenced by other plant, as noted in the measurement schedules. The overall level is then cross-checked to more distant measurement locations at 10 metres and 50 metres from the plant.

The following Table presents the calculated sound power levels.

Table A1: Summary sound power levels, LAeq, Brigalow 1200-1 Drilling Operation

Item of Plant	Sound Power Level LAeq SWL
Drilling Rig (truck, rig motor, drilling, mud pump) – Open hole drilling	115
Drilling Rig (truck, rig motor, drilling, mud pump) – Running casing	115
Drilling Rig (concrete truck and compressor) – Cement casing	118
Drilling Rig (truck, rig motor, drilling) – Core drilling	115
Drill engine	110
Truck engine	106
Mud Pump engine	113
Cement pump / compressor (on truck)	116
Cement pump truck	111
Lighting Generator	86
Power generator	77
Small dewatering pump	105

The predicted LAeq sound levels and distances due to the various drilling rig operations are presented in Table 2. Plates 1 and 2 provide the operational plant layout.

Table A2: Predicted LAeq Sound Levels at Various Offset Distances

Drill Rig and Operation	Weather Condition	Direction	Predicted LAeq Sound Level at Buffer Distances (metres)						
			50m	100m	500m	1000m	1500m	2000m	5000m
Open Hole Drilling	Neutral	Front	70	62	45	36	30	25	<10
		Left	68	61	45	36	30	25	<10
		Back	67	61	44	36	30	25	<10
		Right	69	62	45	36	30	25	<10
Open Hole Drilling	Worst case	Front	72	64	47	38	32	27	<10
		Left	70	64	48	39	33	29	<10
		Back	69	63	47	38	33	28	<10
		Right	71	64	48	39	33	29	11
Running casing	Neutral	Front	70	62	45	36	30	25	<10
		Left	68	61	45	36	30	25	<10
		Back	67	61	44	36	30	25	<10
		Right	69	62	45	36	30	25	<10
Running casing	Worst case	Front	72	64	47	38	32	27	<10
		Left	70	64	47	38	32	28	<10
		Back	69	63	47	38	32	28	<10
		Right	71	64	47	38	33	28	10
Cementing Casing	Neutral	Front	70	62	45	36	30	25	<10
		Left	68	61	45	36	30	25	<10
		Back	67	61	44	36	30	25	<10
		Right	68	62	45	36	30	25	<10
Cement Casing	Worst case	Front	72	66	50	40	35	30	<10
		Left	77	69	51	41	35	30	13
		Back	76	69	50	41	35	30	13
		Right	71	66	50	40	35	30	<10
Core Drilling	Neutral	Front	60	54	39	31	26	22	<10
		Left	64	58	41	33	27	23	<10
		Back	64	58	41	33	27	23	<10
		Right	64	58	41	33	27	23	<10
Core Drilling	Worst case	Front	63	57	39	31	26	22	<10
		Left	68	61	43	35	29	25	<10
		Back	68	61	43	35	29	25	<10
		Right	68	61	43	35	29	25	<10

Notes:

'Front' refers to the direction located by the front of the truck holding the drill rig. That is, standing at the front of the truck and looking back to the drill rig is 'front-to-back'.

'Neutral' is the predictions to the ISO 9613-2 methodology, standard assumptions

'Worst Case' is to CONCAWE methodology with a 6m/s breeze blowing from front to back.

Plate 1: Plant Layout Drilling Operations, with measurement locations

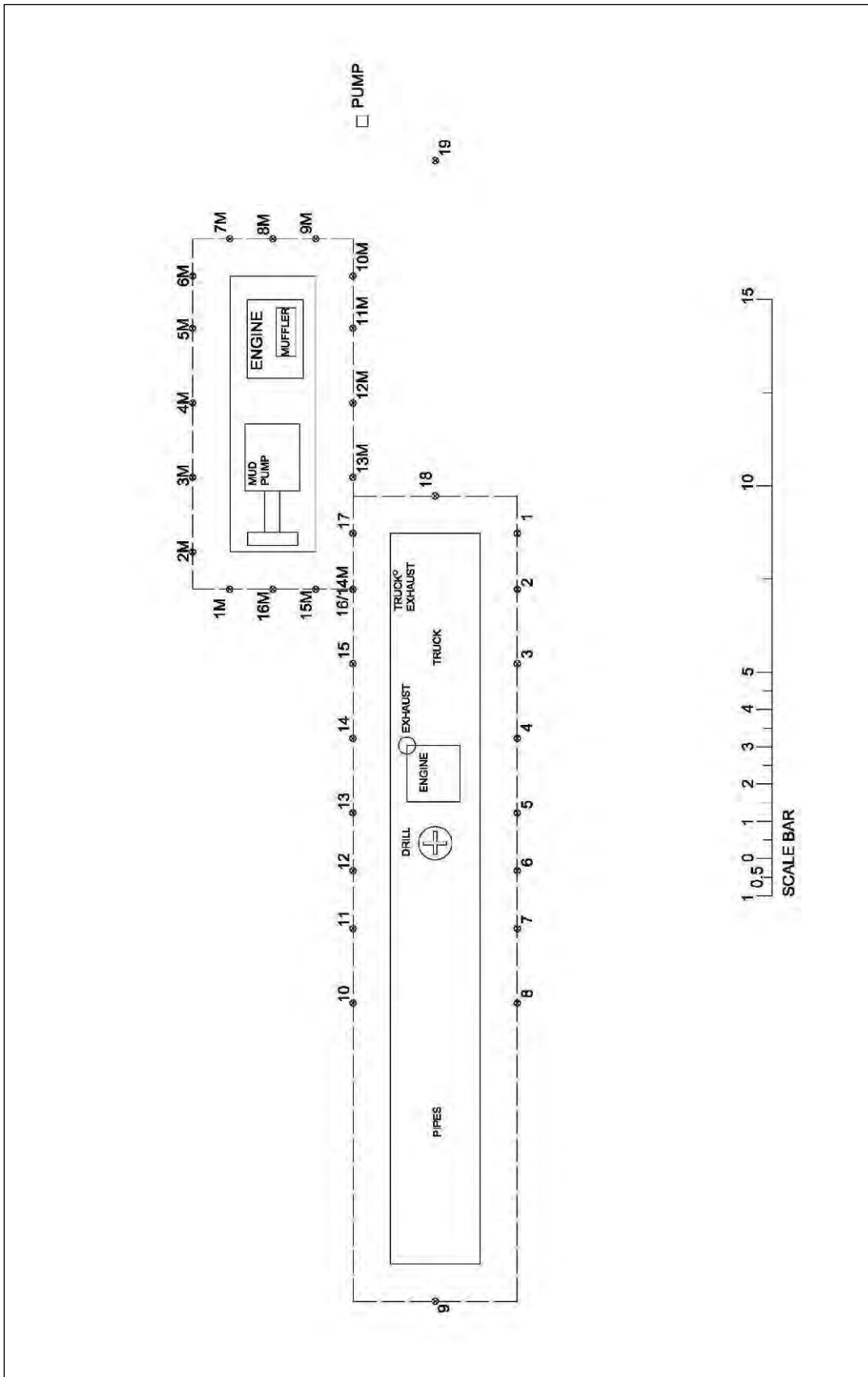
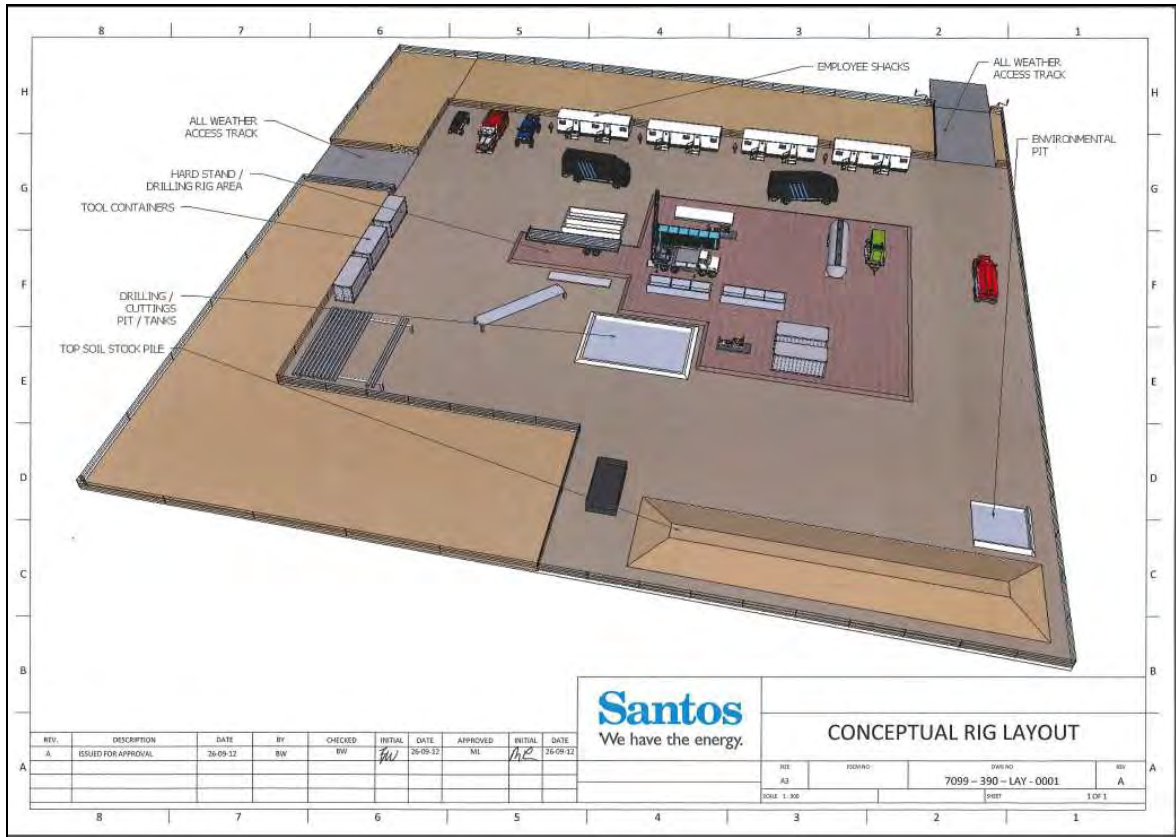


Plate 2: Plant Layout (Indicative)



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

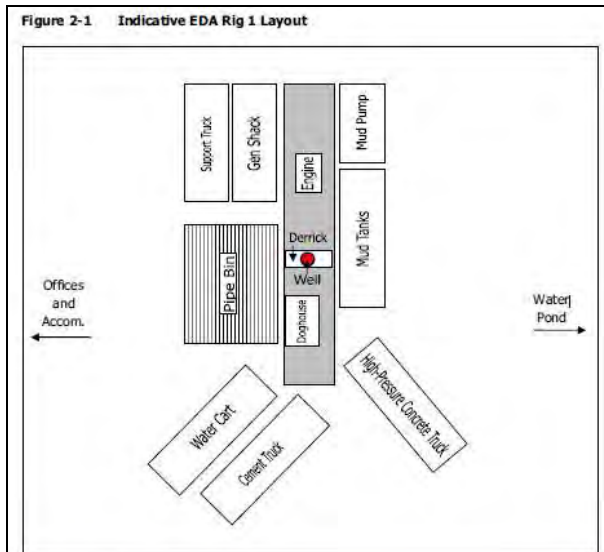


CONCEPTUAL RIG LAYOUT

REV	ISSUED NO	DRAW NO	REV
A3		7099 - 390 - LAY - 0001	A
SCALE 1:XX		SHEET	1 OF 1

ANNEX B EDA Rig 1 Source Noise Levels

A drilling rig that may be utilised within the Project is the Energy Australia Drilling Rig 1 (EDA Rig 1). The following information concerning the rig is drawn from the source noise report prepared by Wilkinson Murray: EDA Rig 1 Source Noise Level Measurements, Report No. 00574, Version A, October 2011. The Report was prepared on for the RPS Group on behalf of Santos Ltd.



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.

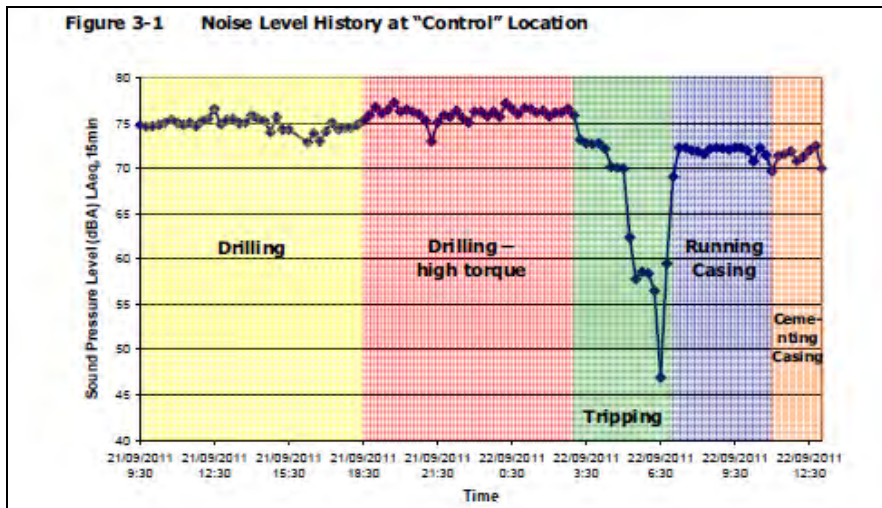


Table 3-1 presents the sound power levels for each plant item. Note that many of these sources radiate over significant areas and thus cannot be equated by point sources in the near field (less than 20m). Determination of the sound power levels has considered the radiated area of these sources. Near 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.

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.

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

ANNEX C Narrabri Meteorological Data

The following meteorological data for the Narrabri area has been sourced from the report *Narrabri Coal Seam Gas Utilisation Project Part 1 – Air Quality Impact Assessment Report No. 585/06* Part 1 November 2007 prepared by Heggies Pty Ltd.

The 2005 annual wind rose from the Narrabri Weather Station is presented following as Figure C1 from the Heggies Report. The wind rose is representative of the meteorological input file used in the assessment, and displays occurrences of winds from all quadrants. The annual wind rose indicates that winds tend to be experienced from the southeast, west and north and are typically mild to moderate, having an average wind speed of between 1.5m/s and 8m/s.

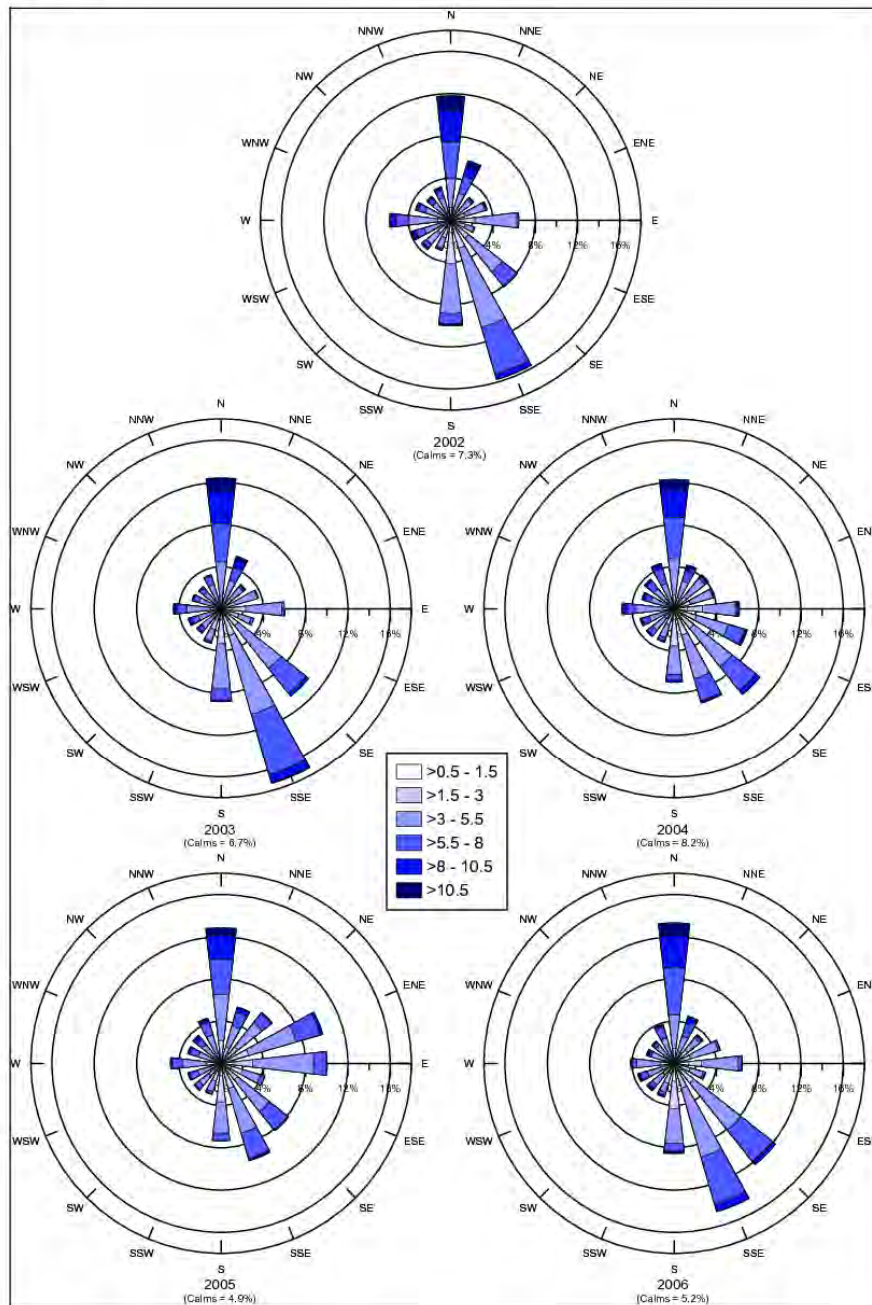
The seasonal variation in wind behaviour at the Narrabri Airport AWS is also presented following as Figure C2 from the Heggies Report. The seasonal wind roses indicate the following:

- In winter, mild to moderate south-southeast winds are experienced 13% of the time, and mild to fresh (1.5 m/s to 10.5 m/s) north winds occur 12% of the time.
- In spring, mild to moderate winds are present from the south-southeast to southeast approximately 13% of the time, while mild to fresh winds occur from the north approximately 17% of the time.
- In summer, moderate to fresh winds occur from the north approximately 15% of the time, while moderate east winds occur 13% of the time.
- In autumn, mild to moderate winds are prevalent from the east to northeast quadrant approximately 45% of the time.

The frequency of occurrence of stability class at the Narrabri AWS site for 2005 is presented in the third chart, following, from the Heggies Report. The results indicate a high frequency of conditions typical of Stability Class "D" throughout the year. Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme (see the EPA Industrial Noise Policy) identifies six Stability Classes, "A" to "F", to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions.

- Stability Class "A" represents highly unstable conditions that are typically found during summer, and are categorised by strong winds and convective conditions.
- Conversely, stability class "F" relates to highly stable conditions, typically associated with clear skies, light winds and the presence of a temperature inversion.
- Classes "B" through to "E" represent conditions intermediate to these extremes.

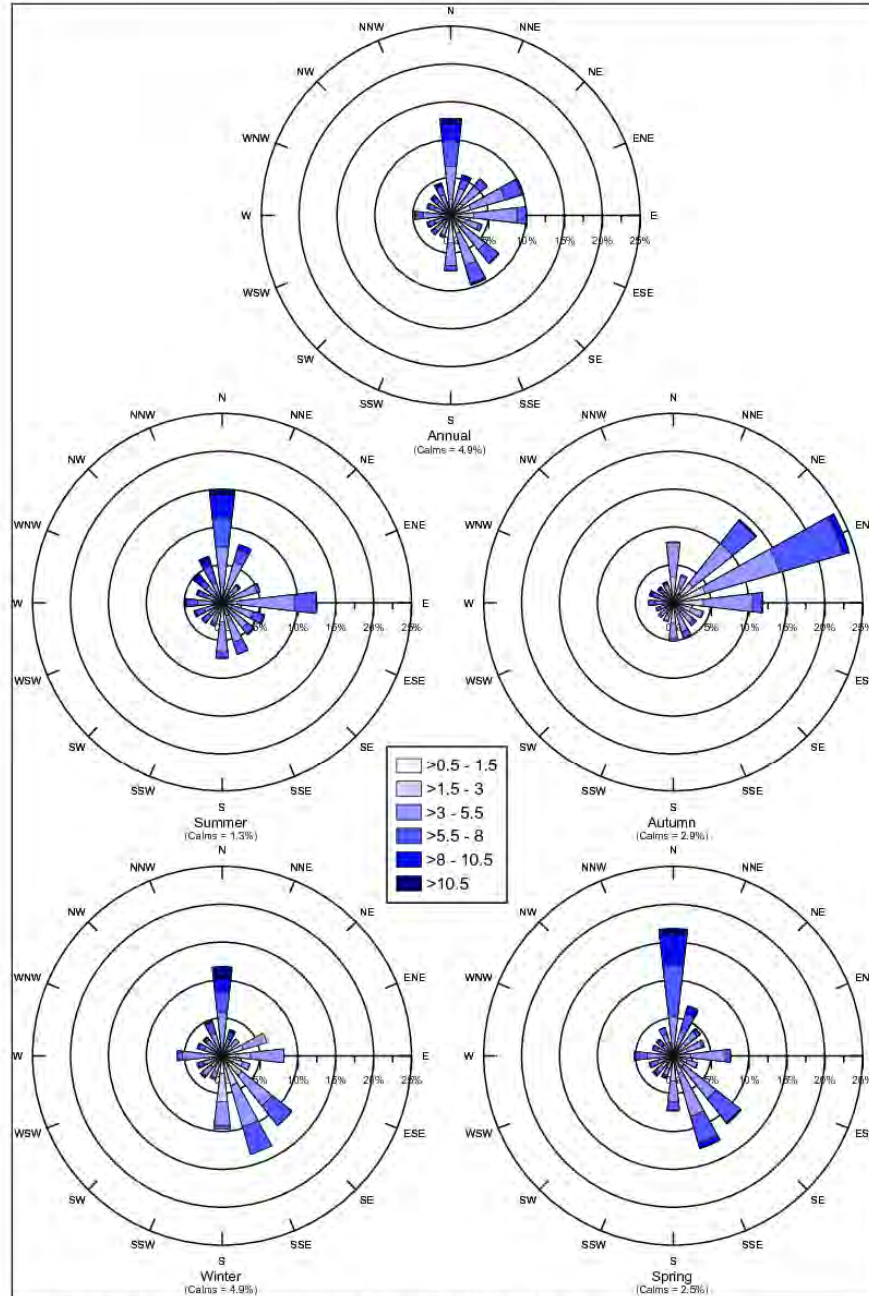
'Normal' or 'Neutral' conditions occur where the temperature slowly increases with height such as overcast conditions and / or when the wind is high enough to cause mixing of any atmospheric layers. These conditions can occur day or night; they will always prevail when it is fairly windy, overcast or at the beginning or end of the day. Category D should be used, regardless of wind speed, for overcast conditions during the day or night and for any sky condition during the hour preceding or following night. Class F conditions occur mainly at night when a layer of cold air is trapped close to the ground, under warmer air. Unusually high noise levels can be experienced.



Note: A Colour Version of this figure is available on the project CD

Figure C1 Annual Wind Roses for Narrabri Airport AWS, 2002-2006

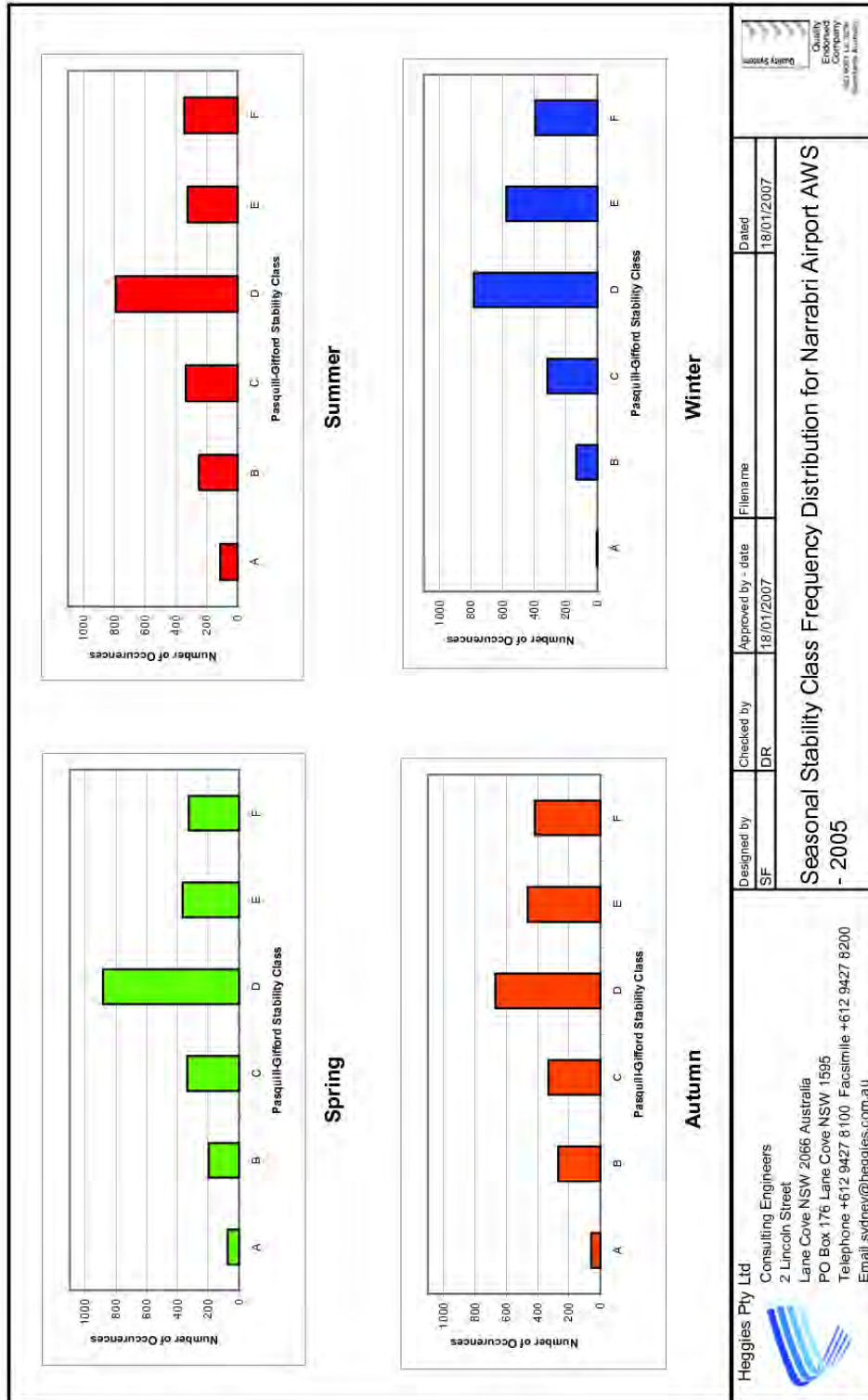
Heggies Pty Ltd



Note: A Colour Version of this figure is available on the project CD

Figure C2 Seasonal Wind Roses for Narrabri Airport AWS, 2005

Heggies Pty Ltd



Designed by	Checked by	Approved by - date	Filename	Dated
SF	DR	18/01/2007		18/01/2007

Seasonal Stability Class Frequency Distribution for Narrabri Airport AWS - 2005

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ANNEX D Noise Prediction Methods

Two different prediction methods are applied, ISO 9613-2 and CONCAWE.

ISO 9613-2

The calculations for the plant, equipment and haulage predictions are based on standard sound propagation theory described in ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors – Part 2, General Method of Calculation*.

Equation of the Method

$$L_p = L_w + D_c - A$$

where

L_p is the sound pressure level at the receiver location

L_w is the sound power level of the source

D_c is the directivity correction of the source; and

A is the excess attenuation due to:

A_{div} geometric divergence

A_{atm} atmospheric absorption

A_{gr} ground cover

A_{bar} barrier effect

A_{misc} miscellaneous other effects

The calculation is in A-weighted equivalent continuous (L_{Aeq}) octave band values for the bands 63Hz to 8000Hz. The standard calculates the average downwind propagation with the wind blowing from source to receiver and a wind speed of 1 to 5 m/s.

The predictions are based on 'most-likely' placement of plant and equipment to give a representative assessment for different plant and activities operating in different locations and for varying times of day or night. Both single point and noise contour calculations are used to determine the noise level at noise sensitive premises. Noise contours show the range of noise levels in the locality due to the operation of the mine and plant. The single point calculations give the predicted noise at a specific location. Refinement may be made this model through collection of reliable sound power level data, modelling for variable source locations, topographic (barrier) effects and meteorological conditions. Night-time levels can be higher due to atmospheric conditions of temperature inversion, so detailed weather data would be of great assistance in modelling different weather based scenarios.

The general order of prediction uncertainty is ± 3 dB at 100 - 1000 metres for an unverified model and less where measured data is used to refine the prediction scheme at distances up to 100 metres. The model is also limited to wind speeds of less than 5 m/s. Verification means that the model has been established with reference to measured sound levels at a receiver, known source levels and tightly defined propagation variables (wind speed and direction, for example). Alternatively a series of predictions with different programs but the same assumption variables can be used for verification purposes. Under light downwind

conditions or temperature inversion conditions, it is likely that the noise levels at the nearest residence will be slightly higher than the predicted level. Conversely, under upwind propagation conditions, lower noise levels would be expected to be encountered. Best practice means that the highest level in the uncertainty range is referenced for assessment of impact, rather than the predicted level.

CONCAWE

The CONCAWE method is based upon the CONCAWE research paper (1). Different implementations of the method have applied modifications e.g. in SoundPLAN, PEN3D. The CONCAWE noise propagation model deals specifically with the influence of wind and the stability of the atmosphere.

Equation of the Method

The sound pressure level at a receiver is calculated as:

$$L_p = L_w + D - \sum K$$

where L_w = sound power of the source

D = directivity of the source

$\sum K$ = correction factors K1...K7

The model takes account of the following attenuation mechanisms (K factors):

- Geometrical spreading (the attenuation of a source with distance);
- Atmospheric absorption (the attenuation due to the atmosphere, varying with temperature and humidity and affecting mainly the higher frequencies);
- Ground attenuation (the additional attenuation that occurs due to complex interference effects over acoustically absorptive (soft) ground);
- Meteorological correction (the correction that accounts for refraction of sound by wind and temperature gradients);
- Source / receptor height correction (validated at a receiver height of 1.2 metres)
- Barrier attenuation (Maekawa method)

The two principal variables are wind and vertical temperature gradient. (A positive gradient is called temperature inversion, zero gradient is neutral, and a negative gradient is termed lapse). The variable K_4 is the meteorological correction due to refractions by wind and temperature gradients based on the meteorological category of the atmosphere assessed in accordance with Pasquill stability factor (2), cloud cover and wind speeds. The meteorological category affects the prediction values, as discussed following.

Accuracy of the CONCAWE Noise Prediction Method

The CONCAWE method was originally developed to predict noise levels at long distances (validated at 100 metres to 2000 metres and for wind speeds up to 7 m/s) from petrochemical plants. With the exception of the geometrical spreading the method is primarily empirically based. The 95% confidence limits for the model were derived from independently measured data and vary with meteorological category. The predictions of the CONCAWE model are less accurate in upwind conditions, when measured noise levels would have been lower and the signal (i.e. the plant noise) to background noise (i.e. overall noise from all sources) ratio would have been lower as well. The 95% confidence limits were found to be:

- Met category 2: ± 6.8 dB(A) e.g. upwind, moderate wind speed vector and zero temperature gradient, or upwind, light wind vector with temperature lapse;
- Met category 3: ± 6.9 dB(A) e.g. upwind, light wind speed vector, zero temperature gradient, or calm

with temperature lapse;

- **Met category 4: ± 5.7 dB(A) calm and zero temperature gradient conditions);**
- Met category 5: ± 4.7 dB(A) e.g. light downwind with zero temperature gradient, or calm with temperature inversion;
- Met category 6: ± 4.5 dB(A) e.g. moderate downwind with zero temperature gradient, or light downwind with temperature inversion.

The 95% confidence limit is interpreted to mean that the "true" sound level at any location will be, with 95% certainty, the predicted level +/- the confidence limit (4.5 dB(A) - 6.8 dB(A)). In practice a mid-point value of ± 6 dB(A) is a reasonable approach.

1. CONCAWE, The propagation of noise from petroleum and petrochemical complexes to neighbouring communities, Report 4/81.
2. NSW EPA 'Industrial Noise Policy' January 2000

IMPLEMENTATION

The method of prediction is ideally suited to a combination of both ISO 9613-2 and CONCAWE methods. The calculation programs available for this purpose are (a) SoundPLAN, which has both methods as separate modules, and (b) PEN3D, an environmental noise model developed by Noise Mapping Pty Ltd Queensland. The PEN3D environmental model is the program used in this Report. It is a faithful representation of the Environmental calculation method described in the book by Bies & Hansen "*Environmental Noise Control*". The program has both propagation and stability analysis functions. The approach incorporates an incoherent reflection from the ground as recommended by Bies & Hansen as appropriate for calculating noise levels at distances more than 100 m from the source. NOTE: Source levels are entered as dB Lin sound power in the environmental model. Output is in dB Lin and dB(A).

Both single point and noise contour calculations are used to determine the noise level at noise sensitive premises. SoundPlan and PEN3D uses calculated sound power levels determined from measured sound pressure levels to calculate the noise level received at a specific location. Noise contours (isobars) show the range of noise levels in the locality due to the operation of the plant. The single point calculations give the predicted noise at a specific location. Best practice means that the uncertainty range of values is referenced for assessment of impact, rather than the (lower) single-number predicted level. Refinement may be made through collection of reliable sound power level data, modelling for variable source locations, topographic (barrier) effects and meteorological conditions. Night-time levels can be higher due to atmospheric conditions of temperature inversion, so detailed weather data is needed for modelling different "most-likely" scenarios. The tolerance in the Sound Power Levels quoted for various items of plant and equipment is typically ± 1 dB(A) under the refinement/verification process. The Primary sound power levels for the assessment are given in Table D1.

Table D1: Modelled sound power levels

Plant Item	SWL	Sum	63	125	250	500	1000	2000	4000	8000
Drilling Rig	Lin	120	114	108	107	111	114	113	105	95
	A	118	88	92	98	108	114	114	106	94
Wellhead	Lin	114	113	105	99	93	89	84	80	86
	A	97	87	89	90	89	89	85	81	84

ANNEX E Plant Sound Power Levels

Typical sound power levels for petroleum and gas activities

The sound power level of typical noise sources relevant to the activities are provided in Table 1. There are many different noise sources associated with petroleum and gas activities. The noise sources are described as having a continuous noise output over time (indicated by use of LAeq in Table 1) and may be *generically* described as being “tonal” with a similar shape of noise spectrum characteristic of a large diesel engine. Only the overall sound power levels differ. Noise sources which can be described as impulsive (indicated by the measure LAmax in Table 1) are more varied and managing these noise sources requires varied solutions such as changing operator behaviour (e.g. controlled braking of vehicles) or installation of specialised low noise equipment (e.g. broadband reverse beepers).

Table 1 – Typical sound power levels of petroleum and gas activity noise sources

Noise Source	Overall Sound Power Level (L_{WA})	Metric
Drill Rig (hydraulic pack)	95-100 dB(A) _W	L_{Aeq}
Drill Rig (air compressor)	95-100 dB(A) _W	L_{Aeq}
Drill Rig (mud pump)	100-105 dB(A) _W	L_{Aeq}
Field Compressor Station (screw drive engines)	110-115 dB(A) _W	L_{Aeq}
Central Compressor Station (reciprocating engines)	120-125 dB(A) _W	L_{Aeq}
Well Head Power Pack	95-105 dB(A) _W	L_{Aeq}
Generator (500kVA)	100-110 dB(A) _W	L_{Aeq}
Stimulation Activity (fracking) (combined sources)	110-120 dB(A) _W	L_{Aeq}
Impacts of Drill Rods/Casings	100-110 dB(A) _W	L_{Amax}
Cavitation/Air Release	115-120 dB(A) _W	L_{Amax}
Engine Brakes	110-115 dB(A) _W	L_{Amax}
Reversing Beeper	100-105 dB(A) _W	L_{Amax}

Source: the Queensland Government Guideline ‘*Prescribing Noise Conditions for Environmental Authorities for Petroleum and Gas Activities*’, issued 2011 by the Department of Environment and Heritage Protection.

The process to install the gas flow line between the Dewhurst wells, and to the collection point, will involve firstly clearing an adequately wide corridor using a grader, digging a 350mm-400mm wide trench, laying out and joining the pipe segments, joining the pipe segments, filling the trench and rehabilitation the disturbed areas. The loudest noise sources during this process are the grader, excavator, diesel generators and other general diesel engined sources. The typical sound power level of a grader is 110-118 dB(A) and an excavator 118 dB(A). Generators and pipe-joining equipment may have a cumulative sound power level this high, although 102-105 dB(A) is more typical of generators. It is planned to have 76 KVA gas generators at Dewhurst 22-25 (inc. 24). The gas generator’s model is ‘Cummins 6BTAA CSM engine’ and will be having

sound level limits of less than 85 dBA from a meter. The level of 85 dB(A) at 1 metre has been calculated as a sound power level of 114 dB(Lin) or 97 dB(A) including a directivity factor (half space) of +3dB.

For cross-reference purposes the sound power levels in Table 8.4 of the Sonus Report “*Surat Gas Project Noise and Vibration Impact Assessment*”, Report S3257C17, November 2011 contains sound power levels and the quantity of each type of equipment proposed at each facility type. The octave band sound power levels for all of the equipment considered are provided in Table E.1, following, of the Report.

Table 8.4: Main noise sources during the construction of the production facilities.

Main Noise Source	Maximum Overall Sound Power Level (dB(A))
Truck	120
Front end loader	118
Excavator	118
Dozer	120
Grader	118
Scraper	116
Crane	115
Generator	119
Welding generator	113
Air compressor	107
Hand-held grinder	106

Table E.1: Sound power levels of the main noise sources at the production facilities.

Noise Source	Maximum Sound Power Level (dB re 1 pW) by Octave Band Frequency (Hz)									Total (dB(A))
	31.5	63	125	250	500	1000	2000	4000	8000	
Long Term Noise Sources										
First Stage Gas Compression Unit										
Screw compressor	98	95	100	101	99	103	119	107	98	113
Electric motor - 2000hp	92	94	96	97	97	97	102	92	85	105
Cooler (2 fans, inlet plus outlet)	112	113	112	109	104	101	94	90	84	106
Further Stages Gas Compression Unit										
Reciprocating compressor	110	106	111	110	108	111	116	113	106	120
Electric motor - 5500hp	95	97	99	100	100	103	103	95	88	108
Cooler (3 fans, inlet plus outlet)	115	116	115	112	107	104	97	93	87	109
Power Generation Plant										
Power generator - 3.5 kW	74	74	77	79	82	82	81	76	68	87
Gas engine - exhaust with manufacturer installed silencer	77	84	88	72	69	73	78	79	68	84
Gas engine - air intake	88	95	101	99	94	93	92	94	95	101
Water Treatment Facility										
Centrifugal pump	74	74	77	79	82	82	81	76	68	87
Electric motor - 55 kW	74	74	77	79	82	82	81	76	68	87
Electric motor - 450 kW	82	84	86	88	90	90	90	86	81	95
Water Transfer Pump										
Centrifugal pump – 150 kW	75	75	88	93	94	95	89	83	75	98
Flare										
Normal operation – 0.02 TJ/d	78	78	79	80	82	83	85	90	85	93
Short Term Noise Sources										
Flare										
Maximum flow – 60TJ/d	102	105	110	105	95	90	95	105	100	107
Maximum flow – 150TJ/d	105	108	113	108	98	93	98	108	103	110

Table E.2: Sound power levels of the main noise sources at the production wells.

Noise Source	Maximum Sound Power Level (dB re 1 pW) by Octave Band Frequency (Hz)									Total (dB(A))
	31.5	63	125	250	500	1000	2000	4000	8000	
Reference Case										
5.7L –V8 gas engine, 60kW motor	111	102	99	98	83	82	73	69	76	86
Alternative Option										
60kW motor (electricity obtained from main power grid)	89	79	75	80	70	70	74	74	77	81

Appendix 5

Ecological Assessment



Ecological Assessment

Dewhurst 26 – 29 Pilot Wells – PEL 238, Narrabri

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
A	Draft for Santos Review	HR, MR, CO	BD	14/1/2013
0	Final for submission	MR	PM, HR	26/02/2013

Approval for Issue

Name	Signature	Date
Brad Dreis		26/02/2013

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Appendix 6	Migratory Species – Likelihood of Occurrence and Potential for Impact
Appendix 7	EPBC Act Significant Impact Assessment
Appendix 8	TSC Act Assessment of Significance
Appendix 9	Anabat Call Analysis Report

Terms and Abbreviations

Abbreviation	Meaning
API	Aerial Photograph Interpretation
AOS	Assessment of Significance
CMA	Catchment Management Area
CSG	Coal Seam Gas
EA	Ecological Assessment
EEC	Endangered Ecological Community
EPBC	Environmental Protection and Biodiversity Act 1998
GIS	Geographic Information System
Ha	Hectare
LGA	Local Government Area
MNES	Matters of National Environmental Significance
OEH	Office of Environment and Heritage
REF	Review of Environmental Factors
RPS	RPS Australia East Pty Ltd
RVC	Regional Vegetation Community
SEWPaC	Department of Sustainability, Environment, Water, Population and Community
TEC	Threatened Ecological Community
TSC Act	Threatened Species and Conservation Act 1995

1.0 Introduction

1.1 Background

RPS was engaged by Santos to undertake an ecological assessment for leases referred to as Dewhurst 26, 27, 28, and 29, and associated access tracks and gathering system, located within the Pilliga East State Forest (**Figure 1.1**; **Figure 1.2**). The purpose of the ecological assessment was to identify ecological constraints, potential impacts, and recommended mitigation measures associated with the development of the leases.

1.2 Site Particulars

1.2.1 Regional Location

The survey area is located approximately 40 km to the south of Narrabri and 35 km west of Boggabri, in the Narrabri Local Government Area (LGA). It is within the Brigalow Belt South Bioregion of the Interim Biogeographic Regionalisation for Australia (IBRA). The area of consideration is located within the Namoi Catchment Management Area (CMA), within the Pilliga (part A) sub-region.

The survey area occurs within the Pilliga East State Forest. The State Forest forms part of a large tract of bushland referred to as the Pilliga Scrub, which encompasses numerous protected estates. The northern part of the area of consideration extends into the Bibblewindi State Forest.

1.2.2 Project Area

Throughout this report, 'survey area' refers to the four leases and associated gathering system, as well as proposed access tracks as discussed below; while the 'area of consideration' includes a much larger area as shown in **Figure 1.1**. Although the majority of impacts would occur within the survey area, it is important to consider habitat values within the broader area when assessing impacts to flora and fauna.

The area of consideration is well vegetated, dominated by Narrow-leaved Ironbark Woodland. The topography is gently undulating rises. Mount Pleasant Creek intersects the flowline, along with two unnamed ephemeral waterways (**Figure 1.1**).

The survey area is located in the southern portion of the area of consideration (**Figure 1.1**). It covers an area of 5.755 ha, which includes:

- Four well sites and associated lease areas (each 100 x 100 m in size);
- A 10 m wide right of way adjacent to Beehive Road to accommodate the central gas and water gathering system (the length of the central gathering system is approximately 1330 m); and
- Four 10 m wide service corridors from Beehive Road to each lease area to provide access to the lease areas and accommodate the gas and water gathering system, including:
 - » 230 m long service corridor between Beehive Road and Dewhurst 26;
 - » 30 m long service corridor between the Dewhurst 26 service corridor and Dewhurst 28;
 - » 150 m long service corridor between Beehive Road and Dewhurst 27; and
 - » 15 m service corridor between Beehive Road and Dewhurst 29.

Vegetation in the survey area, as well as immediately north of the survey area, was surveyed between the 11th and 16th of November 2012. Although ground-truthing was not conducted within other parts of the area of consideration, it was mapped using aerial photograph interpretation (API) in conjunction with a revision of the Namoi CMA vegetation mapping (Namoi CMA, 2010).

1.2.3 Proposed Activity

Santos propose to undertake drilling activities to assess the CSG potential within PEL 238. As part of the assessment program, Santos propose to drill and operate four petroleum exploration pilot wells at Dewhurst 26 to 29. A detailed project description is included in the Review of Environmental Factors (REF), prepared by RPS (2012).

Santos propose to construct 100 m by 100 m lease areas, resulting in 1ha of disturbance at each pilot well location. Additional infrastructure will consist of a 10m wide corridor known as the 'proposed surface infrastructure' corridor (**Figure 1.2**).

Dewhurst 26 and 28 are located to the west of Beehive Road. An access track of approximately 230m will be constructed to facilitate access to Dewhurst 26. From the Dewhurst 26 access track, an additional access track of approximately 30m will be constructed to allow access to Dewhurst 28 (**Figure 1.2**).

Dewhurst 27 is located approximately 150m to the north- west of Beehive Road. The proposed lease area will be accessed via an existing forestry access track or seismic line. Given the narrow width of the existing access track, it is likely that some widening will be required.

Dewhurst 29 is located immediately adjacent to Beehive Road, and is the only lease located to the south of the road. An existing access track / seismic line runs adjacent to the south-west boundary of the lease.

1.3 Scope of the Study

The objective of this assessment was to undertake an ecological assessment of the proposed lease areas and access tracks to identify ecological impacts of the proposed activities, and recommend appropriate mitigation measures to reduce and manage ecological impacts. The specific scope of the assessment was to:

- Conduct a background review of relevant environmental databases, maps and policies;
- Assess the extent, condition and composition of the vegetation communities present in the area of consideration;
- Determine if any of the vegetation communities present constitute the definitions of regionally significant ecological communities such as Threatened Ecological Communities (TEC) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Endangered Ecological Communities (EEC) under the *Threatened Species Conservation Act 1992* (TSC Act);
- Complete targeted searches for threatened flora species listed under the TSC Act and EPBC Act;
- Carry out a detailed trapping program (Elliott traps, cage traps, funnel traps, nocturnal searches, call-playback, Anabat etc), targeted searches and compilation of a fauna list, specifically targeting threatened fauna species listed under the TSC Act and EPBC Act;
- Assess the habitat types of the area of consideration and their value for supporting native flora and fauna, including significant species;
- Assess fauna movement corridors and pathways;
- Identify significant weed species occurring within the area of consideration;

-
- Identify constraints associated with the ecological features of the area of consideration in a legislative and planning context;
 - Identify potential ecological impacts associated with the pilot well lease areas; and
 - Recommend appropriate mitigation measures to minimise potential ecological impacts.

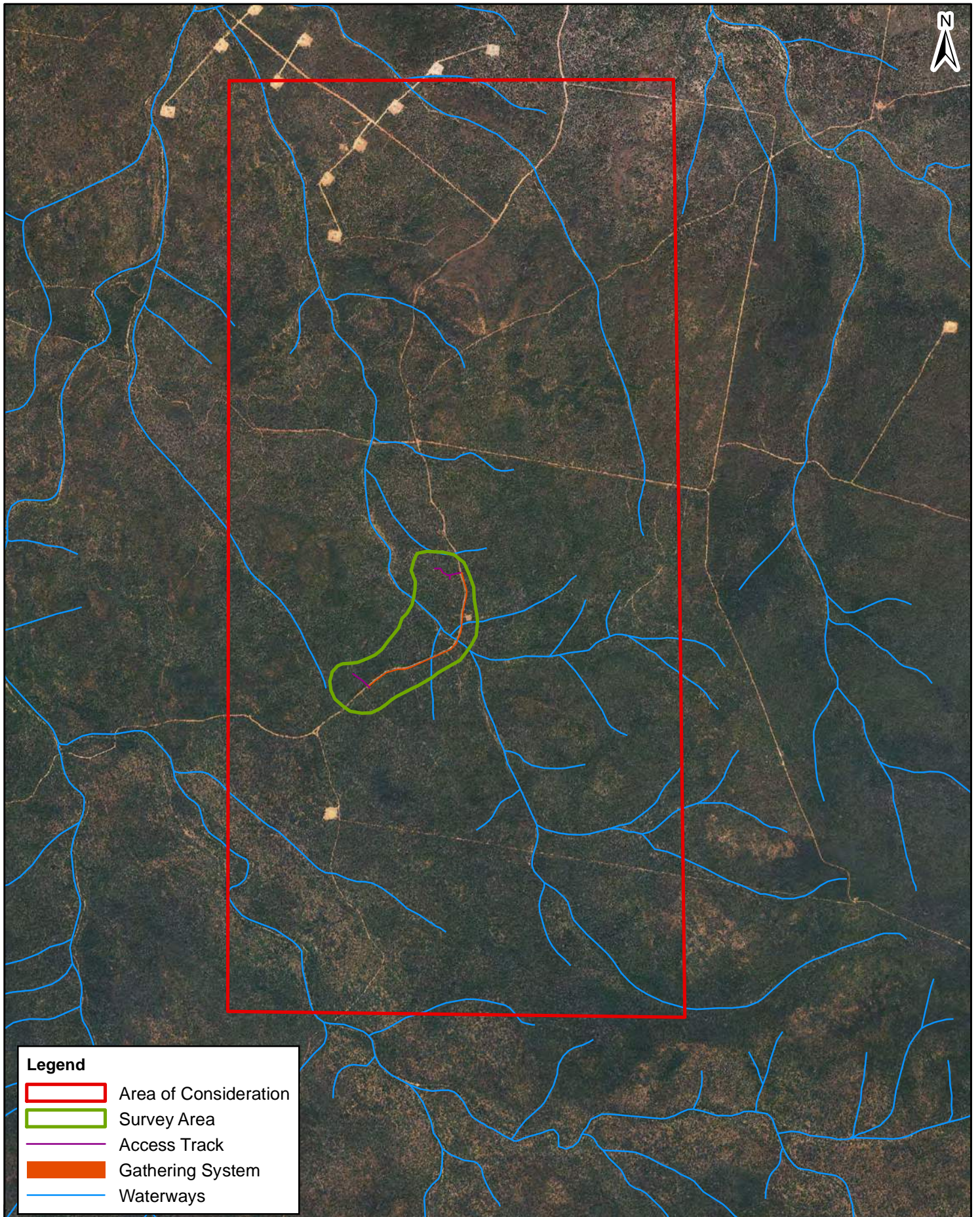
A desktop assessment of the area of consideration was conducted prior to conducting a detailed ecological assessment, including fauna trapping program, was conducted between the 12th November and 16th November 2012.

This assessment details the findings of the background review, preliminary survey and detailed survey. Additionally, Commonwealth, state and local legislation relevant to the proposal have been addressed in this assessment.

I.4 Licensing and Certification

All field surveys were conducted under the following licenses and permits:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S100536 (Valid 31 December 2012);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2013);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2013); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim File No: 01/1522 & Ref No: AW2001/014) issued by NSW Agriculture (Valid 22 May 2014).



Legend

- Area of Consideration
- Survey Area
- Access Track
- Gathering System
- Waterways

Client: Santos	
Compiled by: CO	Date: 03/01/2013
Approved by: HR	Date: 03/01/2013

0 0.45 0.9 1.8
 ─────────── km

Datum: GDA94
Scale: 1:38,000 @ A4

RPS

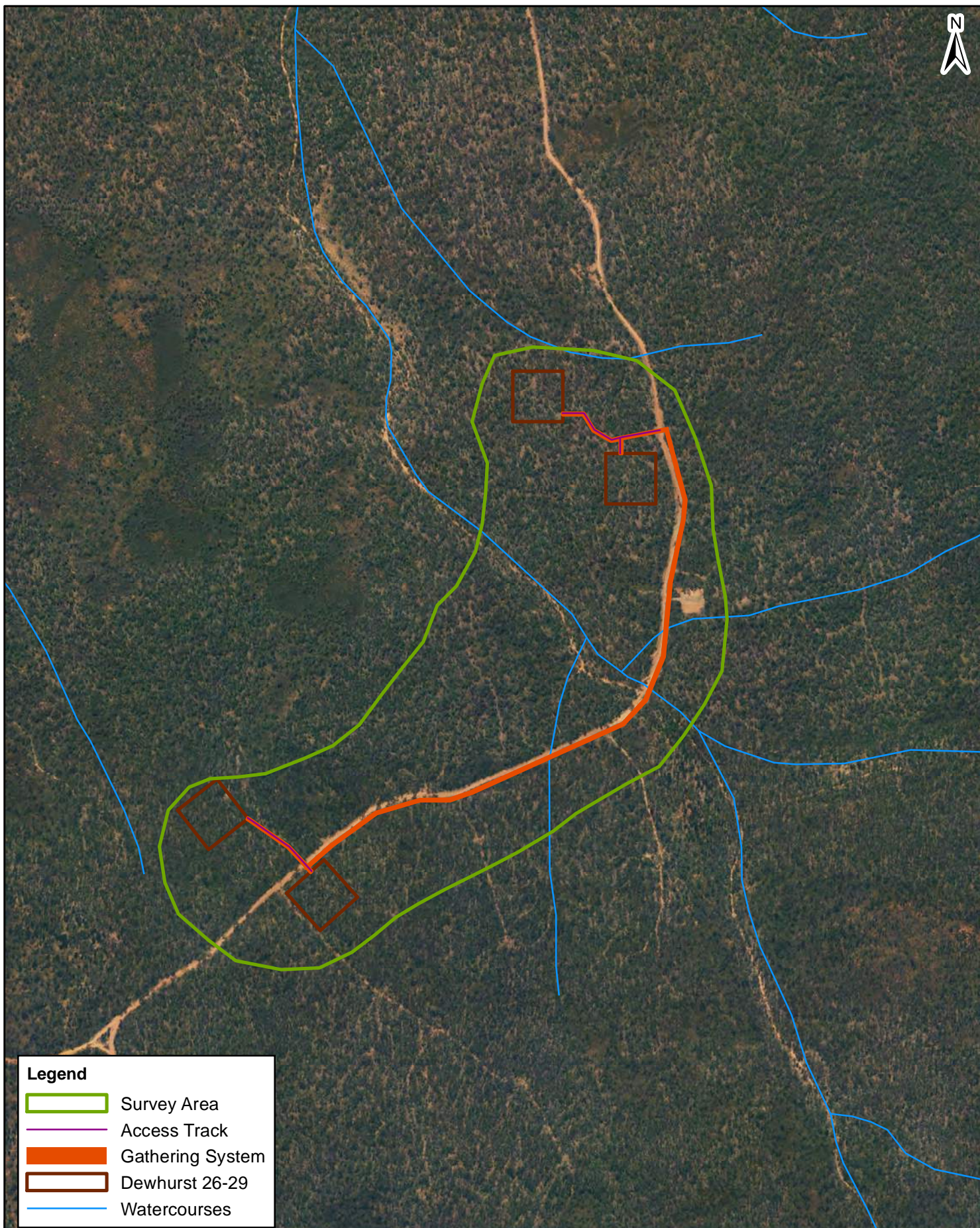
Regional Location

Figure 1.1






Project: Dewhurst 26-29 Pilot Wells

Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2012
Watercourses from OEH 2012



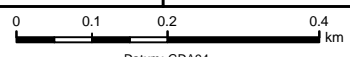


Legend

-  Survey Area
-  Access Track
-  Gathering System
-  Dewhurst 26-29
-  Watercourses

Client: Santos	
Compiled by: CO	Date: 03/01/2013
Approved by: HR	Date: 03/01/2013

Survey Area	
Figure 1.2	Project: Dewhurst 26-29 Pilot Wells



Datum: GDA94
Scale: 1:10,000 @ A4



Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2012
Watercourses from OEH 2012

2.0 Legislative Context

2.1 Commonwealth Legislation

2.1.1 Environmental Protection and Biodiversity Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) provides that a person proposing to take an action that the person thinks may be a "controlled action" must refer the proposal to the Minister for Sustainability, Environment, Water, Population and Communities (Minister). A "controlled action" is an action that:

- Will have or is likely to have a significant impact on:
 - » World heritage areas;
 - » National heritage places;
 - » Ramsar wetlands of international importance;
 - » Commonwealth listed threatened species and communities;
 - » Commonwealth listed migratory species;
 - » Commonwealth marine areas;
 - » The environment on Commonwealth land; and
 - » Great Barrier Reef Marine Park;
- Is undertaken by the Commonwealth and will have or is likely to have a significant impact on the environment;
- Is undertaken by any person on Commonwealth land and will have or is likely to have a significant impact on the environment; or
- Is a nuclear action.

These are referred to as "matters of national environmental significance" (MNES). The EPBC Act sets out the process for identifying and listing the MNES including listed threatened species and listed migratory species.

If the Minister decides that the proposed action is a controlled action, then the approval of the Minister is required under the EPBC Act.

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.

2.2 NSW State Legislation

2.2.1 Environmental Planning and Assessment Act 1979

2.2.1.1 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 RU3 (Forestry) under the *Narrabri Local Environmental Plan 2012* (Narrabri LEP). The proposed activity is permissible without development consent under the Narrabri LEP as the activity is authorised under the *Forestry Act 2012*.

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 or person whose approval is required before an activity may be carried out. The Resources Minister is the determining authority for the purposes of Part 5 of the EP&A Act.

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

Narrabri Local Environmental Plan 2012

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 RU3 Forestry, the objectives of which are:

- To enable development for forestry purposes; and
- To enable other development that is compatible with forestry land uses.

2.2.1.3 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.

2.2.2 Threatened Species Conservation Act 1995

The objectives the *Threatened Species Conservation Act 1995* (NSW) (TSC Act) include:

- To conserve biological diversity and promote ecologically sustainable development;
- Prevent the extinction and promote the recovery of threatened species, populations and ecological communities;
- To protect the critical habitat of those threatened species, populations and ecological communities that are endangered; and
- To ensure that the impact of any action affecting threatened species, populations and ecological preventing the extinction and promoting the recovery of threatened species, populations and ecological communities is properly assessed.

The TSC Act provides the procedure for the listing of threatened species, populations and ecological communities and key threatening processes in New South Wales and the preparation and implementation of recovery plans and threat abatement plans.

The TSC Act also provides the mechanism for applying for and obtaining licenses to take actions which will or is likely to result in harm to any animal that is a threatened species, population or ecological community, the picking of any plant which is part of a threatened species, population or ecological community, damage to critical habitat or damage to habitat of a threatened species, population or ecological community where such actions require a license to be obtained.

A key threatening process is defined under the TSC Act as 'a process that threatens, or that may threaten, the survival or evolutionary development of a species, population or ecological community. Threatening processes that adversely affect threatened species, populations or ecological communities, or possibly cause others that are not currently threatened; to become threatened may be eligible for listing as a key threatening process (KTP).

2.2.3 Fisheries Management Act 1994

The objectives the *Fisheries Management Act 1995* (NSW) (TSC Act) include:

- Conserve fish stocks and key fish habitats;
- Conserve threatened species, populations and ecological communities of fish and marine vegetation; and
- Promote ecologically sustainable development, including the conservation of biological diversity, and, consistently with those objects:
 - » Promote viable commercial fishing and aquaculture industries;
 - » Promote quality recreational fishing opportunities;
 - » Appropriately share fisheries resources between the users of those resources; and
 - » Provide social and economic benefits for the wider community of New South Wales.

To meet these objectives, Part 7 of the FM Act outlines legislative provisions to protect fish habitat and Part 7A outlines provisions to conserve threatened species of fish and marine vegetation and their habitat.

In understanding this definition it is important to remember that the term 'fish' includes all aquatic invertebrates such as yabbies, shrimps, oysters, mussels, insect larvae, beach worms, sea stars, jellyfish etc.

2.2.4 National Parks and Wildlife Act 1974

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.

2.3 Noxious Weeds Act

The *Noxious Weeds Act 1993* (NW Act) is a NSW government instrument outlining the definition, declaration, and control of noxious weeds throughout the State. Local government bodies have the responsibility to ensure that the Act is complied with within their boundaries.

For a plant to be declared a Noxious Weed it must be considered to pose a serious threat to humans, agriculture and/or the environment. There must also be consideration given to the feasibility of control and enforcement of those methods. Plants are declared noxious by order of the Minister for Agriculture.

Landowners or occupiers have obligations under the NW Act to control any declared weed on their property. Council is required to conduct inspections of private properties to check compliance with the NW Act and Noxious Weed Officers have the authority to issue control notices for any breach.

2.4 Native Vegetation Act

The *Native Vegetation Act 2003* (NV Act) sets a framework for:

- Encouragement of revegetation and rehabilitation of land with appropriate native vegetation;
- Providing incentives for landholders to undertake management of native vegetation on their properties; and
- An end to broad scale clearing, unless it improves or maintains the environment.

The NV Act provides three categories of native vegetation including regrowth, protected regrowth and remnant vegetation with clear definitions.

The NV Act provides greater flexibility and incentives for landholders to manage native vegetation sustainably. The Act gives effect to the Government's commitment to ending broad scale clearing unless it improves or maintains environmental outcomes.

Under section 25(g), the NV Act does not apply to any clearing that is part of an activity carried out by a determining authority within the meaning of Part 5 of the EP&A Act where the determining authority has complied with Part 5. Under section 25(m), the NV Act does not apply to any clearing authorised under the Petroleum (Onshore) Act 1991 (NSW).

3.0 Methods

3.1 Desktop Assessment

A desktop assessment was undertaken to identify potential development constraints as well as significant ecosystems and species that may potentially occur on the area of consideration. The following databases and maps were reviewed:

- EPBC Protected Matters Search Tool (Department of Sustainability, Environment, Water, Population and Community (SEWPaC), 2012), undertaken with a 10km radius (**Appendix 1**);
- Threatened fauna and flora records contained in the Office of Environment and Heritage (OEH) Atlas of NSW Wildlife (data within a 10km radius was reviewed);
- National Vegetation Information Systems mapping for the Namoi Catchment;
- Key Fish Habitat (NSW Department of Primary Industries (DPI) 2007);
- Waterways mapping (OEH 2012),
- NSW Wetland Mapping 2006; and
- Aerial photography.

3.2 Field Assessment

A detailed assessment was conducted between the 12th November and 16th November 2012, including detailed flora and fauna surveys. The following sections details the methods utilised to assess the area of consideration.

3.2.1 Flora Survey

Flora surveys were conducted to verify and delineate vegetation communities occurring within the survey area. Aerial photograph interpretation (API) was utilised in conjunction with revision of the Namoi CMA vegetation mapping (Namoi CMA, 2010) to further delineate vegetation within the area of consideration.

A flora survey was conducted within each lease area (100 m by 100 m), to collect the following data:

- Vegetation structure, including number of strata, average height of each strata, and percent cover of each strata;
- Species composition, including dominant species within each strata;
- Diversity and abundance of weed species; and
- Presence of threatened species and identification of suitable habitat for threatened species.

The data was collected by walking transects at 20m intervals throughout the lease area. Quadrats were utilised to assess ground cover, with one quadrat undertaken along each transect.

Additional data was collected along the access tracks and within areas surrounding the lease areas to delineate vegetation community boundaries. Incidental flora observations were recorded within these areas.

All species recorded were identified as far as practicable to species and subspecies (where relevant) level. When a plant could not be identified accurately within the field, a voucher sample was collected, together with notes on habitat, form and height, labelled and identified according to nomenclature in Harden (1992–2002).

Opportunistic sightings of taxa were also collected if they were not found in any of the sampled sites.

3.2.2 Habitat Assessment

Assessments of the relative value of the habitat present within the area of consideration were undertaken to determine the potential value of this area for all native flora and fauna species. The area of consideration was assessed for specific habitat requirements for threatened species identified as likely to occur as part of the desktop assessment.

The habitat assessment for fauna species included determining the presence and abundance of:

- Hollow-bearing trees;
- Fallen woody debris, fallen logs, and hollow logs;
- Ground cover composition, including leaf litter, bare ground, grasses, shrubs, rocks, and herbs and forbs;
- Canopy and shrub cover density;
- Flowering canopy and shrub species; and
- Proximity to water.

Consideration was given to factors such as topography, soil, light and hydrology for threatened flora assemblages.

3.2.3 Landscape Assessment

An assessment of landscape scale attributes were evaluated and analysed utilising a Geographic Information System (GIS). Landscape attributes assessed included size of vegetation community, size of contiguous vegetation patch, and connectivity between patches.

3.2.4 Fauna Survey

The fauna survey methodology initially consisted of the production of an expected fauna species list and an assessment of the potential use of the area of consideration based on the desktop assessment and initial site assessment. A detailed fauna survey was then conducted at two sites located within the survey area and three other sites located within the area of consideration (**Figure 3.1**). Fauna survey methods are outlined below.

Avifauna

The presence of avifauna within the area of consideration was assessed via opportunistic observations throughout all field work. Birds were identified by direct observation or by recognition of calls or distinctive features such as nests, feathers and owl regurgitation pellets etc.

A 30 minute diurnal bird survey was conducted at each of the two sites over two mornings and two evenings. Birds were identified in the same fashion as listed above.

Nocturnal surveys, during spotlighting, attempted to identify roosting diurnal birds in a similar fashion to methods employed during diurnal surveys.

Spotlighting was undertaken as described below, targeting nocturnal avifauna species such as owls.

Spotlighting

Spotlight searches for nocturnally active mammals, as well as birds and herpetofauna including dedicated listening periods for fauna vocalisations, were carried out over two nights within the survey area and adjacent areas using 55 watt spotlights. Species were identified by observation under spotlight or by call identification.

Each survey involved a series of transects conducted on foot or by vehicle. Surveys commenced 1.5 hours after dusk and targeted areas with hollow bearing trees to detect arboreal mammals, forest owls and bats emerging from diurnal roosts to forage. Aquatic habitats were also targeted to detect amphibians.

Active Searches

At each of the two survey sites, an active search for evidence of ground-dwelling mammals (bandicoots, native rats etc.) was focused around key habitat features, such as extensive grassy ground cover and fallen woody debris, hollow logs and burrows that offer potential suitable shelter.

Reptile surveys involved active searches of the area of consideration to identify potential habitat for reptile species, including the Pale-headed Snake (*Hoplocephalus bitorquatus*), which is listed as threatened under NSW legislation.

Survey techniques employed included:

- Diurnal searches for sheltering or basking reptiles as well as indirect evidence of fauna e.g. tracks, scratches, burrows etc;
- Rock, log and debris rolling; and
- Spotlight surveys for nocturnally active species.

Anabat Detection

An Anabat SD2 detection unit was placed for one or two nights in suitable flyways located adjacent to the two survey sites. Positioning was focused on natural flyways below the canopy which typically provide an abundance of microbat foraging resources (insects). The Anabats were set before dusk and retrieved in the morning after sunrise. Anabat survey locations are shown on **Figure 3.1**.

Greg Ford of Balance Environmental undertook Anabat analysis of all bat calls and provided an analysis summary report. Due to the high level of variability and overlap in call characteristics, a conservative approach was taken when analysing calls. Species names used in the Anabat analysis summary follow Churchill (2008) (Balance Environmental, 2012).

Call identification was based on published call descriptions for New South Wales (Pennay *et al* 2004) and on reference calls collected from southern Queensland and northern New South Wales (Balance Environmental, 2012). Determination of species' identification was further refined by considering probability of occurrence based on distributional information presented in Churchill (2008) and Van Dyck & Strahan (2008) (Balance Environmental, 2012).

The format and content of the analysis summary report complies with nationally accepted standards for the interpretation and reporting of Anabat data (Reardon, 2003).

Terrestrial Trapping

Terrestrial trapping was undertaken using 73 Elliott A traps, seven Elliott B traps, nine Elliott E traps, 14 snake funnel traps, four camera traps, 40 hair funnels and 15 pitfall traps set over three, four or five nights. The compositions of traps per site are tabulated in **Table 3.1**.

Elliott traps were baited with a mixture of rolled oats and peanut butter, except for half the Elliott B traps which were baited with a mixture of sardines and flour. Traps were checked early each morning and any captures were identified and immediately released at the point of capture. All bait was collected each morning and traps were closed for the day and then re-baited each evening. The location of each trap line is shown in **Figure 3.1**.

Elliott traps targeted small terrestrial mammals such as Dasyurids (e.g. antechinus and dunnarts) and rodents (e.g. rats and mice), while pitfalls targeted small mammals as well as reptiles and amphibians. Camera traps and hair funnels targeted larger mammals (e.g. bettongs). In total there were 262 Elliott A trap nights, 25 Elliott B trap nights, 34 Elliott E trap nights, 150 hair funnel trap nights, 60 camera trap nights, 57 pitfall trap nights and 54 reptile funnel traps within the area of consideration.

Table 3.1: Trapping Effort Per Site

Trap Type	Survey Area		Area of Consideration		
	Site 2 ¹	Site 3 ¹	Site 1 ¹	Site 4 ¹	Site 5 ¹
Elliott A	65	60	0	60	77
Elliott B	5	6	6	0	8
Elliott E	14	6	0	6	8
Pitfall	20	12	0	9	16
Snake funnel	20	12	0	6	16
Hair funnel	50	30	30	0	40
Motion Detection Camera	20	12	12	0	16

¹No. of trap nights

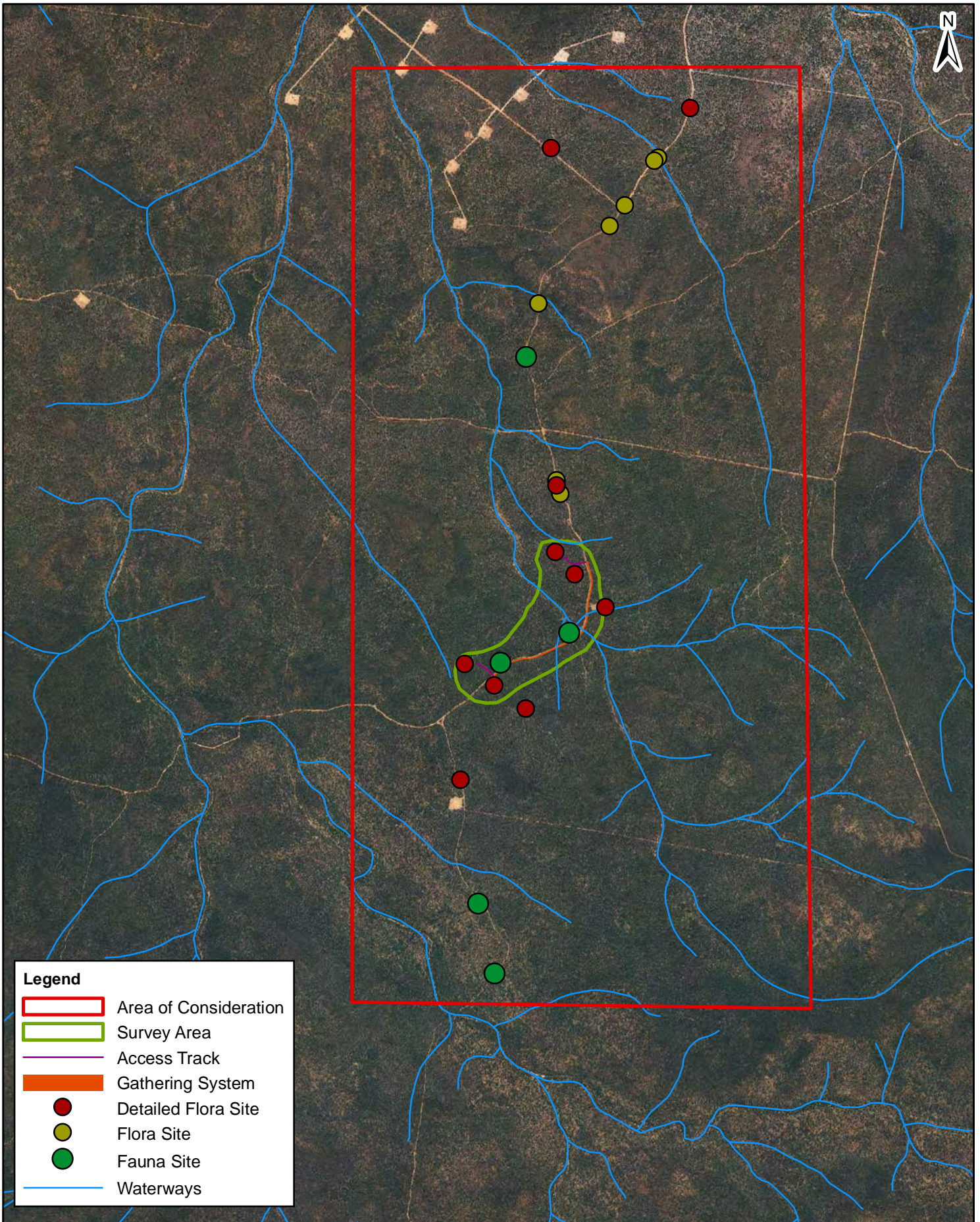
3.3 Survey Limitations

It should be noted that the detectability of plants and the ability to accurately identify plants to species level may vary greatly with the time of year, prevailing climatic conditions and the presence of reproductive material (e.g. flowers, fruit, and seed capsules). Consequently, the survey conducted for the area of consideration should not be regarded as conclusive evidence that certain protected plants do not occur there; however every effort has been made to detect these species in habitats that were considered suitable. Specifically, native grass species and heath species can be difficult to identify due to seasonality.

All fauna surveys are subject to inherent limitations in the detection success of targeted species. These limitations often result in a degree of false-absence records (i.e. a species is present, but not detected). It is important, therefore, that the limitations to fauna surveys are identified and the fauna survey results are viewed with these constraints in mind. The limitations to the fauna surveys conducted in the area of consideration included:

-
- The survey period not coinciding with the period that some migratory or nomadic species occur in the locality;
 - Species with large home ranges (e.g. owls and raptors) not present in this part of their home range during the survey period;
 - The difficulty in detecting certain species during the survey period (e.g. cryptic species, species present in the area of consideration at very low densities, and trap-shy species);
 - Biological factors such as sex, age-class, and breeding biology, which may influence species' habitat use and detectability during different times of the year;
 - The lack of suitable climatic conditions necessary for the presence and/or detectability of certain species (e.g. amphibians following heavy rainfall); and
 - Despite the apparent deficiencies, suitable coverage of the area of consideration was accomplished, in particular the likely occurrence of species was assumed, based on habitat assessments, previous local records, seasonality, predicted faunal movements of locally occurring threatened species in combination with the local knowledge and experience of the authors.

In response to the abovementioned limitations the precautionary approach has been adopted; as such 'assumed presence' of known and expected threatened species, populations and ecological communities has been made where relevant to ensure a holistic assessment.



Legend

- Area of Consideration
- Survey Area
- Access Track
- Gathering System
- Detailed Flora Site
- Flora Site
- Fauna Site
- Waterways

Client: Santos	
Compiled by: CO	Date: 03/01/2013
Approved by: HR	Date: 03/01/2013

0 0.45 0.9 1.8
 km

Datum: GDA94
 Scale: 1:38,000 @ A4

Survey Locations

Figure 3.1

Project: Dewhurst 26-29 Pilot Wells

Source: Imagery from Bing Maps 2012
 Infrastructure from Santos 2012
 Watercourses from OEH 2012



4.0 Flora

4.1 Vegetation Communities

4.1.1 Narrow-leaved Ironbark Woodland

One vegetation community occurs within the survey area, namely Narrow-leaved Ironbark Woodland. The extent of this community is outlined on **figure 4.1**, and a detailed flora species list for the area of consideration is included in **Appendix 2**.

The canopy of this community is dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) with Bulloak (*Allocasuarina luehmannii*) commonly occurring. Occasionally, Dirty Gum (*Eucalyptus chloroclada*) and Brown Bloodwood (*Corymbia trachyphloia*) occur. Height ranges from 13 to 18m, with an average of 15m. The cover is approximately 45%.

A secondary canopy occurs, with a cover of approximately 17%. Heights changes significantly between sites, with height ranging from 4 to 13m. Generally height averages 10m. The secondary canopy is dominated by Bulloak, with Narrow-leaved Ironbark commonly occurring. Black Cypress (*Callitris endlicheri*) and White Cypress (*Callitris glaucophylla*) occasionally occur in this layer.

A sparse primary shrub layer occurs, with a cover of approximately 5%. Height ranges from 2 to 4m. The primary shrub layer is dominated by Carol's Wattle (*Acacia caroleae*), with Bulloak occurring as a sub-dominant species. Mudgee Wattle (*Acacia spectabilis*) also occasionally occurs.

A denser and diverse lower secondary shrub layer occurs ranging in height from 0.5 to 1.5m. Cover reaches up to 65%, however many sparse or bare areas are present. The secondary shrub layer is co-dominated by Sticky Hop-bush (*Dodonaea viscosa*), Common Fringe-myrtle (*Calytrix tetragona*), and Broom Bitter-pea (*Daviesia genstifolia*), and Cough Bush (*Cassinia laevis*). Sandplain Bitter-pea (*Daviesia acicularis*), Honey Myrtle (*Homoranthus flavescens*), Peach Heath (*Lissanthes strigosa*), and Prickly Beard-heath (*Leucopogon juniperous*) commonly occur, while Mudgee Wattle, Fan Wattle (*Acacia amblygona*) and Carol's Wattle, and Persoonia (*Persoonia cuspidifera*) occasionally occur.

Ground cover is sparse, with native plants species comprising 45% of the total cover. Ground-cover is dominated by Rough Saw-sedge (*Gahnia aspera*), with Blueberry Lilly (*Dianella revoluta*), Pomax (*Pomax umbellata*), Variable Saw-sedge (*Lepidosperma laterale*), Common Fringe-sedge (*Fimbristylis dichotoma*), Many-flowered Mat-rush (*Lomandra multiflora*), and Serrated Goodenia (*Goodenia cycloptera*) commonly occurring. Grasses are sparse, with Dark Wiregrass (*Aristida calycina*), Plains Grass (*Austrostipa aristiglumis*), Purple Lovegrass (*Eragrostis lacunaria*), Hairy Panic (*Panicum effusum*), and *Eragrostis sp.*

Condition

This community is considered to be remnant, however condition varies throughout the area of consideration. Disturbances are generally associated with land management practices due to forestry, such as access tracks and logging. Additionally, CSG activities have occurred in the area, with a disused lease and seismic lines occurring in the area of consideration. This has resulted to disturbances to the understorey, where large open areas are present. Weed cover is considered to be low throughout the area of consideration, with only Prickly Pear (*Opuntia stricta*) observed.

Classification

This community is commensurate with the Ironbark Shrubby Woodland of the Pilliga Area, Brigalow Belt South (RVC 33), as mapped by the Namoi CMA (**Figure 4.2**).

This vegetation community does not constitute any community that is listed within the schedules of the EPBC Act or the TSC Act.

4.1.2 Heath

A heath vegetation community occurs within the area of consideration, but well outside of the survey area. This community is characterised by a sparse emergent and canopy layer that is dominated by Narrow-leaved Ironbark.

A dense primary shrub layer occurs, dominated by Carol's Wattle, with Sticky Hop-bush, Prickly Bottlebrush (*Callistemon brachyandrus*) and Black Cypress (*Callitris endlicheri*) commonly occurring.

The secondary shrub layer of this community is comprised of moderately dense heath vegetation. This community is generally dominated by Common Fringe-myrtle. Species commonly occurring include Cough Bush, Honey Myrtle, Dogwood (*Cassinia aculeata*), Emubush (*Eremophila longifolia*), Dean's, Peach Heath (*Lissanthe strigosa*), Fringed Heath-myrtle and Broombush.

Ground cover is sparse. Common species include Woolly Mat-rush (*Lomandra leucocephala*), Rough Saw-sedge and *Dianella* sp. Grasses occur rarely, comprising of Woodland Lovegrass (*Eragrostis sororia*) and Purple Wiregrass (*Aristida ramosa*).

Condition

The condition of this community is considered to be good, with disturbances limited to damage from historical forestry activities (e.g. access tracks). This community is considered to be in a remnant condition.

Classification

This community is similar in composition to RVC 56, namely Ironbark – Brown Bloodwood – Black Cypress Pine heathy woodlands mapped by the Namoi CMA (2010) (**Figure 3.2**).

This community is not considered to be a TEC under the EPBC Act or TSC Act.

4.1.3 Bloodwood Heathy Woodland

Description

This community does not occur within the survey area but there are several large patches within the area of consideration. This community differs from the Heath community due to the presence of a Eucalypt canopy layer as well as dense shrub layers.

The emergent layer of this community is dominated by Brown Bloodwood, with Dirty Gum and Narrow-leaved Ironbark occasionally occurring. Heights range from 14 to 16m, with cover approximately 10%. A low sparse canopy is also present and is dominated by Dirty Gum. Height ranges from 4 to 6m, with approximately 5% cover.

A primary shrub layer occurs, with covers reaching up to 40%. The shrub layer consists of Carol's Wattle, Dean's Wattle and *Persoonia* sp.. The secondary shrub layer is dense, with average cover of

70%. The secondary shrub layer is generally dominated by Common Fringe-myrtle and *Dodonaea* sp., with numerous heath species such as Seven Dwarfs Grevillia (*Grevillia floribunda*), Prickly Beard Heath (*Leucopogon juniperous*), Dogwood, Broombush, Cough Bush, Broombush (*Melaleuca uncinata*), *Hibbertia* sp., Fringed Heath-myrtle, and *Ozothamnus* sp..

Ground cover is moderately sparse, with a cover of approximately 40%. The ground cover is dominated by herbs and forbs, including *Dianella* sp., *Crespedia* sp. and Woolly Mat-rush. Grasses occasionally occur, and are dominated by Purple Wiregrass.

Condition

This community is generally in good condition. Disturbances are limited to historical logging and forestry activities.

Classification

This community is similar in composition to RVC 56, namely Ironbark – Brown Bloodwood – Black Cypress Pine heathy woodlands mapped by the Namoi CMA (2010) (**Figure 3.2**).

This community is not considered to be a TEC under the EPBC Act or TSC Act.

4.1.4 Riparian Woodland

Description

This vegetation community is associated with the ephemeral drainage lines within the area of consideration (**Figure 4.1**), but does not occur within the survey area.

The canopy of this community is dominated Rough-barked Apple (*Angophora floribunda*) with occasional Dirty Gum and Narrow-leaved Ironbark occurring. The canopy cover is approximately 25%, and heights range from 14 to 16m. A sparse secondary canopy occurs, with a cover of approximately 10%. The secondary canopy contains the same composition as the canopy with Rough-barked Apple dominating. Height ranges from 8 to 10m.

One low shrub layer is present, with cover ranging from 30-40%. Height ranges from 1 to 6m. Species commonly occurring include Wattles (*Acacia carolae* and *Acacia deanei*), Dirty Gum, and Western Wedding Bush.

The ground cover comprised approximately 15% herbs and forbs, and 5% native grasses. Common grasses include Reed Grass (*Arundinella nepalensis*), Dark Wiregrass (*Aristida calycina*), Hairy Panicum (*Panicum effusum*) and Purple Wiregrass. Herbs and forbs commonly occurring include Woolly Mat-rush, Many-flowered Mat-rush (*Lomandra multiflora*), Rough Saw-sedge and Blue Flax-lily.

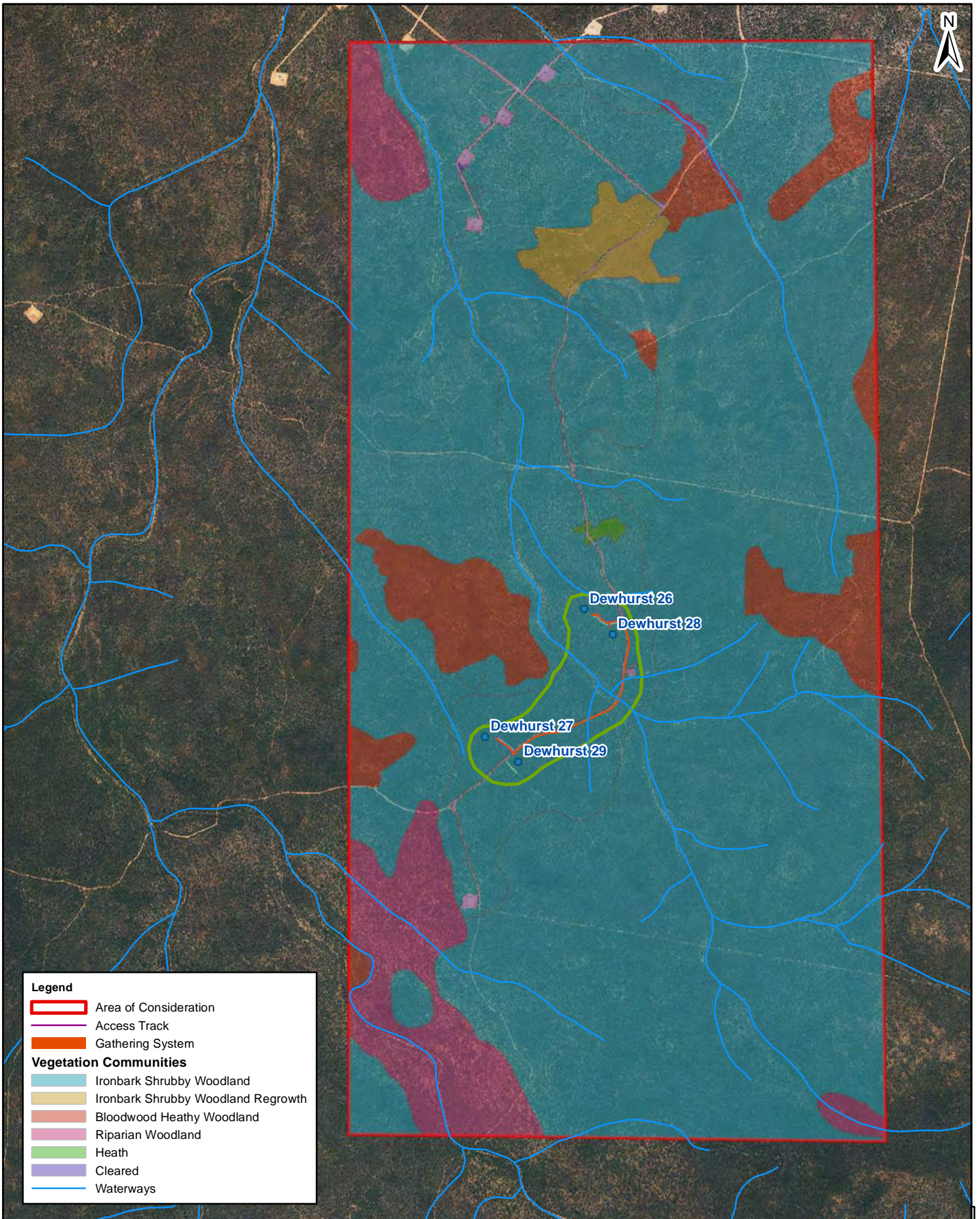
Condition

This community is associated with some of the ephemeral waterways throughout the area of consideration. In many instances, this community occurs as a narrow linear strip closely following waterway banks. As such, it is prone to disturbances resulting from erosion of creekbanks, or disturbances from high flow events. Vegetation is considered to be in a remnant condition, with disturbances generally limited to road crossings and historical forestry activities.

Classification

This community is commensurate with the Rough-barked Apple – Blakely’s Red Gum Riparian Grassy Woodlands, Brigalow Belt South and Nandewar (RVC 20), as mapped by the Namoi CMA (**Figure 4.2**).

As outlined in the RVC description, this community can be commensurate with The EPBC Act listed White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grasslands (Box-Gum Grassy Woodlands and Derived Grasslands), and the TSC Act White Box Yellow Box Blakely’s Red Gum Woodland (Box-Gum Woodland). As outlined in **Section 4.2**, as assessment against the listing criteria determined that this community is not an EPBC Act or TSC Act listed community.



Legend

- Area of Consideration
- Access Track
- Gathering System

Vegetation Communities

- Ironbark Shrubby Woodland
- Ironbark Shrubby Woodland Regrowth
- Bloodwood Heathy Woodland
- Riparian Woodland
- Heath
- Cleared
- Waterways

Client: Santos	
Compiled by: CO	Date: 03/01/2013
Approved by: HR	Date: 03/01/2013

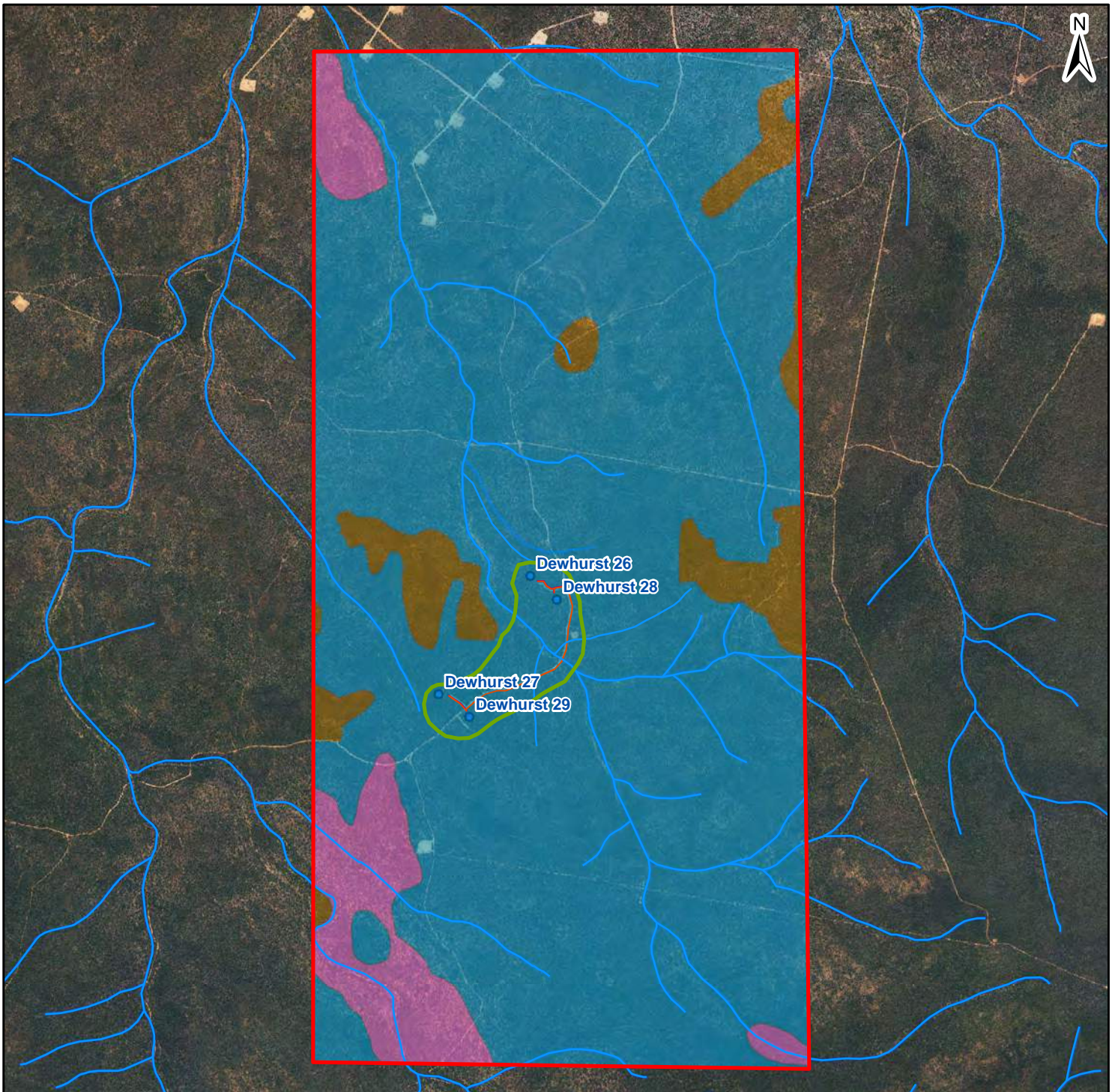
Ground-truthed Vegetation Communities	
Figure 4.1	Project: Dewhurst 26-29 Pilot Wells



0 0.375 0.75 1.5 km

Datum: GDA94
Scale: 1:10,000 @ A4

Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2012
Watercourses from OEH 2012



Legend

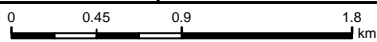
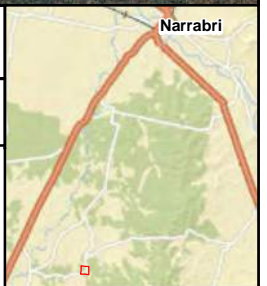
- Area of Consideration
- Survey Area
- Access Track
- Gathering System
- Waterways

Namoi CMA Vegetation Mapping

- Ironbark - Brown Bloodwood - Black Cypress Pine heathy woodlands, Brigalow Belt South
- Ironbark shrubby woodlands of the Pilliga area, Brigalow Belt South
- Rough-barked Apple - Blakely's Red Gum riparian grassy woodlands, Brigalow Belt South and Nandewar

Client: Santos	
Compiled by: CO	Date: 03/01/2013
Approved by: HR	Date: 03/01/2013

Namoi CMA Vegetation Mapping	
Figure 4.2	Project: Dewhurst 26-29 Pilot Wells



Datum: GDA94
Scale: 1:10,000 @ A4



Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2012
Watercourses from OEH 2012
Namoi CMA 2012

4.2 Threatened Ecological Communities

4.2.1 EPBC Act

Four Threatened Ecological Communities (TEC) listed under the EPBC Act were identified as potentially occurring within the area of consideration as part of the EPBC Protected Matters Search Tool, including:

- Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions;
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia;
- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland; and
- Weeping Myall Woodlands.

Additionally, three EEC listed under the TSC Act that are known or predicted to occur within the Namoi CMA have an equivalent TEC listed under the EPBC Act, including:

- Brigalow (*Acacia harpophylla* dominant and co-dominant);
- White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland; and
- Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions.

An assessment of vegetation communities identified within the area of consideration was undertaken to identify potential TEC's, and is included in **Appendix 3**. The assessment determined that no TEC listed under the EPBC Act occur in the area of consideration.

4.2.2 TSC Act

Nine EEC listed under the TSC Act were identified as occurring within the area of consideration, based on known or predicted communities occurring within the Namoi CMA (NSW Atlas of Wildlife Search). These include:

- Brigalow within the Brigalow Belt South, Nandewar, and Darling Riverine Plains Bioregions;
- *Cadellia pentastylis* (Ooline) community in the Nandewar and Brigalow Belt South Bioregions;
- Coolibah-Black Box Woodland of the Darling Riverine Plains and the Brigalow Belt South bioregions;
- Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions;
- Inland Grey Box Woodland in the Riverina; NSW South Western Slopes; Cobar Peneplain; Nandewar and Brigalow Belt South Bioregions;
- Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions;
- Native Vegetation on Cracking Clay Soils of the Liverpool Plains;
- Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions; and
- White Box - Yellow Box - Blakely's Red Gum (Box – Gum) Woodland.

An assessment for likelihood of occurrence was conducted for each listed community, and is included in **Appendix 3**. The assessment determined that no TEC listed under the TSC Act occur in the area of consideration.

4.3 Threatened Flora Species

4.3.1 EPBC Act

The desktop assessment identified five threatened flora species listed under the EPBC Act that potentially occur in the locality. An assessment of likelihood of occurrence was completed for each species, and is included in **Appendix 4**. The assessment identified that the area of consideration provides suitable habitat for four species, namely:

- *Bertya opposens* (Vulnerable);
- Cobar Greenhood Orchid (*Pterostylis cobarensis*)(Vulnerable);
- *Rulingia procumbens* (Vulnerable); and
- *Tylophora linearis* (Endangered).

Searches did not confirm the presence of any threatened flora species within the area of consideration. However one species, *Rulingia procumbens*, has been previously recorded within 10km of this area and is therefore considered a possible occurrence, despite not been recorded during the survey. While the remaining species have not previously been recorded in proximity to the area of consideration, habitat is considered suitable to support these species. Refer to **Section 7.1.6** and **Appendix 4** for potential for impact on the above species.

4.3.2 TSC Act

The desktop assessment identified five threatened flora species potentially occurring within the locality. As assessment of likelihood of occurrence was completed for each species, and is included in **Appendix 2**. The assessment identified that the area of consideration provides suitable habitat for the following species:

- *Bertya opposens* (Vulnerable);
- Native Milkwort (*Polygala linariaefolia*) (Endangered);
- Cobar Greenhood Orchid (*Pterostylis cobarensis*)(Vulnerable);
- *Rulingia procumbens* (Vulnerable); and
- *Tylophora linearis* (Endangered).

Searches did not confirm the presence of any threatened flora species within the area of consideration. However two species, Native Milkwort and *Rulingia procumbens* have been previously recorded within 10km of the survey and are therefore considered possible occurrences, despite not been recorded during the survey. Suitable habitat occurs in the area of consideration to support the remaining species, although they haven't previously been recorded in close proximity to this area. Refer to **Section 7.2** and **Appendix 4** for potential for impact on the above species.

4.4 Weeds

The EPBC Protected Matters Search Tool identified five weeds of national significance (WoNS) as potentially occurring in the area of consideration, namely:

- African Boxthorn (*Lycium ferocissimum*);
- Radiata Pine (*Pinus radiata*);
- Blackberry (*Rubus fruticosus aggregate*);
- Willows (*Salix spp.*); and
- Athel Pine (*Tamarix aphylla*).

No WoNS were observed within the area of consideration.

One weed listed under the *Noxious Weeds Act 1993* was observed on site, namely Prickly Pear (*Opuntia stricta*). Weed cover within the area of consideration is low, with only Prickly Pear observed. No additional listed noxious weeds or environmental weeds were identified within the area of consideration.

5.0 Fauna

5.1 Fauna Results

The fauna survey identified no species protected under the EPBC Act to occur within the area of consideration. However, four species listed as threatened under the TSC Act were recorded, including: Grey-crowned Babbler (*Pomatostomus temporalis*), Speckled Warbler (*Chthonicola sagittata*), Little Pied Bat (*Chalinolobus picatus*) and Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*). Another threatened microbat species; the Bristle-faced Free-tailed bat (*Mormopterus eleryi*) may also have been recorded; however its calls could not be confirmed.

In total, the fauna survey revealed the presence of 45 bird species, 19 mammal species (including 12 microbat species), three amphibians and 12 reptile species within the area of consideration. A detailed fauna species list is included in **Appendix 5**.

5.1.1 Birds

During the survey, 24 bird species were recorded within the survey area and 45 bird species were recorded within the area of consideration (**Appendix 5**). Of the 45 bird species recorded, two are listed as Vulnerable under the TSC Act, namely:

- Grey-crowned Babbler (*Pomatostomus temporalis*); and
- Speckled Warbler (*Chthonicola sagittata*).

These species are discussed further in **Section 5.3**.

Three additional Vulnerable species have been observed in adjacent areas and are very likely to occur within the area of consideration, namely the Hooded Robin (*Melanodryas cucullata*); Diamond Firetail (*Stagonopleura guttata*); and Turquoise Parrot (*Neophema pulchella*).

5.1.2 Mammals

In total, 19 mammal species (three of which were introduced) were recorded during this survey (**Appendix 5**). Two of these species are listed as Vulnerable under the TSC Act, namely:

- Little Pied Bat (*Chalinolobus picatus*); and
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*).

Additionally, the Bristle-faced Free-tailed bat (*Mormopterus eleryi*), listed as Endangered under the TSC Act may also occur in the area of consideration.

There are eight records of Pilliga Mouse (*Pseudomys pilligaensis*), listed as Vulnerable under the EPBC Act and TSC Act, occurring within a 10 km radius of the survey area (OEH, 2012). However, all of these records occurred in vegetation types that differ from the Ironbark Shrubby Woodland found within the area of consideration. The Pilliga Mouse was not recorded during the field survey.

Microbats

Anabat data identified up to 14 species of microbat potentially occurring in the area of consideration. However, only 12 of these species were positively identified, as shown in **Table 5.1**. Two of these species are listed as Vulnerable under the TSC Act: the Little Pied Bat (*Chalinolobus picatus*) and Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*). Although its calls were not confirmed, the

Bristle-faced Free-tailed bat (*Mormopterus eleryi*), listed as Endangered under the TSC Act may also occur in the area of consideration (Balance Environmental, 2012).

Table 5.1: Anabat Analysis Data

Species	12/11/2012	13/11/2012	15/11/2012
Calls/species positively identified			
<i>Chalinolobus gouldi</i>	✓	✓	×
<i>Chalinolobus morio</i>	✓	✓	✓
<i>Chalinolobus picatus</i>	×	×	✓
<i>Mormopterus species 2</i>	×	✓	×
<i>Mormopterus species 3</i>	✓	✓	×
<i>Mormopterus species 4</i>	✓	✓	✓
<i>Nyctophilus sp.</i>	✓	✓	✓
<i>Saccolaimus flaviventris</i>	✓	✓	✓
<i>Scotorepens balstoni</i>	✓	✓	×
<i>Scotorepens greyii</i>	✓	✓	✓
<i>Tadarida australis</i>	✓	×	✓
<i>Vespadelus sp.</i>	✓	✓	✓
Calls/species NOT positively identified			
<i>Mormopterus eleryi</i>	×	□	×
<i>Miniopterus schreibersii</i>	□	□	□
Total sequence files	428	686	257
Total calls identified	86	154	75

* ✓ = species positively identified from call data; □ = species possibly present, but not reliably identified; × = species not recorded (See notes below regarding species identity for calls with poor resolution).

Not all bats could be identified to species level as numerous fragmented and/or brief calls could not be reliably identified; and many good quality calls had intermediate features that may have been attributable to one of several species. Such calls were attributed to a species group depending on frequency range and pulse shape characteristics. Species groupings used in this analysis include (Balance Environmental, 2012):

- *Mormopterus* spp. 2 and 3 (Fc=31-33 kHz);
- *Mormopterus* spp. 3 and 4 (Fc=27-29 kHz);
- *Chalinolobus gouldii* and *Scotorepens balstoni* (Fc=28-35 kHz);
- *C. gouldii*, *S. balstoni* and *Mormopterus* spp.;
- *Chalinolobus picatus* and *Scotorepens greyii* (Fc=39-40 kHz);
- *Scotorepens greyii* and *Mormopterus eleryi* (Fc=36-38 kHz);
- *Nyctophilus* spp.; and
- *Vespadelus* spp. and *Miniopterus schreibersii* (Fc=43-47 kHz).

Where a call is attributed to a species group, all species within the group are listed as “possible” in the results. In some cases, however, one or more of the group members are also identified positively in other calls, in which case, they are shown as ‘positive’ in the table. Issues of call identification reliability and probability of group members occurring in the area of consideration are included in **Appendix 9** (Balance Environmental, 2012).

Mormopterus species

These species produce mostly flat or slightly-curved, narrow-band call pulses with characteristic frequency (Fc) between 24 and 36 kHz. Characteristic frequency can be used to determine species in many cases (*Mormopterus* sp. 4 Fc=24-27 kHz; *Mormopterus* sp. 3 Fc=29-31 kHz; and *Mormopterus* sp. 2 Fc=34-36 kHz); however calls within the overlap zones between these ranges are attributed to either species 2/3 (Fc=31-33 kHz) or species 3/4 (Fc=27-29 kHz) (Balance Environmental, 2012).

Chalinolobus gouldii / *Scotorepens balstoni*

Calls generally have steep, broad-band pulses with Fc of 28-35 kHz. Distinctive inter-pulse frequency alternation usually differentiates *C. gouldii* from the more uniform pulses of *S. balstoni*. Both species were positively identified using these criteria, but a number of calls had inconsistent evidence of alternation and could have been from either species (Balance Environmental, 2012).

C. gouldii / *S. balstoni* / *Mormopterus spp.*

Differentiation is usually on the basis of steep versus flat pulse shapes; however, some calls had pulses of intermediate shape that could have belonged to any of these species (Balance Environmental, 2012).

Chalinolobus picatus / *Scotorepens greyii*

Chalinolobus picatus calls (Fc=39-43 kHz) have steep, broad-band pulses with curved bodies and usually exhibit distinctive frequency alternation between successive pulses. The frequency range and pulse shapes make them very similar to *S. greyii* (Fc=35-40 kHz); however, that species lacks the regular frequency alternation seen in *C. picatus* (Balance Environmental, 2012).

Numerous calls were reliably attributed to *S. greyii* spp. due to their consistent pulse frequencies; but only a few calls had sufficient evidence of alternation to be reliably attributed to *C. picatus*. Many calls in the frequency range were noisy and/or fragmented and could not be reliably attributed to either species (Balance Environmental, 2012).

Scotorepens greyii / *Mormopterus eleryi*

Characteristic frequency (36-38 kHz) and pulse shapes are almost identical in these species and calls are difficult to discriminate. The key differentiating feature seems to be a sharp down-swept tail on the end of a cup-shaped pulse body in *M. eleryi*, compared with no tail and/or less-curved body in *S. greyii*. The latter species was reliably identified in most calls; however, a few calls from several sessions had pulse shapes indicative of, but not positively identified as, *M. eleryi* (Balance Environmental, 2012).

Nyctophilus spp

Long-eared bat calls are readily distinguished from those of other bats; however, the species within the genus cannot be reliably differentiated. Three species potentially occur in the area of consideration, including *N. geoffroyi*, *N. gouldi* and *N. corbeni*. The latter species is a listed threatened species under both the Commonwealth EPBC Act and the New South Wales TSC Act (Balance Environmental, 2012).

Vespadelus spp. / *Miniopterus schreibersii*

Numerous calls with Fc in the range 43-47 kHz had uniform, short-duration, curved to hooked pulses typical of *Vespadelus* species. It is highly likely that most, if not all, of these calls were from *V. vulturnus*, as the Atlas of Living Australia shows numerous records of that species throughout the Pilliga region. However, nearby records also exist for both *V. baverstocki* (to the west) and *V. regulus* (both east and west) and both of these species produce very similar calls to those of *V. vulturnus* (Balance Environmental, 2012).

Miniopterus schreibersii also calls within the same frequency range, but good quality calls are distinguished by their longer pulse duration, flatter pulse bodies and erratic changes in shape and Fc within the call sequence. A number of calls in this data set had pulse shapes intermediate in shape between those of *Vespadelus* spp. and *M. schreibersii*. The Atlas of Living Australia shows no records for the latter species in the Pilliga East area; however, it has been recorded at two localities further to the west, so should be considered as potentially present in the area of consideration (Balance Environmental, 2012).

5.1.3 Reptiles

Eight reptile species were recorded in the survey area including two geckos, three skinks, one dragon and two monitor species. A total of 12 reptile species were recorded in the area of consideration, as listed in **Appendix 5**.

No threatened reptile species were recorded during this survey.

5.1.4 Amphibians

No amphibians were recorded within the survey area during this survey. However, three amphibians were recorded within the area of consideration as listed in **Appendix 5**. The low number of amphibian captures can be attributed to dry conditions experienced throughout the survey.

No threatened amphibian species listed under the TSC Act and/or EPBC Act were recorded during this survey.

5.1.5 Pests

The EPBC Protected Matters Search Tool identified six feral animal species as potentially occur within the area of consideration, namely:

- Cane Toad (*Bufo marinus*);
- Goat (*Capra hircus*);
- Cat (*Felis catus*);
- Rabbit (*Oryctolagus cuniculus*);
- Pig (*Sus scrofa*); and
- Red Fox (*Vulpes vulpes*).

During this survey, three feral animals were recorded within the area of consideration, namely Red Fox, Pig and Cat. Goats, Rabbits and Brown Hares (*Lepus europaeus*) were also recorded opportunistically within close proximity to the area of consideration.

5.2 Habitat Values of the Area of Consideration

The area of consideration contains a diversity of habitats including heath, woodland and riparian ecosystems fulfilling habitat requirements for a range of species. These habitats consist of, and provide, various quality (condition) habitats and resources (e.g. foraging and breeding niches) for native flora and fauna, including:

- Small, medium and large tree hollows;
- Flowering Eucalypts;
- Fallen / felled timber, including hollow-bearing logs;
- Ephemeral waterways;
- A ground layer comprising under-storey vegetation and coarse leaf litter;
- A shrub layer of varying densities;
- Mistletoe within the canopy layer; and
- Roost trees.

In addition to the floristic composition of habitat areas, and the food resources which they may provide to native fauna species (e.g. fruiting and/or flowering trees and water), habitat areas such as woodland also contain elements which fulfil a range of requirements for various native fauna species. For example, elements such as fallen woody debris/ logs, hollow bearing trees and flowering plants fulfil important foraging, sheltering and nesting requirements for amphibians, birds, reptiles and mammals.

5.2.1 Habitat Descriptions and Distribution

The survey area consists of woodland habitat only.

Woodland

The woodland habitat comprises a moderately sparse canopy, and a varying shrub layer (**Figure 5.1**). This habitat type varies in condition, with disturbances present due to clearing related to existing access tracks and previous CSG infrastructure. Additionally, pigs have resulted in disturbances. This vegetation has been historically disturbed due to harvesting of timber for forestry activities, resulting in denser areas of White Cypress in patches, as well as areas that comprise a very sparse shrub layer and limited ground cover.

Hollow bearing Eucalypts are common throughout most of the woodland, with hollow-bearing trees present at a density of approximately 22 per hectare. These hollows generally range from small to medium in size, but occasional large hollows occur. These hollows provide breeding habitat for numerous native birds, mammals and reptiles, including several threatened species, such as Eastern Pygmy Possum (*Cercartetus nanus*), Corben's Long-eared Bat (*Nyctophilus corbeni*), and Barking Owl (*Ninox connivens*) that have been recorded within 10km of the survey area. Several small and medium sized bird nests were also observed throughout the woodland vegetation. Grey-crowned Babbler nests were regularly observed.

While this community is dominated by a Eucalypt canopy, these species do not include primary Koala food trees. Eucalypt canopy species also provide foraging resources for nectar reliant bird species, such as honeyeaters, parrots, and wattlebirds. The moderate to sparse understorey provides foraging, sheltering and breeding opportunities for a variety of native birds, such as Eastern Yellow Robins (*Eopsaltria australis*), Cicadabird (*Coracina tenuirostris*), Grey Fantail (*Rhipidura albiscapa*), Fairy-

wrens (*Malurus* spp.) and Thornbills (*Acanthiza* spp.). No threatened species were recorded during the survey.

Ground cover is generally sparse, however, fallen timber and low shrubs provide additional habitat resources for small to medium sized mammals and reptiles. Fallen timber provides shelter and breeding habitat for many native reptiles and mammals.

The woodland habitat occupies approximately 5.598 ha of the survey area, while 0.159 ha is cleared (**Figure 4.1**). All of this woodland habitat would be impacted by the proposed activities.

5.3 Threatened Species

The following definitions were used to assess likelihood of occurrence:

- Known: Species recorded during the survey;
- Likely: Species previously recorded within 10 kilometres of survey area (OEH 2012) and suitable habitat for the species recorded within the area of consideration;
- Possible: Species previously recorded within 10 kilometres of survey area (OEH 2012) but no suitable habitat of the species recorded within the area of consideration. Or: species not previously recorded within 10 kilometres of survey area (OEH 2012) but suitable habitat of the species recorded within the area of consideration; and
- Unlikely: Species not previously recorded within 10 kilometres of survey area (OEH 2012) and no suitable habitat of the species recorded within the area of consideration.

5.3.1 EPBC Act

Fifteen threatened fauna species listed under the EPBC Act were identified as potentially occurring in the area of consideration (10km buffer) during the desktop assessment. An assessment of likelihood of occurrence was completed for each species, based on habitat preference and known species distribution, and is included in **Appendix 4**.

The assessment identified that the area of consideration provides suitable habitat for the following fauna species:

- Koala (*Phascolarctos cinereus*) - Vulnerable;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – Vulnerable;
- Malleefowl (*Leipoa ocellata*) – Vulnerable;
- Regent Honeyeater (*Anthochaera phrygia*) - Endangered;
- South-eastern Long-eared Bat (*Nyctophilus corbeni*) - Vulnerable;
- Superb Parrot (*Polytelis swainsonii*) - Vulnerable; and
- Swift Parrot (*Lathamus discolor*) – Vulnerable.

None of these species were recorded during the survey. Potential for impact on the above species is discussed in **Section 7.2.6**, **Section 7.3** and **Appendix 7 & 8**.

5.3.2 TSC Act

Twenty-nine threatened species were identified as potentially occurring within the area of consideration as part of the desktop assessment. An assessment of likelihood of occurrence was completed for each species based on habitat preference and known species distribution, and is included in **Appendix 4**.

Four species listed as Vulnerable under the TSC Act were recorded in the area of consideration, namely the Grey-crowned Babbler (*Pomatostomus temporalis*), Speckled Warbler (*Pyrrholaemus sagittatus*), Yellow-bellied Shearwater (*Saccolaimus flaviventris*), and Little Pied Bat (*Chalinolobus picatus*). The Bristle-faced Freetail Bat (*Mormopterus eleryi*), listed as Endangered, was also potentially recorded but could not be confirmed. Potential for impact on the above species is discussed in **Section 7.3** and **Appendix 8**.

Although not recorded during the survey, the following species are considered to possibly occur in the survey area based on available habitat and known distribution:

- Barking Owl (*Ninox connivens*) - Vulnerable;
- Brown Treecreeper (*Climacteris picumnus victoriae*) - Vulnerable;
- Diamond Firetail (*Stagonopleura guttata*) - Vulnerable;
- Eastern Cave Bat (*Vespadelus troughtoni*) - Vulnerable
- Eastern Pygmy-possum (*Cercartetus nanus*); - Vulnerable;
- Glossy Black Cockatoo (*Calyptorhynchus lathamii*) - Vulnerable;
- Hooded Robin (*Melanodryas cucullata*) – Vulnerable;
- Koala (*Phascolarctos cinereus*) – Vulnerable;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – Vulnerable;
- Little Lorikeet (*Glossopsitta pusilla*) - Vulnerable;
- Malleefowl (*Leipoa ocellata*) - Endangered;
- Masked Owl (*Tyto novaehollandiae*) - Vulnerable;
- Regent Honeyeater (*Anthochaera phrygia*) – Critically Endangered;
- South-eastern Long-eared Bat (*Nyctophilus corbeni*) - Vulnerable;
- Square-tailed Kite (*Lophoictinia isura*) – Vulnerable;
- Superb Parrot (*Polytelis swainsonii*) - Vulnerable;
- Swift Parrot (*Lathamus discolor*) - Endangered;
- Turquoise Parrot (*Neophema pulchella*) – Vulnerable; and
- Varied Sittella (*Daphoenositta chrysoptera*) – Vulnerable.

5.4 SEPP 44 – Koala Habitat Protection

Under SEPP 44, potential Koala habitat is defined as ‘areas of native vegetation where 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.’ No feed tree species listed in Schedule 2 occur within the area of consideration. This area is therefore not considered to be potential Koala habitat.

Core habitat is defined as ‘an area of land with a resident population of Koalas, evidenced by attributes such as breeding females and recent sightings of and historical records of a population’. No

evidence of Koalas was observed in the area of consideration. As such, it is unlikely that this area comprises core koala habitat.

While the area of consideration is not considered to be Koala habitat under SEPP 44, it does include low densities of one secondary food tree species, namely Dirty Gum. While no evidence of Koalas was observed in this area, Koalas have been recorded within 10km of the survey area. It is therefore considered likely that Koalas occasionally utilise the survey area.

5.5 Migratory Species

The EPBC Protected Matters Search Tool identified 12 migratory species as potentially occurring in the area of consideration (**Appendix 6**). An assessment of likelihood of occurrence was completed for each species, based on habitat preference and known species distribution, and is included in **Appendix 6**. The assessment confirmed that four species may potentially occur on site, including:

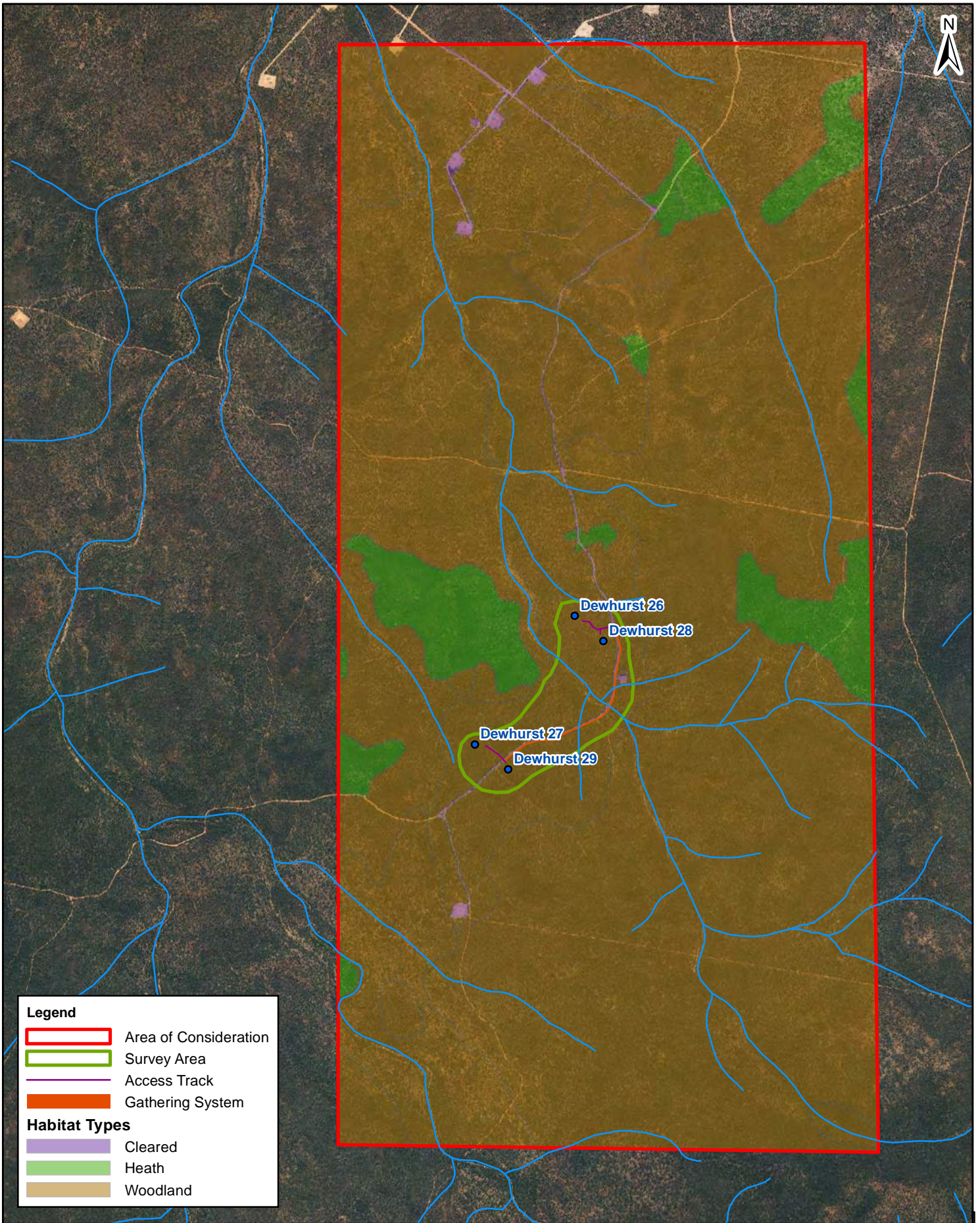
- White-throated Needletail (*Hirundapus caudacutus*);
- Swift Parrot (*Lathamus discolor*) - Endangered;
- Rainbow Bee-eater (*Merops ornatus*); and
- Regent Honeyeater (*Anthochaera phrygia*).

One of these migratory species was recorded within the area of consideration during surveys, namely, the White-throated Needletail (*Hirundapus caudacutus*). No other migratory species were observed during this survey. Potential for impact on the above species is discussed in **Section 7.1.7** and **Appendix 6**.

5.6 Regional Context

The area of consideration occurs within the Pilliga East State Forest, which forms part of the largest contiguous patch of remnant vegetation in NSW, much of which forms state forests and conservation area. The Pilliga Scrub supports a diverse array of habitats, and includes numerous ephemeral waterways. The contiguous nature of the remnant vegetation provides easy movement and dispersal opportunities throughout the Pilliga Forest. Outside of the forested area, barriers to movement include the Newell Highway, and large tracts of agricultural land.

At a local scale, the area of consideration is somewhat fragmented by access tracks, with some disturbances associated with forestry and existing CSG activities. While these are not considered to be serious barriers for movement of most fauna species, smaller mammals may be impacted by local fragmentation.



Legend

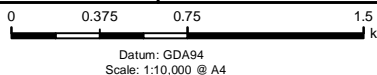
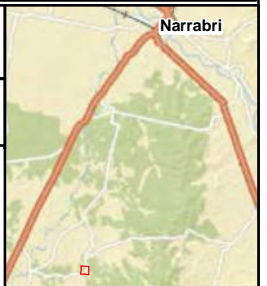
- Area of Consideration
- Survey Area
- Access Track
- Gathering System

Habitat Types

- Cleared
- Heath
- Woodland

Client: Santos	
Compiled by: CO	Date: 03/01/2013
Approved by: HR	Date: 03/01/2013

Habitat Types
Figure 5.1
Project: Dewhurst 26-29 Pilot Wells



Source: Imagery from Bing Maps 2012
 Infrastructure from Santos 2012
 Watercourses from OEH 2012



6.0 Waterways

6.1 Namoi Catchment

The area of consideration 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, Coxs 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.

6.2 Bohena Sub-catchment

The area of consideration 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 major water system of the Bohena sub-catchment is Bohena Creek. Bohena Creek is considered a 5th order stream and is largely ephemeral, draining predominantly during rainfall events.

6.3 Watercourses

Three watercourses are mapped as intersecting the central gathering system, including Mount Pleasant Creek, and two unnamed watercourses (**Figure 6.1**).

The intersected watercourses flow north-west to Cowallah Creek. Cowallah Creek is located approximately 1.6 km east of Dewhurst 27. Cowallah Creek is a tributary of Bohena Creek, which is located approximately 8.1 km north-west of the closest lease area (Dewhurst 26).

The majority of watercourses in the Bohena sub-catchment are ephemeral. This is certainly the case for watercourses intersected by the gathering system. Narrabri has recorded above average rainfall for 2012 (BOM 2012), yet water flow and semi-permanent standing pools were not evident at either watercourse during ground-truthing efforts. This indicates that these watercourses are highly ephemeral and would only flow during times of heavy rainfall.

6.4 Permanent and Semi Permanent Wetlands

The OEH (2006) wetland mapping identified no wetlands within the survey area or surrounds (10 km radius).

There are 3 modified reservoirs located east of the survey area. The nearest is located 31 km east of the survey area, while the furthest is 41 km east. These reservoirs vary in size (6 ha to 23 ha) and appear to be dams, as cropping is evident within the immediate vicinity.

The nearest mapped natural wetland is Yarrie Lake, which is located 39 km north of the site, followed by the Namoi River floodplain, which is located approximately 58 km north-west of the survey area of consideration.

6.5 Aquatic Vegetation

No permanent aquatic vegetation was noted along intersected watercourses during the ground-truthing efforts.

6.6 Riparian Community

No riparian vegetation was identified within the survey area during the ground-truthing efforts. Further, no riparian vegetation is mapped within the Namoi CMA vegetation mapping (**Figure 4.2**).

6.7 Stream Order Index

NSW uses the Strahler stream classification system (Strahler 1957) where waterways are given an 'order' according to the number of additional tributaries associated with each waterway. This system provides a measure of system complexity and therefore the potential for fish habitat to be present. Third order streams and above are likely to display valuable fish habitat, and hence could support viable fish populations.

Stream Order was determined for intersected watercourses identified in **Section 6.3** via the use of drainage lines captured from orthophotos at 1:50,000 scale (**Figure 6.1**).

According to the Strahler (1957) classification system, the stream order classifications for the major creek systems identified in **Section 6.3** are as follows:

- Stream order 3 – Mount Pleasant Creek; and
- Stream order 1 – Unnamed watercourses.

According to the Strahler (1957) classification systems, Mount Pleasant Creek may harbour valuable fish habitat, though it is unlikely that this watercourse supports continuous fish populations due to the highly ephemeral nature of this system and as such is more likely to support common fish species during migration and breeding. The unnamed watercourses are unlikely to harbour valuable fish habitat (stream order 1).

6.8 Waterway Classification

Although some exceptions apply, stream order can also correspond with the waterway classification system. Class 4 waterways generally being 1st and 2nd order streams (and some 3rd order streams), while Class 3 will generally be 3rd order streams. Class 1 and 2 will be 3rd order or above streams.

Applying the general correlation between stream order and waterway classification then the major creek systems identified in **Section 6.3** are classified as:

- Class 3 (minimal fish habitat) – Mount Pleasant Creek; and
- Class 4 (unlikely fish habitat) - Unnamed watercourses.

6.9 Key Fish Habitat Areas

Mount Pleasant Creek has been mapped as key fish habitat by the OEH (2007) Key Fish Habitat mapping, while the unnamed creeks have not been mapped as such.

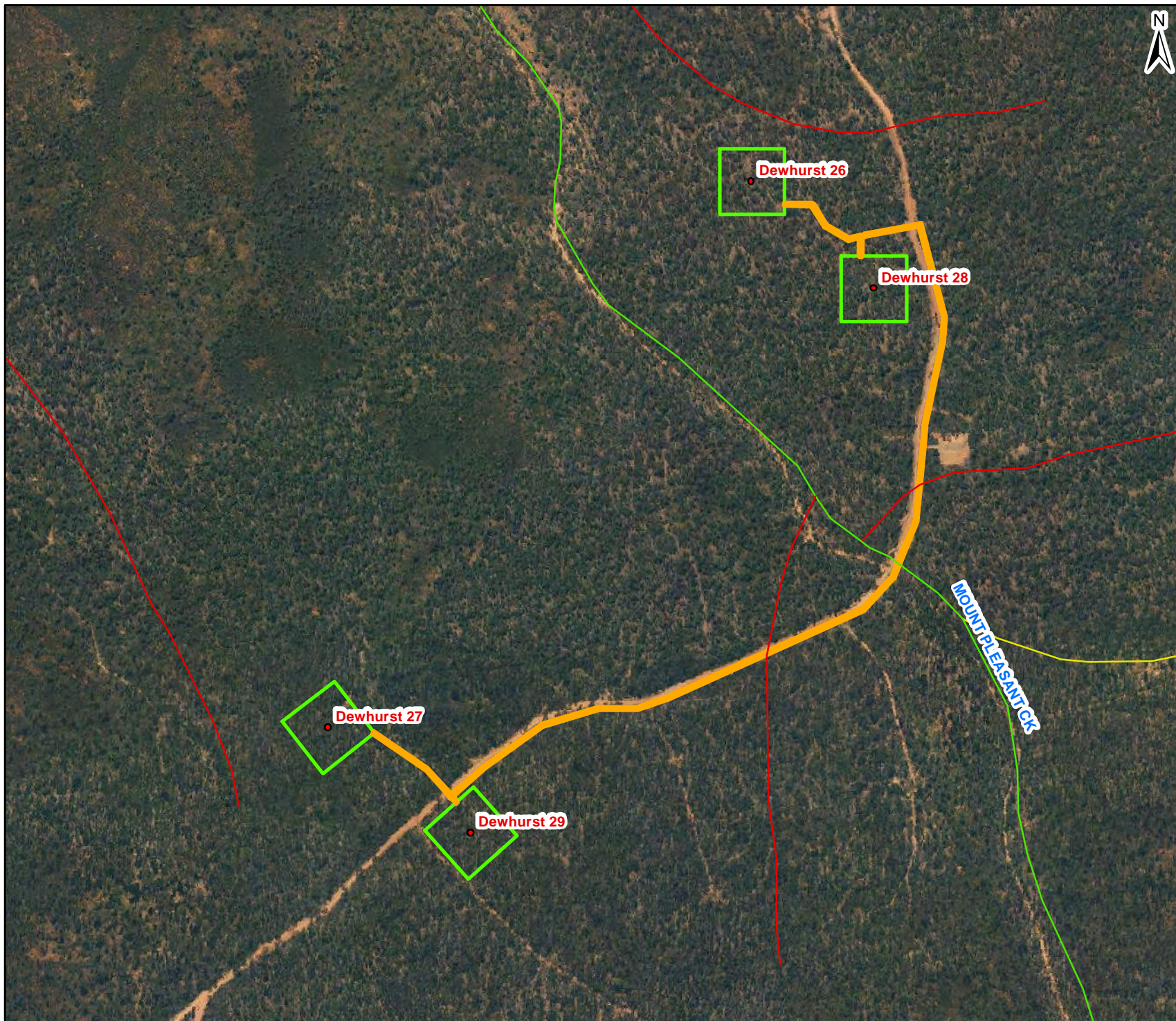
Although Mount Pleasant Creek has been mapped as key fish habitat, it is unlikely to support the endangered Murray Cod (*Maccullochella peelii*), as this species prefers slow flowing deep watercourses. The ephemeral nature of this creek would likely support common fish species during migration and breeding and potentially provide feeding areas for some aquatic fauna (e.g. fish, yabbies).

6.10 Other Habitat Features

While these waterways are small, they are an important component of ecological function, providing breeding and habitat resources for species such as frogs and reptiles. They also may provide for fauna movement throughout the broader landscape.

Table 6.1: Classification of fish habitat in NSW (source: Fairfull and Witheridge 2003).

Classification	Characteristics of Waterway Type
CLASS 1 Major fish habitat	Major permanently or intermittently flowing waterway (e.g. river or major creek); habitat of a threatened fish species or 'critical habitat'.
CLASS 2 Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish species habitat and/or fish observed inhabiting the area.
CLASS 3 Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools from within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
CLASS 4 Unlikely fish habitat	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).



Stream Order Index

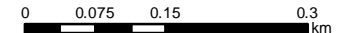
Figure 6.1

Project:		Dewhurst 26 - 29
Client:		Santos
Compiled by:	JC	Date: 26/02/2013
Approved by:	BD	Date: 26/02/2013

Legend

- Pilot Wells
- Strahler Stream Order**
- 1
- 2
- 3
- 4
- 5
- 6
- Access Tracks & Gathering Systems
- Lease Pads

Source: Imagery from Bing Maps 2012
 Infrastructure from Santos 2013
 other data from OEH 2012



Datum: GDA94
 Scale 1:8,000 @ A4



7.0 Ecological Impact Assessment

7.1 Discussion of Impacts

The majority of potential impacts are associated with vegetation removal, as well as increased noise, dust, and light. Additionally, there is the potential for weed incursion due to machinery.

The assessment identified the following impacts occurring as a result of Dewhurst 26 to 29, and associated infrastructure:

- Vegetation clearing;
- Disturbance to vegetation communities and habitats, including edge effects to vegetation to be retained;
- Hollow bearing tree removal;
- Relocation of hollow logs;
- Disturbance or removal of fallen woody debris;
- Fauna displacement;
- Disruption of breeding cycle, roosting and sheltering behaviour;
- Impacts on migration and dispersal ability;
- Disruption of pollination cycle and seed dispersion;
- Introduction of weeds and feral pest species; and
- Noise, dust, and light.

Each of the above listed potential impacts are discussed in greater detail within the following relevant sections.

7.1.1 Vegetation Clearing and / or Disturbance to Habitats and Habitat Features

Construction activities will require the removal of approximately 5.598 ha of vegetation. This will include the clearing of trees with small hollows, removal of old stockpiles of felled vegetation, and disturbances to understorey vegetation and ground cover such as leaf litter and fallen bark.

It is expected that hollow bearing trees may be removed as a result of the proposed activities. These trees provide viable nesting, roosting and/or breeding resources for native birds, arboreal mammals and some reptile species. Of note, hollow-bearing trees provide breeding habitat for a range of threatened species that are known, or potentially occur in the survey area, including Little Lorikeet, Masked Owl and South-eastern Long-eared Bat.

In consideration of the remainder of the area of consideration providing an abundance of hollow bearing trees that also contain viable nesting, roosting and/or breeding resources, the potential removal of hollow bearing trees is not considered to be significant as it is considered unlikely that hollow dependant fauna will be adversely impacted by the proposed activities and should be able to relocate successfully into hollow bearing resources that are present throughout the adjacent habitats. Mitigation measures to help ameliorate these impacts are prescribed in **Section 8**.

It is expected that a relatively small volume of hollow log and fallen woody debris habitats that are currently present in the survey area will be disrupted and relocated as a result of the proposed activities. This is likely to temporarily disrupt the nesting, breeding and/or sheltering behaviour of some reptiles and ground dwelling mammals. However, this disruption is likely to be minimal in extent and is unlikely to be significant, as these habitat resources will be relocated into adjacent habitats within the area of consideration and retained over the long-term, and as a result will not be permanently lost from the area. Mitigation measures to help ameliorate these impacts are prescribed in **Section 8**.

7.1.2 Fauna Displacement and Disruption

The proposed activities are likely to result in the clearing of 5.598 ha of viable habitat from the survey area. This habitat provides foraging, breeding, roosting and sheltering resources that may currently be utilised by all the faunal groups identified in the area of consideration. This will result in the displacement of native fauna across the survey area. Displaced fauna will need to relocate into adjacent habitats, which will place short-term pressure on the available habitat resources within these habitats.

The degree of displacement within the survey area and the intensity of pressure placed on adjacent habitats are minimal based on the percentage of habitats to be lost in comparison to what will be retained in the survey area.

The breeding cycle, roosting, sheltering and foraging behaviour for some species is likely to be impacted by the proposed activities. This impact is most likely to occur where the proposed activities will result in the removal of hollow bearing trees and where hollow logs and fallen woody debris are to be removed from the impact areas and relocated into other parts of the area of consideration.

The impact on the migration and dispersal ability of native flora and fauna, like most of the other impacts, is species specific. Species, which are less mobile (e.g. reptiles and amphibians), residents (e.g. some birds) or species whereby the habitat to be removed forms an important component of the overall habitat area, are those that would be most likely impacted.

The proposed activities are unlikely to fragment or isolate areas of vegetation or impose a significant barrier to the migration and dispersal ability of native biota. Species such as microbats, medium to large mammals and woodland birds are unlikely to be significantly impacted by the proposed activities, given the mobile nature of these species, and the habitat available in the surrounding areas.

While smaller fauna species are generally less mobile, it is considered unlikely that they will be significantly impacted given the minimal clearing required. The extent of habitats to be cleared is 5.755 ha, which is considered small in comparison to the area of habitats to be retained across the area of consideration.

7.1.3 Disruption of Pollination Cycle and Seed Dispersion

Excessive dust from the proposed activities could potentially disrupt the pollination cycle and ability of native plants to regenerate (i.e. germination, revegetation and re-colonisation of existing plants). Mitigation measures to help ameliorate these impacts are prescribed in **Section 8**.

7.1.4 Introduction of Weeds and Feral Pest Species

The proposed activities have the potential to create favourable conditions for introduced weed species within the survey area, which could potentially lead to an increase of existing weed populations and introduction of additional weed species. This is most likely to occur where soil disturbance is to occur, including along access roads, and where earthworks are required. Weed cover in the area of consideration is very low, with only one noxious weed (Prickly Pear) observed in very low densities. While spread of weeds off-site is considered unlikely, there is the risk of introducing weeds to the site from machinery and vehicles. Mitigation measures to help ameliorate these impacts are prescribed in **Section 8**.

7.1.5 Noise and Light

Noise and light pollution as a result of vehicles, machinery and drilling may deter native fauna from utilising the survey area and immediate surrounding areas as habitat. The proposed activities could affect the migration and dispersal ability of native fauna particularly in relation to vehicular movements. The proposed activities may result in increased noise and light pollution which has the potential to disrupt the breeding cycle and the foraging and roosting behaviour of some native fauna species.

7.1.6 Disturbance to Waterways

Construction activities have the potential to impact upon ephemeral creeks that are intersected, including Mount Pleasant Creek. Impacts that may arise include surface water contamination due to run-off from construction sites, as well as erosion and sedimentation.

A range of mitigation measures to reduce potential impacts are outlined in **Section 8**.

7.2 Impact Assessment under the EPBC Act

7.2.1 World Heritage Areas

The proposed activities are not in a World Heritage area, and are not in close proximity to any such area.

7.2.2 National Heritage Places

The proposed activities are not in a National Heritage Place, and are not in close proximity to any such area.

7.2.3 Wetlands Protected by International Importance

The proposed activities are not upstream or in an area where there is any form of Ramsar Wetlands.

7.2.4 Great Barrier Reef Marine Park and Commonwealth Marine Areas

The proposed activities are not within the Great Barrier Reef Marine Park or Commonwealth Marine Area.

7.2.5 Listed Threatened Ecological Communities

As outlined in **Section 4**, seven TEC were identified as potentially occurring in the area of consideration throughout the desktop assessment. The field assessment determined that no TEC occur within the area of consideration.

7.2.6 Listed Threatened Species

While no listed flora species were recorded in the area of consideration, four species have the potential to occur based on habitat available. An assessment of significance was not considered necessary, as targeted searches for these flora species did not record these species within the area of consideration, and an initial assessment of potential for impact determined that significant impacts are considered unlikely (**Appendix 4**).

While no threatened fauna species or populations were recorded on site, it is considered that three species are likely to occur. An assessment of significance for each of these species has been undertaken in accordance with the EPBC Act and *EPBC Act Policy Statement 1.1 - Significant Impact Guidelines Matters of National Environmental Significance* (DEWHA, 2009) and is included in **Appendix 7**. The assessments concluded that no significant impact is anticipated for fauna species.

Table 7.1 provides a summary of the significant impact assessments.

Table 7.1: Summary of EPBC Act Impact Assessment for Threatened Fauna Species

Species	Common Name	EPBC Act Status	Potential Impact	Assessment of Significance of Potential Impacts
<i>Anthochaera phrygia</i>	Regent Honeyeater	E	<ul style="list-style-type: none"> ▪ Loss of woodland habitat and flowering Eucalypts ▪ Disturbances due to noise and light 	Significant impact unlikely
<i>Phascolarctos cinereus</i>	Koala	V	<ul style="list-style-type: none"> ▪ Loss of potential resting habitat ▪ Vehicle strike ▪ Disturbances due to noise and light 	Significant impact unlikely
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat, Corben's Long-eared Bat	V	<ul style="list-style-type: none"> ▪ Loss of woodland habitat and hollow-bearing trees ▪ Disturbances due to noise and light 	Significant impact unlikely

7.2.7 Listed Migratory Species

Two migratory species are considered likely to utilise the study area, namely the Rainbow Bee-eater, and White-throated Needletail.

An assessment of significance was not considered necessary for the Rainbow Bee-eater or White-throated Needletail, as an initial assessment of potential for impact determined that significant impacts are considered unlikely (**Appendix 4**).

7.3 Impact Assessment under the TSC Act

Section 5A of the EP&A Act lists seven factors that must be taken into account in the determination of the significance of potential impacts of proposed activities on 'threatened species, populations or ecological communities (or their habitats)' listed under the TSC Act. The Assessment of Significance (7-part test) is used to determine whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats and thus whether a Species Impact Statement (SIS) is required.

On this basis an assessment of significance was completed for the threatened species populations and ecological communities that are known to occur, or considered likely to occur within the study area. A total of 18 assessments of significance (7-part tests) were undertaken (**Appendix 8**).

The application of the 7-part test concluded that there is not likely to be a significant effect on threatened species, populations, or their habitats arising from the proposed activities. **Table 7.2** provides a summary of assessment of significance of potential impacts.

Table 7.2: Summary of Assessment of Significance for TSC Act listed species

Species	Common Name	TSC Act Status	Potential Impact	Assessment of Significance of Potential Impacts
Fauna Species Recorded in the Area of Consideration				
<i>Chalinolobus picatus</i>	Little Pied Bat	V	<ul style="list-style-type: none"> Loss of woodland habitat Loss of roosting sites 	Significant impact unlikely
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	<ul style="list-style-type: none"> Loss of woodland habitat Disturbance to movement patterns as they are unable to cross open areas Disturbance or removal of nests 	Significant impact unlikely
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	<ul style="list-style-type: none"> Loss of woodland habitat Loss of roosting sites 	Significant impact unlikely
<i>Chthonicola sagittata</i>	Speckled Warbler	V	<ul style="list-style-type: none"> Loss of habitat, particularly understorey vegetation Disturbances to nests, often located on the ground Potential for increased predation of nest sites 	Significant impact unlikely
<i>Mormopterus eleryi</i> [†]	Bristle-faced Freetail Bat	E	<ul style="list-style-type: none"> Loss of woodland habitat Loss of roosting sites 	Significant impact unlikely
Fauna Species Considered Likely to Occur				
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	<ul style="list-style-type: none"> Loss of woodland habitat and flowering Eucalypts Disturbances due to noise and light 	Significant impact unlikely
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	<ul style="list-style-type: none"> Loss of woodland habitat Loss of potential food trees Loss of hollow bearing trees Disturbances due to noise and light 	Significant impact unlikely
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V	<ul style="list-style-type: none"> Loss of habitat Modification to ground habitat 	Significant impact unlikely

Species	Common Name	TSC Act Status	Potential Impact	Assessment of Significance of Potential Impacts
<i>Neophema pulchella</i>	Turquoise Parrot	V	<ul style="list-style-type: none"> ▪ Loss of habitat, particularly hollow bearing trees and ground covers ▪ Potential for increased predation 	Significant impact unlikely
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	<ul style="list-style-type: none"> ▪ Loss of habitat ▪ Loss of hollow-bearing trees ▪ Disturbances due to noise and light 	Significant impact unlikely
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	<ul style="list-style-type: none"> ▪ Loss of woodland habitat ▪ Disturbances to fallen timber used for foraging ▪ Loss of hollow-bearing trees required for nesting 	Significant impact unlikely
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	<ul style="list-style-type: none"> ▪ Loss of habitat ▪ Disturbances to nests 	Significant impact unlikely
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	<ul style="list-style-type: none"> ▪ Loss of habitat ▪ Loss of hollow-bearing trees ▪ Loss of flowering Eucalypts 	Significant impact unlikely
<i>Lophoictinia isura</i>	Square-tailed Kite	V	<ul style="list-style-type: none"> ▪ Loss of habitat 	Significant impact unlikely
<i>Ninox connivens</i>	Barking Owl	V	<ul style="list-style-type: none"> ▪ Loss of habitat ▪ Loss of nesting sites (hollow-bearing trees) 	Significant impact unlikely
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat, Corben's Long-eared Bat	V	<ul style="list-style-type: none"> ▪ Loss of woodland habitat and hollow-bearing trees ▪ Disturbances due to noise and light 	Significant impact unlikely
<i>Phascolarctos cinereus</i>	Koala	E	<ul style="list-style-type: none"> ▪ Loss of secondary food trees ▪ Vehicle strike ▪ Disturbances due to noise and light 	Significant impact unlikely
<i>Stagonopleura guttata</i>	Diamond Firetail	V	<ul style="list-style-type: none"> ▪ Loss of habitat 	Significant impact unlikely
<i>Tyto novaehollandiae</i>	Masked Owl	E	<ul style="list-style-type: none"> ▪ Loss of habitat ▪ Loss of nesting sites (hollow-bearing trees) ▪ Vehicle strikes 	Significant impact unlikely

¹ Although the Bristle-faced Freetail Bat has been assessed as if it was recorded within the area of consideration, its presence was not confirmed.

7.4 Key Threatening Processes Relevant to Proposed Activities

The EPBC Act and TSC Act provide for the identification and listing of key threatening processes (KTP). KTP are defined as a threatening process 'if it threatens or may threaten the survival, abundance, or evolutionary development of a native species or ecological community' (SEWPaC, 2012).

KTP under the EPBC Act and TSC Act that are relevant to the proposed activities are discussed in **Table 7.4**.

Table 7.3: Key Threatening Process Summary

Key Threatening Process	Relevance to Proposed Activities
EPBC Act / TSC Act	
Competition and land degradation by feral European Rabbits	Rabbits were not observed in the area of consideration, but are considered likely to occur. However, it is not anticipated that the proposed activities will increase opportunities for increase to the Rabbit population.
Competition and land degradation by unmanaged goats	Goats were not observed in the area of consideration, but are known to occur in the Pilliga Forest. It is not anticipated that the proposed activities will increase opportunities for increase to the Goat population. Mitigation measures may be required at the completion of the project to ensure rehabilitation activities are not disturbed by unmanaged goats
Dieback caused by the root-rot fungus (<i>Phytophthora cinnamomi</i>)	There exists the potential for the importation of this pathogen on unclean vehicles and plant machinery.
Land clearance / removal of native vegetation	Vegetation clearing will be required. Approximately 5.598 ha of vegetation will be removed to facilitate the construction of four wells and associated infrastructure.
Predation by European Red Fox	Red Fox was observed in the area of consideration. It is considered unlikely that the proposed activities will result in increased predation by European Red Fox, given the relatively limited amount of clearing proposed, in comparison to habitat available in the surrounding areas.
Predation by feral cats	Feral Cats were observed in the area of consideration. If waste is not managed on site, there is the potential to attract Feral Cats to the area.
Predation, habitat degradation, competition and disease transmission by feral Pigs	Evidence of feral pigs was observed in the area of consideration. It is considered unlikely that the proposed activities will result in increased predation, habitat degradation, competition or disease transmission.
TSC Act	
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	The proposed activity will not result in high frequency fires. Fire prevention strategies will be outlined in the REF.
Removal of dead wood and dead trees	Some dead wood in the form of hollow logs and fallen woody debris will be disturbed by the proposed activities, but these habitat resources will be relocated elsewhere in the area of consideration.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	No works are proposed to occur within any streams or wetlands. It is therefore considered that the proposed works will not alter the natural regimes of any rivers, streams and their floodplains and wetlands.
Predation and hybridisation by feral dogs, (<i>Canis lupus familiaris</i>)	Feral dogs were not observed in the area of consideration, but are considered likely to occur. It is considered unlikely that the proposed activities will result in increased predation from feral dogs.
Loss of hollow-bearing trees	Hollow-bearing trees will be removed to facilitate construction (Figure 5.1). Where hollow-bearing trees occur adjacent to leases, they will be retained. The hollow bearing trees to be removed will be placed into adjacent habitats as hollow logs and woody debris.
Invasion of native plant communities by exotic perennial grasses	There exists the potential for the invasion of native woodland and grassland communities by exotic perennial grass species, transferred via vehicles and site machinery.

8.0 Impact Mitigation and Management

8.1 Introduction

In order to minimise potential ecological impacts resulting from the proposed activity, the location and design of the proposed pilot well lease areas and associated infrastructure, and identification of appropriate mitigation measures has been undertaken in accordance with the 'avoid – minimise – mitigate – offset' hierarchy:

- **Avoiding** the impact altogether by relocating the proposed activity, or parts of an activity;
- **Minimising** impacts by restricting the magnitude of the proposed activity and its implementation;
- **Mitigating** the impact of the activity by appropriately managing the proposed activity, and rehabilitating, or restoring the affected environment; and
- **Offsetting** the impacts.

Avoid

Clearing of habitat trees will be avoided where possible. Where hollow-bearing trees occur along lease boundaries, lease areas will be reduced to minimise the removal of these trees.

Existing access tracks have been utilised for connection between well leases where possible. New access tracks have been located to avoid the removal of hollow-bearing trees, and distances minimised where possible.

The well leases and infrastructure have been located within Narrow-leaved Ironbark woodland to avoid core habitat for the Pilliga Mouse. Additionally, the location of the leases has avoided disturbances to waterways in the area of consideration, however 3 ephemeral waterways will be intersected by the associated gathering system.

Minimise

The disturbance area will be minimised to reduce unnecessary clearing and earthworks by ensuring leases are kept to the minimum size of 1ha, and corridor to a width of 10m. Additionally, the disturbance areas will be appropriately demarcated to ensure machinery and personnel are limited to the designated disturbance area. Vehicle speeds along the access tracks and existing roads will be limited to minimise dust generation.

The gathering system has been placed adjacent to existing roads and proposed access tracks to minimise the disturbance width required.

To minimise impacts on nearby waterways, all liquids (fuel, oil, cleaning agents, drilling liquids etc) will be stored appropriately and disposed of at suitably licensed facilities.

Mitigate

A range of mitigation measures will be implemented to minimise impacts upon flora and fauna in the area of consideration.

Introduction and proliferation of weeds may be encouraged due to disturbance of soil, or transport of seeds via dirty vehicles and machinery. Weed management measures will be implemented, including the need for washdowns when travelling from areas of known weed infestations to the site. Monitoring will occur to ensure any weed growth is controlled via mechanical or chemical methods, and will be undertaken within and adjacent to disturbance areas.

Clearing of vegetation cannot be avoided, and may result in disturbances to fauna species. As such, a Flora and Fauna Management Plan is recommended to ensure appropriate mitigation measures are implemented.

When disturbances to vegetation occur, a fauna spotter-catcher must be present to oversee works. The fauna spotter-catcher is responsible for removing fauna from habitat prior to clearing, and inspecting fallen timber following clearing.

Hollow logs are to be removed from the disturbance areas and relocated in habitats adjacent to the lease areas under supervision from the fauna spotter-catcher. Fauna sensitive clearing techniques will be implemented, including vibrating the bucket on large trees (particularly hollow-bearing trees) prior to clearing, and dismantling large trees is recommended.

Should injury to fauna occur, the fauna spotter-catcher must immediately transport injured fauna to a vet. Works cannot commence until the fauna spotter-catcher returns to site. Should injury occur whilst the fauna spotter-catcher isn't present (e.g. – vehicle strike), fauna must be transported to the vet by contractors.

In addition to sensitive clearing techniques, fencing must be installed around lease areas prior to vegetation clearing commencing to clearly demarcate work areas and prevent over-clearing. Access tracks must also be clearly pegged or flagged to ensure vegetation clearing is minimised. Where hollow bearing trees occur on the edge of lease areas, they are to be protected where possible, and clearly marked.

Access to the sites is to be limited to only the designated access tracks to prevent additional disturbances to vegetation. All equipment and machinery is to be stored within the lease areas, and not outside of the fenced areas. Parking is not to occur within adjacent areas.

Dogs are not permitted on site to prevent further risk to native fauna.

Following construction of the lease areas, and operation of the pilot wells, partial rehabilitation will commence, incorporating the reduction of the lease area footprint. A Rehabilitation Management Plan will be implemented. Topsoil is to be stockpiled within the lease area, and is to be respread as part of partial rehabilitation. Where large trees are cleared, timber is to be stockpiled within the lease area for re-spreading as part of partial rehabilitation. Natural regeneration is the preferred approach, with assisted regeneration occurring if natural regeneration is unsuccessful.

Offset

Due to the proposed activities being minimal in extent, as well as the recommended mitigation measures to rehabilitate the activity site being implemented, offsets are not required.

9.0 Conclusion

Santos is proposing to drill and operate four petroleum exploration pilot wells, known as Dewhurst 26 to Dewhurst 29. The area of consideration occurs within the Pilliga East State Forest which forms part of a large tract of bushland referred to as the Pilliga Scrub. This area is well vegetated and mostly occurs on undulating low rises.

The proposal will require the construction of four 100m by 100m lease areas, resulting in 1ha of disturbance at each pilot well location. Additional infrastructure required for the activity includes 6m wide access tracks and a collection system requiring 10m in width.

RPS have undertaken an ecological assessment of the proposed lease areas, access tracks, and gathering system identify potential ecological impacts and recommend appropriate mitigation measures to reduce and manage ecological impacts. A detailed assessment was carried out on the 12th and 16th November 2012, which included flora and fauna surveys. The assessment aimed to identify ecological constraints and assess habitat for potentially occurring significant species as listed under the EPBC Act and TSC Act.

One vegetation community occurs in the disturbance area, namely Narrow-leaved Shrubby Ironbark Woodland. This community is not commensurate with any of the seven TECs or nine EECs that were identified during the desktop assessment.

Although suitable habitat was identified for four EPBC Act and five TSC Act listed flora species, no threatened flora species were recorded in the area of consideration during flora surveys. Two threatened flora species (Native Milkwort and *Rulingia procumbens*) were considered to possibly occur, despite not being recorded, owing to the fact that they have been previously identified within 10km of the disturbance area.

Fauna habitat in the area of consideration is characterised by woodland that provides distinctly unique resources and niches for native fauna. Habitat varies in condition from good to moderate, with disturbances resulting from clearing due to access tracks and CSG infrastructure, as well as logging for forestry.

The woodland habitat generally consists of moderately sparse canopy, with an understorey that ranges from moderately dense heath to areas that are extremely sparse. Hollow bearing Eucalypts are common throughout most of the woodland vegetation and generally range from small to medium in size, but occasional large hollows also occur. Ground cover is generally sparse, however, fallen timber and low shrubs provide additional habitat resources for terrestrial species. Portions of the woodland habitat are associated with ephemeral waterways.

Fauna surveys identified 45 bird species, 19 mammal species, three amphibian and 12 reptile species within the area of consideration. Of these, four TSC Act species were recorded, namely Grey-crowned Babbler, Speckled Warbler, Little Pied Bat and Yellow-bellied Sheath-tail Bat. An Endangered microbat species may also have been recorded, namely Bristle-faced Freetail Bat, but was not positively identified. No species listed under the EPBC Act were recorded in the area of consideration.

In addition to the threatened fauna species recorded in the area of consideration, a further 19 threatened fauna species are considered likely or possible to occur, based on habitat available in the area of consideration, and proximity of previous records. Two migratory species are also expected to occur, the Rainbow Bee-eater and White-throated Needletail; the latter of which was observed within the area of consideration during the survey.

Three watercourses will be intersected by the proposed gathering system, including Mount Pleasant Creek, which has been mapped as key fish habitat by the OEH (2007). Although this creek has been identified as such, it is unlikely to support the endangered Murray cod (*Maccullochella peelii*), as this species prefers slow flowing deep watercourses. The ephemeral nature of this creek would likely support common fish species during migration and breeding and potentially provide feeding areas for some aquatic fauna (e.g. fish, yabbies). The other watercourses intersected are unlikely to provide valuable fish habitat.

Impacts from Dewhurst 26 to 29 have been minimised by locating the infrastructure adjacent to an existing road, where some disturbances such as existing access tracks are present. Given the potential for Pilliga Mouse to occur within the region, the wells have been located within sub-optimal habitat, avoiding disturbances to core heath habitat.

The majority of potential impacts from the project are associated with vegetation removal, as well as increased noise, dust, and light. Additionally, there is the potential for weed incursion due to introduction from vehicles and machinery. In particular the following ecological impacts are likely to occur as a result of Dewhurst 26-29 and associated infrastructure:

- Loss of Narrow-leaved Ironbark Woodland;
- Loss of hollow bearing trees;
- Disturbance and/or loss of habitat associated with fallen woody debris and particularly hollow logs;
- Fauna displacement;
- Disruption of breeding cycle, roosting and sheltering behaviour;
- Impacts on migration and dispersal ability;
- Disruption of pollination cycle and seed dispersion;
- Introduction of weeds and feral pest species; and
- Increased noise, dust and light, particularly during construction and drilling.

To minimise the impacts on the ecological values of the area of consideration, a number of key mitigation measures are proposed and recommended:

- Where possible retain hollow bearing trees occur on the edge of lease areas and access tracks;
- Weed management including washdowns of all vehicles and machinery;
- Fauna spotter-catchers engaged to oversee vegetation clearing;
- Hollow logs are relocated in adjacent vegetation to the lease areas;
- Installation of fencing around lease areas prior to vegetation clearing commencing to clearly demarcate work areas and prevent over-clearing;
- Access tracks must also be clearly pegged or flagged to ensure vegetation clearing is minimised;
- Dogs are not permitted on site to prevent further risk to native fauna;
- Following construction of the lease areas partial rehabilitation will commence to reduce the lease area footprint. Natural regeneration is the preferred approach, with assisted regeneration occurring if natural regeneration is unsuccessful;
- Topsoil is to be stockpiled within the lease area, and is to be respread as part of partial rehabilitation;

-
- Where large trees are cleared, timber is to be stockpiled within the lease area for re-spreading as part of partial rehabilitation; and
 - Full rehabilitation of the well lease is to occur upon decommissioning of the pilot wells and access tracks.

The assessment under the significant impact guidelines concludes that the proposed activities will not have a significant impact on MNES or threatened species and communities listed under the TSC Act provided that the recommended controls and mitigation measures are implemented.

10.0 References

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Appendix I

EPBC Protected Matters Search



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 19/12/12 11:37:09

[Summary](#)

[Details](#)

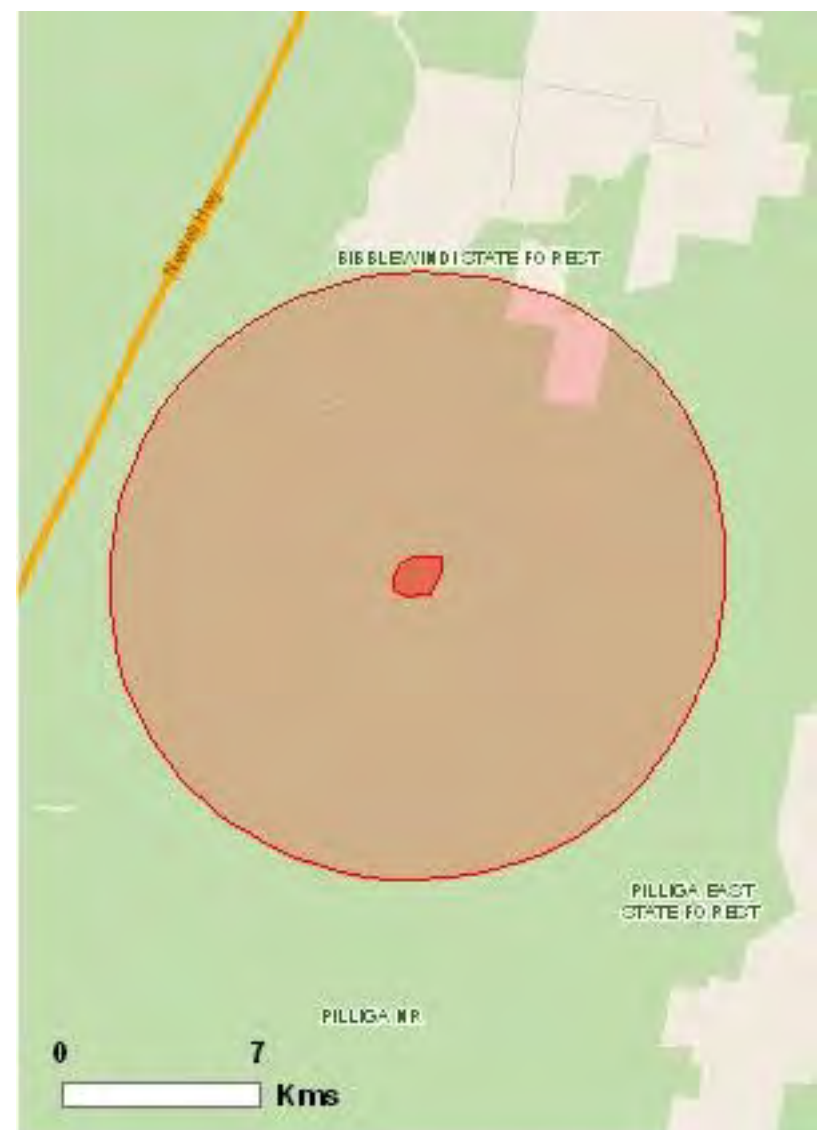
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

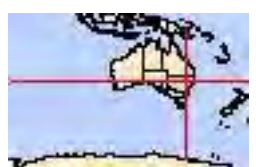
[Acknowledgements](#)



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[Coordinates](#)

[Buffer: 10.0Km](#)



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	20
Listed Migratory Species:	13

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As [heritage values](#) of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	10
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	None
State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	11
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities

[\[Resource Information \]](#)

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community may occur within area
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	Community may occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area

Listed Threatened Species

[\[Resource Information \]](#)

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Endangered	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Vulnerable	Species or species habitat may occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Nyctophilus corbeni South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pseudomys pilligaensis Pilliga Mouse [99]	Vulnerable	Species or species habitat known to occur within area
Plants		
Bertya opposens [13792]	Vulnerable	Species or species habitat likely to occur within area
Philothea ericifolia [64942]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis cobarensis Cobar Greenhood Orchid [12993]	Vulnerable	Species or species habitat likely to occur within area
Rulingia procumbens [12903]	Vulnerable	Species or species habitat likely to occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat may occur within area
Reptiles		
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat may occur within area
Uvidicolus sphyrurus Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko [84578]	Vulnerable	Species or species habitat likely to occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur

Name	Threatened	Type of Presence within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Xanthomyza phrygia Regent Honeyeater [430]	Endangered*	Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat may occur within area
Other Matters Protected by the EPBC Act		
Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species

Name	Threatened	Type of Presence
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		habitat may occur within area Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat likely to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves [\[Resource Information \]](#)

Name	State
Pilliga East	NSW

Invasive Species [\[Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
Frogs		
Bufo marinus Cane Toad [1772]		Species or species habitat likely to occur within area
Mammals		
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Coordinates

-30.696694 149.660261,-30.697341 149.667038,-30.70012 149.66719,-30.702595 149.667228,
-30.708801 149.663345,-30.709257 149.660299,-30.709524 149.655845,-30.707735
149.651543,-30.703585 149.651505,-30.699854 149.653066,-30.697151 149.657596,
-30.696694 149.660261

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Department of Environment, Climate Change and Water, New South Wales](#)
- [-Department of Sustainability and Environment, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment and Natural Resources, South Australia](#)
- [-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [-Environmental and Resource Management, Queensland](#)
- [-Department of Environment and Conservation, Western Australia](#)
- [-Department of the Environment, Climate Change, Energy and Water](#)
- [-Birds Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-SA Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Atherton and Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [-State Forests of NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

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Appendix 2

Site Flora Species List

Scientific Name	Common Name
<i>Acacia amblygona</i>	Fan Wattle
<i>Acacia caroleae</i>	Carol's Wattle
<i>Acacia conferta</i>	Crowded Leaf Wattle
<i>Acacia spectabilis</i>	Mudgee Wattle
<i>Acacia johnsonii</i>	Gereera Wattle
<i>Allocasuarina luehmanni</i>	Bull oak
<i>Aotus ericoides</i>	Common Aotus
<i>Aristida calycina</i>	Dark Wiregrass
<i>Aristida ramosa</i>	Purple Wiregrass
<i>Callitris endlicheri</i>	Black Cypress
<i>Callitris glaucophylla</i>	White Cypress
<i>Calytrix tetragona</i>	Common Fringe-myrtle
<i>Cassinia laevis</i>	Cough Bush
<i>Cheilanthes sieberi</i>	Mulga Fern
<i>Corymbia trachyphloia</i>	Brown Bloodwood
<i>Daviesia acicularis</i>	Sandplain Bitter-pea
<i>Daviesia genistifolia</i>	Broom Bitter-pea
<i>Dianella revoluta</i>	Blueberry Lily
<i>Dodonaea filifolia</i>	Thread-leaf Hopbush
<i>Dodonaea viscosa</i>	Sticky Hopbush
<i>Eremophila longifolia</i>	Emubush
<i>Eragrostis lacunaria</i>	Purple Lovegrass
<i>Eragrostis sp.</i>	
<i>Eucalyptus chloroclada</i>	Dirty Gum
<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark
<i>Fimbristylis dichotoma</i>	Common Fringe-sedge
<i>Gahnia aspera</i>	Rough Saw-sedge
<i>Goodenia cycloptera</i>	Serrated Goodenia
<i>Goodenia hederacea</i>	Forest Goodenia
<i>Homoranthus flavescens</i>	Honey Myrtle
<i>Hybanthus monopetalus</i>	Slender Violet-bush
<i>Laxmannia gracilis</i>	Slender Wire lily
<i>Leucopogon juniperous</i>	Prickly Beard-heath
<i>Lissanthes strigosa</i>	Peach Heath
<i>Lomandra leucocephala</i>	Woolly Mat-rush
<i>Lomandra multiflora</i>	Many-flowered Mat-rush
<i>Opuntia stricta</i>	Prickly Pear
<i>Ozothamnus diosmifolius</i>	Rice Flower
<i>Panicum decompositum</i>	Native Millet
<i>Panicum effusum</i>	Hairy Panic
<i>Pomax umbellata</i>	Pomax
<i>Persoonia cuspidifera</i>	
<i>Pimelia linifolia</i>	Slender Rice-flower

Scientific Name	Common Name
<i>Pimelea stricta</i>	Cough Bush
<i>Thryptomeme micrantha</i>	Heather Bush
<i>Wahlenbergia gracilis</i>	Australian Bluebells
<i>Jacksonia scoparia</i>	Native Cherry

Appendix 3

Threatened Ecological Communities – Likelihood of Occurrence and Potential for Impact

Threatened ecological communities (listed under the TSC Act and the EPBC Act) that have been gazetted / recorded from within the locality have been considered in this ecological assessment. Each community is considered for its potential to occur within the area of consideration and the likely level of impact as a result of the proposed activities. This ecological assessment deals with each community separately and identifies the ecological parameters of significance associated with the proposed activities.

'TEC'– Lists each threatened ecological community known from the vicinity of the site. The status of each community under the *TSC Act* and *EPBC Act* is also provided.

'Habitat' – Provides a brief account of community and the preferred habitat attributes required for the existence / survival of each community.

'Likelihood of Occurrence'– Assesses the likelihood of each community to occur within the site in terms of the aforementioned habitat description and taking into account local habitat preferences, results of recent field investigations, data gained from various sources and previously gained knowledge via fieldwork undertaken within other ecological assessments in the locality.

'Potential for Impact' – Through consideration of the likely level / significance of impacts to each community that would result from the proposed activities, taking into account both short and long-term impacts, a decision has been made whether further assessment is required. This assessment is largely based on the chance of occurrence of each community. It also considers the scope of the proposed activities.

Community	TSC Act	EPBC Act	Description	Likelihood of Occurrence	Potential for Impact
<p>TSC Act - Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions</p> <p>EPBC Act - Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions</p>	EEC	E	<p>Distribution is limited to the Darling Riverine Plains and the Brigalow Belt South Bioregions. This ecological community represents occurrences of one type of eucalypt woodland where (Coolibah, Coolabah (<i>Eucalyptus coolabah</i> subsp. <i>coolabah</i>) and/or Black Box (<i>Eucalyptus largiflorens</i>) are the dominant canopy species and where the understorey tends to be grassy. This community is found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees. The main tree species in the canopy of the woodland are Coolibah (<i>Eucalyptus coolabah</i> subsp. <i>coolabah</i>) and/or Black Box (<i>Eucalyptus largiflorens</i>). Other trees that may be present include: <i>Acacia salicina</i> (Cooba), <i>Acacia stenophylla</i> (River Cooba), <i>Casuarina cristata</i> (Belah), <i>Eremophila bignoniiflora</i> (Eurah), <i>Eucalyptus camaldulensis</i> (River Red Gum) and <i>Eucalyptus populnea</i> (Bimble Box, Poplar Box).</p>	This ecological community was not identified in the area of consideration.	Considered unlikely to be adversely affected by the proposed activities, as this ecological community is not known to occur in the area of consideration, therefore AoS for this species is not required.
<p>TSC Act - Inland Grey Box Woodland in the Riverina; NSW South Western Slopes; Cobar Penepplain; Nandewar and Brigalow Belt South Bioregions</p> <p>EPBC Act - Grey Box (<i>Eucalyptus microcarpa</i>) grassy woodlands and derived native grasslands of south-eastern Australia</p>	EEC	E	<p>Inland Grey Box Woodland includes those woodlands in which the most characteristic tree species, <i>Eucalyptus microcarpa</i> (Inland Grey Box), is often found in association with <i>E. populnea</i> subsp. <i>bimbil</i> (Bimble or Poplar Box), <i>Callitris glaucophylla</i> (White Cypress Pine), <i>Brachychiton populneus</i> (Kurrajong), <i>Allocasuarina luehmannii</i> (Bulloak) or <i>E. melliodora</i> (Yellow Box), and sometimes with <i>E. albens</i> (White Box). The community generally occurs as an open woodland 15–25 m tall but in some locations the overstorey may be absent as a result of past clearing or thinning, leaving only an understorey.</p> <p>Inland Grey Box Woodland occurs predominately within the Riverina and South West Slopes regions of NSW down to the Victorian border. This community also extends across the slopes and plains in Central and Northern NSW up to the Queensland Border.</p>	The main indicator canopy species (Grey Box) was not recorded within the area of consideration, therefore this community does not occur.	Considered unlikely to be adversely affected by the proposed activities, as this ecological community is not known to occur in the area of consideration, therefore AoS for this species is not required.
<p>TSC Act - Native Vegetation on Cracking Clay Soils of the Liverpool Plains</p> <p>EPBC Act – Natural Grasslands on Basalt and Fine-textured Alluvial Plains of Northern New South Wales and Southern Queensland</p>	EEC	CE	<p>Native Vegetation on Cracking Clay Soils of the Liverpool Plains is mainly a native grassland community which includes a range of small forb and herb species. The main grass species include Plains Grass (<i>Austrostipa aristiglumis</i>), Queensland Bluegrass (<i>Dichanthium sericeum</i>) and Coolibah Grass (<i>Panicum queenslandicum</i>). It also contains scattered and patchy shrubs and trees, including Boree (<i>Acacia pendula</i>), Rough-barked Apple (<i>Angophora floribunda</i>), Fuzzy Box (<i>Eucalyptus conica</i>), Bimble Box (<i>E. populnea</i>) and Yellow Box (<i>E. melliodora</i>). In wetter locations rushes and sedges are common.</p> <p>This community is located around Coonabarabran, Gunnedah, Murrurundi, Narrabri, Tamworth and Quirindi, on the North West Slopes and Plains of NSW. Most surviving remnants of the community are on Travelling Stock Routes.</p>	No grasslands were observed within the area of consideration. This community does not occur.	Considered unlikely to be adversely affected by the proposed activities, as this ecological community is not known to occur in the area of consideration, therefore AoS for this species is not required.

Community	TSC Act	EPBC Act	Description	Likelihood of Occurrence	Potential for Impact
<p>EPBC Act - Weeping Myall Woodlands</p> <p>TSC Act - Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions</p>	EEC	E	<p>This ecological community is scattered across the eastern parts of the alluvial plains of the Murray-Darling river system. Typically, it occurs on red-brown earths and heavy textured grey and brown alluvial soils within a climatic belt receiving between 375 and 500 mm mean annual rainfall. The structure of the community varies from low woodland and low open woodland to low sparse woodland or open shrubland, depending on site quality and disturbance history. The tree layer grows up to a height of about 10 metres and invariably includes Weeping Myall (<i>Acacia pendula</i>) as one of the dominant species or the only tree species present.</p> <p>This EEC is known from parts of the Local Government Areas of Berrigan, Bland, Bogan, Carrathool, Conargo, Coolamon, Coonamble, Corowa, Forbes, Gilgandra, Griffith, Gwydir, Inverell, Jerilderee, Lachlan, Leeton, Lockhart, Moree Plains, Murray, Murrumbidgee, Narrabri, Narranderra, Narromine, Parkes, Urana, Wagga Wagga and Warren, and but may occur elsewhere in these bioregions.</p>	This ecological community was not identified in the area of consideration.	Considered unlikely to be adversely affected by the proposed activities, as this ecological community is not known to occur in the area of consideration, therefore AoS for this species is not required.
<p>TSC Act - White Box Yellow Box Blakely's Red Gum Woodland</p> <p>EPBC Act - White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland</p>	EEC	E	<p>White Box Yellow Box Blakely's Red Gum Woodland (commonly referred to as Box-Gum Woodland) is an open woodland community (sometimes occurring as a forest formation) , in which the most obvious species are one or more of the following: White Box <i>Eucalyptus albens</i>, Yellow Box <i>E. melliodora</i> and Blakely's Red Gum <i>E. blakelyi</i>. Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs.</p>	This ecological community was not identified in the area of consideration.	Considered unlikely to be adversely affected by the proposed activities, as this ecological community is not known to occur in the area of consideration, therefore AoS for this species is not required.
<p>TSC Act - Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions</p> <p>EPBC Act - Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant).</p>	EEC	E	<p>The listed ecological community is characterised by the presence of Brigalow (<i>Acacia harpophylla</i>) as one of the three most abundant tree species. Brigalow is usually either dominant in the tree layer or co-dominant with other species such as <i>Casuarina cristata</i> (Belah), other species of <i>Acacia</i>, or species of <i>Eucalyptus</i>. Occasionally Belah, or species of <i>Acacia</i> or <i>Eucalyptus</i> may be more common than Brigalow within the broad matrix of Brigalow vegetation. The structure of the vegetation ranges from open forest to open woodland. The height of the tree layer varies from about 9 m in low rainfall areas (averaging around 500 mm per annum) to around 25 m in higher rainfall areas (averaging around 750 mm per annum) (Butler 2007). A prominent shrub layer is usually present.</p>	This community was not observed within the area of consideration, and is considered unlikely to occur.	Unlikely to be impacted by the proposed activity.

Community	TSC Act	EPBC Act	Description	Likelihood of Occurrence	Potential for Impact
TSC Act – Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandawar Bioregions. EPBC Act - Semi-evergreen Vine Thickets of the Brigalow Belt South (north and south) and Nandawar Bioregions	EEC	E	A form of dry rainforest which in New South Wales is found in the Brigalow Belt South and Nandawar Bioregions. The Community is made up of vines, deciduous (and/or facultatively deciduous) tree species that have affinities with species from subtropical rainforest. Characteristic canopy dominants are <i>Cassine australis</i> var. <i>angustifolia</i> , <i>Geijera parvifolia</i> and <i>Notelaea microcarpa</i> var. <i>microcarpa</i> , but with emergents typical of the surrounding woodlands (<i>Eucalyptus albens</i> , <i>Eucalyptus melanophloia</i> and <i>Callitris glaucophylla</i>).	This community was not observed within the area of consideration, and is considered unlikely to occur.	Unlikely to be impacted by the proposed activity.
TSC Act - <i>Cadellia pentastylis</i> (Ooline) community in the Nandawar and Brigalow Belt South Bioregions	EEC	-	The Ooline community is an unusual and distinctive forest community with the canopy dominated by the tree Ooline (<i>Cadellia pentastylis</i>). Other canopy species include White Box (<i>Eucalyptus albens</i>), Ironbarks (<i>E. beyeriana</i> and <i>E. melanophloia</i>), Dirty Gum (<i>E. chloroclada</i>), Narrow-leaved Grey Box (<i>E. pilligaensis</i>), Green Mallee (<i>E. viridis</i>) and White Cypress Pine (<i>Callitris glaucophylla</i>). The understorey is made up of a range of shrubs such as Wattles and grasses.	This community was not observed within the area of consideration, and is considered unlikely to occur.	Unlikely to be impacted by the proposed activity.
Fuzzy Box Woodland on alluvial soils of the south western slopes, Darling Riverine Plains and Brigalow Belt South bioregions	EEC	-	Woodland or open forest usually dominated by Fuzzy Box <i>Eucalyptus conica</i> , which often grows with Inland Grey Box <i>Eucalyptus microcarpa</i> , Yellow Box <i>Eucalyptus melliodora</i> or Kurrajong <i>Brachychiton populneus</i> . Bulloak <i>Allocasuarina luehmannii</i> is common in places. Shrubs are generally sparse and include <i>Acacia deanei</i> , <i>Dodonaea viscosa</i> , <i>Geijera parvifolia</i> , <i>Acacia implexa</i> , <i>Senna artemisioides</i> sens. lat., <i>Myoporum montanum</i> and <i>Cassinia aculeata</i> . Small shrubs include <i>Maireana microphylla</i> and <i>Sclerolaena muricata</i> . The ground cover may be dense after rain but is usually moderately dense. It comprises native forbs, including <i>Calotis cuneifolia</i> , <i>Sida corrugata</i> , <i>Einadia hastata</i> , <i>Dianella revoluta</i> and <i>Bracteantha viscosa</i> , prostrate shrubs such as <i>Eremophila debilis</i> , <i>Maireana enchylaenoides</i> , and native grasses including <i>Austrostipa scabra</i> , <i>Chloris truncata</i> , <i>Elymus scaber</i> , <i>Themeda australis</i> and <i>Austrodanthonia setacea</i> .	This community was not observed within the area of consideration, and is considered unlikely to occur.	Unlikely to be impacted by the proposed activity.

Appendix 4

Threatened Flora and Fauna - Likelihood of Occurrence and Potential for Impact

Those threatened flora and fauna species (listed under the TSC Act and the EPBC Act) that have been gazetted / recorded from within the locality have been considered in this ecological assessment. EEC's and Endangered Populations known from the broader area have also been addressed. Each species / community / population is considered for its potential to occur within the area of consideration and the likely level of impact as a result of the proposed activities. This ecological assessment deals with each species / community / population separately and identifies the ecological parameters of significance associated with the proposed activities.

Those species / communities that have been identified as potentially being impacted have been assessed as set out in **Appendix 4** and **Appendix 5**.

'Species' – Lists each threatened species known from the vicinity of the site, as identified throughout the desktop assessment. The status of each threatened species under the *TSC Act* and *EPBC Act* is also provided.

'Habitat' – Provides a brief account of the species and the preferred habitat attributes required for the existence / survival of each species / community / population.

'Likelihood of Occurrence' – Assesses the likelihood of each species to occur within the site in terms of the aforementioned habitat description and taking into account local habitat preferences, results of recent field investigations, data gained from various sources and previously gained knowledge via fieldwork undertaken within other ecological assessments in the locality.

Likelihood of occurrence were divided into four categories (Known, Likely, Possible and Unlikely), with classification differing slightly between flora and fauna species:

Fauna

- **Known:** Species recorded during the survey;
- **Likely:** Species previously recorded within 10km of survey area (OEH 2012) and suitable habitat of the species recorded within the area of consideration;
- **Possible:** Species previously recorded within 10km of survey area (OEH 2012) but no suitable habitat of the species recorded within the area of consideration. Or: species not previously recorded within 10km of study area (OEH 2012) but suitable habitat of the species recorded within the area of consideration; and
- **Unlikely:** Species not previously recorded within 10km of survey area (OEH 2012) and no suitable habitat of the species recorded within the area of conservation.

Flora

- **Known:** Species recorded during the survey;
- **Possible:** Species previously recorded within 10km of survey area (OEH 2012) and suitable habitat occurs in the area of consideration; and
- **Unlikely:** Species not previously recorded within 10km of survey area (OEH 2012) and no suitable habitat of the species recorded within the area of consideration.

‘Potential for Impact’ – Through consideration of the likely level / significance of impacts to each species that would result from the proposed activities, taking into account both short and long-term impacts, a decision has been made whether further assessment is required. This assessment is largely based on the chance of occurrence of each species / community with due recognition to other parameters such as home range, habitat use, connectivity etc. It also considers the scope of the proposed activities.

Threatened species included in the table below have been identified as potentially occurring based on:

- Results from an EPBC Act Protected Matters Search using a central coordinate buffered by 10km, and
- Records extracted from data provided by OEH (Ban Baa map sheet) within a 10km radius of the well leases.

Table 10.1: Threatened Flora and Fauna Likelihood of Occurrence and Potential for Impact

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
Flora						
<i>Bertya opponens</i>	Coolabah Bertya	V	V	Known populations within NSW occur in a number of different habitats, ranging from stony mallee ridges, heathy understoreys, and cypress pine forests of the inland, to cliff edges in the high rainfall eastern fall areas of the Great Dividing Range (DSEWPaC, 2012a).	Possible. Vegetation within the area of consideration comprises suitable habitat for this species, particularly within heathy areas. This species was not identified throughout site assessments, and has not previously been recorded within 10km of the survey area.	While suitable habitat to support this species occurs within the area of consideration, clearing is considered to be minimal compared to surrounding available habitat. Given that it is unlikely that this species will be removed as part of the proposed activity, the potential for impact is considered to be low. Therefore, an AOS has not been undertaken for this species.
<i>Philothea ericifolia</i>	-	-	V	Occurs in drainage areas in dry sclerophyll open forest or woodland on sandstone and in heath on damp sandy flats and gullies. Specific microclimates include damp sandy flats, alluvial deposits of coarse gravel in dry creek beds and along a spur receiving soakage from high ground. Associated species include <i>Eucalyptus crebra</i> , <i>Beyeria viscosa</i> and <i>Philothea australis</i> (DSEWPaC, 2012a).	Unlikely. Vegetation within the area of consideration does not include the specific microclimate required for this species, due to the lack of damp sandy flats and creek beds. This species was not identified throughout site assessments, and has not previously been recorded within 10km of the survey area.	The potential for significant impact is considered to be low, given that it is unlikely to occur in the area of consideration.
<i>Polygala linariifolia</i>	Native Milkwort	E	-	Occurs in sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of <i>Eucalyptus caleyi</i> , <i>Eucalyptus dealbata</i> and <i>Callitris</i> , and in yellow podsollic soil on granite in layered open forest. In the Pilliga area, this species has been recorded in Fuzzy Box woodland,	Possible. Suitable habitat occurs in the area of consideration. While not observed in the area of consideration, this species is known to occur within 10km of the survey area.	While suitable habitat to support this species occurs within the area of consideration, clearing is considered to be minimal compared to surrounding available habitat. Given that it is unlikely that this species will be removed as part of the proposed activity, the potential for impact is considered to be low. Therefore, an AOS has not been undertaken for

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
				White Cypress Pine-Bulloak - Ironbark woodland, Rough-barked Apple riparian forb-grass open forest, and Ironbark - Brown Bloodwood shrubby woodland. Other associated species include <i>Eucalyptus trachyphloia</i> , <i>Eucalyptus sphaerocarpa</i> , <i>Angophora floribunda</i> , <i>Angophora leiocarpa</i> , <i>Tristania suaveolens</i> , <i>Allocasuarina torulosa</i> and <i>Wahlenbergia</i> species in the understorey (OEH, 2012a).		this species.
<i>Pterostylis cobarensis</i>	Cobar Greenhood Orchid	V	V	This species inhabits Eucalypt woodland, open mallee, or <i>Callitris</i> shrubland on low stony ridges and slopes with skeletal sandy-loam soils. The known distribution of this species overlaps with the Semi-Evergreen Vine Thickets of the Brigalow Belt and Nandewar Bioregions, the Brigalow ecological communities and the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland communities and the Bulloak Woodlands of Riverina and Murray-Darling Depression Bioregions (DSEWPaC, 2008a).	Possible. Suitable habitat occurs within the area of consideration, given the presence of Eucalypt Woodland. Vegetation surveys did not identify this species occurring within the area of consideration.	The potential for significant impact is considered to be low. This species was not observed within the area of consideration. Therefore, an AOS has not been undertaken for this species.
<i>Rulingia procumbens</i>	-	V	V	Occurs in sandy soils, often in disturbed habitats such as road verges, quarry boundaries, gravel stockpiles, and power line easements It is often found in communities of <i>Eucalyptus dealbata</i> - <i>E. sideroxylon</i> woodland, <i>Melaleuca uncinata</i> shrubland, and mallee eucalypt with <i>Calytrix tetragona</i> understorey. Associated species include <i>Acacia triptera</i> , <i>Callitris endlicheri</i> , <i>Eucalyptus melliodora</i> , <i>Allocasuarina diminuta</i> , <i>Philothea salsolifolia</i> , <i>Xanthorrhoea</i> spp., <i>Exocarpos cupressiformis</i> , <i>Leptospermum parvifolium</i> , and <i>Kunzea parvifolia</i> . The	Possible. Suitable habitat occurs in the area of consideration, including adjacent to the existing access tracks within sandy soils. Vegetation surveys did not identify this species occurring within the area of consideration, however, it is known to occur within 10km of the survey area.	While suitable habitat to support this species occurs within the area of consideration, clearing is considered to be minimal compared to surrounding available habitat. Given that it is unlikely that this species will be removed as part of the proposed activity, the potential for impact is considered to be low. Therefore, an AOS has not been undertaken for this species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
				distribution of this species overlaps with the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act-listed threatened ecological community (TSSC, 2008c).		
<i>Tylophora linearis</i>	-	V	E	Typically inhabiting higher landscapes, it can be found occurring in shrublands, open forest and woodlands associated with <i>Melaleuca uncinata</i> , <i>Eucalyptus fibrosa</i> , <i>Eucalyptus sideroxylon</i> , <i>Eucalyptus albens</i> , <i>Callitris endlicheris</i> , <i>Callitris glaucophylla</i> , <i>Allocasuarina luehmannii</i> , <i>Acacia hakeoides</i> and <i>Acacia lineata</i> on sedimentary flats. Has been found in association with <i>Dodonaea viscosa</i> .	Possible. Suitable habitat occurs in the area of consideration. Vegetation surveys did not identify this species occurring within the area of consideration.	The potential for significant impact is considered to be low. This species was not observed within the area of consideration. Therefore, an AOS has not been undertaken for this species.
Birds						
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E Migratory	Mostly occur in dry Box-Ironbark eucalypt woodland and dry sclerophyll forest associations in areas of low to moderate relief, wherein they prefer moister, more fertile sites available, for example along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing River Oak (<i>Casuarina cunninghamiana</i>), and with Needle-leaf Mistletoe (<i>Amyema cabbagei</i>), are also important for feeding and breeding. At times of food shortage (e.g. when flowering fails in preferred habitats), Regent Honeyeaters also use other woodland types and wet lowland coastal forest dominated by Swamp Mahogany (<i>Eucalyptus robusta</i>) or Spotted Gum (<i>Corymbia maculata</i>). They are typically associated with plant species that reliably	Possible. Suitable habitat is present within areas of Narrow-leaved Ironbark Woodland, and Riparian woodland. This species was not recorded on site, and has not been recorded within 10km of the survey area, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 7 and Appendix 8</i>

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
				produce copious amounts of nectar, such as Mugga Ironbark (<i>Eucalyptus sideroxylon</i>), Yellow Box (<i>E. melliodora</i>), White Box and Yellow Gum (<i>E. leucoxylon</i>), but also are in association with woodland species such as Grey Box (<i>E. microcarpa</i>), Red Box (<i>E. polyanthemos</i>), Blakely's Red Gum (<i>E. blakelyi</i>), River Red Gum (<i>E. camaldulensis</i>), Silver-leaved Ironbark (<i>E. melanophloia</i>), Narrow-leaved Ironbark (<i>E. crebra</i>), Caley's Ironbark (<i>E. caleyi</i>) and Rough-barked Apple (<i>Angophora floribunda</i>) (DSEWPaC, 2012a).		
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E	This species inhabits estuarine and terrestrial wetlands with dense vegetation where it builds nests and forages on invertebrates and small vertebrates.	Unlikely This species has not been recorded within 10km of the site and no suitable habitat exists on site. It is therefore considered unlikely that this species would occur on site.	This species is considered unlikely to occur on site; therefore it is not likely to be impacted upon as a result of the proposed actions.
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	V	-	Occurs mainly in eucalypt forests and woodlands in which there is a sub canopy or understory of <i>Allocasuarina</i> or <i>Casuarina</i> , however Brigalow is also used in south-eastern Queensland (DSEWPaC, 2012b).	Likely Suitable habitat occurs within the Narrow-leaved Ironbark Woodland, as some food trees are present. Suitable hollow-bearing trees also occur throughout the area of consideration. This species was not recorded within the area of consideration, but has been recorded within 10km of the site, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8.</i>
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	-	Occupies eucalypt woodlands, particularly open woodland lacking a dense understory, nesting in tree hollows (OEH, 2011a).	Likely. Suitable habitat occurs within the area of consideration,	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon</i>

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
					particularly within areas with a sparser understorey. This species was not recorded within the area of consideration, but has been recorded within 10km of the site, based on OEH records.	<i>this species it is assessed in Appendix 8.</i>
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and <i>Acacia</i> woodland (OEH, 2011b).	Likely. Suitable habitat occurs within the area of consideration. This species was not recorded within the area of consideration, but has been recorded within 10km of the site, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8.</i>
<i>Geophaps scripta scripta</i>	Squatter Pigeon	E	V	Range from tropical, open dry sclerophyll woodlands and savannahs of north-eastern Australia. Prefer grassy understorey of eucalypt woodland close to permanent water bodies (Garnett, 1992).	Unlikely. The area of consideration is at the far southern extent of this species habitat. While Eucalypt woodland is a preferred habitat type, given the lack of permanent water bodies, and lack of grassy understorey that provides breeding habitat, this species is considered unlikely to occur. This species was not recorded on site, and has not been recorded within 10km of the survey area, based on OEH records.	Unlikely to be significantly impacted by the proposed action. Therefore, an AOS has not been undertaken for this species.
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-	Mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the	Likely. Suitable habitat occurs within the area of consideration. This species was not recorded within the area of consideration, and has been	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8</i>

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
				tree canopy, particularly on profusely-flowering eucalypts and also on melaleucas and mistletoes. On the western slopes and tablelands, White Box (<i>Eucalyptus albens</i>) and Yellow Box (<i>E. meliodora</i>) are particularly important food sources for pollen and nectar respectively (OEH, 2011c).	recorded within 10km of the survey area, based on OEH records, and is therefore considered likely to occur.	
<i>Lathamus discolor</i>	Swift Parrot	E	E Marine	This species is semi-nomadic during winter, foraging in dry woodlands mainly in Victoria and New South Wales. Smaller but significant numbers have been recorded regularly in south-eastern Queensland and occasionally in the Australian Capital Territory and south-eastern South Australia. In New South Wales, Swift Parrots forage in forests and woodlands throughout the coastal and western slopes regions each year. Coastal regions tend to support larger numbers of birds when inland habitats are subjected to drought. The breeding range closely mirrors the distribution of Blue Gum <i>Eucalyptus globulus</i> in Tasmania (Birds Australia, 2011).	Possible. Suitable habitat present within the area of consideration, however this species was not recorded on site, and has not been recorded within 10km of the survey area, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. Though as the species only possible occurs it is expected that the likely significant impact will be low and therefore an AOS has not been completed for this species.
<i>Leipoa ocellata</i>	Malleefowl	E	V Migratory	Occurs in semi-arid and arid zones of temperate Australia, where it occupies shrublands and low woodlands that are dominated by mallee vegetation. It also occurs in other habitat types including eucalypt or native pine <i>Callitris</i> woodlands, acacia shrublands, Broombush <i>Melaleuca uncinata</i> vegetation or coastal heathlands.	Possible. Potential habitat is present within area of consideration, particularly within areas with a denser heath understorey. However, none of these areas are dominated by Mallee vegetation. This species was not recorded on site, and has not been recorded within 10km of the survey area, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. Though as the species only possible occurs it is expected that the likely significant impact will be low and therefore an AOS has not been completed for this species.
<i>Melanodryas cucullata</i>	Hooded Robin	V	-	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and	Likely.	The proposed action has potential to remove and disturb suitable habitat

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>cucullata</i>	(south-eastern form)			mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey (OEH, 2012b).	Suitable habitat for this species occurs within the area of consideration. This species was not recorded on site, but has been recorded by RPS in adjacent areas.	for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8.</i>
<i>Neophema pulchella</i>	Turquoise Parrot	V	-	Habitat includes the steep, rocky ridges and gullies, rolling hills, valleys and river-flats and the nearby plains of the Great Dividing Range. The species occurs in eucalyptus woodlands and open forests, with a ground cover of grasses and low understorey of shrubs. These forests/woodlands usually have mixed assemblages of native pine <i>Callitris</i> and a variety of <i>Eucalyptus</i> species, especially White Box <i>E. albens</i> , Yellow Box <i>E. melliodora</i> , Blakely's Red Gum <i>E. blakelyi</i> , Red Box <i>E. polyanthemos</i> , Red Stringybark <i>E. macrorhyncha</i> , Bimble Box <i>E. populnea</i> or Mulga Ironbark <i>E. sideroxylon</i> . The species has also been recorded in a variety of other habitats, including savannah and riparian woodlands and farmland, preferring edges of forest and pasture or other grassland (NPWS, 1999b).	Likely. Suitable habitat for this species occurs within the area of consideration. This species was not recorded on site, but has been recorded by RPS in adjacent areas, and within 10km of the survey area based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8.</i>
<i>Ninox connivens</i>	Barking Owl	V	-	Habitat typically dominated by eucalypts, often red gum species and, in the tropics, paperbarks <i>Melaleuca</i> species. It usually roosts in or under dense foliage in large trees including rainforest species of streamside gallery forests, River She-oak <i>Casuarina cunninghamiana</i> , other <i>Casuarina</i> and <i>Allocasuarina</i> species, eucalypts, <i>Angophora</i> or <i>Acacia</i> species. Roost sites are often near watercourses or	Likely. Suitable habitat occurs within the area of consideration. This species was not recorded within the area of consideration, but has been recorded within 10km of the site, based on OEH records. The Pilliga Scrub is known to	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8.</i>

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
				wetlands. It typically breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands. Barking Owls have been recorded in remnants of forest and woodland and in clumps of trees at farms, towns and golf courses (NPWS, 2003).	support a significant population (DPI 2009). Given the large home ranges of these species, it is therefore considered likely that this species utilises the area of consideration.	
<i>Polytelis swainsonii</i>	Superb Parrot	V	V	Mainly inhabits forests and woodlands dominated by eucalypts, especially River Red Gums (<i>Eucalyptus camaldulensis</i>) and box eucalypts such as Yellow Box (<i>Eucalyptus melliodora</i>) or Grey Box (<i>E. macrocarpa</i>). The species also seasonally occurs in box-pine (<i>Callitris</i>) and Boree (<i>Acacia pendula</i>) woodlands (DSEWPaC, 2012a).	Possible. Marginal habitat occurs within the area of consideration. This species was not recorded on site, and has not been recorded within 10km of the survey area, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. Though as the species only possible occurs it is expected that the likely significant impact will be low and therefore an AOS has not been completed for this species.
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	-	In NSW, the Grey-crowned Babbler occurs on the western slopes and plains but was less common at the higher altitudes of the tablelands. Isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra. The species occupy open woodlands dominated by mature eucalypts, with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs (NSWSC, 2011).	Known. This species was commonly recorded during fauna surveys.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8.</i>
<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	V	-	Occurs in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy (NSWSC, 2012).	Known. This species was recorded during fauna surveys, within areas of Narrow-leaved Ironbark Woodland.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8</i>
<i>Rostratula australis</i>	Australian Painted Snipe	E	V	Inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps	Unlikely Suitable habitat is not present in the area of consideration.	Unlikely to be significantly impacted by the proposed action. Therefore an AOS has not been undertaken.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
<i>Stagonopleura guttata</i>	Diamond Firetail	V	-	and claypans (DSEWPaC, 2012a). Species mainly inhabit grassy woodlands or wooded farmlands containing River Red Gum <i>Eucalyptus camaldulensis</i> , Yellow Gum <i>Eucalyptus leucoxylon</i> , Murray Pine <i>Callitris gracilis</i> or Bulloak <i>Allocasuarina luehmannii</i> near permanent water (SWIFFT, 2008).	Possible. Some suitable habitat occurs with Bulloak occurring throughout many of the vegetation communities. This species was not recorded within the area of consideration.	The proposed action has potential to remove and disturb suitable habitat for this species. Though as the species only possible occurs it is expected that the likely significant impact will be low and therefore an AOS has not been completed for this species.
<i>Tyto novaehollandiae</i>	Masked Owl	V	-	The Masked Owl inhabits a diverse range of forests and woodlands including agricultural and forest mosaics. Forests with relatively open understoreys, particularly when these habitats adjoin areas of open or cleared land, are particularly favoured (DSEWPaC, 2012a).	Likely. Suitable habitat occurs within the area of consideration. This species was not recorded within the area of consideration, but has been recorded within 10km of the site, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8.</i>
<i>Lophoictinia isura</i>	Square-tailed Kite	V	-	Square-tailed Kite is endemic to Australia and is widespread throughout the mainland (absent from Tasmania). It is recorded mainly in coastal and sub-coastal regions, although it has been observed inland. It is migratory throughout its range and is a spring-summer breeding migrant to south-eastern, southern and south-western Australia. It inhabits open forests and woodlands, particularly those on fertile soils with abundant passerines. It may also range in nearby open habitats but not into extensive treeless regions. It is notably absent from alpine regions and small isolated remnant woodlands in large open areas. Within NSW <i>L. isura</i> has been recorded in ridge and gully forests dominated by <i>Eucalyptus longifolia</i> (Woollybutt), <i>Eucalyptus elata</i> (River Peppermint), <i>Eucalyptus smithii</i> (Blackbutt	Likely. This species has been recorded within 10km of the site (OEH 2012 records). It was not detected during field surveys. Due to the wide range of habitats in which this species forages, it cannot be ruled out as not occurring on site. Therefore it has potential to occur.	This species is considered to have potential to occur on site. Therefore it has potential to be impacted upon as a result of the proposed actions. <i>As there is potential for impact upon this species it is assessed in Appendix 8.</i>

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
				Peppermint) and <i>Corymbia maculata</i> (Spotted Gum), as well as in forests of <i>Angophora</i> and <i>Callitris</i> with shrubby understorey.		
Fish						
<i>Maccullochella peelii</i>	Murray Cod	-	V	Occur in diverse range of habitats, including clear rocky streams to slow flowing, turbid rivers and billabongs. Usually found near complex structural cover such as large rocks, snags, overhanging vegetation and other woody structures (National Murray Cod Recovery Team, 2009).	Unlikely. No suitable habitat occurs in the area of consideration. This species has not been recorded within 10km of the survey area, based on OEH records.	Unlikely to be significantly impacted by the proposed action.
Mammals						
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	-	Found in temperate rainforest, dry and wet sclerophyll forest, banksia woodland, and coastal heath. The species shelters in a spherical nest of bark and leaves in tree hollows or other crannies (Dickman, Lunney & Menkhorst, 2008).	Likely. Large areas of suitable habitat present within the area of consideration, with numerous hollow-bearing trees observed. This species was not recorded within the area of consideration, but has been recorded within 10km of the site, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8</i>
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat, Large Pied Bat	V	V	Known populations in Queensland are from sandstone escarpments in the Carnarvon, Expedition Ranges and Blackdown Tablelands and Isla Gorge National Parks. Prefer sandstone cliffs and fertile woodland valley habitat as well as rainforest and moist eucalypt forest habitats on other geological substrates (DSEWPaC, 2012c).	Possible. Suitable foraging habitat is present within the area of consideration, particularly within Narrow-leaved Ironbark Woodland, but the likelihood of the species occurring is reduced due to the lack of sandstone ridges. This species was not recorded on site, and has not been recorded within 10km of the	Unlikely to be significantly impacted by the proposed action, as suitable breeding and roosting habitat will not be disturbed by the proposed action. Therefore, an AOS has not been undertaken for this species. .

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
					survey area, based on OEH records.	
<i>Chalinolobus picatus</i>	Little Pied Bat	V	-	Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress pine forest and mallee and Bimil box woodlands. Roosts in caves, rocky outcrops, mine shafts, tunnels, tree hollows and buildings (REF).	Known. This species was recorded in the area of consideration using Anabat. Large areas of suitable habitat present within area of consideration.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8</i>
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat, Corben's Long-eared Bat	V	V	Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands. The species also occurs in Bulloak woodland, Brigalow woodland, Belah woodland, Smooth-barked Apple, <i>Angophora leiocarpa</i> , woodland; River Red Gum, <i>Eucalyptus camaldulensis</i> , forests lining watercourses and lakes, Black Box, <i>Eucalyptus largiflorens</i> , woodland, dry sclerophyll forest. Throughout inland Queensland, the species habitat is dominated by various eucalypt and bloodwood species, and various types of tree mallee with it being most abundant in vegetation with a distinct canopy and a dense cluttered shrub layer. In the Hunter Valley, NSW, the species is found in areas such as the Monobalai Nature Reserve and Goulburn River and Wollemi National Parks. It has primarily been recorded in moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses. There are a small number of records from closed forest adjacent to dry sclerophyll woodlands; in Araucarian notophyll vine forest in the Bunya Mountains and in semi evergreen vine thickets on the banks of the Dawson River	Likely. Large areas of suitable habitat present within area of consideration. While this species was not observed throughout the site assessment, it is known to occur within 10km of the site, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 7 and Appendix 8</i>

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
				and in the Brigalow Belt Bioregion (DSEWPaC, 2012a).		
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E	V	Occurs in forests and woodlands along the Great Divide and on the western slopes in escarpment country with rocky outcrops, steep rocky slopes, gorges, boulders and isolated rocky areas. The majority of populations favour north-facing aspects, but some southern aspects have been recorded. Apart from the critical rock structure <i>Petrogale penicillata</i> also requires adjacent vegetation types, associated types include, dense rainforest, wet sclerophyll, vine thicket, dry sclerophyll forest and open forest.	Unlikely. No suitable habitat in the form of rocky outcrops exists on site, and no records for this species exist within 10km of the site (OEH 2012). Therefore, it is considered unlikely to occur on site.	This species is unlikely to occur on site. Therefore it is not likely to be impacted upon as a result of the proposed actions. An AoS is not required for this species.
<i>Phascolarctos cinereus</i>	Koala (combined populations of Qld, NSW and the ACT)	V	V	Common throughout the broad band of forests and woodlands dominated by <i>Eucalyptus</i> spp. extending from north Queensland to the south-eastern corner of mainland South Australia (Maxwell <i>et al.</i> , 1996). Occupy forests and woodlands where there are acceptable food trees (<i>Eucalyptus</i> spp., <i>Corymbia</i> spp., etc.). Distribution is affected by altitude, temperature and leaf moisture (DSEWPaC, 2012a).	Likely. Suitable habitat is present within the area of consideration. Although no primary food trees occur within the area of consideration, scattered secondary tree species occur, namely Dirty Gum. While this species was not recorded in the area of consideration, it has previously been recorded within 10km of the site, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 7 and Appendix 8.</i>
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	V	V	No specific habitat type has been identified for the Pilliga Mouse as specimens have been captured in different vegetation types within the Pilliga Scrub (Fox & Briscoe 1980). These included mixed <i>Eucalyptus</i> , <i>Acacia</i> and <i>Callitris</i> open forest. However, the Pilliga Mouse is found in greatest abundance in recently burnt moist gullies, areas dominated by	Unlikely This species is known to occur within the locale, but is primarily found in heath or riparian habitats. Heath or riparian habitat does not occur within the survey area. While this species was not	This species is unlikely to occur on site. Therefore it is not likely to be impacted upon as a result of the proposed actions. An AoS is not required for this species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
				Broombush (<i>Melaleuca uncinata</i>) and areas containing an understorey of <i>Acacia burrowii</i> with a <i>Corymbia trachyphloia</i> overstorey. Habitat features include a relatively high plant species richness; a moderate to high low-shrub cover; site moisture retention; and groundcover of plants, litter and fungi. Areas with high rates of capture have extensive low grasses and sedges, with little shrub cover and large areas of ash-covered ground (Fox & Briscoe 1980; NSW DECC 2005ad; Tokushima et al. 2008).	recorded in the area of consideration, it has previously been recorded within 10km of the site, based on OEH records.	
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	-	The Yellow-bellied Sheath-tailed bat is found in a wide variety of habitats, including eucalypt forests and open habitats. It roosts in tree hollows. In the arid and semi-arid parts of its range, it is most frequent in mangrove or riparian habitat (McKenzie & Pennay, 2008).	Known. This species was recorded in the area of consideration using Anabat. Large areas of suitable habitat present within area of consideration.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 8</i>
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	-	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT. The species is cave-roosting, usually found in dry open forest and woodland, near cliffs or rocky overhangs. The species has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals. They are occasionally found along cliff-lines in wet eucalypt forest and rainforest (OEH, 2012c).	Possible Suitable habitat to support this species, such as caves and overhangs do not occur however the area may be used for foraging. While this species was not recorded in the area of consideration, it has previously been recorded within 10km of the site, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. Though as the species only possible occurs it is expected that the likely significant impact will be low and therefore an AOS has not been completed for this species.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Description	Likelihood of Occurrence	Potential for Impact
Reptiles						
<i>Aprasia parapulchella</i>	Pink-tailed legless lizard	-	V	Makes preference to sloping woodland areas where open grassland is present and there's a substantial layer of rocks. Soil is preferably well drained.	Unlikely. Unsuitable habitat within the area of consideration due to the lack of sloping woodland areas.	Considered unlikely to be adversely affected by the proposed activities due to the unsuitable habitat and minimal disturbance resulting from the proposed activities. Therefore, an AoS is not required.
<i>Uvidicolus sphyrurus</i>	Border Thick-tailed Gecko	V	V	Occurs in dry sclerophyll open forest and woodland associated with outcrops of granite, basalt, sandstone and metamorphic rocks. Geckos show a preference for canopy cover between 45 and 60 %, low vegetation cover (average 34 %), medium rock cover (average 37 %) and high litter cover (average 25 %). Shelter sites include rocks, decaying logs, bark, and litter in rocky rubble. Shelter sites are usually laying on a litter substrate and shaded by nearby vegetation (DSEWPac (2012a).	Unlikely. The area of consideration is located just outside of the species predicted distribution.	The proposed action has potential to remove and disturb suitable habitat for this species. Though as the species only possible occurs it is expected that the likely significant impact will be low and therefore an AOS has not been completed for this species.

Appendix 5

Site Fauna Species List

Non-listed Native Species

Species	Common Name
Reptiles	
<i>Diplodactylus vittatus</i>	Wood Gecko
<i>Strophurus williamsi</i>	Eastern Spiny-tailed Gecko
<i>Cryptoblepharus virgatus</i>	Cream-striped Shinning-skink
<i>Ctenotus robustus</i>	Robust Ctenotus
<i>Lerista punctatovittata</i>	Eastern Robust Slider
<i>Lerista timida</i>	Timid Slider
<i>Lygisaurus foliorum</i>	Tree-base Litter-skink
<i>Morethia boulengeri</i>	South-eastern Morethia Skink
<i>Amphibolurus nobbi</i>	Nobbi Dragon
<i>Pogona barbata</i>	Bearded Dragon
<i>Varanus gouldii</i>	Gould's Goanna
<i>Varanus varius</i>	Lace Monitor
Amphibians	
<i>Limnodynastes salmini</i>	Salmon Striped Frog
<i>Platyplectrum ornatum</i>	Ornate Burrowing Frog
<i>Litoria latopalmata</i>	Broad-palmed Frog
Mammals	
<i>Chalinolobus gouldii</i>	Gould's Wattle Bat
<i>Chalinolobus morio</i>	Chocolate Wattle Bat
<i>Macropus giganteus</i>	Eastern Grey Kangaroo
<i>Macropus robustus</i>	Common Wallaroo
<i>Macropus rufogriseus</i>	Red-necked Wallaby
<i>Miniopterus schreibersii</i> *	Common Bent-wing Bat
<i>Mormopterus sp. (2)</i>	-
<i>Mormopterus sp. (3)</i>	-
<i>Mormopterus sp. (4)</i>	-
<i>Nyctophilus sp.</i>	-
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat
<i>Scotorepens greyii</i>	Little Broad-nosed Bat
<i>Tadarida australis</i>	White-striped Freetail Bat
<i>Vespadelus sp.</i>	-
<i>Wallabia bicolor</i>	Swamp Wallaby
Birds	
<i>Acanthiza nana</i>	Yellow Thornbill
<i>Acanthiza pusilla</i>	Brown Thornbill
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar
<i>Artamus cyanopterus</i>	Dusky Woodswallow
<i>Artamus personatus</i>	Masked Woodswallow
<i>Colluricincla harmonica</i>	Grey Shrike-thrush
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike

<i>Coracina tenuirostris</i>	Cicadabird
<i>Cormobates leucophaea</i>	White-throated Treecreeper
<i>Corvus coronoides</i>	Australian Raven
<i>Cracticus torquatus</i>	Grey Butcherbird
<i>Dacelo novaeguineae</i>	Laughing Kookaburra
<i>Dicaeum hirundinaceum</i>	Mistletoebird
<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater
<i>Eolophus roseicapillus</i>	Galah
<i>Eopsaltria australis</i>	Eastern Yellow Robin
<i>Gerygone fusca</i>	Western Gerygone
<i>Gerygone olivacea</i>	White-throated Gerygone
<i>Grallina cyanoleuca</i>	Magpie-lark
<i>Hirundapus caudacutus</i>	White-throated Needle-tail
<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater
<i>Lichenostomus leucotis</i>	White-eared Honeyeater
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater
<i>Lichmera indistincta</i>	Brown Honeyeater
<i>Malurus cyaneus</i>	Superb Fairy-wren
<i>Malurus lamberti</i>	Variiegated Fairy-wren
<i>Manorina melanocephala</i>	Noisy Miner
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater
<i>Microeca fascinans</i>	Jacky Winter
<i>Myiagra rubecula</i>	Lead-en Flycatcher
<i>Pachycephala rufiventris</i>	Rufous Whistler
<i>Pardalotus punctatus</i>	Spotted Pardalote
<i>Pardalotus striatus</i>	Striated Pardalote
<i>Phaps chalcoptera</i>	Common Bronzewing
<i>Philemon corniculatus</i>	Noisy Friarbird
<i>Platycercus eximius</i>	Eastern Rosella
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler
<i>Rhipidura albiscapa</i>	Grey Fantail
<i>Rhipidura leucophrys</i>	Willie Wagtail
<i>Smicromnis brevirostris</i>	Weebill
<i>Strepera graculina</i>	Pied Currawong
<i>Zosterops lateralis</i>	Silvereye

Species Listed under the TSC Act

Species	Common Name
Birds	
<i>Chthonicola sagittata</i>	Speckled Warbler
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler
Mammals	
<i>Chalinolobus picatus</i>	Little Pied Bat
<i>Mormopterus eleryi</i> *	Bristle-faced Free-tailed Bat
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat

* Potentially recorded in the area of consideration, but call could not be confirmed

Introduced Pest Species

Species	Common Name
Mammals	
<i>Vulpes vulpes</i>	Red Fox
<i>Felis catus</i>	Feral Cat
<i>Sus scrofa</i>	Feral Pig

Appendix 6

Migratory Species – Likelihood of Occurrence and Potential for Impact

Migratory species (listed under the EPBC Act) that have been gazetted / recorded from within the locality have been considered in this ecological assessment. Each species is considered for its potential to occur within the area of consideration and the likely level of impact as a result of the proposed activities. This ecological assessment deals with each species and identifies the ecological parameters of significance associated with the proposed activities.

Those species that have been identified as potentially being impacted have been assessed as set out in **Appendix 4** and **Appendix 5**.

'Species' – Lists each threatened species known from the vicinity of the site. The status of each threatened species under the EPBC Act is also provided.

'Habitat' – Provides a brief account of the species and the preferred habitat attributes required for the existence / survival of each species.

'Likelihood of Occurrence' – Assesses the likelihood of each species to occur within the site in terms of the aforementioned habitat description and taking into account local habitat preferences, results of recent field investigations, data gained from various sources and previously gained knowledge via fieldwork undertaken within other ecological assessments in the locality.

Likelihood of occurrence was divided into four categories (Known, Likely, Possible and Unlikely):

- **Known:** Species recorded during the survey;
- **Likely:** Species previously recorded within either Pilliga East State Forest or Bibblewindi State Forest (OEH 2012) and suitable habitat of the species recorded within the area of consideration;
- **Possible:** Species previously recorded within either Pilliga East State Forest or Bibblewindi State Forest (OEH 2012) but no suitable habitat of the species recorded within the area of consideration or species not previously recorded within either Pilliga East State Forest or Bibblewindi State Forest (OEH 2012) but suitable habitat of the species recorded within the area of consideration; and
- **Unlikely:** Species not previously recorded within either Pilliga East State Forest or Bibblewindi State Forest (OEH 2012) and no suitable of the species recorded within the area of consideration.

'Potential for Impact' – Through consideration of the likely level / significance of impacts to each species that would result from the proposed activities, taking into account both short and long-term impacts, a decision has been made whether further assessment is required. This assessment is largely based on the chance of occurrence of each species / community with due recognition to other parameters such as home range, habitat use, connectivity etc. It also considers the scope of the proposed activities.

Threatened species included in the table below have been identified as potentially occurring based on:

- Results from an EPBC Act Protected Matters Search using a central coordinate buffered by 10km, and
- Records extracted from data provided by OEH (BioNet Atlas) within either Pilliga East State Forest or Bibblewindi State Forest 10km radius of the well leases.

Scientific Name	Common Name	Status		Habitat Description ¹	Likelihood of Occurrence	Potential for Impact
Birds						
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	Migratory Endangered	Mostly occur in dry Box-Ironbark eucalypt woodland and dry sclerophyll forest associations in areas of low to moderate relief, wherein they prefer moister, more fertile sites available, for example along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing River Oak (<i>Casuarina cunninghamiana</i>), and with Needle-leaf Mistletoe (<i>Amyema cambagei</i>), are also important for feeding and breeding. At times of food shortage (e.g. when flowering fails in preferred habitats), Regent Honeyeaters also use other woodland types and wet lowland coastal forest dominated by Swamp Mahogany (<i>Eucalyptus robusta</i>) or Spotted Gum (<i>Corymbia maculata</i>). They are typically associated with plant species that reliably produce copious amounts of nectar, such as Mugga Ironbark (<i>Eucalyptus sideroxylon</i>), Yellow Box (<i>E. melliodora</i>), White Box and Yellow Gum (<i>E. leucoxylon</i>), but also are in association with woodland species such as Grey Box (<i>E. microcarpa</i>), Red Box (<i>E. polyanthemos</i>), Blakely's Red Gum (<i>E. blakelyi</i>), River Red Gum (<i>E. camaldulensis</i>), Silver-leaved Ironbark (<i>E. melanophloia</i>), Narrow-leaved Ironbark (<i>E. crebra</i>), Caley's Ironbark (<i>E. caleyi</i>) and Rough-barked Apple (<i>Angophora floribunda</i>) (DSEWPac, 2012a).	Possible. Suitable habitat is present within areas of Narrow-leaved Ironbark Woodland, and Riparian woodland. This species was not recorded on site, and has not been recorded within 10km of the survey area, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. <i>As there is potential for impact upon this species it is assessed in Appendix 7 and Appendix 8</i>

Scientific Name	Common Name	Status	Habitat Description ¹	Likelihood of	Potential for	
<i>Apus pacificus</i>	Fork-tailed Swift	-	Marine Migratory	Exclusively aerial, this species occurs over inland plains, cliffs and beaches, mostly over dry or open habitat including riparian woodland and tea-tree swamp. Sometimes occurs above foothills or in coastal areas.	Possible. Some suitable habitat present within area of consideration though would only be observed flying over site.	Proposed action has potential to remove and disturb suitable habitat, however a significant impact is not anticipated.
<i>Ardea alba / Egretta alba</i>	Great Egret	-	Marine	Occurs in a diversity of wetland habitats. Its distribution is widely spread around Australia.	Unlikely due lack of suitable habitat present within area of consideration.	Unlikely to be significantly impacted by the proposed action.
<i>Ardea ibis</i>	Cattle Egret	-	Marine Migratory	Occurs in tropical and temperate grasslands, woodlands and terrestrial wetlands. Its distribution is widely spread around Australia.	Unlikely due lack of suitable habitat present within area of consideration.	Unlikely to be significantly impacted by the proposed action.
<i>Gallinago hardwickii</i>	Latham's Snipe	-	Marine Migratory	Occurs in permanent and ephemeral wetlands up to 2,000 m above sea-level but can also be found in saline and brackish water, modified or artificial habitat, saltmarsh, mangrove creeks, around bays and beaches. Migrates to Australia in summer. Its distribution is widely spread around the eastern side of Australia.	Unlikely due lack of suitable habitat present within area of consideration.	Unlikely to be significantly impacted by the proposed action.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	-	Marine Migratory	Found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. Habitats include the presence of large areas of open water (larger rivers, swamps, lakes, the sea).	Unlikely due lack of suitable habitat present within area of consideration.	Unlikely to be significantly impacted by the proposed action.
<i>Hirundapus caudacutus</i>	White-throated Needletail	-	Marine Migratory	Exclusively aerial. Its distribution is widespread in eastern and south-eastern Australia, flying above a wide variety of habitats ranging from heavily treed forests to open habitats, such as farmland, heathland or mudflats.	Known. This species was recorded during fauna surveys, within areas of Narrow-leaved Ironbark Woodland.	Proposed action has potential to remove and disturb suitable habitat, however a significant impact is not anticipated.
<i>Lathamus discolor</i>	Swift Parrot	E	Marine Endangered	This species is semi-nomadic during winter, foraging in dry woodlands mainly in Victoria and New South Wales. Smaller but	Possible. Suitable habitat present within the area of	The proposed action has potential to remove and disturb

Scientific Name	Common Name	Status	Habitat Description ¹	Likelihood of	Potential for	
			significant numbers have been recorded regularly in south-eastern Queensland and occasionally in the Australian Capital Territory and south-eastern South Australia. In New South Wales, Swift Parrots forage in forests and woodlands throughout the coastal and western slopes regions each year. Coastal regions tend to support larger numbers of birds when inland habitats are subjected to drought. The breeding range closely mirrors the distribution of Blue Gum <i>Eucalyptus globulus</i> in Tasmania (Birds Australia, 2011).	consideration, however this species was not recorded on site, and has not been recorded within 10km of the survey area, based on OEH records.	suitable habitat for this species. Though as the species only possible occurs it is expected that the likely significant impact will be low and therefore an AOS has not been completed for this species.	
<i>Leipoa ocellata</i>	Malleefowl	E	Migratory Vulnerable	Occurs in semi-arid and arid zones of temperate Australia, where it occupies shrublands and low woodlands that are dominated by mallee vegetation. It also occurs in other habitat types including eucalypt or native pine <i>Callitris</i> woodlands, acacia shrublands, Broombush <i>Melaleuca uncinata</i> vegetation or coastal heathlands.	Possible. Potential habitat is present within area of consideration, particularly within areas with a denser heath understorey. However, none of these areas are dominated by Mallee vegetation. This species was not recorded on site, and has not been recorded within 10km of the survey area, based on OEH records.	The proposed action has potential to remove and disturb suitable habitat for this species. Though as the species only possible occurs it is expected that the likely significant impact will be low and therefore an AOS has not been completed for this species.
<i>Merops ornatus</i>	Rainbow Bee-eater	-	Marine Migratory terrestrial	The Rainbow Bee-eater is distributed across much of mainland Australia, and occurs on several near-shore islands. The species occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. Open woodlands and shrublands, including mallee, and in open forests that are usually dominated by eucalypts provide suitable habitat. It also occurs in grasslands, especially in arid or semi-arid areas, in	Likely. Suitable habitat is present within the area of consideration and has previously been recorded within Bibblewindi or Pilliga East SF. Particularly along riparian woodland habitats.	Proposed action has potential to remove and disturb suitable habitat, however a significant impact is not anticipated.

Scientific Name	Common Name	Status	Habitat Description ¹	Likelihood of	Potential for	
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	-	Marine Migratory	riparian, floodplain or wetland vegetation assemblages.		
				In NSW, the Satin Flycatcher is widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains. They inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Satin Flycatchers are mainly recorded in eucalypt forests, especially wet sclerophyll forest, often dominated by eucalypts such as Brown Barrel, <i>Eucalyptus fastigata</i> , Mountain Gum, <i>E. dalrympleana</i> , Mountain Grey Gum, Narrow-leaved Peppermint, Messmate or Manna Gum, or occasionally Mountain Ash, <i>E. regnans</i> . Such forests usually have a tall shrubby understorey of tall acacias, for example Blackwood, <i>Acacia melanoxylon</i> .	Unlikely due lack of suitable habitat present within area of consideration.	Unlikely to be significantly impacted by the proposed action.
<i>Rostratula australis</i>	Australian Painted Snipe	E	Marine Migratory Vulnerable	The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum <i>Muehlenbeckia</i> or canegrass or sometimes tea-tree (<i>Melaleuca</i>). The Australian Painted Snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber.	Unlikely due lack of suitable habitat present within area of consideration.	Unlikely to be significantly impacted by the proposed action.

Appendix 7

EPBC Act Significant Impact Assessment

An assessment of significance for each of the fauna species considered likely to occur within the survey area has been undertaken in accordance with the EPBC Act and EPBC Act Policy Statement 1.1 - Significant Impact Guidelines Matters of National Environmental Significance (DEWHA, 2009) as follows:

Koala (*Phascolarctos cinereus*)

Significant Impact Criteria	Preliminary Assessment
Lead to a long-term decrease in the size of an important population of a species	Unlikely. Although the species has been previously recorded within 10km of the survey area (OEH 2012), the species was not recorded during the survey. The area of consideration does not contain any primary or secondary food trees under Schedule 2 of State Environmental Planning Policy 44 (SEPP 44) (Environmental Planning and Assessment Act 1979), and is therefore not considered to be potential or core Koala habitat under the policy. In addition, the proposed works will only disturb a small area (approx 5.598 ha) of the potential habitat within the area of consideration and any chance of incidental deaths through clearing will be minimised through the presence of a spotter catcher. It is therefore not expected that the works will lead to a long-term decrease in the population.
Reduce the area of occupancy of an important population	Minimal. The proposed work will result in a minor loss of habitat for the species. Consequently, this disturbance will reduce the area of occupancy of the important population. The activity will result in the loss of 5.598 ha of potential Koala habitat. The loss of habitat is considered to be minimal in the context of habitat within the area of consideration. In addition, these areas do not contain any primary food trees under Schedule 2 of SEPP 44.
Fragment an existing important population into two or more populations	Unlikely. The survey area is a smaller component of the overall habitat used by this species as they often have large home ranges and are known to traverse open landscapes. This species would primarily utilise the survey area as a foraging resource, although the similar habitats within the locality surrounding the survey area are more extensive and are of greater foraging and breeding importance to this species. Koala food trees are generally concentrated on alluvial soils associated with waterways and drainage lines in the area of consideration. These areas are likely to be more critical for dispersal and impacts on these areas have been minimised.
Adversely affect habitat critical to the survival of a species	Unlikely. The proposed activities involve the clearing of 5.598 ha of woodland habitat; though no primary or secondary food trees will be removed. Therefore, it is unlikely to constitute habitat critical for the survival of the species due to an expanse of native vegetation in adjacent lands that has similar habitat values.
Disrupt the breeding cycle of an important population	Possibly. The breeding season for the species is between September and March (SEWPaC 2012). If works are to occur during this period increased noise, dust and vibrations may interfere with breeding. If works were to occur outside this period it is expected that there would be little to no impact on the breeding cycle of the species despite the direct impact of clearing habitat.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely. The proposed works will remove, destroy and degrade potential habitat of the species but due to the small area in which the works is to occur it is expected that this will not be at an extent that is likely to cause a decline in the species.

Significant Impact Criteria	Preliminary Assessment
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely. If appropriate mitigation measures are put in place it is expected that the proposed works will not result in an increase in invasive species.
Introduce disease that may cause the species to decline, or	Unlikely. The proposed works is unlikely result in the introduction of any diseases that may cause a decline in the species.
Interfere substantially with the recovery of the species.	Unlikely. The main identified threats to the species include habitat loss, degradation or fragmentation, encounter mortality from dogs and cars; disease, climate change and drought, habitat degradation due to overbrowsing, and low genetic variability (SEWPaC 2012). The proposed works primarily relates to the threat of habitat loss, degradation or fragmentation, however, as the proposed works will only impact a small area of potential habitat (5.755 ha) it is unlikely that this will substantially interfere with the recovery of the species.

South-eastern Long-eared Bat (South-eastern Form) / Corben's Long-eared Bat (*Nyctophilus corbeni*)

Significant Impact Criteria	Preliminary Assessment
Lead to a long-term decrease in the size of an important population of a species	<p>Unlikely. The species has been previously recorded within 10km of the survey area (OEH 2012), though was not recorded during the survey. Large areas of potential habitat were recorded within the survey area, including several hollow bearing / loss barked tress. It is therefore likely that the species does occur within the survey area and maybe potentially impacted by the proposed activities. However, as the proposed works will only disturb a small area (approx 5.598 ha) of the potential habitat within the survey area and the ability of the species to easily relocate when disturbed, it is not expected that the works will lead to a long-term decrease in the population.</p> <p>This population was assessed as an important population as it has potential to be necessary for maintaining genetic diversity, particularly within the Narrabri / Pilliga Area.</p>
Reduce the area of occupancy of an important population	<p>Yes. The proposed work will disturb areas identified as suitable habitat for the species. Consequently, this disturbance will reduce the area of occupancy of the important population. The activity will result in the loss of 5.598 ha of potential roosting and foraging habitat. This loss of habitat is however considered to be minimal in the context of habitat within the area of consideration</p>
Fragment an existing important population into two or more populations	<p>Unlikely. The survey area is a smaller component of the overall habitat used by this species as they often have large home ranges and are known to exploit large areas. This species would primarily utilise the survey area as a foraging resource, although the similar habitats within the locality surrounding the survey area are of equal or greater foraging and roosting importance to this species.</p> <p>The proposed activities are likely to disturb a relatively small amount (4.4 ha) of existing potential habitat for the species; however the amount to be removed is minimal (2.98%) in comparison to the amount to be retained in the area of consideration. As the species would be easily able to move around these cleared areas it is unlikely that the proposed works will fragment the population.</p>
Adversely affect habitat critical to the survival of a species	<p>Unlikely. The proposed activities involve the clearing of 5.598 ha of woodland habitat; in which no individuals were recorded during the survey. In addition, this area to be removed is considered minimal in comparison to the amount of similar habitat to be retained within the area of consideration. Therefore, the disturbance area is unlikely to constitute habitat critical for the survival of the species due to an expanse of native vegetation in adjacent lands that has similar habitat values.</p>
Disrupt the breeding cycle of an important population	<p>Possibly. Little information is known about the breeding cycle of this species and therefore it is difficult to plan works around peak breeding times (SEWPaC 2012). If works do occur during this period, increased noise, dust and vibrations may interfere with breeding. If works were to occur outside this period it is expected that there would be little to no impact on the breeding cycle of the species despite the direct impact of clearing habitat.</p>
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	<p>Unlikely. The proposed works will remove, destroy and degrade potential habitat of the species but due to the small area in which the works is to occur it is expected that this will not be at an extent that is likely to cause a decline in the species.</p>
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	<p>Unlikely. If appropriate mitigation measures are put in place it is expected that the proposed works will not result in an increase in invasive species.</p>
Introduce disease that may cause the	<p>Unlikely. The proposed works is unlikely result in the introduction of any diseases that may cause a decline in the species.</p>

Significant Impact Criteria	Preliminary Assessment
species to decline, or	
Interfere substantially with the recovery of the species.	Unlikely. The main identified threats to the species include habitat loss, habitat fragmentation, fire, forestry activities, overgrazing, predation by feral species, tree hollow competition, exposure to agrichemicals and climate change (SEWPaC 2012). The proposed works primarily relates to the threats of habitat loss and tree hollow competition, however, as the proposed works will only impact a small area of potential habitat (5.598 ha) and minimal hollow bearing trees it is unlikely that this will substantially interfere with the recovery of the species.

Regent Honeyeater (*Anthochaera phrygia*)

Significant Impact Criteria	Preliminary Assessment
Lead to a long-term decrease in the size of an important population of a species	Unlikely. The species has been previously recorded within the Pilliga and Bibblewindi State Forests, of which the survey area is located (OEH 2012), though was not recorded during the survey. Large areas of potential habitat were recorded within the survey area and therefore it is likely the species does occur periodically within the survey area due to its migratory nature and may be potentially impacted by the proposed activities. However, as the proposed works will only disturb a small area (5.598 ha) of the potential habitat within the survey area and the ability of the species to easily relocate when disturbed, it is not expected that the works will lead to a long-term decrease in the population.
Reduce the area of occupancy of an important population	No. Given the small scale of clearing proposed, it is unlikely that the proposal will reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	Unlikely. The survey area is a smaller component of the overall habitat used by this species as they often have large home ranges and are known to exploit large areas. This species would primarily utilise the survey area as a foraging resource, although the similar habitats within the locality surrounding study area are of equal or greater foraging and breeding importance to this species. The proposed activities are likely to disturb a relatively small amount (5.598 ha) of existing potential habitat for the species; however, this loss of habitat is considered to be minimal in the context of habitat within the adjoining Pilliga State Forest (~160,000ha). As the species would be easily able to move around these cleared areas it is unlikely that the proposed works will fragment the population.
Adversely affect habitat critical to the survival of a species	Unlikely. The proposed activities involve the clearing of 5.598 ha of woodland habitat; in which no individuals were recorded during the survey. In addition, this loss of habitat is considered to be minimal in the context of habitat within the adjoining Pilliga State Forest (~160,000ha). Therefore, the disturbance area is unlikely to constitute habitat critical for the survival of the species due to an expanse of native vegetation in adjacent lands that has similar habitat values.
Disrupt the breeding cycle of an important population	Possible. The breeding season for the species is between May and March (SEWPaC 2012). If works are to occur during this period increased noise, dust and vibrations may interfere with breeding. If works were to occur outside this period it is expected that there would be little to no impact on the breeding cycle of the species despite the direct impact of clearing habitat.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is	Unlikely. The proposed works will remove, destroy and degrade potential habitat of the species but due to the small area in which the works is to occur and the migratory nature of the species, it is expected that this will not be at an extent that is likely to cause a decline in the species.

Significant Impact Criteria	Preliminary Assessment
likely to decline	
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely. If appropriate mitigation measures are put in place it is expected that the proposed works will not result in an increase in invasive species.
Introduce disease that may cause the species to decline, or	Unlikely. If appropriate mitigation measures are put in place it is expected that the proposed works will not result in the introduction of any diseases that may cause a decline in the species.
Interfere substantially with the recovery of the species.	Unlikely. The main identified threats to the species include loss, fragmentation and degradation of the species' habitat (SEWPaC 2012). The proposed works primarily relates to the threats of habitat loss, however, as the proposed works will only impact a small area of potential habitat (18.29ha) it is unlikely that this will substantially interfere with the recovery of the species.

Appendix 8

TSC Act Assessment of Significance

AI.1 Approach

Section 5A of the EP&A Act lists seven factors that must be taken into account in the determination of the significance of potential impacts of proposed activities on 'threatened species, populations or ecological communities or their habitats' (threatened biota) listed under the TSC Act. The so-called '7-part test' is used to determine whether there is likely to significantly effect a threatened species, populations or ecological communities, or their habitats and thus whether a Species Impact Statement (SIS) is required to be produced.

The significance of the impacts on those threatened species, which have been recorded in the area of consideration or are likely to occur, and are likely to utilise habitat to be potentially impacted by the proposed activities have been assessed. The following species have been considered:

Fauna

- Eastern Pygmy-possum (*Cercartetus nanus*); and
- Koala (*Phascolarctos cinereus*);

Those threatened fauna species that possess similar habitat requirements or are from the same faunal group have been grouped together into a table format for ease of presentation and include the following:

Woodland / Forest Owls

- Barking Owl (*Ninox connivens*);
- Masked Owl (*Tyto novaehollandiae*); and
- Square-tailed Kite (*Lophoictinia isura*).

Woodland Dependent Birds

- Diamond Firetail (*Stagonopleura guttata*);
- Little Lorikeet (*Glossopsitta pusilla*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Brown Treecreeper (*Climacteris picumnus*);
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*);
- Hooded Robin (*Melanodryas cucullata cucullata*);
- Turquoise Parrot (*Neophema pulchella*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Speckled Warbler (*Pyrrholaemus sagittatus*); and
- Glossy Black-Cockatoo (*Calyptorhynchus lathamii*).

Woodland Dependent Microbats

- Little Pied Bat (*Chalinolobus picatus*);
- South-eastern Long-eared Bat (*Nyctophilus corbeni*);
- Bristle-faced Free-tailed Bat (*Mormopterus eleryi*); and
- Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*).

AI.1.1 Threatened Fauna

Eastern Pygmy-possum (*Cercartetus nanus*)

The Eastern Pygmy-possum (*Cercartetus nanus*) is a small arboreal marsupial that is distributed in the south-eastern corner of mainland Australia and in Tasmania. In New South Wales the species is found in coastal areas and at higher elevation in the south, but north of Newcastle at higher elevation only. Pygmy-Possums are agile climbers that feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit (NSWDEH 2012). Found in temperate rainforest, dry and wet sclerophyll forest, banksia woodland, and coastal heath. The species shelters in a spherical nest of bark and leaves in tree hollows or other crannies (Dickman, Lunney & Menkhorst, 2008).

7-Part Test Criteria

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.*

No Eastern Pygmy-possums were recorded during the survey but potential habitat occurs in the survey area. The proposed activities may lead to the clearing of approximately 5.598 ha of woodland habitat that potentially provides breeding and foraging resource for the species, due to the presence of large hollow bearing Eucalypts. However the relatively small amount of habitat to be removed is unlikely to constitute habitat critical for the maintenance of a local population of the Eastern Pygmy-possum, due to the area of consideration's connectivity with similar habitats.

The woodland habitat surrounding the survey area also provides similar habitat values to the woodland to be potentially impacted within the survey area. The Eastern Pygmy-possum is a mobile species and would be able to relocate into these surrounding habitats. It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of the Eastern Pygmy -possum 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.*

There is no endangered population for these species currently listed on the TSC Act within the survey area.

(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.**

This factor does not apply to threatened species.

(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**

Approximately 5.598 ha of woodland habitat is to be cleared from the survey area, as a result of the proposed activities.

(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

Habitat within the survey area has been identified as a breeding and foraging resource for the Eastern Pygmy-possum. Adjacent and relatively extensive woodland habitats surrounding the survey area provide similar breeding and foraging resources as the survey area, of which the species may currently inhabit. The clearing of a small proportion of this species habitat is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.

(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.

Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating the species from similar viable habitats in the wider area of consideration or locality and as such would not have a significant impact on the long-term survival of the species.

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

There is no critical habitat listed for these species on the register of critical habitat.

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

There is no recovery plan for this species however there are 7 priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any the 7 priority actions and the small area affected, it is considered that there would be no negative impact on the long-term persistence and recovery of this species.

(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

There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant one is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.

Clearing of native vegetation - The proposed activities will clear approximately 5.598 ha of this species habitat. The loss of this relatively small amount of habitat is unavoidable in light of the objective of the proposed activities and is unlikely to result in the decline of this species habitat in the locality.

Conclusion

Based on the consideration of the above factors, the proposed activities are not likely to significantly impact the listed threatened species Eastern Pygmy-possum or its habitats.

Koala (*Phascolarctos cinereus*)

The Koala is the largest of Australia's arboreal mammals. Its home range size varies with quality of habitat, ranging from less than two hectares to several hundred hectares in size. Koalas typically inhabit eucalypt woodlands and forests where they feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area would select preferred browse species.

They are generally inactive for most of the day, feeding and moving mostly at night. Koalas spend most of their time in trees, but would descend and traverse open ground to move between trees. This species is generally solitary, but has complex social hierarchies based on a dominant male with a territory overlapping several females and subordinate males on the periphery. Females breed at two years of age and produce one young per year (DECC, 2008).

7-Part Test Criteria

- (h) 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.**

No Koalas were recorded during the survey, however secondary food trees occur in the survey area. Under SEPP 44, the survey area is not considered to be potential or core habitat, as the canopy does not comprise at least 15% primary food tree species. The proposed activities involve the clearing of only 5.598 ha of woodland habitat; though no primary food trees will be removed. Therefore, it is unlikely to constitute habitat critical for the maintenance of a local population of the Koala due to an expanse of native vegetation in adjacent lands that has similar habitat values.

The survey area is a smaller component of the overall habitat used by this species as they often have large home ranges and are known to traverse open landscapes. This species would primarily utilise the survey area for dispersal and as an occasional foraging resource, although the similar habitats within the locality surrounding the survey area are more extensive and are of greater importance to this species.

The proposed activities are likely to disturb a relatively small amount (5.598 ha) of existing foraging habitat for a local Koala; however the amount to be removed is insignificant in comparison to the amount to be retained in the area of conservation. The proposed activities are unlikely to significantly affect breeding and foraging success, or dispersal of local Koalas.

It is therefore unlikely that the proposed activities would have an adverse effect on the life cycle of the Koala such that a viable local population of the species is likely to be placed at risk of extinction.

- (i) 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.**

There is no endangered population for these species currently listed on the TSC Act within the study area.

- (j) 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.**

This factor does not apply to threatened species.

(k) 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***

The vegetation to be cleared comprises structurally modified woodland habitat due to past and ongoing agricultural land use. There are three species of SEPP 44 listed secondary Koala feed trees located within the study area along with other less significant habitat trees, the Koala may utilise these trees opportunistically as a foraging resource. However, this impact is minimal in comparison to the relatively high number of Koala feed trees that are to be retained in the area of consideration.

(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*

The effectiveness of the area of consideration as a movement corridor and habitat resource for a local Koala population would not be negatively affected, as connectivity with similar woodland habitat surrounding the disturbance area will be maintained. Therefore, the proposed activities would not impose a barrier to movement for the Koala into adjacent lands.

(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.*

Due to the relatively minor loss of marginal habitat and the large amount of alternative breeding and feeding habitat within surrounding areas, the area to be affected by the proposed activities are not considered an important resource for the Koala and the proposed vegetation clearing would not have a significant impact on the long-term survival of the species or the local population of Koalas.

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

There is no critical habitat listed for these species on the register of critical habitat.

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

There is a recovery plan for the Koala (DECC 2008), which outlines specific objectives to help conserve the Koala and its habitat. Ten current threats to Koalas are identified. Habitat loss and fragmentation are the most important threats to this species in NSW. Although the proposed activities are not consistent with the objectives of the recovery plan it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.

The similar woodland habitats within Bibblewindi and Pilliga East State Forest, strengthens the vegetation connectivity of the area of consideration and provides habitat linkages in this area.

The vegetation to be cleared is small in comparison to woodland vegetation associated with adjacent lands and would not be significantly fragment Koala populations or habitats within the area.

(n) *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*

There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant one to this proposed activities and the Koala is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.

Clearing of native vegetation - The proposed activities will disturb approximately 5.598 ha of Koala habitat that contains three species of secondary Koala feed trees under Schedule 2 of SEPP 44. The loss of this

relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of this species in the locality.

Conclusion

Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species Koala or its habitats.

Table A8.1: Assessment of Significance of Woodland Raptors

Barking Owl (<i>Ninox connivens</i>)	Masked Owl (<i>Tyto novaehollandiae</i>)	Square-tailed Kite (<i>Lophoictinia isura</i>)
Background Information		
<p>Barking Owl is found throughout Australia except for the central arid regions and Tasmania (DECC 2008). The species inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses (DECC 2008). Denser vegetation is used occasionally for roosting (DECC 2008).</p> <p>Territories range from 30 to 200 hectares and birds are present all year (DECC 2008). During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as <i>Acacia</i> and <i>Casuarina</i> species, or the dense clumps of canopy leaves in large Eucalypts (DECC 2008). Breeding occurs during late winter and early spring, with eggs laid in nests in hollows of large, old eucalypts including River Red Gum (<i>Eucalyptus camaldulensis</i>), White Box (<i>Eucalyptus albens</i>), Red Box (<i>Eucalyptus polyanthemus</i>) and Blakely's Red Gum (<i>Eucalyptus blakelyi</i>) (DECC 2008).</p>	<p>The Masked Owl lives in eucalypt forests and woodlands from the coast, where it is most abundant, to the western plains. Inland records for this species are sparse but, overall, records fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in distribution. Potential habitat for the Masked Owl is mostly in conservation reserves and state forests, although this species is also found throughout large areas of forest or woodland on other public lands and on private land, including suburban bushland. The Masked Owl has been recorded in many national parks and state forests throughout its range in NSW (DECC 2006)</p>	<p>Square-tailed Kite is endemic to Australia and is widespread throughout the mainland (absent from Tasmania). It is recorded mainly in coastal and sub-coastal regions, although it has been observed inland. It is migratory throughout its range and is a spring-summer breeding migrant to south-eastern, southern and south-western Australia. It inhabits open forests and woodlands, particularly those on fertile soils with abundant passerines. It may also range in nearby open habitats but not into extensive treeless regions. It is notably absent from alpine regions and small isolated remnant woodlands in large open areas. Within NSW <i>L. isura</i> has been recorded in ridge and gully forests dominated by <i>Eucalyptus longifolia</i> (Woollybutt), <i>Eucalyptus elata</i> (River Peppermint), <i>Eucalyptus smithii</i> (Blackbutt Peppermint) and <i>Corymbia maculata</i> (Spotted Gum), as well as in forests of <i>Angophora</i> and <i>Callitris</i> with shrubby understorey.</p> <p>This species was not recorded on site, but has been recorded within 10km of the survey area, based on OEH 2012 records. Due to the wide range of habitats in which this species forages, it cannot be ruled out as occurring on site.</p>
<p><i>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;</i></p> <p>The proposed activities may lead to the clearing of approximately 5.598 ha of woodland habitat that currently provides an important breeding and foraging resource for these species, due to the presence of large hollow bearing trees, in particular large eucalypt trees. However the small amount of habitat to be removed is unlikely to constitute habitat critical for the maintenance of a local population, due to the area of consideration's connectivity with similar habitats.</p> <p>The woodland habitat surrounding the survey area also provides similar habitat values to the woodland to be potentially impacted within the survey area. These species are highly mobile species and would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of these species such that a viable local population of the species is likely to be placed at risk of extinction.</p>		
<p><i>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;</i></p> <p>There is no endangered population of these species currently listed on the TSC Act within the survey area.</p>		
<p><i>c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:</i></p> <ul style="list-style-type: none"> ▪ 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 		

Barking Owl (<i>Ninox connivens</i>)	Masked Owl (<i>Tyto novaehollandiae</i>)	Square-tailed Kite (<i>Lophoictinia isura</i>)
<i>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,</i>		
This factor does not apply to threatened species.		
<i>d) In relation to the habitat of a threatened species, population or ecological community:</i>		
<ul style="list-style-type: none"> ▪ the extent to which habitat is likely to be removed or modified as a result of the action proposed, and ▪ 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 		
<i>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,</i>		
<p>Approximately 5.598 ha of woodland habitat is to be cleared as a result of the proposed activities. The clearing of a small proportion of this species habitat is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.</p> <p>This habitat has been identified as a breeding and foraging resource for these species. Adjacent and relatively extensive woodland habitats surrounding the survey area provide similar breeding and foraging resources as the survey area, of which these species may currently inhabit.</p> <p>Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating the species from similar viable habitats in the wider area of consideration or locality and as such would not have a significant impact on the long-term survival of the species.</p>		
<i>e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);</i>		
There is no critical habitat listed for these species on the register of critical habitat.		
<i>f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;</i>		
<p>There is a recovery plan for the Barking Owl (NSW National Parks and Wildlife Service, 2003), which outlines specific objectives to help conserve the Barking Owl and its habitat. Five current threats to Barking Owls are identified. "Clearing of native vegetation" is the primary threat posed by the proposed activities.</p> <p>The retention of woodland remnants, especially those containing hollow bearing trees is one of the key strategies to recover the species. Although the proposed activities are inconsistent with these objectives due to the small area of habitat being cleared it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.</p>	<p>The Masked Owl is included in the Large Forest Owls recovery plan. As part of this recovery plan there are 7 recovery objectives. The objective that is most relevant to the proposed activities is objective 5, "Minimise further loss and fragmentation of habitat by protection and more informed management of significant owl habitat. In addition to this there are 26 priority actions of which the proposed actions are inconsistent with a few. Although the proposed activities are inconsistent with these objectives and actions, due to the small area of habitat being cleared it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.</p>	<p>There is no recovery plan for this species however there are three priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any of the three priority actions and the small area affected, it is assessed that there likely to be no negative impact on the long-term persistence and recovery of this species.</p>

Barking Owl (<i>Ninox connivens</i>)	Masked Owl (<i>Tyto novaehollandiae</i>)	Square-tailed Kite (<i>Lophoictinia isura</i>)
<p><i>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.</i></p>		
<p>There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant one is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.</p>		
<p><i>Clearing of native vegetation</i> - The proposed activities will clear approximately 5.598 ha of this species habitat. The loss of this relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of this species in the locality.</p>		
<p>Conclusion</p>		
<p>Based on the consideration of the above factors, the proposed activities are not likely to significantly affect these species or their habitats.</p>		

Table A8.2: Assessment of Significance of Woodland Dependent Threatened Birds

Little Lorikeet (<i>Glossopsitta pusilla</i>)	Brown Treecreeper (<i>Climacteris picumnus</i>)	Grey-crowned Babbler (<i>Pomatostomus temporalis temporalis</i>)
Background Information		
<p>Forages primarily in the canopy of open Eucalypt forest and woodland. Riparian habitats are particularly used, due to higher soil fertility. Also found in isolated flowering trees in open country, e.g. paddocks and roadside remnants.</p>	<p>The Brown Treecreeper is endemic to eastern Australia. It is found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range. It is typically not found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging. Hollows in standing dead or live trees and tree stumps are essential for nesting (DECCW, 2005).</p>	<p>In NSW, the Grey-crowned Babbler occurs on the western slopes of the Great Dividing Range, the woodlands in the Hunter Valley and in several locations on the north coast of NSW. This species prefers open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Grey-crowned Babbler feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. They build and maintain several conspicuous, dome-shaped stick nests about the size of a football. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts.</p>
<p><i>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;</i></p>		
<p>The proposed activities may lead to the clearing of approximately 5.598 ha of woodland habitat that currently provides an important breeding and foraging resource for these species, which include hollow bearing trees. However the small amount of habitat to be removed is unlikely to constitute habitat critical for the maintenance of a local population of these species, due to the survey area's connectivity with similar habitats.</p> <p>The woodland habitat surrounding the survey area also provides similar habitat values to the woodland to be potentially impacted within the survey area. These woodland depended species are highly mobile species and would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of these species such that a viable local population of the species is likely to be placed at risk of extinction.</p>		
<p><i>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;</i></p>		
<p>There is no endangered population of these species currently listed on the TSC Act within the survey area.</p>		
<p><i>c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:</i></p> <ul style="list-style-type: none"> ▪ 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 ▪ 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, 		
<p>This factor does not apply to threatened species.</p>		

Little Lorikeet (<i>Glossopsitta pusilla</i>)	Brown Treecreeper (<i>Climacteris picumnus</i>)	Grey-crowned Babbler (<i>Pomatostomus temporalis temporalis</i>)
<p>d) <i>In relation to the habitat of a threatened species, population or ecological community:</i></p> <ul style="list-style-type: none"> ▪ the extent to which habitat is likely to be removed or modified as a result of the action proposed, and ▪ 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 ▪ 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, 		
<p>Approximately 5.598 ha of woodland habitat is to be cleared from the survey area, as a result of the proposed activities. The clearing of a small proportion of these species habitats is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.</p> <p>This habitat has been identified as a breeding and foraging resource for these woodland dependant species. Adjacent and relatively extensive woodland habitats surrounding the survey area provide similar breeding and foraging resources as the survey area, of which these species currently inhabits.</p> <p>Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating these species from similar viable habitats in the wider area of consideration or locality and as such would not have a significant impact on the long-term survival of the species.</p>		
<p>e) <i>Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);</i></p>		
<p>There is no critical habitat listed for these species on the register of critical habitat.</p>		
<p>f) <i>Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;</i></p>		
<p>There is no recovery plan or priority action statement for this species. However, there are some objectives relevant to the proposed activities to recover the species, these include:</p> <ul style="list-style-type: none"> ▪ Retain large old trees, especially those that are hollow-bearing; ▪ Ensure recruitment of trees into the mature age class so that there is not a lag period of decades between the death of old trees and hollow formation in younger trees; ▪ Protect large flowering Eucalyptus trees throughout the habitats frequented by this species. Manage remnant woodlands and forest for recovery of old-growth characteristics; and ▪ Where natural tree recruitment is inadequate, replant local species to maintain foraging habitat and breeding sites. <p>Although the proposed activities are inconsistent with these objectives due to the small area which will be</p>	<p>There is no recovery plan for this species however there are 7 priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any the 7 priority actions and the small area affected, it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.</p>	<p>There is no recovery plan for this species however there are 5 priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any the 5 priority actions and the small area affected, it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.</p>

Little Lorikeet (<i>Glossopsitta pusilla</i>)	Brown Treecreeper (<i>Climacteris picumnus</i>)	Grey-crowned Babbler (<i>Pomatostomus temporalis temporalis</i>)
affected it is assessed that there would be no negative impact on the long term persistence and recovery of this species.		
<i>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.</i>		
There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant KTP is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.		
Clearing of native vegetation - The proposed activities will clear approximately 5.598 ha of habitat for these species. The loss of this relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of this species in the locality.		
Conclusion		
Based on the consideration of the above factors, the proposed activities are not likely to significantly affect these listed species.		

Table A8.3: Assessment of Significance of Woodland Dependent Threatened Birds

Glossy Black-Cockatoo (<i>Calyptorhynchus lathamii</i>)	Hooded Robin (<i>Melanodryas cucullata cucullata</i>)	Turquoise Parrot (<i>Neophema pulchella</i>)	Diamond Firetail (<i>Stagonopleura guttata</i>)
Background Information			
<p>The Glossy Black-Cockatoo inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of She-oak species, particularly Black She-oak (<i>Allocasuarina littoralis</i>), Forest She-oak (<i>A. torulosa</i>) or Drooping She-oak (<i>A. verticillata</i>) occur. In the Riverina area, again usually associated with woodlands containing Drooping She-oak but also recorded in open woodlands dominated by Belah (<i>Casuarina cristata</i>). Feeds almost exclusively on the seeds of several species of she-oak (<i>Casuarina</i> and <i>Allocasuarina</i> species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites. One or two eggs are laid between March and August (NSWSC, 2012).</p>	<p>Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey (OEH, 2012b).</p>	<p>Habitat includes the steep, rocky ridges and gullies, rolling hills, valleys and river-flats and the nearby plains of the Great Dividing Range. The species occurs in eucalyptus woodlands and open forests, with a ground cover of grasses and low understorey of shrubs. These forests/woodlands usually have mixed assemblages of native pine <i>Callitris</i> and a variety of Eucalyptus species, especially White Box <i>E. albens</i>, Yellow Box <i>E. melliodora</i>, Blakely's Red Gum <i>E. blakelyi</i>, Red Box <i>E. polyanthemos</i>, Red Stringybark <i>E. macrorhyncha</i>, Bimble Box <i>E. populnea</i> or Mulga Ironbark <i>E. sideroxylon</i>. The species has also been recorded in a variety of other habitats, including savannah and riparian woodlands and farmland, preferring edges of forest and pasture or other grassland (NPWS, 1999b).</p>	<p>Species mainly inhabit grassy woodlands or wooded farmlands containing River Red Gum <i>Eucalyptus camaldulensis</i>, Yellow Gum <i>Eucalyptus leucoxyton</i>, Murray Pine <i>Callitris gracilis</i> or Bulloak <i>Allocasuarina luehmannii</i> near permanent water (SWIFFT, 2008).</p>
<p><i>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;</i></p>			
<p>The proposed activities may lead to the clearing of approximately 5.598 ha of woodland habitat that currently provides an important breeding and foraging resource for the species, which include hollow bearing trees and <i>Allocasuarina</i> species. However the small amount of habitat to be removed is unlikely to constitute habitat critical for the maintenance of a local population of the Glossy Black-Cockatoo, due to the survey area's connectivity with similar</p>	<p>The proposed activities may lead to the clearing of approximately 5.598 ha of woodland habitat that currently provides an important breeding and foraging resource for the species, which include shrubby understorey. However the small amount of habitat to be removed is unlikely to constitute habitat critical for the maintenance of a local population of the Hooded Robin, due to the survey area's connectivity with similar habitats. The woodland habitat surrounding the survey</p>	<p>The proposed activities may lead to the clearing of approximately 5.598 ha of woodland habitat that currently provides an important breeding and foraging resource for the species, which include hollow bearing trees. However the small amount of habitat to be removed is unlikely to constitute habitat critical for the maintenance of a local population of the Turquoise Parrot, due to the survey area's connectivity with similar habitats. The woodland habitat surrounding the</p>	<p>The proposed activities may lead to the clearing of approximately 5.598 ha of woodland habitat that currently provides potential breeding and foraging resource for the species. However the small amount of habitat to be removed is unlikely to constitute habitat critical for the maintenance of a local population of the Diamond Firetail, due to the area of consideration's connectivity with similar habitats. The habitat surrounding the area of</p>

Glossy Black-Cockatoo (<i>Calyptorhynchus lathamii</i>)	Hooded Robin (<i>Melanodryas cucullata cucullata</i>)	Turquoise Parrot (<i>Neophema pulchella</i>)	Diamond Firetail (<i>Stagonopleura guttata</i>)
<p>habitats and the lack of preferred food trees.</p> <p>The woodland habitat surrounding the survey area also provides similar habitat values to the woodland to be potentially impacted within the survey area. The Speckled Warbler is a highly mobile species and would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of the Glossy Black-Cockatoo such that a viable local population of the species is likely to be placed at risk of extinction.</p>	<p>area also provides similar habitat values to the woodland to be potentially impacted within the survey area. The Hooded Robin is a highly mobile species and would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of the Hooded Robin such that a viable local population of the species is likely to be placed at risk of extinction.</p>	<p>survey area also provides similar habitat values to the woodland to be potentially impacted within the survey area. The Turquoise Parrot is a highly mobile species and would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of the Turquoise Parrot such that a viable local population of the species is likely to be placed at risk of extinction.</p>	<p>consideration also provides similar habitat values to the habitat to be potentially impacted within the area of consideration. The Diamond Firetail is a highly mobile species and would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of the Diamond Firetail such that a viable local population of the species is likely to be placed at risk of extinction.</p>
<p><i>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;</i></p>			
<p>There is no endangered population of these species currently listed on the TSC Act within the survey area.</p>			
<p><i>c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:</i></p> <ul style="list-style-type: none"> ▪ 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 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, 			
<p>This factor does not apply to threatened species.</p>			
<p><i>d) In relation to the habitat of a threatened species, population or ecological community:</i></p> <ul style="list-style-type: none"> ▪ the extent to which habitat is likely to be removed or modified as a result of the action proposed, and ▪ 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 <p><i>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,</i></p>			

Glossy Black-Cockatoo (<i>Calyptorhynchus lathamii</i>)	Hooded Robin (<i>Melanodryas cucullata cucullata</i>)	Turquoise Parrot (<i>Neophema pulchella</i>)	Diamond Firetail (<i>Stagonopleura guttata</i>)
<p>Approximately 5.598 ha of woodland habitat is to be cleared from the survey area, as a result of the proposed activities. The clearing of a small proportion of this species habitat is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.</p> <p>This habitat has been identified as a breeding and foraging resource for the Glossy Black-Cockatoo. Adjacent and relatively extensive woodland habitats surrounding the survey area provide similar breeding and foraging resources as the survey area, of which the species may currently inhabit.</p> <p>Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating the species from similar viable habitats in the wider area of conservation or locality and as such would not have a significant impact on the long-term survival of the species.</p>	<p>Approximately 5.598 ha of woodland habitat is to be cleared from the survey area, as a result of the proposed activities. The clearing of a small proportion of this species habitat is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.</p> <p>This habitat has been identified as a breeding and foraging resource for the Hooded Robin. Adjacent and relatively extensive woodland habitats surrounding the survey area provide similar breeding and foraging resources as the survey area, of which the species may currently inhabit.</p> <p>Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating the species from similar viable habitats in the wider area of consideration or locality and as such would not have a significant impact on the long-term survival of the species.</p>	<p>Approximately 5.598 ha of woodland habitat is to be cleared from the survey area, as a result of the proposed activities. The clearing of a small proportion of this species habitat is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.</p> <p>This habitat has been identified as a breeding and foraging resource for the Turquoise Parrot. Adjacent and relatively extensive woodland habitats surrounding the survey area provide similar breeding and foraging resources as the survey area, of which the species may currently inhabit.</p> <p>Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating the species from similar viable habitats in the wider area of consideration or locality and as such would not have a significant impact on the long-term survival of the species.</p>	<p>Approximately 5.598 ha of woodland habitat is to be cleared from the survey area, as a result of the proposed activities. The clearing of a small proportion of this species habitat is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.</p> <p>Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating the species from similar viable habitats in the wider area of consideration or locality and as such would not have a significant impact on the long-term survival of the species.</p>
<p><i>e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);</i></p>			
<p>There is no critical habitat listed for these species on the register of critical habitat.</p>			
<p><i>f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;</i></p>			
<p>There is no recovery plan for this species however there are 10 priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any the 10 priority actions and the small area</p>	<p>There is no recovery plan for this species however there are 5 priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any the 5 priority actions and the small area affected, it is</p>	<p>There is no recovery plan for this species however there are 10 priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any the 10 priority actions and the small</p>	<p>There is no recovery plan for this species however there are 5 priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any the 5 priority actions and the small</p>

Glossy Black-Cockatoo (<i>Calyptorhynchus lathamii</i>)	Hooded Robin (<i>Melanodryas cucullata cucullata</i>)	Turquoise Parrot (<i>Neophema pulchella</i>)	Diamond Firetail (<i>Stagonopleura guttata</i>)
affected, it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.	assessed that there would be no negative impact on the long-term persistence and recovery of this species.	area affected, it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.	area affected, it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.
<i>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.</i>			
<p>There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant one is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.</p> <p>Clearing of native vegetation - The proposed activities will clear approximately 5.598 ha of this species habitat. The loss of this relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of this species in the locality.</p>	<p>There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant one is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.</p> <p>Clearing of native vegetation - The proposed activities will clear approximately 5.598 ha of this species habitat. The loss of this relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of this species in the locality.</p>	<p>There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant one is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.</p> <p>Clearing of native vegetation - The proposed activities will clear approximately 5.598 ha of this species habitat. The loss of this relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of this species in the locality.</p>	<p>There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant one is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.</p> <p>Clearing of native vegetation - The proposed activities will clear approximately 5.598ha of this species habitat. The loss of this relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of this species in the locality.</p>
Conclusion			
Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species Glossy Black-Cockatoo or its habitats.	Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species Hooded Robin or its habitats.	Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species Turquoise Parrot or its habitats.	Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species Diamond Firetail or its habitats.

Table A8.4: Assessment of Significance of Woodland Dependent Threatened Birds

Varied Sittella (<i>Daphoenositta chrysoptera</i>)	Speckled Warbler (<i>Chthonicola sagittata</i>)	Regent Honeyeater (<i>Anthochaera phrygia</i>)
Background Information		
The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland (OEH, 2011b).	Occurs in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy (NSWSC, 2012).	Mostly occur in dry Box-Ironbark eucalypt woodland and dry sclerophyll forest associations in areas of low to moderate relief, wherein they prefer moister, more fertile sites available, for example along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing River Oak (<i>Casuarina cunninghamiana</i>), and with Needle-leaf Mistletoe (<i>Amyema cambagei</i>), are also important for feeding and breeding. At times of food shortage (e.g. when flowering fails in preferred habitats), Regent Honeyeaters also use other woodland types and wet lowland coastal forest dominated by Swamp Mahogany (<i>Eucalyptus robusta</i>) or Spotted Gum (<i>Corymbia maculata</i>). They are typically associated with plant species that reliably produce copious amounts of nectar, such as Mugga Ironbark (<i>Eucalyptus sideroxylon</i>), Yellow Box (<i>E. melliodora</i>), White Box and Yellow Gum (<i>E. leucoxylon</i>), but also are in association with woodland species such as Grey Box (<i>E. microcarpa</i>), Red Box (<i>E. polyanthemos</i>), Blakely's Red Gum (<i>E. blakelyi</i>), River Red Gum (<i>E. camaldulensis</i>), Silver-leaved Ironbark (<i>E. melanophloia</i>), Narrow-leaved Ironbark (<i>E. crebra</i>), Caley's Ironbark (<i>E. caleyi</i>) and Rough-barked Apple (<i>Angophora floribunda</i>) (DSEWPac, 2012a).
<p><i>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;</i></p> <p>The proposed activities may lead to the clearing of approximately 5.598 ha of woodland habitat that currently provides an important breeding and foraging resource for these species, which include hollow bearing trees. However the small amount of habitat to be removed is unlikely to constitute habitat critical for the maintenance of a local populations of these species, due to the survey area's connectivity with similar habitats.</p> <p>The woodland habitat surrounding the survey area also provides similar habitat values to the woodland to be potentially impacted within the survey area. These species are highly mobile species and would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.</p>		
<p><i>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;</i></p>		
There is no endangered population of these species currently listed on the TSC Act within the survey area.		

Varied Sittella (<i>Daphoenositta chrysoptera</i>)	Speckled Warbler (<i>Chthonicola sagittata</i>)	Regent Honeyeater (<i>Anthochaera phrygia</i>)
<p><i>c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed 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 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,</i></p>		
<p>This factor does not apply to threatened species.</p>		
<p><i>d) In relation to the habitat of a threatened species, population or ecological community:</i></p> <ul style="list-style-type: none"> ▪ the extent to which habitat is likely to be removed or modified as a result of the action proposed, and 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 <p><i>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,</i></p>		
<p>Approximately 5.598 ha of woodland habitat is to be cleared from the survey area, as a result of the proposed activities. The clearing of a small proportion of habitat is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.</p> <p>This habitat has been identified as a breeding and foraging resource for these species. Adjacent and relatively extensive woodland habitats surrounding the survey area provide similar breeding and foraging resources as the survey area, of which the species currently inhabits.</p> <p>Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating the species from similar viable habitats in the wider area of consideration or locality and as such would not have a significant impact on the long-term survival of these species.</p>		
<p><i>e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);</i></p>		
<p>There is no critical habitat listed for these species on the register of critical habitat.</p>		
<p><i>f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;</i></p>		
<p>There is no recovery plan or priority action statement for this species. For this reason and due to the small area of habitat which will be affected by the proposed activities it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.</p>	<p>There is no recovery plan for this species however there are 7 priority actions listed for this species within the priority action statement. However, as the proposed activities do not relate to any the 7 priority actions and the small area affected, it is assessed that there would be no negative impact on the long-term persistence and recovery of this species.</p>	<p>There is no recovery plan for this species however there are 41 priority actions listed for this species within the priority action statement. The main priority action that relates to the proposed activities is “Ensuring appropriate environmental impact assessment of proposals impacting on Regent Honeyeater habitat”. As the proposed activities are consistent with the recovery plan objectives and will only impact a small area of suitable habitat, it is assessed that there would be no negative impact on the long term persistence and recovery of this species.</p>

Varied Sittella (<i>Daphoenositta chrysoptera</i>)	Speckled Warbler (<i>Chthonicola sagittata</i>)	Regent Honeyeater (<i>Anthochaera phrygia</i>)
<p><i>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.</i></p>		
<p>There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant KTP is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.</p>		
<p>Clearing of native vegetation - The proposed activities will clear approximately 5.598 ha of these species habitats. The loss of this relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of these species in the locality.</p>		
<p>Conclusion</p>		
<p>Based on the consideration of the above factors, the proposed activities are not likely to significantly affect these threatened species.</p>		

Table A8.5: Assessment of Significance of Woodland Dependent Threatened Bats

Little Pied Bat (<i>Chalinolobus picatus</i>)	South-eastern Long-eared Bat / Corben's Long-eared Bat (<i>Nyctophilus corbeni</i>)	Yellow-bellied Sheath-tail Bat (<i>Saccolaimus flaviventris</i>)	Bristle-faced Free-tailed Bat (<i>Mormopterus eleryi</i>)
Background Information			
<p>Occurs in dry open forest, open woodland, Mulga and riverine open forests, dry open forest, open woodland, chenopod shrublands, Callitris forest, Casuarina pauper woodlands and mallee and forage predominantly on Moths. The Little Pied Bat roosts in hollow bearing trees, caves, abandoned mines and buildings. They often roost alone and favour large mature trees with dead limbs and dead trees that have fallen over leaving a hollowed stump. They will move roost location most days, although remaining in the same general area (all roosts within 200 m) (Churchill, 2008).</p>	<p>Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands. The species also occurs in Buloke woodland, Brigalow woodland, Belah woodland, Smooth-barked Apple, <i>Angophora leiocarpa</i>, woodland; River Red Gum, <i>Eucalyptus camaldulensis</i>, forests lining watercourses and lakes, Black Box, <i>Eucalyptus largiflorens</i>, woodland, dry sclerophyll forest. Throughout inland Queensland, the species habitat is dominated by various eucalypt and bloodwood species, and various types of tree mallee with it being most abundant in vegetation with a distinct canopy and a dense cluttered shrub layer. In the Hunter Valley, NSW, the species is found in areas such as the Monobalai Nature Reserve and Goulburn River and Wollemi National Parks. It has primarily been recorded in moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses. There are a small number of records from closed forest adjacent to dry sclerophyll woodlands; in Araucarian notophyll vine forest in the Bunya Mountains and in semi evergreen vine thickets on the banks of the Dawson River and in the Brigalow Belt Bioregion (DSEWPaC, 2012a).</p>	<p><i>Saccolaimus flaviventris</i> (Yellow-bellied Sheath-tail-bat) is widespread across Australia and its apparent rarity is probably due to its flying so high and fast that it is seldom collected. It has been reported from a wide variety of habitats. Hunting height appears to vary depending on the height of the dominant vegetation in Eucalypt forests it feeds above the canopy, but in mallee or open country it comes lower to the ground. Prey species include beetles, long-horned grasshoppers, shield bugs and flying ants. Usually solitary, but occasionally occurring in colonies of less than ten individuals, the <i>S. flaviventris</i> roosts in tree hollows, animal burrows, dry clay cracks, under rock slabs, abandoned <i>Petaurus breviceps</i> (Sugar Glider) nests, and has been found resting on the walls of buildings in broad daylight, and one such individual, caught at Queanbeyan, NSW, appeared to be so exhausted that it made no effort to escape. Similar reports suggest that it is migratory in southern Australia and that individuals found resting in the open are in the course of a winter migration from the cooler to warmer areas. They have been reported from southern Australia only between January and June.</p>	<p><i>Mormopterus eleryi</i> (Bristle-faced Free-tailed Bat) is a small insectivorous bat and is Distributed from the southern half of the Northern Territory to central Queensland and north-western NSW. In NSW, the species has been recently recorded from only three disjunct locations: thirteen individuals from Gundabooka National Park, south of Bourke; one individual from Dhinnia Dthinawan Nature Reserve (formerly Bebo State Forest), north of Warialda two individuals near Bonshaw. Knowledge of the ecology of the Bristle-faced Free-tailed Bat is limited; however evidence suggests that the species depends on hollows and tree fissures for roosting sites. All other Australian species from the same family generally roost in tree hollows and fissures. This species appears to be extremely rare throughout its range. Nationally, it has been recorded from only 15 locations.</p>
<p>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;</p>			
<p>The proposed activities may lead to the clearing of 5.598 ha of woodland habitat</p>	<p>The proposed activities may lead to the clearing of 5.598 ha of woodland habitat that provides important foraging, roosting and breeding resources for the species. However the small amount of primarily breeding habitat to be potentially removed is unlikely to</p>		

Little Pied Bat (<i>Chalinolobus picatus</i>)	South-eastern Long-eared Bat / Corben's Long-eared Bat (<i>Nyctophilus corbeni</i>)	Yellow-bellied Sheathtail Bat (<i>Saccolaimus flaviventris</i>)	Bristle-faced Free-tailed Bat (<i>Mormopterus eleryi</i>)
<p>that provides important foraging, roosting and breeding resources for the species. However the small amount of primarily breeding habitat to be potentially removed is unlikely to constitute habitat critical for the maintenance of a local population of the species, due to the survey area's connectivity with similar habitats.</p> <p>The woodland habitat surrounding the survey area also provides similar habitat values than the woodland to be potentially impacted within the survey area. Even though the Little Pied Bat generally has a small home range based around regular roosts sites, it is known to travel up to 17 km to forage and is a highly mobile species that would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of the Little Pied Bat such that a viable local population of the species is likely to be placed at risk of extinction.</p>	<p>constitute habitat critical for the maintenance of a local population of these species, due to the survey area's connectivity with similar habitats.</p> <p>The woodland habitat surrounding the survey area also provides similar habitat values than the woodland to be potentially impacted within the survey area. These species are mobile, and would be able to relocate into these surrounding habitats.</p> <p>It is therefore unlikely that the proposed activities would have an adverse affect on the life cycle of these species such that a viable local population of the species is likely to be placed at risk of extinction.</p>		
<p><i>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;</i></p>			
<p>There is no endangered population currently listed on the TSC Act within the survey area.</p>			
<p><i>c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: 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</i></p>			
<p>This factor does not apply to threatened species.</p>			

Little Pied Bat (<i>Chalinolobus picatus</i>)	South-eastern Long-eared Bat / Corben's Long-eared Bat (<i>Nyctophilus corbeni</i>)	Yellow-bellied Sheath-tail Bat (<i>Saccolaimus flaviventris</i>)	Bristle-faced Free-tailed Bat (<i>Mormopterus eleryi</i>)
<p>d) <i>In relation to the habitat of a threatened species, population or ecological community:</i></p> <ul style="list-style-type: none"> ▪ the extent to which habitat is likely to be removed or modified as a result of the action proposed, and 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 			
<p>Approximately 5.598 ha of woodland habitat is to be cleared from the survey area, as a result of the proposed activities. The clearing of a small proportion of habitat is unlikely to fragment the remainder, as good connectivity already exists. Therefore it is unlikely to isolate or fragment the remaining habitat from similar adjacent habitats as a result of the proposed activities.</p> <p>This habitat has been identified as a breeding and foraging resource for these species. Adjacent and relatively extensive woodland habitats surrounding the survey area provide similar breeding and foraging resources as the survey area, of which these species may currently inhabit.</p> <p>Due to the presence of alternative breeding and foraging habitat adjacent to the survey area, the minimal amount of habitat to be affected by the proposed activities are not isolating these species from similar viable habitats in the wider area of conservation or locality and as such would not have a significant impact on the long-term survival of these species.</p>			
<p>e) <i>Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);</i></p>			
<p>There is no critical habitat listed for this species on the register of critical habitat.</p>			
<p>f) <i>Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;</i></p>			
<p>There is no recovery plan for this species however there are 24 priority actions listed for this species within the priority action statement. Two high priority actions include ensuring the largest hollow bearing trees and standing dead trees are given highest priority for retention and identify areas of private land that contain high densities of trees with hollows and dead standing trees as areas of high conservation value for planning and land management instruments.</p> <p>Although the proposed activities are not consistent with some of the objectives of the 24 priority actions it is assessed that due to the small area the proposed activities will impact there would be no negative impact on the long-term persistence and recovery of this species.</p>	<p>There is no recovery plan for this species however there are 23 priority actions listed for this species within the priority action statement. Two high priority actions include ensuring the largest hollow bearing trees and standing dead trees are given highest priority for retention and encouraging the protection and enhancement of understorey vegetation.</p> <p>Although the proposed activities are not consistent with some of the objectives of the 23 priority actions it is assessed that due to the small area the proposed activities will impact there would be no negative impact on the long-term persistence and recovery of this species.</p>	<p>There is no recovery plan for this species however there are 21 priority actions listed for this species within the priority action statement. High priority actions include encouraging the retention of the largest hollow bearing trees.</p> <p>Although the proposed activities are not consistent with some of the objectives of the 21 priority actions it is assessed that due to the small area the proposed activities will impact there would be no negative impact on the long-term persistence and recovery of this species.</p>	<p>There is no recovery plan for this species however there are 7 priority actions listed for this species within the priority action statement. High priority actions include ensuring the largest hollow bearing trees and standing dead trees are given highest priority for retention and to initiate long term monitoring and conduct further research into the ecology, life history and habitat requirements of this little-known species.</p> <p>Although the proposed activities are not consistent with some of the objectives of the 7 priority actions it is assessed that due to the small area the proposed activities will impact there would be no negative impact on the long-term persistence and recovery of this species.</p>

Little Pied Bat (<i>Chalinolobus picatus</i>)	South-eastern Long-eared Bat / Corben's Long-eared Bat (<i>Nyctophilus corbeni</i>)	Yellow-bellied Sheath-tail Bat (<i>Saccolaimus flaviventris</i>)	Bristle-faced Free-tailed Bat (<i>Mormopterus eleryi</i>)
<p><i>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.</i></p>			
<p>There are currently 36 key threatening processes (KTP's) listed under the TSC Act. The most relevant KTP is the clearing of native vegetation which is listed as a KTP under TSC and EPBC Acts.</p> <p><i>Clearing of native vegetation</i> - The proposed activities will clear approximately 5.598 ha of species habitat. The loss of this relatively small amount of habitat is unavoidable in light of the objectives of the proposed activities and is unlikely to result in the decline of these species in the locality.</p>			
<p>Conclusion</p>			
<p>Based on the consideration of the above factors, the proposed activities are not likely to significantly affect these species.</p>			

Appendix 9

Anabat Call Analysis Report



Microbat Call Identification Report

Prepared for ("Client"):	RPS
Survey location/project name:	Pilliga East State Forest, NSW
Survey dates:	6-16 November 2012
Client project reference:	PR113570-3
Job no.:	RPS-1210
Report date:	18 December 2012

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Methods

Data receipt and processing

Bat calls were recorded over two weeks (6th – 16th November 2012) using Anabat detectors (Titley Scientific, Brisbane). Survey data were downloaded from the detectors by the client and saved as Anabat sequence files (zero-crossing format). A total of 6164 Anabat sequence files were submitted to Balance Environmental for analysis.

Zero-crossing analysis

The Anabat sequence files were viewed using *AnalookW* (Corben 2009), and a representative sub-set (935 calls in total) of all observed call types were extracted for identification. Calls with fewer than four clearly-defined, non-fragmented pulses were excluded from the identification process.

Species identification was achieved manually by viewing sonograms of the extracted calls in *AnalookW* and comparing them with published call descriptions (e.g. Reinhold *et al.* 2001; Pennay *et al.* 2004) and/or with reference calls from southern Queensland and northern New South Wales.

Determination of species' identity was refined by considering probability of occurrence based on general distribution information (e.g. Churchill 2008; van Dyck & Strahan 2008) and/or database records obtained from the Atlas of Living Australia (<http://www.ala.org.au>).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at <http://www.ausbats.org.au/>.

Species nomenclature follows Armstrong & Reardon (2006).

Results

Twelve microbat species were positively identified from this survey data. Up to eighteen species may have been present, but some species could not be reliably identified due to a combination of poor call quality and interspecific similarities in call characteristics.

Table 1 provides a breakdown of which species were recorded on each night by each detector. Where calls were recorded that may have been from more than one species, all potentially-responsible species are shown as "possibly present".

Table 1. Microbat species recorded during the Pilliga East State Forest survey, November 2012.

- ◆ = species positively identified from call data
- = species possibly present, but not reliably identified

Detector:	Anabat 1								Anabat 2							
Date:	06/11	07/11	08/11	09/11	13/11	14/11	15/11	05/11	06/11	07/11	08/11	09/11	12/11	13/11	14/11	15/11
Total sequence files:	560	374	380	82	141	342	946	627	258	170	257	260	428	686	396	257
No. calls identified:	82	47	60	8	33	59	81	46	45	29	47	71	86	154	12	75
SPECIES																
<i>Chalinolobus gouldii</i>	◆	◆	◆	◆	◆	◆	◆		◆	□	◆	◆	◆	◆	◆	
<i>Chalinolobus morio</i>	◆		◆		◆	◆	◆	◆				◆	◆	◆		◆
<i>Chalinolobus picatus</i>	□	□	◆					□		◆	□	□			□	◆
<i>Nyctophilus</i> species	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
<i>Scotorepens balstoni</i>	◆	◆	◆		◆	◆	◆	◆	◆	□	□	◆	◆	◆	◆	
<i>Scotorepens greyii</i>	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
<i>Vespadelus</i> species	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	□	◆	◆	◆	□	◆
<i>Miniopterus schreibersii</i>	□	□				□	□	□	□	□	□	□	□	□	□	□
<i>Tadarida australis</i>		◆	◆		◆	◆	◆	◆		◆	◆	◆	◆	◆		◆
<i>Mormopterus eleryi</i>						□	□				□	□		□		
<i>Mormopterus</i> species 2	◆		◆			□								◆	◆	
<i>Mormopterus</i> species 3	◆		◆		◆	◆	◆	◆	□		◆	◆	◆	◆		□
<i>Mormopterus</i> species 4	◆	◆	◆		◆		◆	◆		◆	◆	◆	◆	◆		◆
<i>Saccolaimus flaviventris</i>	◆	◆	◆	◆	◆		◆			◆	◆	◆	◆	◆		◆

Discussion

The majority of calls were reliably attributed to known species, although several species that are likely to occur in the area have similar call characteristics and are difficult to differentiate in Anabat data. Such calls are attributed to a species group depending on pulse shape, band-width and characteristic frequency (Fc).

Species groupings used in this analysis for calls with low reliability of identification include:

- *Mormopterus* spp. 2 & 3;
- *Mormopterus* spp. 3 & 4;
- *Chalinolobus gouldii* / *Scotorepens balstoni*;
- *C. gouldii* / *S. balstoni* / *Mormopterus* spp.;
- *Chalinolobus picatus* / *Scotorepens greyii*;
- *S. greyii* / *Mormopterus eleryi*
- *Nyctophilus* spp.; and
- *Vespadelus* spp. / *Miniopterus schreibersii*.

Where a species group is identified, all species within the group are listed as “possible” in the results; however, if a species within the group was also identified positively from other calls recorded in the same session, then it is listed as such in Table 1. Identification issues and probability of occurrence for the various group members is discussed below.

Mormopterus species

These species produce mostly flat or slightly-curved, narrow-band call pulses with characteristic frequency (Fc) between 24 and 36 kHz. Characteristic frequency can be used to determine species in many cases (*Mormopterus* sp. 4 Fc=24-27 kHz; *Mormopterus* sp. 3 Fc=29-31 kHz; and *Mormopterus* sp. 2 Fc=34-36 kHz); however calls within the overlap zones between these ranges are attributed to either species 2/3 (Fc=31-33 kHz) or species 3/4 (Fc=27-29 kHz).

Chalinolobus gouldii / *Scotorepens balstoni*

Calls generally have steep, broad-band pulses with Fc of 28-35 kHz. Distinctive inter-pulse frequency alternation usually differentiates *C. gouldii* from the more uniform pulses of *S. balstoni*. Both species were positively identified using these criteria, but a number of calls had inconsistent evidence of alternation and could have been from either species.

C. gouldii / *S. balstoni* / *Mormopterus* spp.

Differentiation is usually on the basis of steep versus flat pulse shapes; however, some calls had pulses of intermediate shape that could have belonged to any of these species.

Chalinolobus picatus / *Scotorepens greyii*

Chalinolobus picatus calls (Fc=39-43 kHz) have steep, broad-band pulses with curved bodies and usually exhibit distinctive frequency alternation between successive pulses. The frequency range and pulse shapes make them very similar to *S. greyii* (Fc=35-40 kHz); however, that species lacks the regular frequency alternation seen in *C. picatus*.

Numerous calls were reliably attributed to *S. greyii* spp. due to their consistent pulse frequencies; but only a few calls had sufficient evidence of alternation to be reliably attributed to *C. picatus*. Many calls in the frequency range were noisy and/or fragmented and could not be reliably attributed to either species.

Scotorepens greyii / *Mormopterus eleryi*

Characteristic frequency (36-38 kHz) and pulse shapes are almost identical in these species and calls are difficult to discriminate. The key differentiating feature seems to be a sharp down-swept tail on the end of a cup-shaped pulse body in *M. eleryi*, compared with no tail and/or less-curved body in *S. greyii*. The latter species was reliably identified in most calls; however, a few calls from several sessions had pulse shapes indicative of, but not positively identified as, *M. eleryi*.

Nyctophilus spp

Long-eared bat calls are readily distinguished from those of other bats; however, the species within the genus cannot be reliably differentiated. Three species potentially occur in the study area, including *N. geoffroyi*, *N. gouldi* and *N. corbeni*. The latter species is a listed threatened species under both the Commonwealth *EPBC Act* and the New South Wales *TSC Act*.

Vespadelus spp. / *Miniopterus schreibersii*

Numerous calls with Fc in the range 43-47 kHz had uniform, short-duration, curved to hooked pulses typical of *Vespadelus* species. It is highly likely that most, if not all, of these calls were from *V. vulturnus*, as the Atlas of Living Australia shows numerous records of that species throughout the Pilliga region. However, nearby records also exist for both *V. baverstocki* (to the west) and *V. regulus* (both east and west) and both of these species produce very similar calls to those of *V. vulturnus*.

Miniopterus schreibersii also calls within the same frequency range, but good quality calls are distinguished by their longer pulse duration, flatter pulse bodies and erratic changes in shape and Fc within the call sequence. A number of calls in this data set had pulse shapes intermediate in shape between those of *Vespadelus* spp. and *M. schreibersii*. The Atlas of Living Australia shows no records for the latter species in the Pilliga East area; however, it has been recorded at two localities further to the west, so should be considered as potentially present in the study area..

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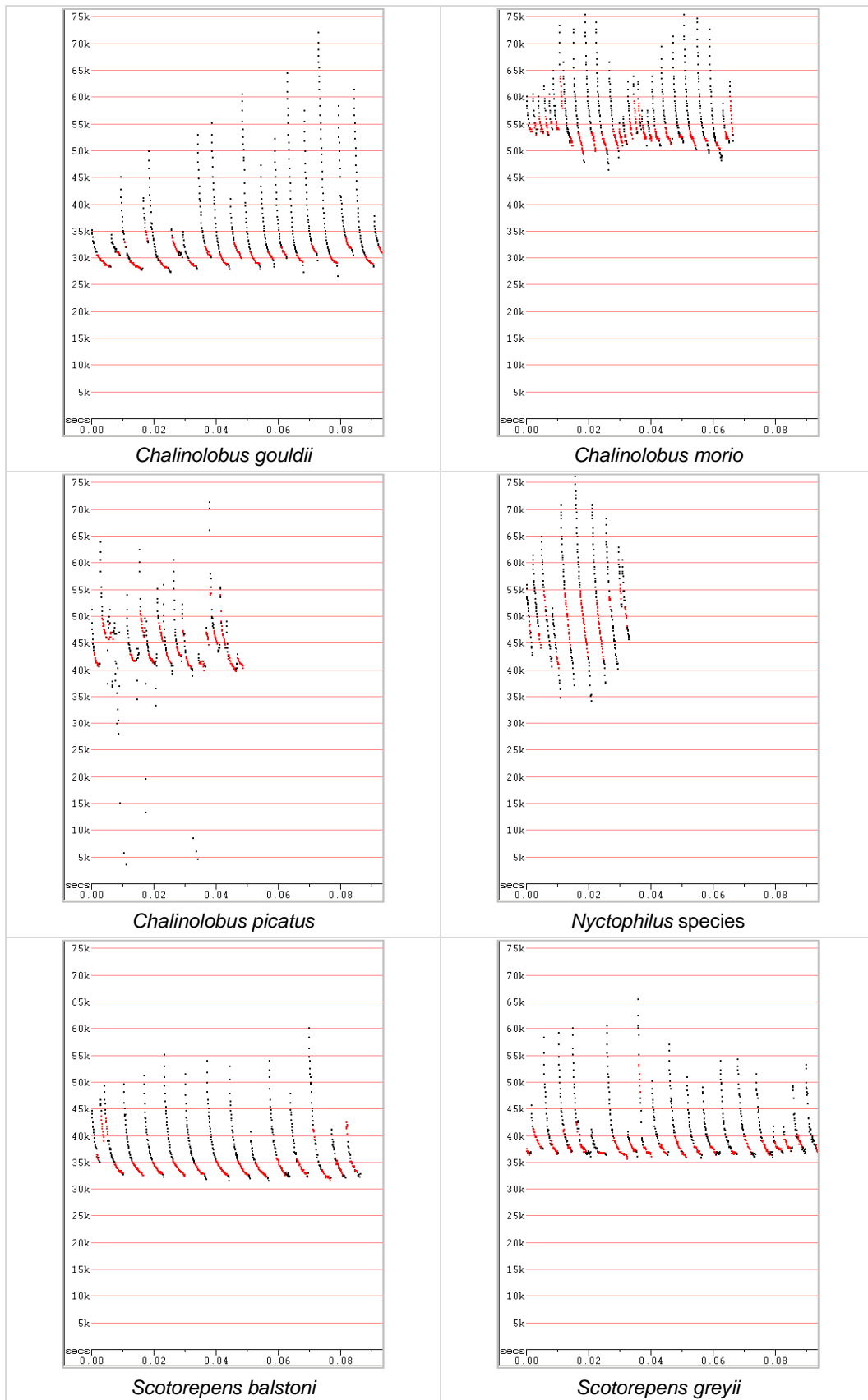


Figure 1 Representative call sequences recorded at Pilliga East State Forest, November 2012. (10msec per tick; time between pulses removed)

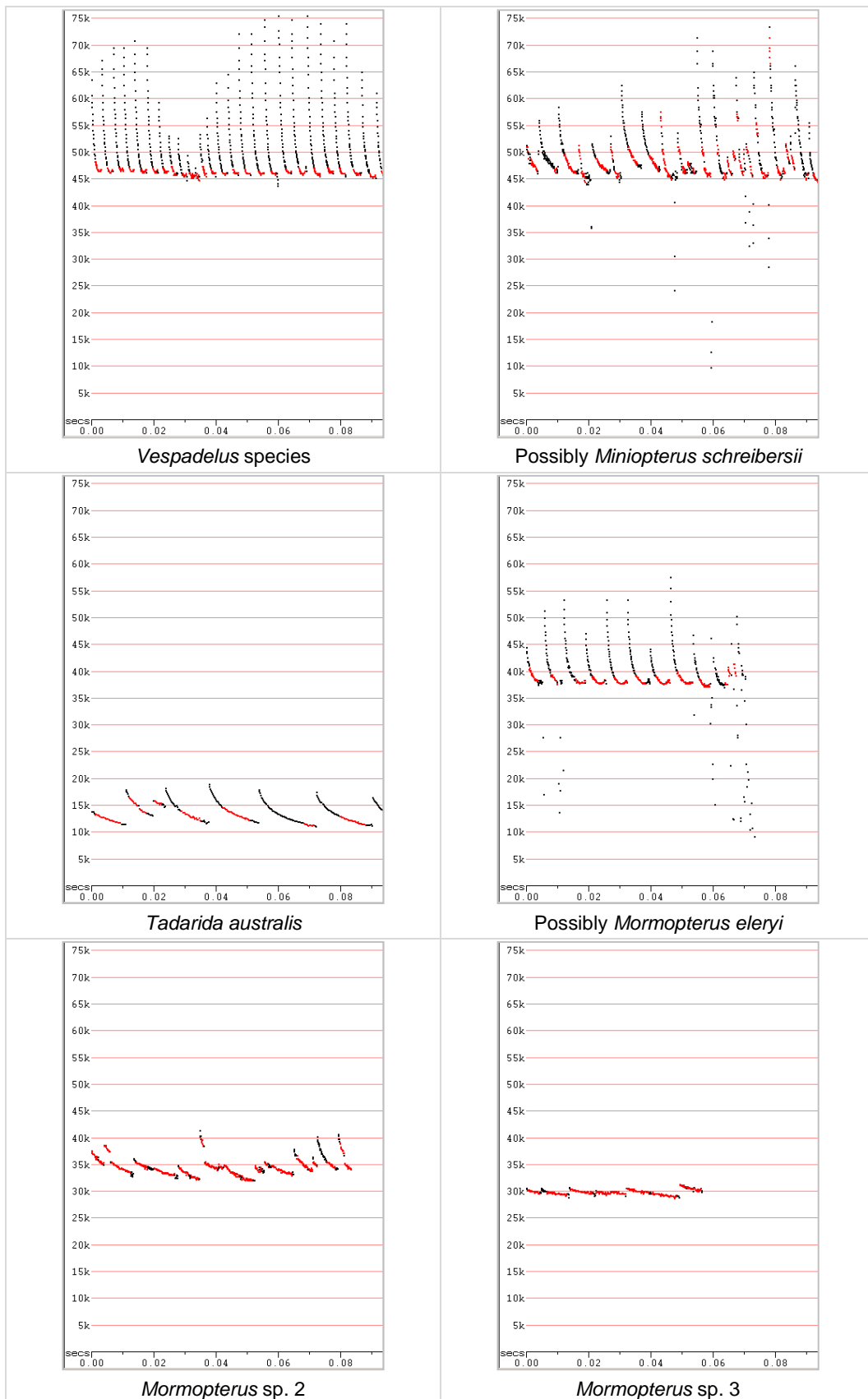


Figure 1 (cont.) Representative call sequences recorded at Pilliga East State Forest, November 2012. (10msec per tick; time between pulses removed)

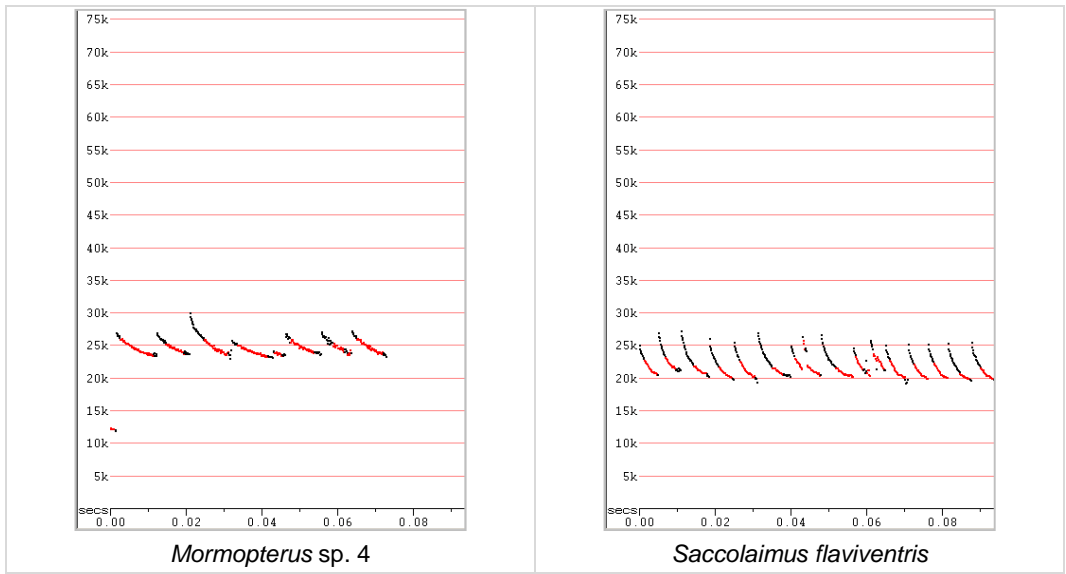


Figure 1 (cont.) Representative call sequences recorded at Pilliga East State Forest, November 2012. (10msec per tick; time between pulses removed)

Appendix 6

Aboriginal and Historical Heritage Due Diligence Report



Aboriginal and Historic Heritage Due Diligence Report

Dewhurst 26-29 Pilot Wells, Pilliga East State Forest, NSW

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Executive Summary

RPS has been engaged by Santos to prepare an Aboriginal and Historic Due Diligence Assessment for four proposed pilot well locations (Dewhurst 26-29) and an associated gas/water gathering system, herein referred to as the 'Project Area', in the Pilliga East State Forest. The Project Area is wholly located within the Narrabri Local Government Area (LGA) and Petroleum Exploration Licence (PEL) 238.

This assessment has been undertaken in accordance with the *Due Diligence Code of Practice for the Protection of Aboriginal Objects* (DECCW 2010) 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 is required (DECCW 2010:2).

The assessment contained in this report goes beyond the requirements of the Due Diligence Code to consider any potential impact on identified historic heritage items within the Project Area and determine if a Statement of Heritage Impact for historic heritage is required.

Investigations under the code have considered:

- a search of the Aboriginal Heritage Information Management System (AHIMS) database, which identified that there were no Aboriginal objects or Aboriginal places in the Project Area;
- a search of the relevant heritage registers and databases, which identified that there were no historic heritage objects or sites within the Project Area;
- a consideration of archaeologically sensitive landscape features and whether or not the proposed activity will occur: within 200 metres of water; within dune systems; on ridge tops and headlands; immediately above or below cliff faces and/or rockshelters/caves. Although a number of creek lines run within and near to the Project Area, they are likely to be ephemeral drainage lines active only in periods of high water and were not active during the visual inspection. Two drainage lines were identified within the Project Area but were not active, and no Aboriginal objects or sites were identified in association with these sensitive landscape features. No other sensitive landscape features were identified in or within 200 metres of the Project Area;
- a desktop assessment including a review of previous archaeological and heritage studies in the vicinity of the Project Area; and
- a visual inspection of the Project Area was undertaken and no Aboriginal objects or historic heritage items were identified.

No Aboriginal objects or places have been identified within 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.

No historic heritage sites have been identified within the Project Area. As such there is no identified impact to historic heritage and therefore a Statement of Heritage Impact is not required.

RECOMMENDATIONS

General mitigations have been provided for undertaking the proposed activity/works as they set out contingency procedures should unexpected Aboriginal objects, skeletal remains or suspected additional historic cultural heritage material be identified during the proposed works. The following recommendations must be followed for undertaking the proposed works.

The proposed works can proceed within the Project Area as planned.

Recommendation 1

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 2

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

Recommendation 3

All works must be undertaken to comply with Part 6 of the *National Parks and Wildlife Act 1974*. 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 must be notified by ringing the Enviroline 131 555 so that the site can be adequately assessed and managed.

Recommendation 4

All works must be undertaken to comply with Part 6 of the *National Parks and Wildlife Act 1974*. 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 the remains are determined to be of Aboriginal origin, the Office of Environment and Heritage 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 5

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

1.0 Introduction

RPS has been engaged by Santos (the proponent) to prepare an Aboriginal and Historic 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").

The assessment contained in this report goes beyond the requirements of the Due Diligence Code to consider any potential impact on identified historic heritage items within the Project Area and determine if a Statement of Heritage Impact for historic heritage is required.

This report has considered the relevant environmental and archaeological information, landscape features, disturbances and the nature of the proposed activities 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, herein referred to as the "Project Area". The Project Area is located wholly within PEL 238 in the Narrabri Local Government Area (LGA).

The Dewhurst 26-29 Project Area is located in the Pilliga East State Forest approximately 44 kilometres south of Narrabri and 37 kilometres west of Boggabri. The Project Area is accessed from Beehive Road. Beehive Road is an unsealed vehicle track which leads east from Garlands Road and the Newell Highway.

The total Project Area is 5.755 hectares. This includes:

- Four well sites and associated lease areas, each 100 x 100 metres in size.
- A 10 metre wide right of way adjacent to Beehive Road to accommodate the central gas and water gathering system. The length of the central gathering system is approximately 1330 metres.
- Four 10 metre wide service corridors from Beehive Road to each lease area to provide access to the lease areas and accommodate the gas and water gathering system, including:
 - » 230 metre long service corridor between Beehive Road and Dewhurst 26
 - » 30 metre long service corridor between the Dewhurst 26 service corridor and Dewhurst 28
 - » 150 metre long service corridor between Beehive Road and Dewhurst 27
 - » 15 metre service corridor between Beehive Road and Dewhurst 29.

1.2 The Proposed Activity

The scope of the proposed activity includes:

- Clearing a 10 metre wide service corridor between Beehive Road and each well site to accommodate access tracks and the gas and water gathering system.
- Constructing access tracks between Beehive Road and each lease area, within the cleared 10 metre wide service corridors.
- Establishing four lease areas each up to approximately 100 by 100 metres in size.
- Clearing a 10 metre wide right of way for the central gathering system along the eastern side of Beehive Road.

- Drilling a pilot well on each lease area, including two vertical pilots wells (Dewhurst 26 and 28) and two tri-stacked lateral pilots (Dewhurst 27 and 29) to intercept the vertical wells.
- Constructing a buried gas and water gathering system within the cleared right of way.
- Installing surface infrastructure on each lease area to allow operation of the pilot wells.
- Installing a flare and water transfer tank on the Dewhurst 28 lease area to manage gas and water from the wells.
- Rehabilitating the lease areas back to the well head and essential infrastructure.
- Operating the pilot wells for the life of PEL 238 or until critical reservoir data is collected.
- Gas and water management during pilot testing.
- Where pilot testing indicates that commercial gas production is not viable, decommissioning the wells and ancillary infrastructure, and completely rehabilitating the lease areas.

Works associated with the proposed activity will involve sub-surface drilling, as well as ground surface disturbance due to the frequent and sustained movement of heavy machinery, ancillary equipment and vehicles within the Project Area. A due diligence assessment is therefore required under S1 and S2a of the Due Diligence Code (DECCW 2010:11). This due diligence assessment was extended to include historic heritage, to determine if this would be impacted by the proposed development works.

1.3 Authorship and Acknowledgements

This report was prepared by RPS Archaeologist Karyn Virgin with contributions from RPS Senior Spatial Analyst Thomas Wilson. Assistance with report production was provided Audrey Churm, RPS Business Support Manager.

The report was reviewed by RPS Technical Director Cultural Heritage, Darrell Rigby.

Fieldwork was undertaken on 14 November 2012 by RPS Graduate Archaeologist Karyn Virgin in conjunction with RPS Senior Ecologist Brad Dreis and RPS Ecologist Hannah Rowan, and in the presence of Wayne Bartesko (Senior Landholder Advisor) of Santos.

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 and Regulations 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 cultural heritage (places and objects) within NSW; the *National Parks and Wildlife Regulation 2009* provides a framework for undertaking activities and exercising due diligence; whilst the *Heritage Act 1977* protects historic heritage.

2.1 *National Parks & Wildlife Act 1974*

The *National Parks & Wildlife Act 1974* (NPW Act) protects Aboriginal cultural heritage within NSW. Protection of Aboriginal cultural 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 \$220,000 for a corporation.

Harm

Under the NPW Act, harm is defined as any act that: destroys, defaces or damages the object; moves the object from the land on which it has been situated; and/or 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 cultural 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 OEHS 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 of Aboriginal cultural heritage. The NPW Regulation outlines the recognised due diligence codes of practice which are relevant 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 *National Parks & Wildlife Regulation 2009* ("NPW Regulation") the following due diligence codes are 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 to be followed. The purpose of the 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 activities are likely to harm Aboriginal objects (if present); and

(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 code listed above. Other requirements under the 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 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), such as this, an activity must proceed with caution. If any Aboriginal objects are identified during the activity, then works should cease in that area and OEHL notified (DECCW 2010:13). The due diligence defence does not authorise continuing harm.

2.3.2 Aboriginal Community Consultation

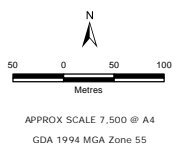
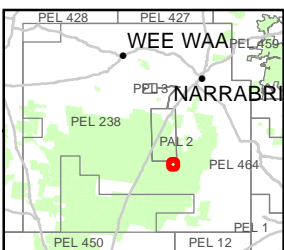
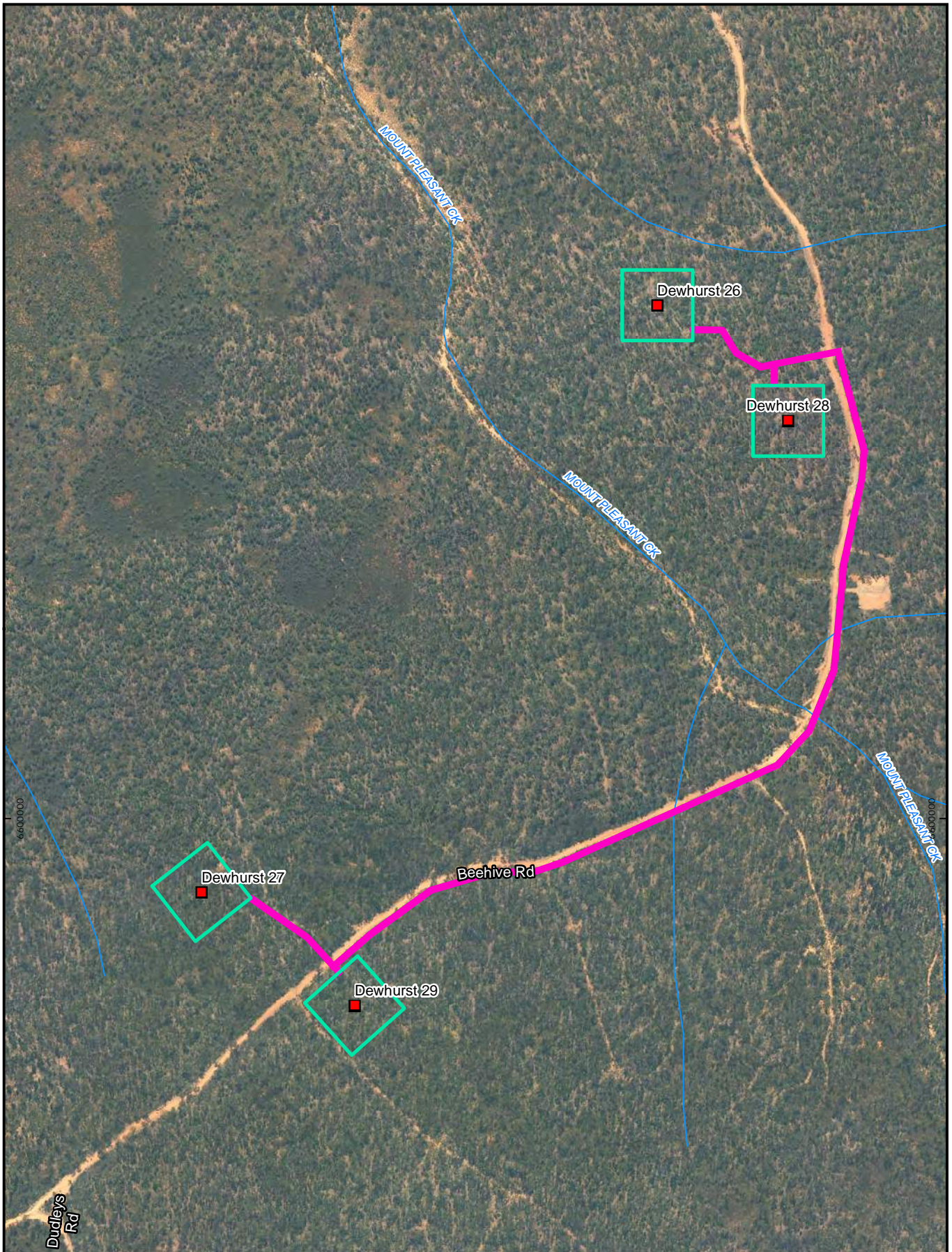
Aboriginal community consultation is not a formal requirement of the due diligence process (DECCW 2010:3); therefore the proponent is not obliged to undertake Aboriginal community consultation.

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

2.4 Heritage Act 1977

This Act protects the natural and historic cultural heritage of NSW with emphasis on historic heritage (such as 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. Further information on historic heritage items associated with the proposed activity and Project Area is provided in Section 4.2 of this report.

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.



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 and proposed Lease from survey report

LEGEND

- Proposed Well
- Access Track / Gathering Line Corridor (10m)
- Watercourse
- Proposed Lease Area



FIGURE 1
Project Area

3.0 Environmental Context

Aboriginal cultural heritage due diligence requires that available knowledge and information is considered and forms part of the desktop assessment required under 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. The Project Area is in the Pilliga sub-region of the Brigalow Belt South Bioregion (NPWS 2003: 137).

3.1.1 Geology and Soils

The Project Area is predominantly located on the Jurassic Pilliga Sandstone geological formation. Pilliga Sandstone is coarse textured and porous quartz sandstone with interbedded claystones, pebble beds and conglomerates (Ward 1999: 14). In areas, Pilliga Sandstone overlies the Walloon Coal Measures, which comprise claystone, shale and siltstone (Geoscience Australia 2012: Online). The landscape is characterised by stepped sandstone ridges with low cliff faces, and broad alluvial floodplains and valleys. There is a high proportion of rock outcrop and long gentle outwash slopes, which are intersected by sandy stream beds and prior stream channels, and interspersed with patches of heavy clay (Wallis 1971: 1).

Soils in the Project Area are typically shallow black earths and red loams on basalts. Extensive harsh texture contrast duplex soils with linear patterns of deep yellow sands and stony red broom earths are typical, as are cracking clay sub-soils. These soils are typical of those derived from the Pilliga Sandstone and are described as highly siliceous. They are characterised by the dense growth of trees and shrubs and high species diversity (Norris 1996: 1).

The geology and soils of the Project Area demonstrates that the landscape prior to European contact was capable of supporting Aboriginal populations by providing resources, and would have been suitable for habitation.

3.1.2 Topography and Hydrology

The Project Area is located within the Pilliga East State Forest on slightly elevated land of around 300 metres Australian Height Datum (AHD) (Department of Lands 1973: Topoview Raster Viewer). Several water sources are located within and near to the Project Area. At their closest, Mount Pleasant Creek and several of its minor tributaries are within 500 metres of the Dewhurst 26-29 lease areas. The proposed gathering system intersects with a section of Mount Pleasant Creek and two unnamed creeks. Cowallah Creek and its tributaries also run within 500 metres of the Project Area, and the high order Bohena Creek is located less than 9 kilometres to the west.

The topography and hydrology of the Project Area demonstrates that the landscape would have been habitable for past populations; the area would have provided sufficient water resources and been fertile enough to sustain human occupation.

3.1.3 Climate

During the last glacial maximum (approximately 30,000-19,000 years ago), large ice sheets covered high latitude Europe and North America and the Antarctic ice sheet was more extensive than today. Sea levels stood some 120-130 metres lower than today (Lambeck et al 2002:343) and the earth's climate was distinctly different from that of the present interglacial conditions. As the ice began to melt climatic conditions began to alter (Lambeck et al 2002:343). This affected the movement and behaviour of past populations within their environs. Sea levels started to rise, with a corresponding increase in rainfall and temperature. Short's (2000:19-21) research suggests the change in climatic conditions reached its peak about 6,000 years ago.

Temperatures stabilised around 1,000 years ago and, 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. New South Wales is described as being in the temperate zone, although the climate undergoes large variations depending on proximity to the coast and mountains (DECCW 2012: 46).

The Project Area is located within the eastern sub-humid region of Australia (NPWS 2000b: 3), which has erratic rainfall and no water surplus available for run-off. In the regional area, rainfall is typically well distributed geographically, however, long droughts and occasional high-intensity, short-duration storms are typical, resulting in an unreliable water source (Ward 1999: 18). Temperatures are at their highest in December (37.1° Celsius) and January (37.3° Celsius) with an average maximum of 28.0° Celsius. The coldest month is July with an average maximum temperature of 20.9° Celsius (BOM 2012: Online).

3.1.4 Flora and Fauna

Although vegetation in the regional area has largely been cleared for agricultural and farming purposes, vegetation at the time of European settlement was partly dry sclerophyll forest and partly grassland (Ward 1999: 11). Remnant vegetation associated with these communities is observable in the vicinity of the Project Area.

In upland areas, tree species such as bumble box, white cypress pine, Blakely's red gum, white box, bull oak and wilga are typical, as are various species of wattle. Wire-grasses are also dominant in these areas, and rough speargrass and slender bamboo grass may also be present. On the alluvial plains, grassland is dominant, with typical species including curly windmill grass, nardoo, common rush, various species of roly-poly and wild turnip. A sparse tree population is also present; belah, a *Casuarina* species is prominent, though bumble box, silver-leaved ironbark, wilga, white cypress pine and bull oak are also typical. Along Galathera Creek, vegetation predominantly comprises common rush, while along the Namoi River, river red gum is common (Ward 1999: 11-12). A full ecological assessment for the Project Area has been prepared by RPS Ecology (RPS 2013) as a companion to this report.

This vegetation community would have provided habitats for a variety of animals and would also have provided potential food and raw material sources for Aboriginal people.

3.1.5 Synthesis of Environmental Context

A review of environmental data indicates that, despite the landscape being highly disturbed by commercial and agricultural pursuits, prior to European occupation there would have been bountiful food, water and other resources available for exploitation by Aboriginal people and in sufficient quantities to sustain a local population.

This synthesis demonstrates that there is potential for Aboriginal cultural heritage sites to be present in the vicinity of the Project Area.

4.0 Heritage Context

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.

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 peoples dates to approximately 40,000 to 60,000 years ago (Dorey 2012: Online).

4.1.1 Aboriginal Heritage Information Management System (AHIMS)

A search was undertaken of the Aboriginal Heritage Information Management System (AHIMS) for the Project Area on 7 November 2012 in accordance with the Due Diligence Code (DECCW 2010:11). The search was conducted with a one kilometre buffer for the following area: GDA, Zone 55: Eastings 752737 – 757853 Northings 6598171 - 6604960.

The AHIMS search revealed that there are **no previously recorded Aboriginal sites** and **no previously declared Aboriginal places** in, or within, one kilometre of the Project Area.

4.1.2 National Native Title Tribunal Registers

A search was undertaken of the National Native Title Tribunal (NNTT) registers on 15 October 2012 in accordance with the *ESG2: Environmental Impact Assessment Guidelines* (NSW Trade and Investment 2012: Online). The search was conducted for the Narrabri LGA (Search Reference: 5153/12sj).

This search identified one native title claimant, being the Gomeroi People. Their claim extends over an area of 111,340 square kilometres and includes the Narrabri Shire Council area. This claim was filed with the NNTT on 20 December 2011 and the notification completed on 15 August 2012. A former claim in 2007 by the Gomeroi Narrabri People was discontinued. Under the *Native Title Act 1993* the valid grant of a freehold estate (other than certain types of Aboriginal and Torres Strait Islander land) on or before 23 December 1996 is known as a 'previous exclusive possession act', meaning that native title has been extinguished over the area. As PEL 238 was granted prior to the commencement of the *Native Title Act 1993* (Cth), there is no further need to comply with the *Native Title Act* for the conduct of the proposed activity

4.1.1 Archaeology and Cultural Heritage Literature Review

A review of previous archaeological and heritage reports is required as part of the desktop assessment and has been undertaken in accordance with the code (DECCW 2010:13). The most relevant publications are outlined below.

Appleton, J. (2009), Narrabri Longwall Stage 2 Project: Aboriginal Heritage Assessment. Whitehaven Coal: Sydney.

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 across the four survey areas. The majority of sites were identified in the longwall panels 8-26 (69), 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.

Trindall, E. (2007), Narrabri Coal Seam Gas Utilisation Project: Aboriginal Heritage Assessment, Santos Limited: Sydney.

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 had 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.

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 kilovolt (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 accessed.

Eight sites and seven 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 suggested that these were from hearths, however conceded later in the report that they were likely the result of European clearing and burning of timber.

4.1.2 Synthesis of Aboriginal Cultural Heritage Context

The AHIMS search conducted for the Project Area returned a negative result, which may be partially explained by the lack of archaeological studies that have been undertaken in the immediate vicinity of the Project Area to date; previous archaeological work in the region suggests that the broader regional area was utilised by past Aboriginal communities. This is in part due to the ready availability of food, water and other resources; the availability of water being a crucial factor in the frequency of occupation, as rivers and creeks are markers of community identity, traditional meeting places and the chosen location of settlements (NPWS 2000a: 36).

Trindall (2007: 5-11) observed the paucity of sites within the Pilliga forest as being a direct consequence of the lack of reliable water, whilst areas outside the Pilliga and closer to permanent water contained a variety of site types. However, the potential for sites remaining must be tempered with previous land disturbances. The AHIMS search results together with previous land disturbances suggests that the potential for Aboriginal objects or places to be present within the Project Area is low.

4.2 Historic Heritage Context

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 Brigalow Belt South Bioregion was first visited by John Oxley, the explorer and then Surveyor General of NSW in 1817, who noted the presence of Aboriginal people and the suitability of the land for agriculture (NPWS 2000b: 133).

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 revealed there to be 20 World Heritage listings (one listing may contain several properties) in Australia, six of which are in NSW. There are **no World Heritage** listings in the Narrabri LGA, and therefore no listings within the Project Area.

4.2.2 National Heritage

The National Heritage List is the lead statutory document for the protection of heritage places considered to have national importance. Listed places are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A search of the Australian Heritage Database with reference to the National Heritage List on 15 October 2012 indicates that there are no heritage items in the town of Narrabri or the Narrabri LGA, on the National Heritage List, and consequently **no national heritage items** within or near to the Project Area.

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 of the Australian Heritage Database with reference to the Register of the National Estate on 15 October 2012 revealed six heritage sites within the Narrabri LGA on the Register of the National Estate. The searches revealed that **no heritage sites** on the Register of the National Estate 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. A search of the Australian Heritage Database with reference to the Commonwealth Heritage List, on 15 October 2012 revealed that one site in the town of Narrabri, the Narrabri Post Office and former Telegraph Office, is listed on the Commonwealth Heritage List. The Post Office and former Telegraph Office is located in Maitland Street, Narrabri, outside of the Project Area. There are **no Commonwealth heritage items** in the Project Area.

4.2.4 State Heritage

The NSW State Heritage Inventory (SHI) database is maintained by the Heritage Branch, Office of Environment and Heritage 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 15 October 2012 revealed one item of State Heritage Significance listed on the NSW State Heritage Register (Narrabri Gaol and Residence, Bowen Street, Narrabri) in the Narrabri LGA. The item is outside of the Project Area and therefore there are **no heritage items of State Significance** 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 heritage items** subject to a s136 order.

4.2.5 Local Heritage

The *Narrabri Local Environmental Plan (LEP) 2012* lists a total of 40 local heritage items, 21 of which are located in Narrabri. A search of the SHI database on 8 January 2013 revealed that 23 items of local heritage significance have been listed by Local Government and State Agencies for the Narrabri LGA, 16 of which are included in the *Narrabri Local Environmental Plan 2012*. There are **no local heritage items** located in or near to the Project Area in either the SHI database or the *Narrabri LEP 2012*.

4.2.6 Synthesis of Historic Heritage Context

Although the Narrabri region has been settled for almost 200 years, the search results indicate that there are no known (i.e. reported, recorded or identified) historic heritage items within or near to the Project Area. It is therefore considered that there are **no historic heritage constraints** associated with the project.

5.0 Visual Inspection and Field Results

The visual inspection (pedestrian survey) of the Dewhurst 26-29 Project Area was undertaken on 14 November 2012 by RPS Archaeologist Karyn Virgin. The Dewhurst 26-29 Project Area is located in the Pilliga East State Forest to the east of the Newell Highway. Access tracks of varying lengths for each of the lease areas were also visually inspected as part of this assessment.

The general area had been partially disturbed by nearby track grading, vehicle access, and past vegetation clearance (Plates 2 & 3). The definition of 'disturbed land' used in this assessment conforms to the definition given by the Office of Environment and Heritage (OEH) (2010:18) and described in Section 6.0 of this report.

As part of the survey, the perimeters of each lease area were inspected and the entire lease areas were surveyed by way of pedestrian transects. These transects were walked at 5-10 metre intervals, and particular attention was given to any ground surface exposures. The service corridors and gathering system right of way were each surveyed in a single linear transect.

Vegetation in the Project Area was dominated by thick regrowth and remnant vegetation, with some mature trees observed including narrow-leaf ironbark, and brown bloodwood (Plates 1-5). Midstorey vegetation was dense within the lease areas, and was dominated by wattle.

Ground surface visibility varied within the Project Area. Within the lease areas, ground surface visibility was limited (less than 10%) due to the density of vegetation and leaf litter (Plates 1-4). Ground surface visibility in the service corridors and gathering system right of way was higher (25-30%) (Plate 6), though in some areas, particularly those featuring dense vegetation, thick grass cover or leaf litter, ground visibility was considerably lower (5-15%). Observed exposures in this component of the Project Area were almost exclusively located along existing vehicle tracks (95%).

Throughout the Project Area, up to five centimetres of loose yellow /orange-red sand overlaid orange clay B horizon subsoil (Plate 6). In many areas, particularly along the tracks, subsoil clay was exposed. As clay subsoil layers are considered to be archaeologically sterile (naturally formed), it was not anticipated that artefacts would be contained within subsoil layers and the potential for intact archaeological deposits to be present in the Project Area was assessed as low to nil.

Lithology in the Project Area comprised primarily shale, ironstone gravels, and sandstone. Chert and quartz pebbles were also noted. The majority of lithic material observed in the Project Area was highly fragmented due to sustained vehicle movement and previous track grading in the area, and none appeared suitable for stone tool manufacture.

A dry drainage line was observed in the Project Area at location 755199E – 6600137N (Plate 7), and a segment of Mount Pleasant Creek, also dry, was observed at location 755784E – 6603744N (Plate 8). These drainage lines, both of which intersect Beehive Road and the proposed service corridor and gathering system right of way, were thoroughly inspected for any evidence of Aboriginal sites or objects; none were identified. No water courses were identified in any of the lease areas.

Although two drainage lines were identified within the Project Area during the visual inspection, no evidence of Aboriginal objects or sites was observed. The immediate Project Area was therefore unlikely to have been suitable for continuous habitation. The land may still have been used for transient or temporary purposes, though evidence of such use would not necessarily be left in the archaeological record. Further, past land uses such as vegetation clearance, track grading and other commercial pursuits may have damaged and/or destroyed any remnant evidence of such transient occupation. The archaeological potential for the Project Area was therefore assessed as very low to nil.

No Aboriginal sites or objects were identified in the Project Area, and no historic heritage items or sites were identified. Additionally, no trees exhibiting evidence of cultural modification/scarring were observed and no vegetation with natural heritage significance was identified.

6.0 Impact Assessment

Although a number of drainage lines run through and near to the Project Area, they are likely to be ephemeral drainage lines active only in periods of high water and were not active during the visual inspection. No Aboriginal objects or sites were identified in association with these sensitive landscape features. As aforementioned, vegetation was observed to comprise regrowth vegetation in many areas, with no trees suitable for cultural modification or scarring identified.

RPS description of the landscape conforms to the Office of Environment and Heritage (OEH) definition of disturbed land (2010:18):

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.

The RPS assessment confirms the land to be disturbed and the archaeological sensitivity and research potential to be low to nil.

No Aboriginal places, sites or objects were identified within the Project Area during the visual inspection. Likewise, no culturally modified trees were observed in the Project Area. The extensive disturbance of the Project Area due to past land uses and the distance from larger, more permanent water sources suggest that the potential for any Aboriginal cultural heritage material to be present within the Project Area is low to nil.

The results of the AHIMS and historic heritage searches together with the visual inspection indicate that there are no identified Aboriginal objects or historic 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 **no historic heritage sites were identified within the Project Area, there is no identified risk of harm to historic heritage and a Statement of Heritage Impact is not required.**

The proposed works can proceed within the Project Area as planned.

7.0 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 following recommendations must be followed for undertaking the proposed works.

RECOMMENDATIONS

The proposed works can proceed within the Project Area as planned.

Recommendation 1

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 2

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

Recommendation 3

All works must be undertaken to comply with Part 6 of the *National Parks and Wildlife Act 1974*. 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 must be notified by ringing the Enviroline 131 555 so that the site can be adequately assessed and managed.

Recommendation 4

All works must be undertaken to comply with Part 6 of the *National Parks and Wildlife Act 1974*. 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 the remains are determined to be of Aboriginal origin, the Office of Environment and Heritage 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 5

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

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9.0 Plates



Plate 1 : Ground surface visibility and vegetation in the Dewhurst 26 Lease Area



Plate 2 : Ground surface visibility, vegetation and disturbance in the Dewhurst 27 Lease Area



Plate 3 : Ground surface visibility, vegetation and disturbance in the Dewhurst 28 Lease Area



Plate 4 : Ground surface visibility and vegetation in the Dewhurst 29 Lease Area



Plate 5 : Vegetation within the service corridor/gathering system right of way



Plate 6 : Area of ground surface exposure and soils within the Project Area



Plate 7 : Unnamed drainage line intersecting the service corridor/gathering system right of way



Plate 8 : Section of Mount Pleasant Creek intersecting the service corridor/gathering system right of way

10.0 Terms, Definitions, and 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)
LEP	Local Environment Plan
NPWS	National Parks and Wildlife Service
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)
Project Area	Project Area is the area subject to the proposed activity
REF	Review of Environmental Factors

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 Chief Executive (formerly 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 and 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; and
- (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 (now Chief Executive) 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 (now Chief Executive) to issue and 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: 07 November 2012

Attention: Karyn Virgin

Email: karyn.virgin@rpsgroup.com.au

Dear Sir or Madam:

AHIMS Web Service search for the following area at Datum :GDA, Zone : 55, Eastings : 752737 - 757853, Northings : 6598171 - 6604960 with a Buffer of 1000 meters. conducted by Karyn Virgin on 07 November 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

National Native Title Tribunal Search Results



National
Native Title
Tribunal



16 October 2012

Karyn Virgin
Graduate Archaeologist
RPS Australia East Pty Ltd
Level 9, 17 York Street
SYDNEY NSW 2000

Sydney Office, Operations East

Level 16, Law Courts Building,
Queens Square
Sydney NSW 2000
GPO Box 9973
Sydney NSW 2000
Telephone (02) 9227 4000
Facsimile (02) 9227 4030

Our Reference: 5153/12sj

Your Reference: PR113359-2, PR114737-2, PR114487-2, PR114695-2

Dear Karyn

Native Title Search Results of Narrabri Shire Local Government Area

Thank you for your search request of 15 October 2012 in relation to the above area.

Search Results

The results provided are based on the information you supplied and are derived from a search of the following Tribunal databases:

Register Type	NNTT Reference Numbers
Schedule of Applications (unregistered claimant applications)	Nil.
Register of Native Title Claims	NC2011/006
National Native Title Register	Nil.
Register of Indigenous Land Use Agreements	Nil.
Notified Indigenous Land Use Agreements	Nil.

I have included a Register Extract and NNTT Registers fact sheet to help you understand the search result.

Please note that there may be a delay between a native title determination application being lodged in the Federal Court and its transfer to the Tribunal. As a result, some native title determination applications recently filed in the Federal Court may not appear on the Tribunal's databases.

The search results are based on analysis against external boundaries of applications only. Native title applications commonly contain exclusions clauses which remove areas from within the

external boundary. To determine whether the areas described are in fact subject to claim, you need to refer to "Area covered by claim" section of the relevant Register Extract or Application Summary and any maps attached.

Search results and the existence of native title

Please note that the enclosed information from the Register of Native Title Claims and/or the Schedule of Applications is **not** confirmation of the existence of native title in this area. This cannot be confirmed until the Federal Court makes a determination that native title does or does not exist in relation to the area. Such determinations are registered on the National Native Title Register.

Tribunal accepts no liability for reliance placed on enclosed information

The enclosed information has been provided in good faith. Use of this information is at your sole risk. The National Native Title Tribunal makes no representative, either express or implied, as to the accuracy or suitability of the information enclosed for any particular purpose and accepts no liability for use of the information or reliance placed on it.

If you have any further queries, please contact me on 1800 640 501.

Yours sincerely



Sylvia Jagtman | SENIOR CASE MANAGEMENT ASSISTANT

National Native Title Tribunal | Sydney Office, Operations East

Telephone (02) 9227 4013 | Facsimile (02) 9227 4030 | Email sylvia.jagtman@nntt.gov.au

Freecall 1800 640 501 | www.nntt.gov.au

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NATIONAL NATIVE TITLE TRIBUNAL

Application Information and Extract from the Register of Native Title Claims

Application Information

Application numbers: Federal Court number: NSD2308/11
NNTT number: NC11/6

Application name: Gomeroi People

Registration history: Registered from 20/01/2012.

Register Extract (pursuant to s.186 of the *Native Title Act 1993*)

Application filed with: Federal Court of Australia

Date application filed: 20/12/2011

Date claim entered on Register: 20/01/2012

Applicants: Ms Patricia Margaret Boney, Mr Norman McGrady, Ms Susan Smith, Mr Michael Anderson, Mr William Robinson, Mr Raymond Welsh, Mr Richard Green, Mr Greg Griffiths, Ms Elaine Binge, Mr Alfred Priestley, Mr Leslie Woodbridge, Mr Craig Trindall, Mr Burrul Galigabali, Mr Bob Weatherall, Ms Elizabeth Allan, Mr Ray Tighe, Mr Anthony Munro, Ms Madeline McGrady, Mr Jason Wilson

Address for service: NTSCORP Limited
Unit 1a Suite 2.02
44-70 Rosehill Street
REDFERN NSW 2016
Phone: (02) 9310 3188
Fax: (02) 9310 4177

Additional Information:

Not Applicable

Area covered by the claim:

The area covered by the application ('the Application Area') comprises all the land and waters within the external boundaries described in Attachment B and depicted in the map at Attachment C.

The Application Area description and map have been prepared with the assistance of the Geo-Spatial Unit of the National Native Title Tribunal. The area covered by this application does not include the areas described at point B below.

(B) Areas within the external boundaries not covered by the application

1. The area covered by the application excludes any land and waters covered by past or present freehold title or by previous valid exclusive possession acts as defined by section 23B of the Native Title Act 1993 (Cth)
2. The area covered by the application excludes any land and waters which are:
 - a) a Scheduled interest;
 - b) a freehold estate;
 - c) a commercial lease that is neither an agricultural lease nor a pastoral lease;
 - d) an exclusive agricultural lease or an exclusive pastoral lease;
 - e) a residential lease;
 - f) a community purpose lease;
 - g) a lease dissected from a mining lease and referred to in s 23B(2)(c)(vii) of the Native Title Act (1993) (Cth); and
 - h) any lease (other than a mining lease) that confers a right of exclusive possession over particular land or waters.
3. Subject to paragraphs 5 and 6, the area covered by the application excludes any land or waters covered by the valid construction or establishment of any public work, where the construction or establishment of the public work commenced on or before 23 December 1996.
4. Subject to paragraphs 5 and 6, exclusive possession is not claimed over areas which are subject to valid previous non-exclusive possession acts done by the Commonwealth, State or Territory.
5. Subject to paragraph 7 below, where the act specified in paragraphs 2, 3 and 4 falls within the provisions of:
 - a) s 23B(9) Exclusion of acts benefiting Aboriginal Peoples or Torres Strait Islanders;
 - b) s 23B(9A) Establishment of a national park or state park;
 - c) s 23B(9B) Acts where legislation provides for non-extinguishment;
 - d) s 23B(9C) Exclusion of Crown to Crown grants; and
 - e) s 23B(10) Exclusion by regulation;the area covered by the act is not excluded from the application.
6. Where an act specified in paragraphs 2, 3 and 4 affects or affected land or waters referred to in:
 - f) s 47 Pastoral leases etc covered by claimant application;
 - g) s 47A Reserves covered by claimant application;
 - h) s 47B Vacant Crown land covered by claimant application;the area covered by the act is not excluded from the application.
7. The area covered by the application excludes land or waters where the native title rights and interests claimed have been otherwise extinguished.

Persons claiming to hold native title:

The Gomeroi People are the native title claim group on whose behalf the Applicant makes this application. The native title claim group comprises all the descendants of the following apical ancestors: Thomas Pitt (who was born in 1838).

Billy Barlow (who was born in Tycannah in 1835)

Peter James Cutmore (who was born in Tycannah in 1849)

James Swan (who was born in Combadello in 1825)

Harriett Wyndham (who was born in Mungie Bundie in 1863)

William Levy (who was born in Terry Hie Hie in 1867)
Sally Nerang (who was born in Terry Hie Hie circa 1840)
Eliza Barlow (who was born in Terry Hie Hie circa 1860)
Kitty Dangar (who was born in Walgett in 1837)
William Clark (who was born in Collarenebri in 1845)
Murray Ippai (who was born in Collarenebri)
Mary Ann Ippai (who was born on the Barwon River)
Edward Morgan (who was born in Dungalear in 1855)
Nancy Morgan (who was born in Dungalear in 1861)
Robert Nicholls (who was born in Collarenebri in 1842)
Frank Mundy (who was born in Collymongle in 1872)
Lena Combo (who was born in Mogil Mogil in 1876)
Jack Thunderbolt (who was born in Walgett in 1847)
Betsy Yates (also known as Polly Yates and Polly Burras) (who was born on the Barwon River circa 1860)
Jenny (who was born in Walgett circa 1840)
Dick Silk (who was born in Walgett)
Fred Parker (who was born in Gingie in 1864)
Murray Rook (who was born in Collarenebri in 1865)
Ethel Tinker (who was born in Mercadool circa 1878)
Emily McPherson (who was born in Collarenebri in 1892)
Billy Whitford (who was born in 1828)
King Robert Cobbler (who was born in Mogil Mogil in 1855)
Billy Wightman (who was born in Kunopia in 1813)
John McGrady (who was born in Moree in 1853)
William Dennison (who was born in Kunopia in 1843)
Charlie Dennison (who was born circa 1846-1866)
Alice Dennison (who was born in Moree circa 1863 -1873)
Lucy Long (who was born in Boomi circa 1850)
Minnie Lance (who was born in Boomi circa 1868), Harry Denham
Charles Cubby (who was born on the Boomi River)
Sarah Wilson (also known as Sarah Murphy and Sarah Witman) (who was born in Kunopia in 1868)
Reuben Bartman (who was born in Boomi in 1876)
Billy Dunn (who was born in Mungindi)
William Edwards (who was born in Thallon)
Queen Susan (who was born in Welltown)
Phoebe Munday-Williams (who was born in Mungindi in 1864)
George Bennett (who was born in Mungindi in 1873)
Amelia Bell (also known as Amelia Brown) (who was born in Bingara in 1862)
William Snow (who was born in Tamworth or Moonbi in 1855)
Francis Snow (who was born in Tamworth in 1858)
Matilda Wyndham (who was born in Bingara in 1842)
Thomas Duke (who was born in Bingara in 1847)
Teasie Griffen (also known as Jessie Griffen and Ellen Griffen) (who was born in Barraba in 1859)
Mary Anne Hammond (who was born in Tamworth in 1836)
Elizabeth Guest (also known as Eliza Gillan) (who was born in Liverpool Plains in 1840)
Jane Maloney (who was born in Walhallow in 1838)
Mary Ann Healy (who was born in Murrurundi in 1829)
Thomas Taylor (who was born in Coolah in 1836)
Elizabeth Loder (also known as Elizabeth Bates) (who was born in Murrurundi in 1843)
Sarah Gatehouse (who was born in Aberdeen in 1835)
William Duncomb (who was born in Muswellbrook circa 1830)
John Morris Tighe (who was born in 1852)
Susan Bishop-Young (also known as Susan Dangar) (who was born in Warialda)
Sarah Murphy (who was born in 1846)
Thomas French (who was born in Scone in 1825)
John Thomas Bates (who was born on the Mooki River in 1840)
Alexander Nean (who was born in Liverpool Plains in 1843)

David Johnson (who was born in Cassilis circa 1838-1844)
 Mary Orr (also known as Nellie Orr) (who was born in Garrawilla in 1853)
 Julia Campbell (who was born on the Castlereagh River circa 1833-1834)
 Annie Jendis (who was born in Burbagate in 1845)
 Harriet Munro (who was born in Gunnedah in 1867), Alice Eliza Natty (who was born on the Namoi River near Boggabri in 1857)
 James Tighe (who was born in Coonabarabran in 1842)
 William Tighe (who was born in Toorawandi in 1844)
 Patrick Tighe (who was born in Coonabarabran in 1852)
 Jane Tighe (who was born in 1864)
 Mary Jane Griffin (also known as 'Old Ibidah')
 Susan Slater (who was born in Coonabarabran in 1839)
 Thomas Leslie (who was born in Kirban circa 1850-1854)
 James Leslie (who was born in born Armatree in 1853)
 Ellen Fuller (who was born in Rockgidgiel in 1854)
 Sarah Hughes (who was born in Coonabarabran circa 1834-1859)
 James Cole (who was born in NSW in 1845)
 Mary Ann Hall (who was born on the Castlereagh River in 1840)
 Samuel Bruce Smith (who was born in Tambar Springs circa 1860 – 1863)
 Elizabeth Ann Smith (who was born in Mullaley in 1866)
 William Green (also known as William Edwards) (who was born in Kings Plains near Inverell in 1853)
 Angus Landsborough (who was born in Newstead in 1867)
 Patrick Landsborough (who was born in Newstead in 1872)
 Alec Brown (who was born in Bundarra in 1873)
 Margaret King (who was born in Gummin Gummin near Gulargambone circa 1854-1858)
 William James King (who was born in Coonabarabran circa 1851-1853)
 Florence May Blackman (also known as Louisa Florima Blackman) (who was born in Coonamble in 1846)
 Euphemia Blackman (who was born on the Castlereagh River in 1851)
 Henry Arthur Yates (who was born in Coonamble in 1860)
 Betsy Yates (who was born in Wingadee in 1854)
 Annie Day (who was born in Bullarora Station near Coonamble circa 1871-1876)
 Army Toomey (who was born in Wingadee near Coonamble in 1886)
 Maria Clare Hall (who was born in Gulargambone circa 1830-1833)
 Thomas Carney (who was born in Tonderburine in 1852)
 Jim Duncan (who was born in Coonamble in 1854)
 Thomas Reid (who was born in Cuttabri in 1840)
 Thomas John Blacklock (who was born in Terembone in 1851)
 Thomas Dangar (who was born in Drilldool in 1857), Harry Doolan (who was born in Pilliga in 1855)
 George Green (who was born in 1851)
 Lucy Barr (who was born in Boggabri in 1851)
 Peggy Reid (who was born in Cuttabri in 1836)
 Julia Jane Saunders (who was born in Wee Waa in 1845)
 William Newman (who was born in Cuttabri in 1807)
 Emma Dingwell (who was born in Bograh Station near Narrabri in 1864)
 Kate Purser (who was born in Narrabri in 1863)
 Mary Ann Lucas (who was born in Millie in 1840)
 Frank Maybury (who was born in Killarney Station near Narrabri circa 1840)
 Charlotte Hagan (also known as Charlotte Keegan) (who was born in Narrabri circa 1850-1870)
 Nellie Combo (who was born in Wallah Station near Narrabri in 1850)
 Mary Peake (who was born in Narrabri in 1848)
 Descendants include persons who are descendants by adoption according to traditional law and custom.
 See further information attached and marked 'A'.

Registered native title rights and interests:

The following Native Title Rights & Interests were entered on the Register on 20/01/2012:

1. Where exclusive native title can be recognised (such as areas where there has been no prior extinguishment of native title or where s.238 and/or ss.47, 47A and 47B apply), the Gomeroi People as defined in Schedule A of this application, claim the right to possession, occupation, use and enjoyment of the lands and waters of the application area to the exclusion of all others subject to the valid laws of the Commonwealth and the State of New South Wales.
2. Where exclusive native title cannot be recognised, the Gomeroi People as defined in Schedule A of this application, claim the following non-exclusive rights and interests including the right to conduct activities necessary to give effect to them
 - (a) the right to access the application area;
 - (b) the right to use and enjoy the application area;
 - (c) the right to move about the application area;
 - (d) the right to camp on the application area;
 - (e) the right to erect shelters and other structures on the application area;
 - (f) the right to live being to enter and remain on the application area;
 - (g) the right to hold meetings on the application area;
 - (h) the right to hunt on the application area;
 - (i) the right to fish in the application area;
 - (j) the right to have access to and use the natural water resources of the application area;
 - (k) the right to gather and use the natural resources of the application area (including food, medicinal plants, timber, tubers, charcoal, wax, stone, ochre and resin as well as materials for fabricating tools, hunting implements, making artwork and musical instruments);
 - (m) the right to share and exchange resources derived from the land and waters within the application area;
 - (n) the right to participate in cultural and spiritual activities on the application area;
 - (o) the right to maintain and protect places of importance under traditional laws, customs and practices in the application area;
 - (p) the right to conduct ceremonies and rituals on the application area;
 - (q) the right to transmit traditional knowledge to members of the native title claim group including knowledge of particular sites on the application area;
3. The native title rights and interests referred to in paragraph 2 do not confer possession, occupation, use or enjoyment of the lands and waters of the application area to the exclusion of all others.
4. The native title rights and interests are subject to and exercisable in accordance with:
 - (a) the laws of the State of New South Wales and the Commonwealth of Australia including the common law;
 - (b) the rights (past or present) conferred upon persons pursuant to the laws of the Commonwealth and the laws of the State of New South Wales; and
 - (c) the traditional laws and customs of the Gomeroi People for personal, domestic and communal purposes (including social, cultural, religious, spiritual and ceremonial purposes).

Register attachments:

1. Map of the area covered by the application , Attachment C of the Application, 1 page - A4 , 20/12/2011.
2. Description of area covered by the application, Attachment B of the Application, 5 pages - A4 , 20/12/2011.

Note: The Register may, in accordance with s.188 of the Native Title Act 1993, contain confidential information that will not appear on the Extract.



Searching the NNTT Registers in New South Wales

Search service

On request the National Native Title Tribunal will search its public registers for you. A search may assist you in finding out whether any native title applications (claims), determinations or agreements exist over a particular area of land or water.

In New South Wales native title cannot exist on privately owned land including family homes or farms.

What information can a search provide?

A search can confirm whether any applications, agreements or determinations are registered in a local government area. Relevant information, including register extracts and application summaries, will be provided.

In NSW because we cannot search the registers in relation to individual parcels of land we search by local government area.

Most native title applications do not identify each parcel of land claimed. They have an external boundary and then identify the areas not claimed within the boundary by reference to types of land tenure e.g., freehold, agricultural leasehold, public works.

What if the search shows no current applications?

If there is no application covering the local government area this only indicates that at the time of the search either the Federal Court had not received any claims in relation to the local government area or the Tribunal had not yet been notified of any new native title claims.

It does not mean that native title does not exist in the area.

Native title may exist over an area of land or waters whether or not a claim for native title has been made.

Where the information is found

The information you are seeking is held in three registers and on an applications database.

National Native Title Register

The National Native Title Register contains determinations of native title by the High Court, Federal Court and other courts.

Register of Native Title Claims

The Register of Native Title Claims contains applications for native title that have passed a registration test.

Registered claims attract rights, including the right to negotiate about some types of proposed developments.

Register of Indigenous Land Use Agreements

The Register of Indigenous Land Use Agreements contains agreements made with people who hold or assert native title in an area.

The register identifies development activities that have been agreed by the parties.

Application summaries

An application summary contains a description of the location, content and status of a native title claim.

This information may be different to the information on the Register of Native Title Claims, e.g., because an amendment has not yet been tested.

How do you request a search?

A search request form is available on the Tribunal's web site at:
<http://www.nntt.gov.au/registers/search.html>
Mail, fax or email your request to the Tribunal's Sydney registry, identifying the local government area/s you want searched.

Email: NSWEnquiries@nntt.gov.au

Fax: (02) 9227 4030

Address: GPO Box 9973, Sydney NSW 2001

Phone: (02) 9227 4000

Appendix 7

Groundwater Impact Assessment



Dewhurst 26-29 Pilot

Narrabri Gas Project

Santos Ltd

29 January 2013



Dewhurst 26-29 Pilot

Document: 462587C Version: 1

Narrabri Gas Project

Santos Ltd

29 January 2013

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Document history

Dewhurst 26-29 Pilot

Narrabri Gas Project

Santos Ltd

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
0	11/01/2013	Draft	Thomas Neame	Tom Henderson	
1	29/01/2013	Final	Thomas Neame	Tom Henderson	Camilla West

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Appendix

1 Introduction

1.1 Dewhurst 26-29 Pilot Trial

Santos Ltd (Santos) is in the process of preparing a Review of Environmental Factors (REF) as part of exploration activities for the Dewhurst 26-29 Pilot to inform the development of the Narrabri Gas Project. A Groundwater Impact Assessment (GIA) is required for the proposed pilot as part of this REF.

Halcrow Australasia Pty Ltd (Halcrow, a CH2M Hill company) provided its fee proposal to conduct exploration phase numerical groundwater flow modelling work for Santos in its letter of 31 October 2012. Instruction to proceed with the proposed work was granted by Santos by means of its purchase order no. 920534-157, dated 7 November 2012.

1.2 Scope of work

The scope of work was prepared to meet the requirements for groundwater impact assessment within the context of a REF. The *ESG2: Environmental Impact Assessment Guidelines for exploration, mining and petroleum activities subject to Part 5 of the Environmental Planning and Assessment Act 1979* (DTIRIS 2012) indicates that cognisance should be given to the assessment of impact to groundwater, without providing explicit guidance. However, the draft *Additional Part 5 REF Requirements for Petroleum Prospecting* (DTIRIS 2011) indicates the following requirements:

1. Describe and quantify any proposed extraction of groundwater
2. Describe any potential for aquifer interference (including changes to inter-aquifer connectivity)
3. Assess the impact of that extraction or interference on existing groundwater resources, including groundwater dependent ecosystems.
Note: Depending on the type of activity, volume of extraction proposed and potential for cumulative impacts, hydro-geological modeling may be required to assess these impacts.
4. Quantify the potential impacts on users of these groundwater resources.

To meet these requirements, Halcrow defined a scope comprising the numerical re-modeling of the locality of the proposed pilot using its existing Narrabri groundwater flow model to yield the following data:

1. An estimate of the volume of water to be extracted from the coal seam targets during the pilot trial;
2. The potential water level drawdown in strata overlying the coal seam targets associated with the proposed exploration activities; and
3. The potential flux of water induced between formations, specifically the groundwater sources specified in the Aquifer Interference Policy

Note: this report documents the impacts of coal seam gas (CSG) water extraction but does not consider the potential changes to aquifer interconnectivity wrought by CSG wells installation or operation.

1.3 Limitations

This report has been prepared for the exclusive use of Santos Ltd (the Client) in accordance with the Scope of Work agreed between Halcrow/CH2M HILL and the Client. No warranty, expressed or implied, is made. There are no beneficiaries to this report other than the Client, and no other person or entity is entitled to rely upon this report without the written consent of Halcrow/CH2M HILL, and a written agreement limiting Halcrow/CH2M HILL's liability.

This report is based, in part, on unverified information supplied to Halcrow/CH2M HILL from several sources. Halcrow/CH2M HILL does not guarantee the completeness or accuracy of this information, and assumes no responsibility for errors or omissions related to this externally supplied information.

Groundwater data are likely to vary spatially and to fluctuate with time. Interpretations have been made based on incomplete data and partial knowledge of the subsurface and of the groundwater conditions therein. The interpretations made in this report are based on the data supplied and alternative interpretations may be applicable following the realisation of new or additional data.

2 Background

2.1 Narrabri Gas Project

The Narrabri Gas Project is located approximately 16 km southwest of the township of Narrabri and approximately 13 km west of Baan Baa in New South Wales (NSW), as shown in Figure 2-1.

The Project lies within Petroleum Exploration License (PEL) 238 and Petroleum Assessment Lease (PAL) 2, both held by Santos, as illustrated in Figure 2-1. The Project will primarily target CSG reserves associated with Early Permian coal seams of the Maules Creek Formation, located at depth in the northern portion of the Gunnedah Basin.

2.2 Previous Work

A groundwater impact assessment (GIA) has been prepared for the Narrabri Gas Project. In order to predict impacts to groundwater, a numerical groundwater flow model was constructed, calibrated and subsequently used for simulating CSG water extraction. The Narrabri Gas Project numerical groundwater flow model simulated a CSG well field of approximately 390 wells spread across the project area. This study utilises the numerical model developed as a part of the Narrabri Gas Project GIA.

2.3 Dewhurst 26-29 Pilot

The Dewhurst 26-29 Pilot is located within the southern part of Petroleum Exploration Lease 238 (PEL 238) immediately south of the south eastern corner of Petroleum Assessment Lease 2 (PAL 2) as illustrated in Figure 2-1. The pilot consists of four surface positions comprising two vertical wells (Dewhurst 27 and 29) and two directionally-drilled wells which extend laterally in-seam (Dewhurst 26 and 28). Dewhurst 26 and 28 are both triple-lateral wells within the Bohena, Namoi and Rutley seams which will intersect Dewhurst 27 and 29 respectively. The locations of wells included in this pilot are presented in Table 2-1.

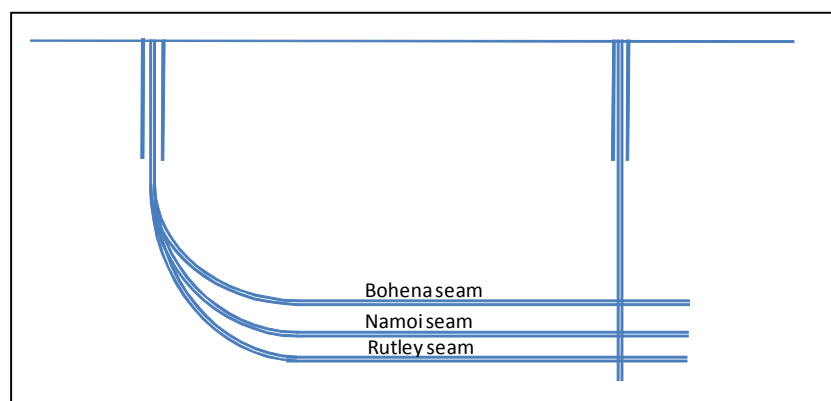
Table 2-1: Pilot wells

Well name	Easting	Northing	Type	Target
Dewhurst 26	754309	6599871	Triple-lateral	Bohena, Namoi & Rutley
Dewhurst 27	754943	6600649	Vertical	
Dewhurst 28	754525	6599701	Triple-lateral	Bohena, Namoi & Rutley
Dewhurst 29	755159	6600479	Vertical	

(Surface location in MGA Zone 55 Projection)

The “build zone” where the initially-vertical well is incrementally inclined to penetrate the seam and continue in-seam laterally is understood to consist of approximately 200 m horizontal distance. The lateral is designed to continue in-seam beyond the intersection with its corresponding vertical counterpart by approximately 100 m.

Triple-lateral well arrangement



In order to conduct the pilot, water will be extracted from the target seam(s) from all four pilot wells simultaneously. Water production will be increased in three steps over the first 200 days reaching a maximum predicted rate of 299 m³/day by day 208 from inception of the pilot. After this it will be maintained between 267 m³/day and 299 m³/day averaging of 275 m³/day to day 700. From day 700, it is predicted to decline steadily to approximately 180 m³/day by the end of the pilot, 1096 days from inception. A hydrograph of the proposed abstraction rate is presented in Figure 2-2.

2.4 Environmental Values

The pilot is located within the Pilliga Forest. There are a range of Environmental Values (EVs), to which the potential impacts from the pilot CSG water extraction must be considered. These include registered groundwater extraction bores, Groundwater Dependent Ecosystems (GDEs) and the aquifers which support these EVs.

Figure 2-3 illustrates the distribution of registered groundwater extraction bores within the vicinity of the Narrabri Gas Project. The majority of these bores are completed within, and extract water from, the alluvial deposits of the Lower and Upper Namoi Alluvium, which together form the NSW Upper and Lower Namoi groundwater source. A limited number are completed within, and extract water from, the Pilliga Sandstone which in this area belongs to the NSW GAB groundwater source. To the east of the Narrabri Gas Project, a few bores are completed within, and extract water from, the Triassic strata, principally the Napperby Formation, which forms part of the NSW Murray Darling Basin Porous Rock groundwater source, the same groundwater source from which the CSG water extraction is proposed to occur.

Figure 2-4 illustrates the locations of Groundwater Dependent Ecosystems within the vicinity of the Narrabri Gas Project area. Both Eather Spring and Hardy's Spring are understood to comprise recharge rejection springs associated with the junction of the unconfined Pilliga Sandstone and the underlying Purlawaugh Formation. The Purlawaugh Formation acts as a barrier to further percolation of groundwater within the Pilliga Sandstone and thus groundwater discharges at this interface. Hence fluctuations within the strata underlying the Purlawaugh Formation are unlikely to be able to influence the characteristics of flow in either spring.

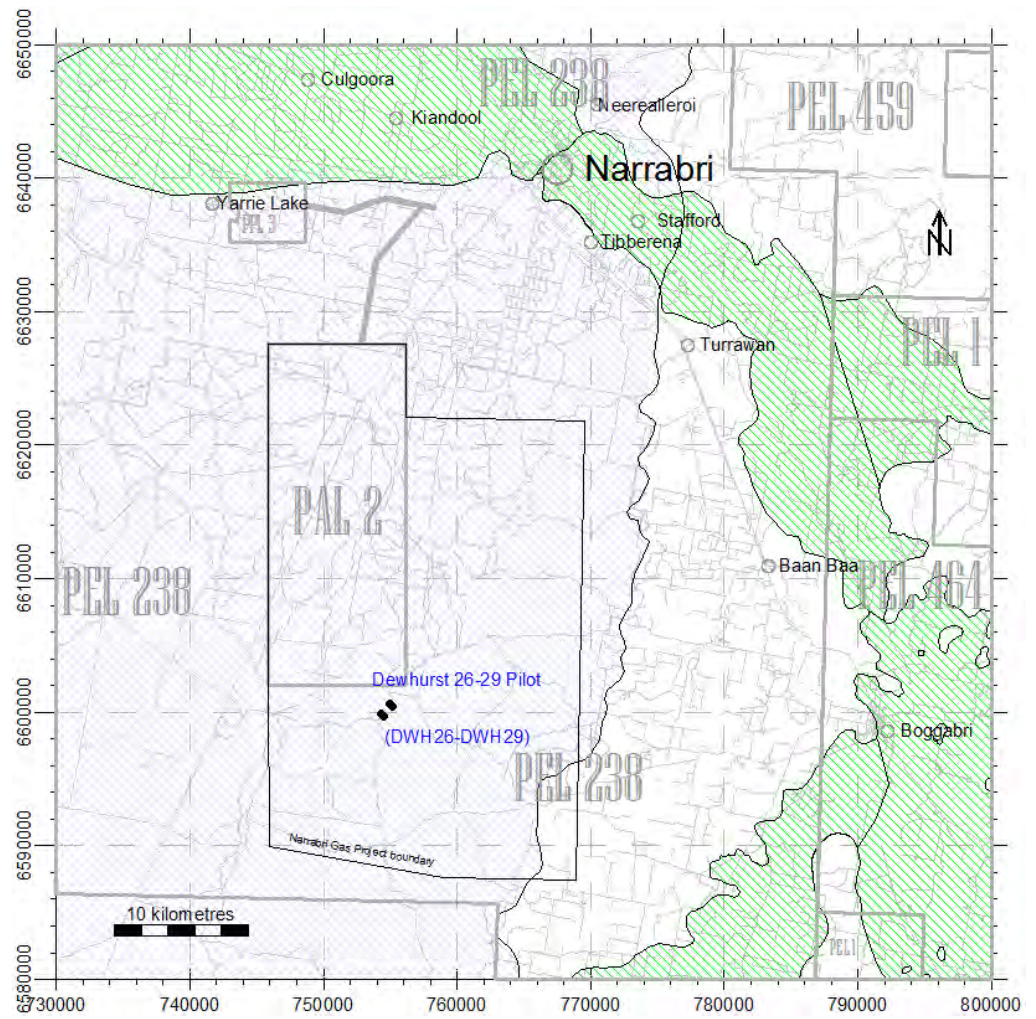


Figure 2-1: Site location plan

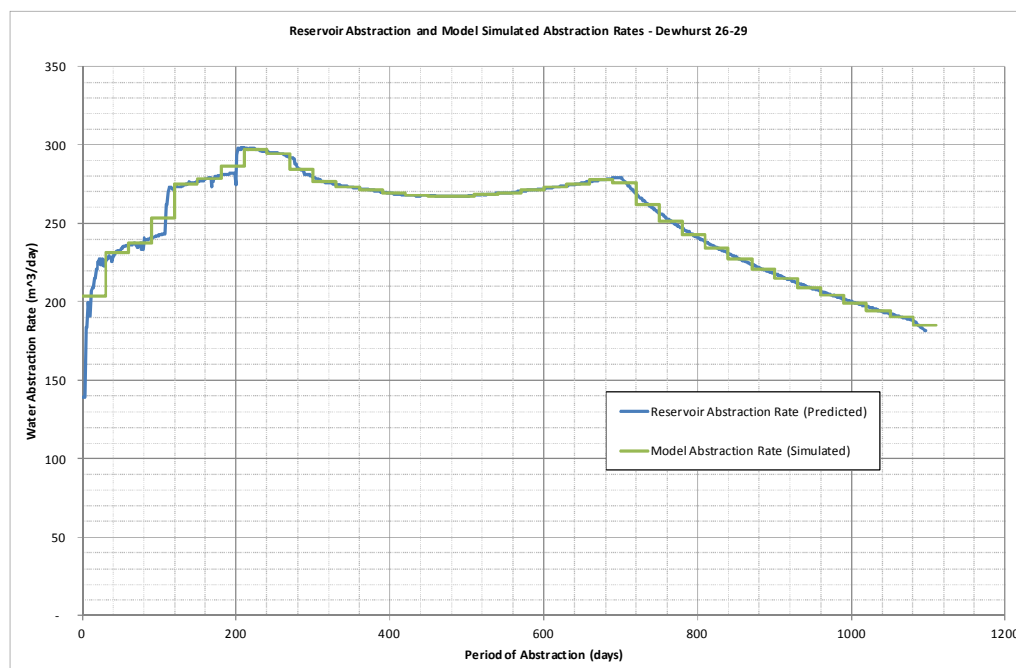


Figure 2-2: Predicted water curve: Dewhurst 26-29 Pilot (after Santos, 2012)

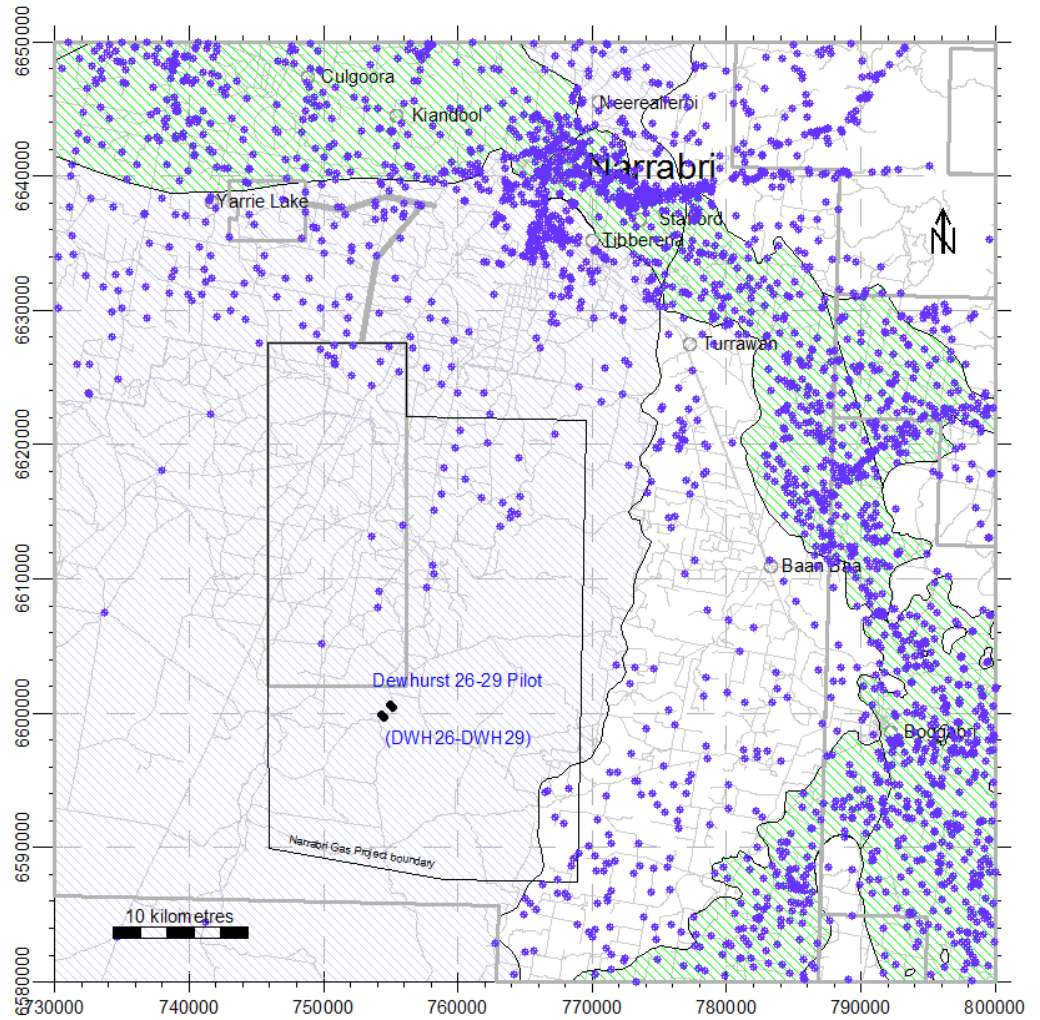


Figure 2-3: Location of Registered Groundwater Extraction Bores (showing water sharing plan boundaries)

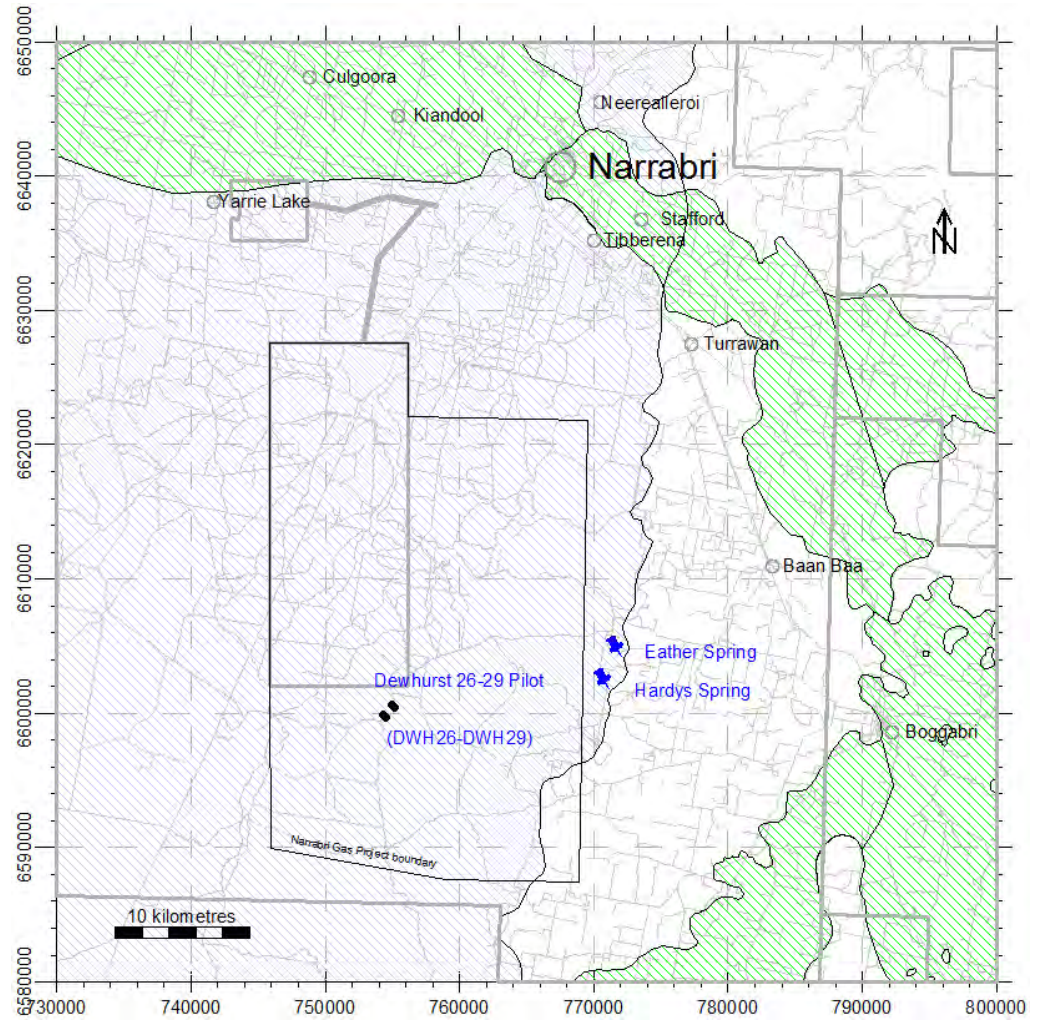


Figure 2-4: Location of Groundwater Dependent Ecosystems

3 Water Management relevant to the Exploration Assessment

3.1 Water Management Act 2000

The *Water Management Act 2000* dictates how both surface and groundwater resources are managed in NSW. Its main objective is to ensure the future and present supply of water sources at a state level, and protect, develop and restore water resources in the region. It controls the extraction of water, how water can be used, the construction of works such as dams and weirs and the carrying out of activities on or near water sources.

The main tool the Act provides for in managing the State's water resources are Water Sharing Plans (WSP). The Act will generally apply to surface and groundwater sources in areas where a WSP is in place (and outlined in Section 3.2 below). In areas where there is no WSP, the *Water Act 1912* applies. A number of WSPs apply to the Narrabri Gas Project area and surrounding region.

An amendment to the Act requires new mining and petroleum exploration activities that take more than three megalitres per year from groundwater sources to hold a water access licence.

A water licence is required under the Act where any aquifer interference activity (discussed further in Section 3.3) causes:

- the removal of water from a water source; or
- the movement of water from one part of an aquifer to another part of an aquifer; or
- the movement of water from one water source to another water source, such as:
 - From an aquifer to an adjacent aquifer; or
 - From an aquifer to a river/ lake; or
 - From a river/ lake to an aquifer.

3.2 Water Sharing Plans

Water Sharing Plans (WSPs) are legally prepared documents currently used to manage water resources in NSW. They establish the rules for sharing water between different water users (including the environment) and between different types of users. WSPs also set rules for water trading, and dealing with access licences and access regimes for the extraction of water from the groundwater and surface water systems. WSPs set out the overall limit on surface and ground water that can be extracted from the source and the circumstances in which access licences can be granted.

There are three 'hard rock' WSPs: the *GAB groundwater sources WSP*, the *MDB porous rock groundwater source WSP* and the *MDB fractured rock groundwater sources WSP*; two 'unconsolidated deposits' WSPs: the *Upper & Lower Namoi groundwater sources WSP* and the *GAB shallow groundwater sources WSP*; and one 'surface water' WSP: the *Upper Namoi & Lower Namoi Regulated River WSP*. WSPs for the various water sources

relevant to the Narrabri Gas Project area are illustrated in Figure 3-1 and outlined in the following sections.

3.2.1 NSW Great Artesian Basin Groundwater Sources WSP

The plan covers all water contained in the sandstone aquifers of the NSW portion of the GAB. The basin has been divided into five groundwater sources – the Eastern and Southern Recharge Groundwater Sources in the non-artesian eastern fringes of the basin, and the Surat, Warrego and Central Groundwater Sources in the artesian western part of the basin, where water flows naturally to the surface.

The pilot study area is defined as being within the Southern Recharge Groundwater Source of the GAB. The Permian strata from which the CSG extraction is targeted underlie the GAB and are excluded from this WSP. However, the proposed exploration activities have the potential to affect the groundwater resources addressed under this WSP through induced vertical leakage of groundwater from the overlying GAB formations due to vertical propagation of depressurisation effects from the Permian coal measures.

3.2.2 NSW Murray-Darling Basin Porous Rock Groundwater WSP

The *Porous Rock Groundwater WSP* covers porous rock aquifers within the MDB not already included in other WSPs. In particular, this WSP establishes the framework for licensing and allocation of groundwater resources within the Gunnedah-Oxley Basin porous rock formations, and sets limits on the long-term abstraction rates. The WSP includes an allowance for additional entitlements for aquifer water access licences to allow CSG activities to proceed in catchments which are subject to the WSP.

The pilot study area overlies this WSP domain and water will be extracted from Early Permian Maules Creek Formation strata forming a part of the Gunnedah Basin which is managed under the terms of this WSP.

3.2.3 NSW Murray-Darling Basin Fractured Rock Groundwater WSP

The *Fractured Rock Groundwater WSP* has designated water management areas in the fractured rock aquifers of the MDB. These cover basalts and fold belts that have groundwater flow due to the fractures within the rock. Three water sources within this plan fall within the Namoi catchment and at or beyond the limits of the model domain surrounding the Narrabri Gas Project study area. These water sources are associated with the fractured rocks of the New England Fold Belt, Liverpool Ranges Basalt and Warrumbungle Basalt.

There is a very limited extent of basalt in the Bohena Sub-basin and as such it is considered unlikely that depressurisation associated with the exploration activities will extend to any of these fractured rock management areas.

3.2.4 NSW Upper and Lower Namoi Groundwater Sources WSP

This WSP covers the Upper and Lower Namoi Groundwater Sources including all water contained in the unconsolidated alluvial aquifers associated with the Namoi River and its tributaries. These deposits are present at surface in the vicinity of the pilot study area. The current WSP aims to reduce the Available Water Determinations (AWD) for Supplementary Water Access Licences as well as reducing the extraction

limit. This is in response to the observed decline in groundwater levels in the Upper and Lower Namoi alluvium.

3.2.5 NSW Great Artesian Basin Shallow Groundwater Sources WSP

This WSP covers groundwater resources associated with the alluvial formations and all other formations to a maximum depth of 60 metres below the surface of the ground which overlie the NSW GAB formations and are not included in any other WSP. Of the sources identified, the GAB Surat Shallow Groundwater extends across the north-western quarter of the Narrabri Gas Project area. This WSP allows for granting of water access licences as part of a controlled allocation order made in relation to any unassigned water in this water source.

3.2.6 Upper Namoi and Lower Namoi Regulated River WSP

This plan applies to two water sources – the Upper Namoi including the regulated river sections between Split Rock Dam and Keepit Dam and the Lower Namoi including the regulated river sections downstream of Keepit Dam to the Barwon River, including the regulated sections of the Gunidgera/ Pian system.

While not directly relevant to the Narrabri Gas Project, this WSP would apply if CSG extraction or CSG water management activities were found to have an impact on these surface water sources. However, it is considered unlikely that depressurisation associated with the exploration activities will extend to any of these management areas.

3.3 NSW Aquifer Interference Policy

The purpose of the *NSW Aquifer Interference Policy* is to explain the water licensing and approval processes and requirements for aquifer interference activities under the *Water Act 1912* and the *Water Management Act 2000*, and other relevant legislative frameworks.

The Policy adopts the definition of an aquifer interference activity from the *Water Management Act 2000*, which includes any of the following:

- the penetration of an aquifer;
- the interference with water in an aquifer;
- the obstruction of the flow of water in an aquifer;
- the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations; and
- the disposal of water taken from an aquifer (for example, as a consequence of mining or CSG activities).

The Policy specifies that the volume of water taken from a water source(s) as a result of an activity is required to be predicted prior to the granting of water access licences and aquifer interference approvals. Aquifer interference approvals will not be granted unless the Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to an aquifer or its dependent ecosystems. The volume of water to be produced during the pilot is stated in Section 4.5.

“Minimal impact consideration” criteria are specified in the policy for highly productive and less productive groundwater sources. The Pilliga Sandstone and the Upper and Lower Namoi Alluvium groundwater sources are considered to be “Highly Productive” groundwater sources. The Permo-Triassic Gunnedah Basin strata groundwater sources are considered to be “Less Productive” groundwater sources.

The criteria determining minimal impact for highly productive alluvial groundwater sources are:

for the water table: *“Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic ‘post-water-sharing-plan’ variations, 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule to the relevant water sharing plan; or a maximum of a 2 m decline cumulatively at any water supply work”.*

for water pressure: *“A cumulative pressure head decline of not more than 40% of the ‘post-water-sharing-plan’ pressure head above the base of the water source to a maximum of a 2 m decline, at any water supply work”.*

The criteria determining minimal impact for highly productive porous rock groundwater sources are:

for the water table: *“Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic ‘post-water-sharing-plan’ variations, 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule to the relevant water sharing plan; or a maximum of a 2 m decline cumulatively at any water supply work”.*

for water pressure: *“A cumulative pressure head decline of not more than a 2 m decline, at any water supply work”.*

The criteria determining minimal impact for highly productive GAB Southern Recharge groundwater source are:

for the water table: *“Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic ‘post-water-sharing-plan’ variations, 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule to the relevant water sharing plan; or a maximum of a 2 m decline cumulatively at any water supply work”.*

for water pressure: *“Less than 0.2 m cumulative variation in the groundwater pressure, allowing for typical climatic ‘post-water-sharing-plan’ variations, 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule to the relevant water sharing plan; or a cumulative pressure level decline of not more than 15 m allowing for typical climatic ‘post-water-sharing-plan’ variations”.*

The criteria determining minimal impact for less productive porous rock groundwater sources are:

for the water table: *“Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic ‘post-water-sharing-plan’ variations, 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule to the relevant water sharing plan; or a maximum of a 2 m decline cumulatively at any water supply work”.*

for water pressure: *“A cumulative pressure head decline of not more than a 2 m decline, at any water supply work”.*

The method of determining the magnitude of the cumulative variation percentages, “allowing for typical climatic ‘post-water-sharing-plan’ variations” and the data with which to establish the percentages remain unclear. Consequently, thresholds of significance of water level decline or pressure head decline of 0.5 metres and 2.0 metres have been considered by which to determine significant impact on highly productive and less productive groundwater sources, respectively, in this assessment. Where no impact is considered likely, this has been stated.

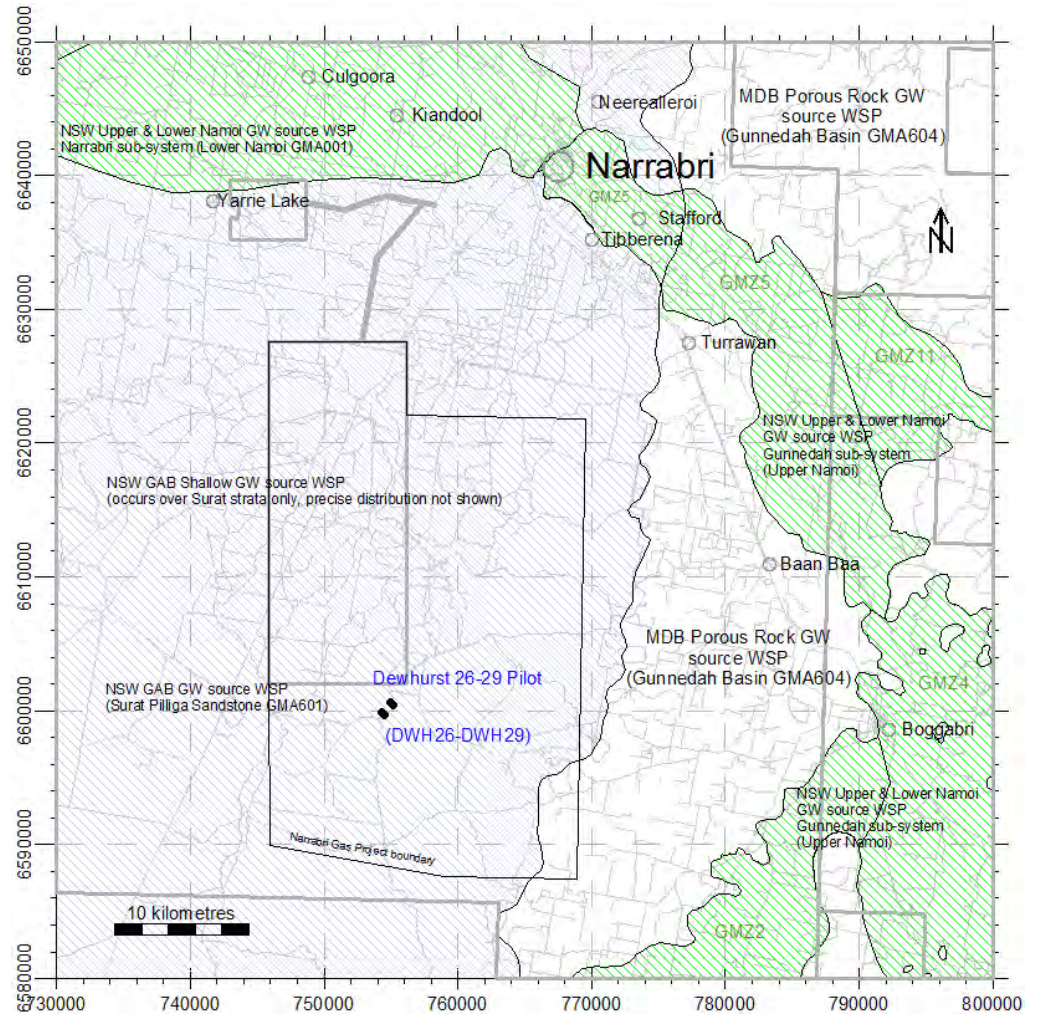


Figure 3-1: Water Sharing Plans relevant to Dewhurst 26-29 Pilot

4 Methodology for the predictive modelling

4.1 Hydrogeological Conceptual Model

The Dewhurst 26-29 Pilot occupies a small area to the immediate south of the south eastern corner of PAL 2, within the central southern part of the Narrabri Gas Project area and as such, the same hydrogeological conceptual model applies as that described for the Narrabri Gas Project groundwater impact assessment, and précised below.

CSG extraction is proposed from the Early Permian coal seams of the Maules Creek Formation. The Maules Creek Formation rests within the base of a basement depression known as the Bohena Trough and strata of this formation onlap onto the sides of the trough (Figure 4-1). Overlying the Maules Creek Formation are strata belonging to the Middle Permian Porcupine and Watermark Formations of the Millie Group, successively overlain by Late Permian Black Jack Group strata and the Triassic Digby, Napperby and Deriah Formations infilling the Bohena Trough. The Triassic strata outcrop to the east of the Narrabri Gas Project area in the vicinity of Baan Baa. Together, the Permo-Triassic strata represent the Gunnedah Basin sediments and comprise the NSW Murray Darling Basin Porous Rock Water Sharing Plan referred to in Section 3.

Overlying the Permo-Triassic strata across almost the entire Narrabri Gas Project area and including the vicinity of the Dewhurst 26-29 Pilot lie strata belonging to the Jurassic period comprising sediments of the southern extension of the Surat Basin known as the Coonamble Embayment, including the Purlawaugh Formation and the Pilliga Sandstone. The Pilliga Sandstone comprises over 200 m of sandstones with intercalated terrigenous clastic strata and is considered to represent the basal intake beds of the Great Artesian Basin. It is referred to as the Southern Recharge Beds of the Great Artesian Basin in the area south of Moree. The Purlawaugh Formation comprises up to 100 m of claystone and siltstone and is considered to represent a barrier to vertical groundwater flow between the Pilliga Sandstone aquifer and the underlying Permo-Triassic strata.

Incised into both the Gunnedah Basin deposits to the east and the Surat Basin deposits to the west and north of the Narrabri Project Area are Quaternary sediments belonging to the Upper Namoi Alluvium and Lower Namoi Alluvium respectively. Weakly consolidated or unconsolidated sediments of the successively shallower Cubbaroo, Gunnedah and Narrabri formations occupy the palaeochannel of the River Namoi flowing northwards in the east and westwards in the north of the Project Area. The Upper and Lower Namoi Alluvium together constitute the NSW Upper and Lower Namoi Groundwater Sources Water Sharing Plan, although it is subdivided into the Gunnedah sub-system south of Narrabri (effectively the Upper Namoi Alluvium) and the Narrabri sub-system west of Narrabri (effectively the Lower Namoi Alluvium).

Drill Stem Test evidence across the area encompassing the Narrabri Gas Project area indicates that strata at depth are over-pressured by comparison with shallower strata, such that a hydraulic gradient exists from strata within the Maules Creek Formation upwards through the Black Jack Group into the Triassic strata and overlying Pilliga Sandstone. This overpressuring is understood to originate from recharge of the

basement around Mt Katapur to the east of the Bohena Trough and to be maintained by the successively overlying layers of strata exhibiting low hydraulic conductivity.

4.2 Existing Numerical Model

A quasi-3-dimensional numerical groundwater flow model was constructed using MODFLOW-2005 and the graphical user interface Groundwater Vistas™ interface V6.22 Build 2 and calibrated in order to provide a basis for predictive simulations for the CSG water extraction relating to the Narrabri Gas Project. A comprehensive description of the modelling process undertaken to conduct simulations for the Narrabri Gas Project is contained within the Narrabri Gas Project Groundwater Impact Assessment (Halcrow, 2012). However, to provide clarity of reference for this document, Table 4-1 illustrates the relationship between stratigraphy and model layering.

Table 4-1: Stratigraphy and model layering correlation table

Epoch	Hydrostratigraphic unit	Model layer
Quaternary	Alluvium	1
Jurassic	Pilliga Sandstone	2 and 3
	Purlawaugh Fm	4
	Garrawilla Volcanics	
Triassic	Deriah Fm	5 and 6
	Napperby Fm	
	Digby Fm	
Permian	Black Jack Group	7, 8 and 9
	Millie Group (Porcupine Fm & Watermark Fm)	10
	Upper Maules Creek Fm	11
	Target coal seam (Bohena seam)	12
	Lower Maules Creek Fm	13
Pre-Permian	Basement	14

The Dewhurst 26-29 Pilot lies entirely within the domain of the Narrabri Gas Project model and the same hydrogeological conceptual model applies and as such it was seen as appropriate to adopt the Narrabri Gas Project numerical groundwater flow model to conduct simulations specifically for this pilot.

4.3 Grid refinement

The cell spacing of the regional groundwater flow model discussed above included a minimum cell spacing of 500 m by 500 m. It was considered appropriate to facilitate more accurate representation of the curvature of the water table, in the vicinity of the localised hydraulic stress imposed by the Dewhurst 26-29 Pilot, to refine the model grid in the vicinity of the pilot wells. Hence, in the vicinity of the pilot, the model cells have been refined horizontally to 50 m by 50 m.

4.4 Configuration of Pilot Trial

As described in Section 2, the pilot includes two well pairs (Dewhurst 26/27 and Dewhurst 28/29) each consisting of a triple-lateral well (Dewhurst 26 and Dewhurst 28) and a vertical intersecting counterpart (Dewhurst 27 and Dewhurst 29).

Within the Narrabri Gas Project GIA, four potential target seams were recognised within the Maules Creek Formation including the Bohena seam, the primary target, and the Namoi, Rutley and Parkes seams, additional targets.

Within the regional numerical model, these seams were subsumed into one layer, equal in thickness to the sum of the thickness of each of the four seams. Hence the single lateral CSG pilot well has been represented in the model in a similar manner. The in-seam extent of the lateral well was identified and MODFLOW well boundaries applied to the respective cells in Layer 12 of the model, corresponding to the Bohena Seam / Maules Creek coals. Figure 4-2 illustrates schematically the pilot model representation. Individual MODFLOW well nodes are illustrated in yellow shading, whilst the grey circles and emanating lines indicate the pilot well ground locations and in-seam trajectories. Hence each well pair consists of 15 well boundary nodes.

The consequence of the inclusion of the Parkes seam with the pilot target seams (Bohena, Namoi & Rutley) is considered in more detail in Section 5-2.

Evaluation of the Dewhurst 26-29 Pilot required simulation by MODFLOW using two separate approaches. Depressurisation of the target seam was accomplished using MODFLOW drains (specified head) at 30 locations to simulate depressurisation of the coal seam in accordance with the technical pilot schedule. Depressurisation was simulated using drains because using simulated wells (specified flux) did not achieve the expected drawdown. This is due to excessive simulated leakage between model layers. The use of drains to simulate depressurisation, in lieu of wells, is commonplace, and allows simulation of conditions which approximate those estimated by reservoir engineering calculations for the target seam. The model schedule for lowering the piezometric head of the target layer at each drain node is given in Figure 4-2. However, due to the excessive leakage described above, fluxes out of the model domain associated with the drains are overestimated. As such, simulation of actual fluxes, was accomplished using MODFLOW wells to simulate extraction rates. Evaluation of water level or pressure impacts were evaluated using the simulation with drains. Evaluation of inter-layer flux impacts were evaluated using the simulation with wells.

4.5 Abstraction rates

The regional groundwater flow model included 430 MODFLOW well boundary cells to represent an approximation to the proposed field development plan and from which to extract water in accordance with the proposed water curve. These were removed and the water curve illustrated in Figure 2-2 was used to describe the extraction schedule for the pilot wells.

The abstraction schedule was divided into 37 equal duration stress periods equating to the 1096 day duration of the pilot programme. The mean extraction rate calculated for each stress period was divided equally between the 30 well boundary cells. The extraction rates applied to individual well nodes during each stress period are listed in Figure 4-2.

The total quantity of water proposed to be abstracted during the pilot is estimated as 276 ML (275,784 m³), equating to an average of 251.6 m³/day over the 1096 day duration of the proposed pilot.

4.6 Initial conditions

The regional numerical groundwater flow model was calibrated to steady-state conditions. However, in order to provide an appropriate array of initial head conditions within the refined grid model developed for the Dewhurst 26-29 Pilot modelling, the model was re-run under steady-state conditions with no extraction simulated. This produced a revised calibrated steady-state model (DWH26-29_SS) similar to the original regional model but with head values calculated in each layer for all additional model cells created through the grid refinement process.

The calculated steady-state heads were used as the initial conditions from which to commence transient simulations of CSG water extraction using both drains (DWH26-29_drn) and wells (DWH26-29_wel), as described previously in Section 4.4.

4.7 Model simulation duration

The duration of the pilot was understood from the extraction schedule to be 1096 days, equivalent to 3 years. Consequently the well nodes within the model simulation were active for the same duration. Following 1096 days, the well nodes were switched off and the hydraulic heads within the model domain allowed to recover over a period of 537 years, equating to the simulation period of the regional Narrabri Gas Project model that formed the basis of this modelling exercise.

The duration of recovery was designed to ensure that impacts arising due to releases from aquifer storage at late times, delayed yield, induced by greater-than-negligible drawdown due to water extraction, could be captured.

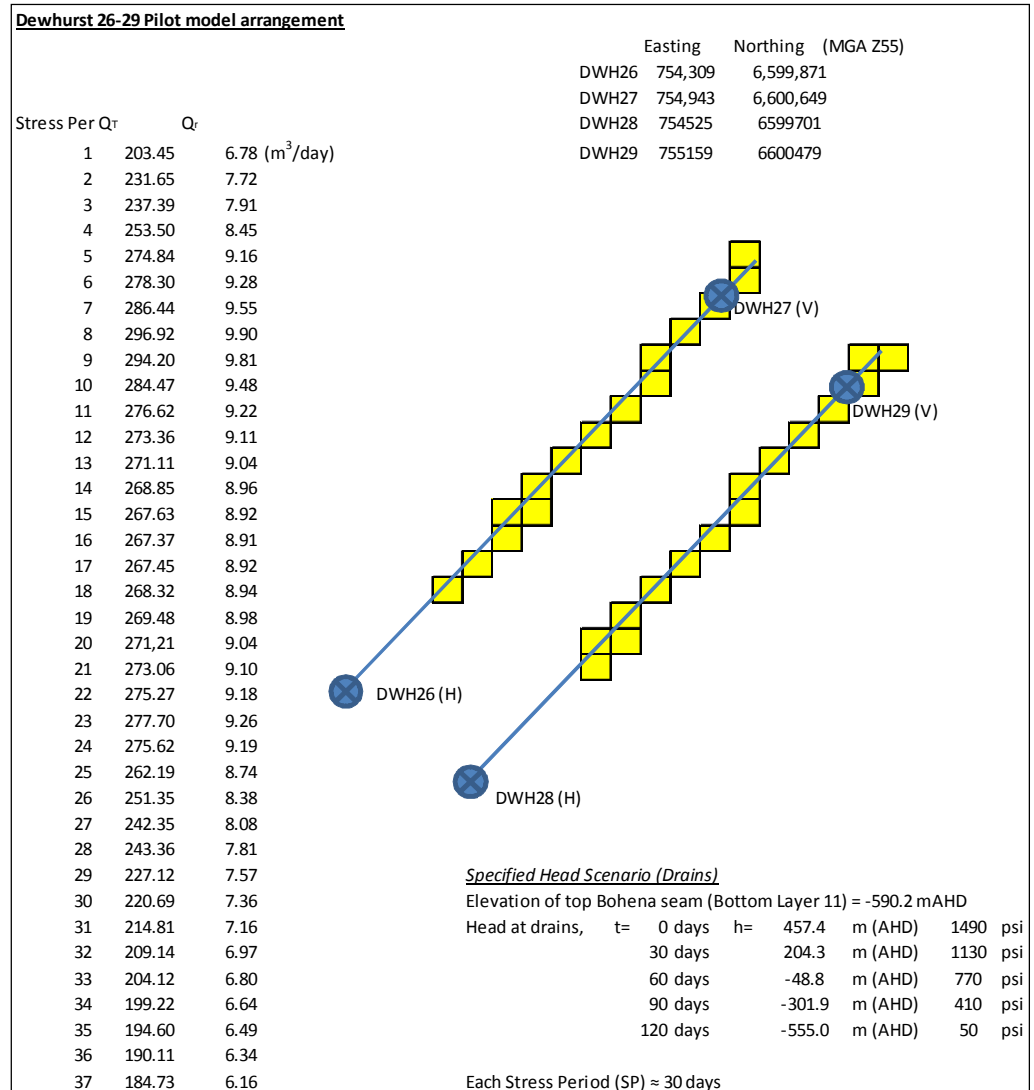


Figure 4-2: Dewhurst 26-29 pilot – concept model arrangement

5 Simulation outcomes

5.1 Depressurisation

Depressurisation due to CSG water extraction from the pilot well pair, represented in the model as 30 drain nodes, was observed to occur rapidly, achieving a maximum simulated drawdown of 904 metres in the target model layer representing the Maules Creek coal seams (Layer 12) within 6 months of the beginning of the extraction period (Figure 5-1). Following the end of the extraction period (1096 days, or 3 years), recovery within Layer 12 occurred rapidly, reaching greater than 90% recovery (residual drawdown 88.0 m) after 1641 days (or 4.5 years) from the cessation of water extraction.

Reflecting the delay in response to depressurisation of the adjacent layers in accordance with the principle of delayed yield referred to in Section 4.7, overlying layers responded more slowly.

Layer 10, corresponding to the Middle Permian Millie Group Porcupine and Watermark Formations, exhibited a drawdown of 2.08 metres by the end of the pilot CSG water extraction period (1096 days), reaching a maximum drawdown of 5.40 metres after 5475 days (15 years) from initiation of pilot CSG water extraction. Recovery was much slower in this layer, reflecting the low hydraulic conductivity and hence low rate of replenishment of depleted storage, with 88% recovery (residual drawdown 0.65 m) at the end of the simulation (after 540 years).

However, no other model layers exhibited drawdown approaching 0.5 metres within the duration of the model simulation. Whilst it is recognised that depressurisation will propagate beyond Layer 10 after longer time periods than considered in the model simulation, the magnitude of the hydraulic gradient developed between Layer 10 and overlying layers is only a fraction of that exhibited between Layer 10 and Layer 11 and between Layer 11 and Layer 12 (the target extraction layer). Hence it is considered unlikely to be possible for drawdown in excess of 0.5 m to develop in overlying layers.

5.2 Predicted fluxes

During the GIA conducted for the Narrabri Gas Project, it was found that a hydraulic gradient extended from the deeper strata to the shallower strata, evidenced by DST data which indicated higher hydraulic pressures at greater burial depths within the Bohena Trough. Consequently, it was recognised that fluxes exist in the pre-CSG water extraction state whereby water flows may be occurring naturally from deeper strata into shallower strata. The magnitude of these flows, or fluxes, was likely to be small but not necessarily negligible. This would imply that comparison of inter-formational fluxes initiated by CSG water extraction with a steady-state condition may not accurately represent the balance of flows within the basin.

In addition, it should be noted that the various coal seams within the target area are simulated in the numerical model as a single model layer, the thickness of which represents the summed thicknesses of those seams. Thus, simulation of extraction from the target seam using model layer 12 likely underestimates the actual impacts in that individual seam. The impact in the individual seam has been simulated via reservoir engineering techniques, and the impact of extraction of water from the

target seam(s) on the overlying groundwater system appears to be adequately represented using the refined model.

In order to evaluate inter-layer fluxes and overall water balance considerations, the transient simulation with pilot well extraction (DWH26-29_wel) was run for the full simulation period of 540 years and a second simulation was run over the same timeframe but with the pilot wells switched off (DWH26-29_wel_NoFlux). Comparison of the fluxes induced solely by CSG water extraction for the pilot could then be made between the two simulations at any given stress period (elapsed time within the model simulation). Figure 5-2 illustrates the detailed mass balances for each of the two model simulations referred to above, at the end of stress period 36, 1094 days after the start of the pilot.

In Figure 5-2, each layer is considered in isolation, with exchanges between layers represented by coloured arrows and text and changes in storage within the layer represented by circles. Fluxes out of the layer are indicated by red arrows and adjacent text whilst fluxes into the layer are indicated by blue arrows and adjacent text. The net change across either the upper surface of the layer or the lower surface of the layer is indicated by a green triangle (delta symbol) and a corresponding value (in black for a net layer gain and in green for a net layer loss). The net change in layer storage is illustrated by a simple traffic light scheme. The pilot extraction from Layer 12 is indicated by the black arrow.

This figure indicates that there is a consistent upward flux through the model in the simulation without pilot extraction (DWH26-29_wel_NoFlux), in accordance with the hydrogeological conceptual model and supporting the inferences made from DST data. After three years of pilot operation (DWH26-29_wel), the water extraction from Layer 12 (-190.1 m³/day) is supplied by a net increase in inflow from Layer 13 (2866 - 2794 = 172 m³/day) and a net decrease in outflow to Layer 11 (2794 - 2692 = 102 m³/day), offset by a slight decrease in storage in Layer 12 of 15.4 m³/day.

As indicated above, the impacts of depressurisation of the Maules Creek coal seams are confined to the Early Permian (Maules Creek Formation, Layers 11, 12 and 13) and Middle Permian (Porcupine and Watermark Formations, Layer 10). Fluxes originating from layers above Layer 10 are negligible, as illustrated in Figure 5-3, at the end of the pilot extraction period of three years and Figure 5-4, after 15 years from the start of depressurisation.

Figure 5-2 illustrates the case for Layer 10 in detail, confirming no net change in inflow/outflow across the top of the layer (2794 - 2794 = 0 m³/day), a net decrease in layer storage of 4.11 m³/day and a decrease in inflow from the underlying layer (2794-2773 = 21 m³/day).

The Maules Creek Formation (Layers 11 and 13), the coals within (Layer 12) and the Porcupine and Watermark Formations (Layer 10), together with the unaffected overlying Black Jack Group (Layers 9 to 7) and Triassic Digby-Napperby-Deriah Formations (Layers 6 and 5) all form part of the MDB Porous Rock groundwater source Water Sharing Plan (Gunnedah Basin).

No measurable flux is induced between the MDB Porous Rock groundwater source and the NSW GAB groundwater source.

5.3 Predicted impacts

The predicted impacts occur in different layers at different times, as illustrated in Figure 5-1. Layer 12 develops maximum drawdown after 3 years, after which the zone of influence of the depressurisation within the layer shrinks as the pilot extraction ceases and inflows to the layer continue. The impact on hydraulic head in Layer 10, however, is continuing to develop at three years, having reached only 2.08 metres drawdown. Figure 5-1 illustrates that the maximum drawdown in Layer 10, the model equivalent to the Porcupine and Watermark Formations of the Middle Permian Millie Group, reaches a maximum of 5.40 metres only after 15 years from the commencement of the pilot, 12 years after pilot extraction has ceased.

Consequently, the extent of impact in these affected layers is best illustrated on the occasions of maximum drawdown in the respective layers. Figure 5-5 illustrates the maximum extent of drawdown in Layer 12 (at 3 years from pilot start) and Figure 5-7 illustrates the maximum extent of drawdown in Layer 10 (at 15 years from pilot start). As has been discussed in Section 5.2 and illustrated in Figures 5-3 and 5-4, no other layer exhibits equal to or greater than 0.5 metres of drawdown during the 540 year long simulation.

Figure 5-5 illustrates how the zone of influence of the pilot CSG water extraction, very close to the end of the pilot extraction period and when Figure 5-1 confirms drawdown has reached its maximum, has only relatively limited spatial extent. Figure 5-6 comprises a close-up of the area, illustrating the potentiometric contours of drawdown (0.5 m, 10 m, 50 m, 100 m and in 100 metre increments thereafter).

Figure 5-7 illustrates the zone of influence in the Porcupine and Watermark Formations (Layer 10) and Figure 5-8 comprises a close-up of the same area, illustrating the potentiometric contours of drawdown (0.5 m, 1.0 m, 1.5 m, 2.0 m and 3.0 m). Potentiometric contours of drawdown in Layers 9 to 1 have not been prepared as each would comprise zero drawdown.

5.4 Outcomes related to the Aquifer Interference Policy

The outcomes of the simulations have been considered in the context of the Aquifer Interference Policy (AIP) minimal harm consideration criteria described in Section 3.3.

The alluvial groundwater sources of the Upper and Lower Namoi Alluvium (NSW Upper and Lower Namoi groundwater source WSP) are considered within the context of the AIP to be highly productive alluvial groundwater sources. These deposits are represented in the model as Layer 1 and no decline in water table level or change in flux is indicated by the detailed comparison of simulations described in Section 5-2 and illustrated in Table 5-2. Hence no aquifer interference to this groundwater source is indicated by the modelling of the pilot CSG water extraction activities.

The porous rock groundwater source of the GAB Surat Pilliga Sandstone (NSW GAB groundwater source WSP) is considered within the context of the AIP to be a highly productive porous rock groundwater source. These strata are represented in the model as Layers 2 & 3. The Purlawaugh Formation (represented in the model as Layer 4, with the Garrawilla Volcanics) also forms part of the same WSP although it is considered to constitute a non-aquifer. No decline in water table level or change in

flux in Layers 2, 3 or 4 is indicated by the detailed comparison of simulations described in Section 5-2 and illustrated in Table 5-2. Hence no aquifer interference to this groundwater source is indicated by the modelling of the pilot CSG water extraction activities.

The porous rock groundwater source of the Gunnedah Basin (GMA604) (NSW MDB Porous Rock groundwater source WSP), comprising the Triassic strata of the Digby, Napperby and Deriah Formations (Layers 5 and 6) and the Permian strata of the Black Jack Group (Layers 7, 8 and 9) down to and including the Maules Creek Group (Layers 11, 12 and 13), is considered within the context of the AIP to be a less productive porous rock groundwater source. These combined strata are represented in the model as Layers 5 to 13, with the CSG water abstraction occurring in Layer 12. No decline in water table level or change in flux in Layers 5, 6, 7, 8 and 9 is indicated by the detailed comparison of simulations described in Section 5-2 and illustrated in Table 5-2. **However, given that the pilot CSG water extraction will occur within this AIP-classified water source, the impact on hydraulic (pressure) head within the combined group of layers (5-13) and the fluxes developed within the groundwater source to meet the pilot CSG water demand are interpreted to comprise an aquifer interference and will require licensing.**

As described in Section 2.4, the two high priority GDEs identified in the vicinity of the Narrabri Gas Project, Hardy's Spring and Eather Spring, are understood to be hydrogeologically associated with the Pilliga Sandstone. As stated above, the Pilliga Sandstone forms part of the NSW GAB groundwater source WSP but modelling has indicated no decline in water table level or change in flux in the relevant model layers and hence no impact on either of these GDEs is predicted to occur.

Figures 5-5 to 5-8 illustrate the extent of drawdown in the target seam (Layer 12) and the Millie Group: Porcupine and Watermark Formations (Layer 10). The zones of influence illustrated in these four figures remain within the Narrabri Gas Project boundary and west of the outcrop of the Gunnedah Basin: Permo-Triassic strata. Figure 5-2 illustrates that Layers 9 and above experience no impact in flux and thus the effects of CSG water extraction from Layer 12 are confined to Layers 10-13 only. Hence the bores illustrated in Figure 2-3 within the region of the MDB Porous Rock (Gunnedah Basin GMA604) groundwater source WSP which extract from this groundwater source will not be impacted by the pilot CSG water extraction. Those bores illustrated in Figure 2-3 that also lie within the zones of influence shown in Figures 5-5 to 5-8 are positioned on the outcrop of the Pilliga Sandstone and highly likely to be completed within this groundwater source only and will therefore experience no impact.

Dewhurst 26-29 Pilot Appraisal

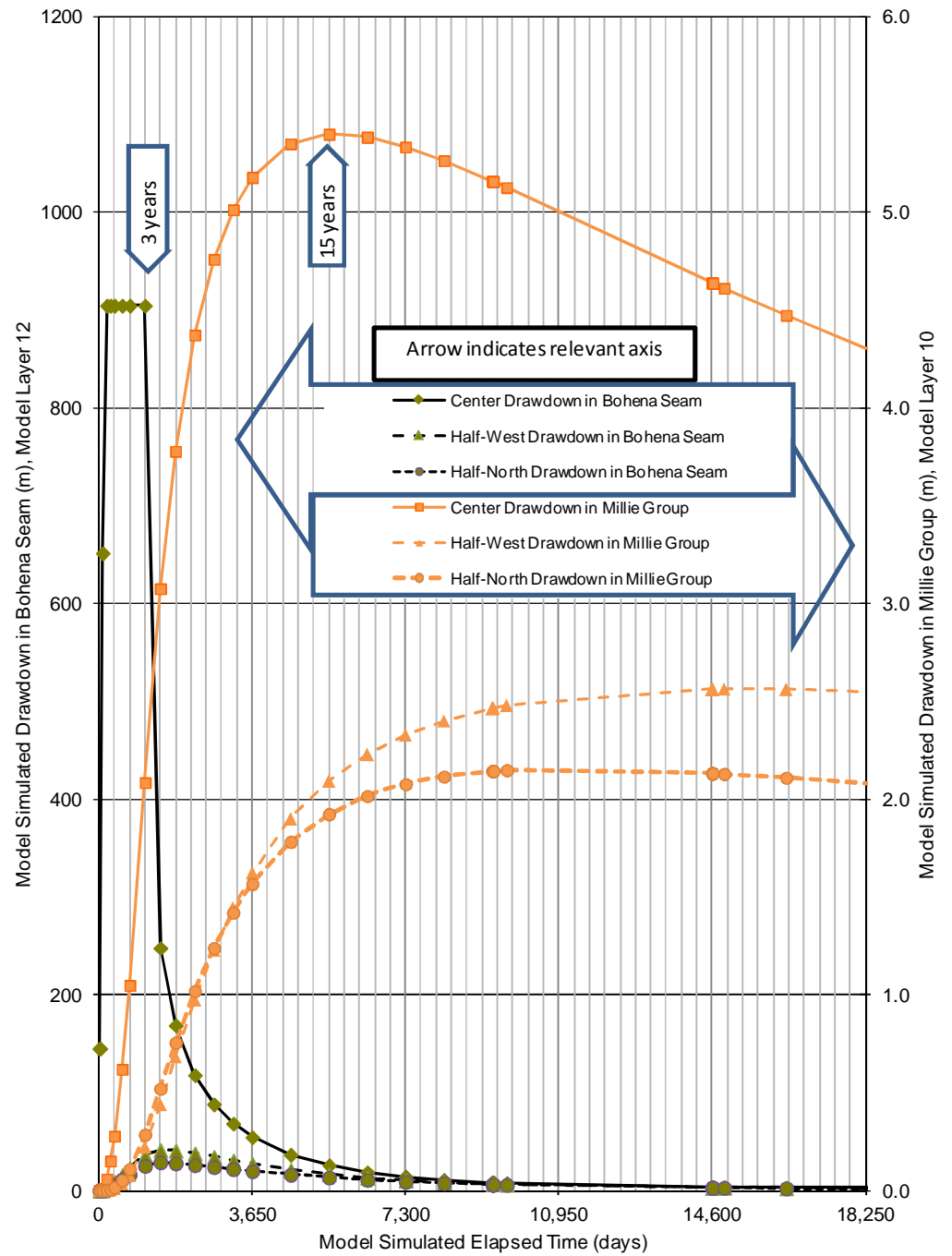


Figure 5-1: Hydrograph of drawdown during first 50 years of simulation (Simulation DWH26_29_wel)

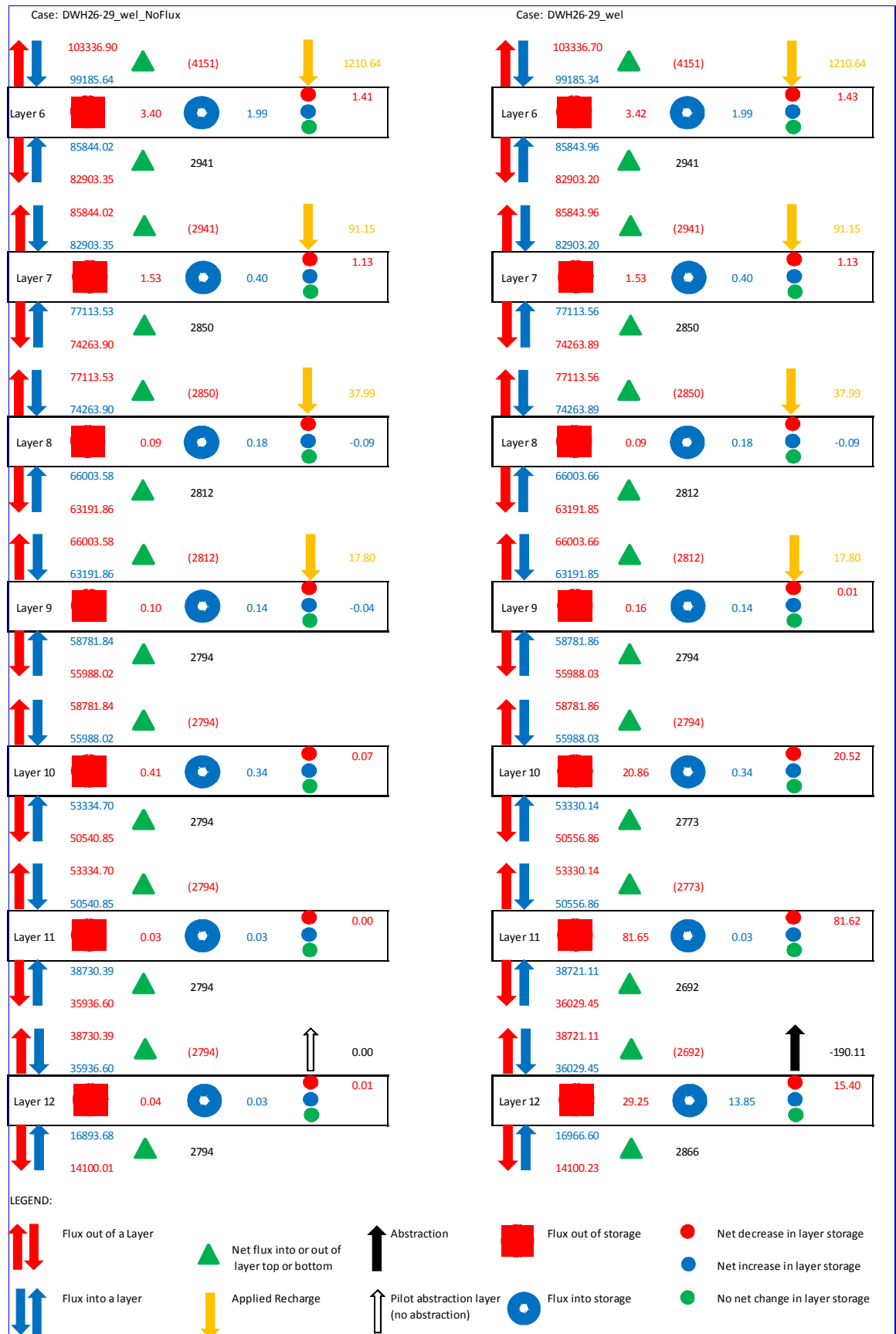


Figure 5-2: Mass balance comparison of simulations with and without pilot extraction (SP36 TS3) (m³/day)



Figure 5-3: Mass balance summary by model layer, 3 years from start of pilot (Simulation DWH26_29_wel)

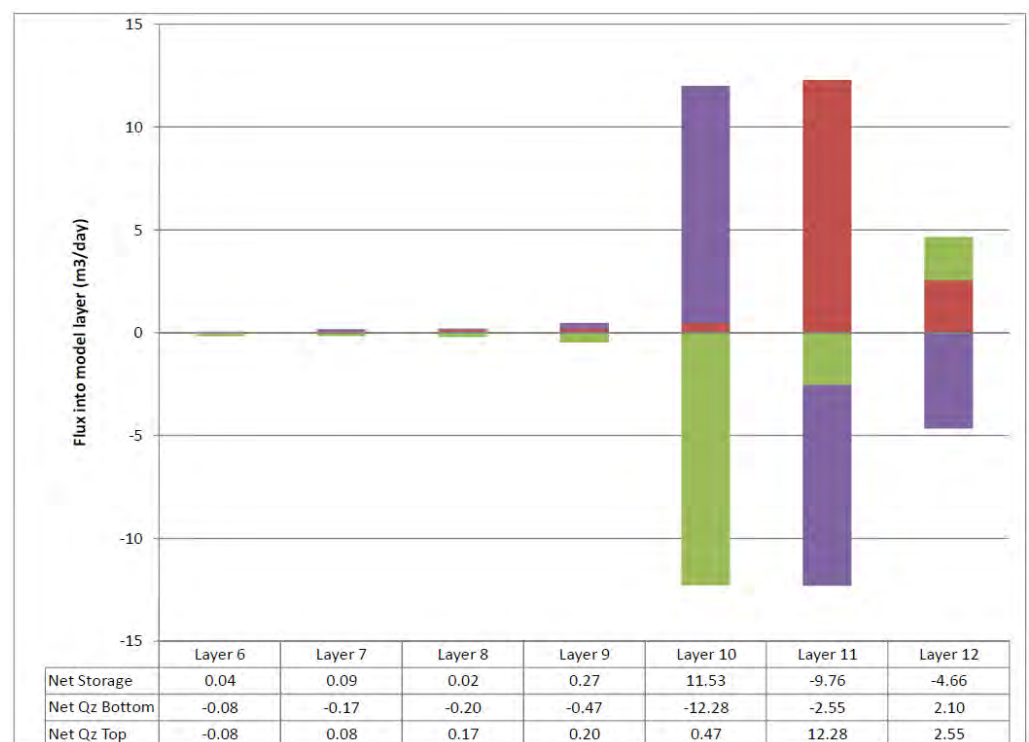


Figure 5-4: Mass balance summary by model layer, 15 years from start of pilot (Simulation DWH26_29_wel)

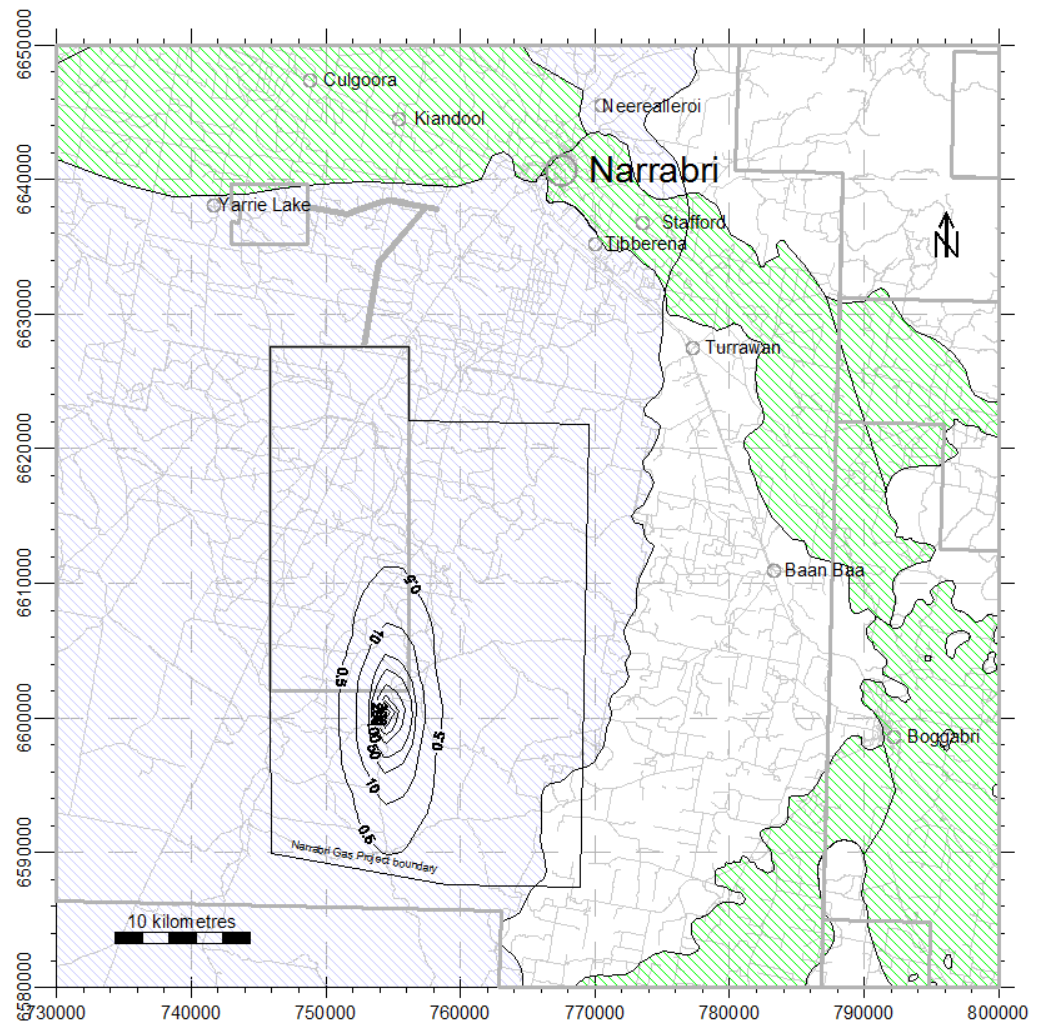


Figure 5-5: Potentiometric map of drawdown in Layer 12 at 3 years from pilot start (occurrence of maximum drawdown in model layer)

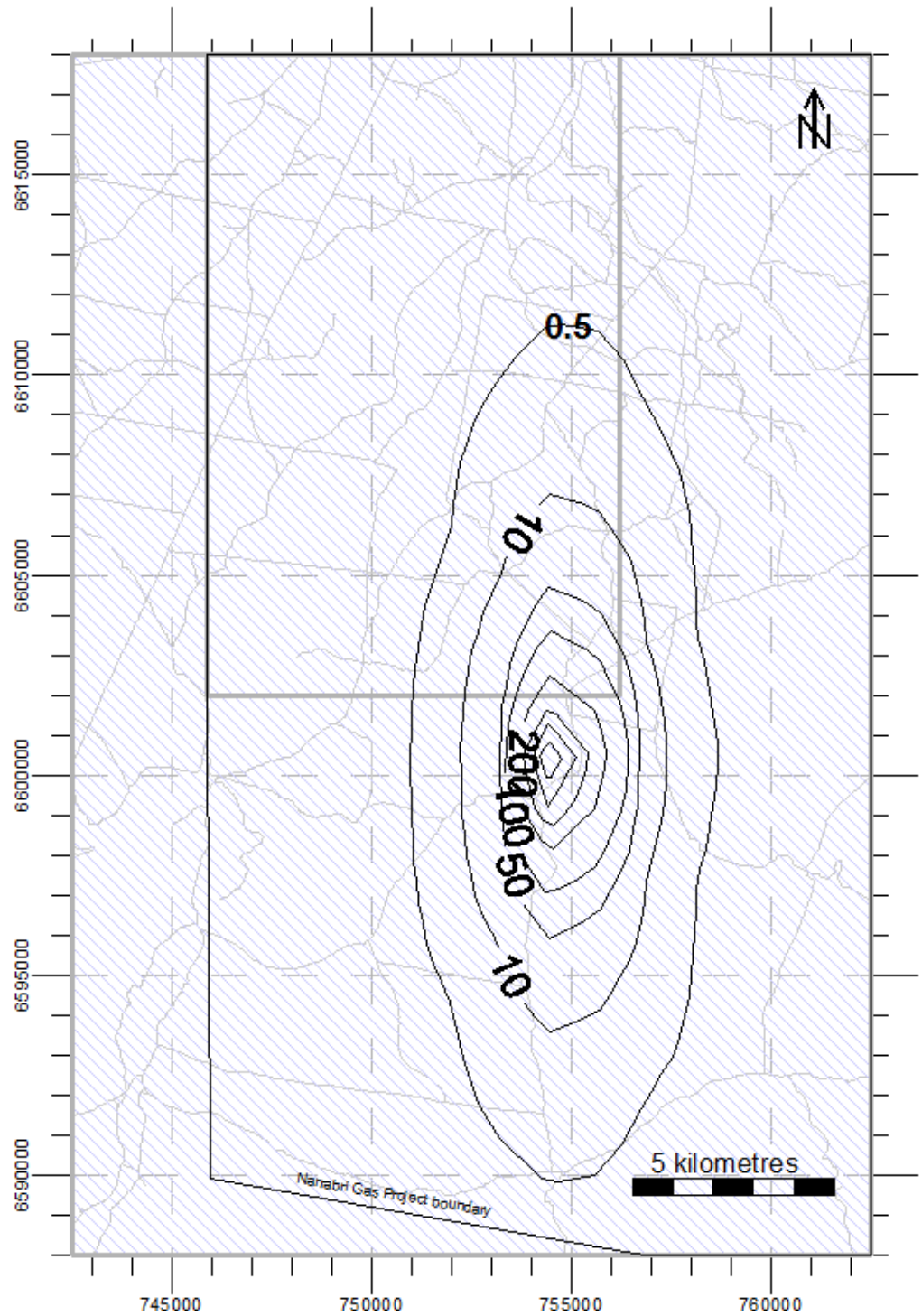


Figure 5-6: Close up of impacted area within Layer 12 at 3 years from pilot start (occurrence of maximum drawdown in model layer)

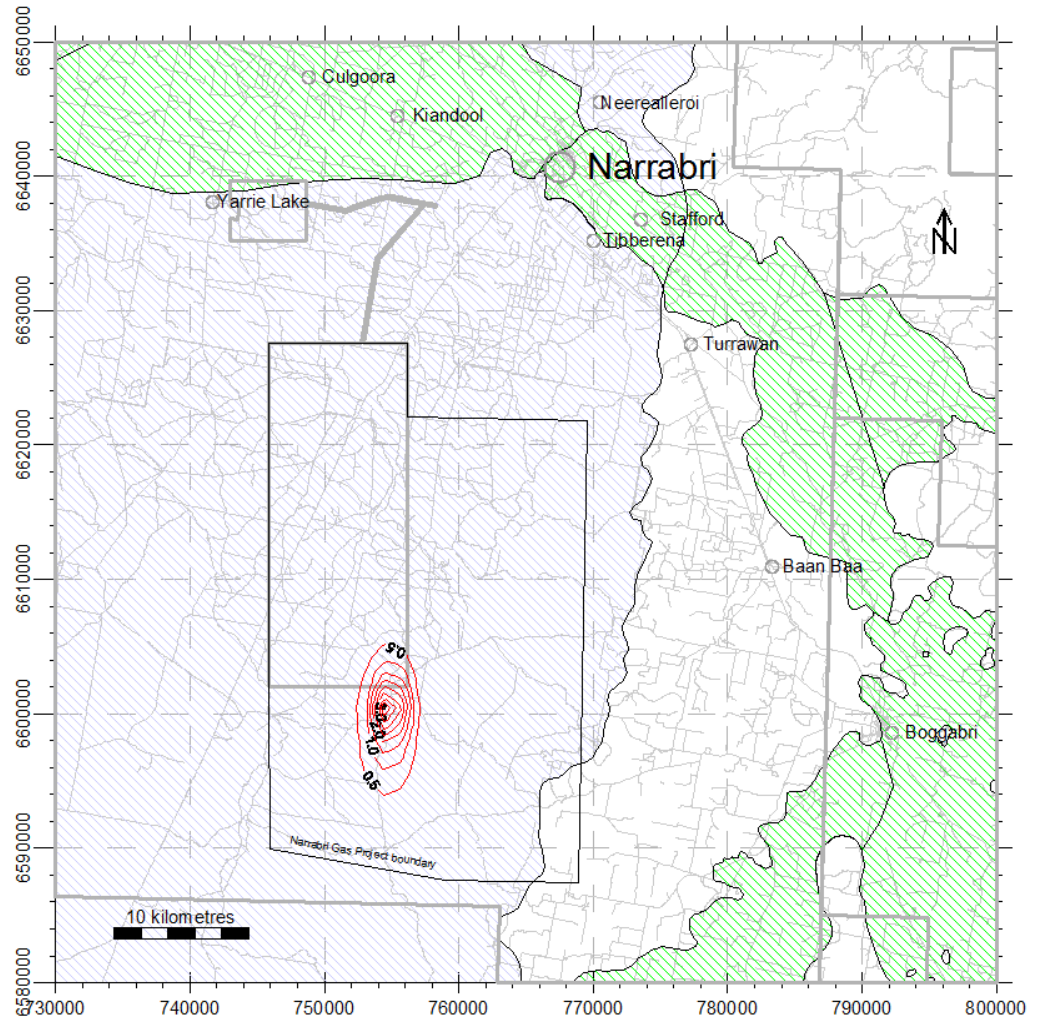


Figure 5-7: Potentiometric map of drawdown in Layer 10 at 15 years from pilot start (occurrence of maximum drawdown in model layer)

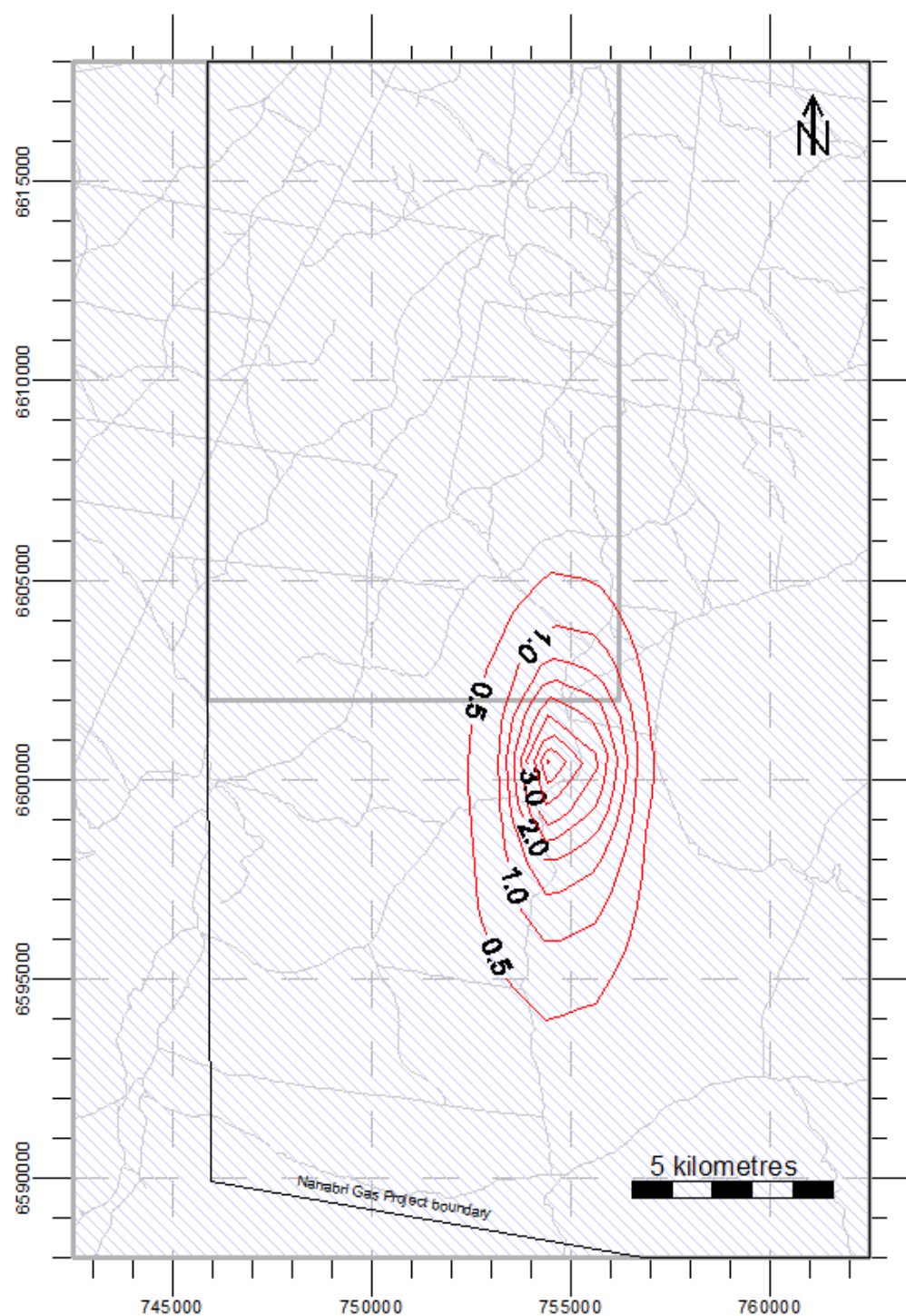


Figure 5-8: Close up of impacted area within Layer 10 at 15 years from pilot start (occurrence of maximum drawdown in model layer)

6 Mitigation

Detailed numerical groundwater flow modelling of the Dewhurst 26-29 Pilot has been conducted and the simulations have indicated that no impact as a consequence of the pilot CSG water extraction is likely to be experienced:

1. Within the alluvial groundwater sources associated with the NSW Upper and Lower Namoi groundwater source WSP also identified within the context of the Aquifer Interference Policy as highly productive groundwater sources;
2. Within the porous rock groundwater sources associated with the NSW GAB groundwater source WSP also identified within the context of the Aquifer Interference Policy as highly productive groundwater sources;
3. At any high priority GDE within the vicinity of the Narrabri Gas Project; and,
4. At any water supply work within the vicinity of the Narrabri Gas Project.

The same modelling has indicated that all fluxes and water level or pressure impacts associated with the pilot CSG water extraction will be limited to the porous rock groundwater sources associated with the NSW MDB Porous Rock (Gunnedah Basin) groundwater source WSP. This groundwater source is identified within the context of the Aquifer Interference Policy as a less productive groundwater source. The extent of the impacts will be limited in extent as illustrated in Figures 5-5 to 5-8. Recovery of water pressures and return of fluxes to pre-CSG pilot conditions will occur through very slow leakage over timescales longer than the maximum simulation period of 540 years. The magnitude of these leakage fluxes will be negligible in the context of seasonal fluctuations and the pressure changes so induced will also be negligible.

It is therefore considered unnecessary to instigate mitigation measures in relation to the proposed Dewhurst 26-29 Pilot.

7 Summary

A CSG exploration pilot is proposed at Dewhurst 26-29 Pilot site, comprising two triple-lateral wells and two counterpart vertical wells.

The CSG pilot wells will be extracting CSG from the Bohena, Namoi and Rutley seams of the Maules Creek Formation towards the base of the Permo-Triassic geological sequence of strata in the Bohena trough, a sub-basin of the Gunnedah Basin.

In order to recover CSG from the coal seams it is necessary to depressurise the seam by lowering the hydraulic head through the extraction of CSG water.

This assessment has considered the characteristics of the proposed water extraction in the context of the hydrogeological setting of the Bohena Trough / Gunnedah Basin to assess the impact of the extraction on groundwater.

The existing numerical model developed for the Narrabri Gas Project groundwater impact assessment has been modified to permit detailed modelling of the Dewhurst 26-29 Pilot.

The numerical model has been modified by refining the model grid in the vicinity of the proposed pilot and by replacement of the scheme of CSG wells proposed for the

wider Narrabri Gas Project with a model representation of the wells pertaining only to this pilot. In order accurately to represent the proposed depressurisation, the extent and propagation of drawdown has been modelled using MODFLOW drain cells whilst the magnitude of induced fluxes has been modelled using MODFLOW well nodes.

A transient simulation was conducted without CSG water extraction to quantify background fluxes between individual model layers (DWH26-29_wel_NoFlux) and this was then followed by simulations of the pilot water extraction (DWH26-29_wel) and pilot requisite depressurisation (DWH26-29_drn). All three simulations were conducted for a period of 540 years, comprising 3 years of CSG pilot water extraction and a further 537 years to investigate hydraulic head recovery.

The development of drawdown in each model layer was analysed to determine the timing and maximum extent of impact arising from the water extraction. Fluxes were calculated between the respective model layers.

The modelling and subsequent post-processing analysis indicates that the depressurisation will be largely limited to model layers 10-13, corresponding to the Middle and Early Permian strata at the base of the Bohena Trough.

No significant impact on hydraulic head is indicated for model layers 9 (Black Jack Group) or above and hence no significant impact on hydraulic head is indicated for the Pilliga Sandstone or Namoi Alluvium.

The instigation of significant fluxes by CSG water extraction are limited to the same layers, 10-13 and no significant quantifiable flux is predicted to occur from the overlying NSW GAB groundwater source to the MDB Porous Rock groundwater source within the period of the simulation.

The CSG water extraction is sourced from aquifer storage within the impacted model layers identified and recovery of hydraulic heads continues beyond the end of the modelling period through induced minor increased rates of recharge from the base of the model, Layer 14.

8 Conclusions

- The total quantity of water proposed to be abstracted during the pilot is estimated as 276 ML (275,784 m³), equating to an average of 251.6 m³/day over the 1096 day (3 year) duration of the proposed pilot;
- No aquifer interference to either the alluvial groundwater sources of the Upper and Lower Namoi Alluvium (NSW Upper and Lower Namoi groundwater source WSP) or the GAB Surat Pilliga Sandstone (NSW GAB groundwater source WSP) is indicated by the modelling of the pilot CSG water extraction activities;
- No decline in water table level, water pressure or change in flux is indicated for the majority of the porous rock groundwater source (Black Jack Group and overlying Triassic strata) of the Gunnedah Basin (GMA604) (NSW MDB Porous Rock groundwater source WSP);
- The impact on hydraulic (pressure) head and the fluxes developed within the lower part of the groundwater source (strata beneath the Black Jack Group) to meet the pilot CSG water demand are interpreted to comprise an aquifer interference within the combined groundwater source and will require licensing;
- No impact on either high priority GDEs identified in the vicinity of the Narrabri Gas Project area is predicted to occur as a consequence of the Dewhurst 26-29 Pilot;
- No impact on any registered water extraction bores identified in the vicinity of the Narrabri Gas Project area is predicted to occur as a consequence of the Dewhurst 26-29 Pilot; and
- It is therefore considered unnecessary to instigate mitigation measures in relation to the proposed Dewhurst 26-29 Pilot.



References

Appendix A References

Halcrow, 2012. Narrabri Gas Project Groundwater Impact Assessment.

Appendix 8

Agricultural Impact Statement



Dewhurst 26 – 29 Exploration Pilot Wells

Agricultural Impact Statement

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
Rev A	Draft for internal review	JC	DF	08/01/2013
Rev B	Draft for client review		JC	15/02/2013
Rev 0	Final for release		JC/PM/DF	07/03/2013

Approval for Issue

Signature	Date
	07/03/2013

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I.0 Summary

An agricultural impact statement (AIS) has been prepared for the proposed exploration pilot wells Dewhurst 26, 27, 28, 29 and surrounding areas. The AIS determines if any agricultural resources or associated agricultural infrastructure would be impacted by the proposed drilling and ancillary activities at the site.

In the context of the total area of the site and the wider agricultural uses of the region, the temporary and minor loss of land is considered to have low risk on agricultural resources and industries. The proposed mitigation, management and monitoring systems in place indicate that negative impacts are unlikely or rare. The site will not impact on any biophysical Strategic Agricultural Land (BSAL) or Critical Industry Clusters (CIC). However, as the proposed activity includes pilot testing, the Strategic Regional Land Use Policy (SRLUP) considers this moderate to high risk in nature.

There will be no pressure on agricultural support infrastructure including:

- Water services;
- Travelling stock routes;
- Railways; and
- Processing facilities.

The proposed activity will result in minor increases in traffic along Beehive Road throughout the duration of the proposed activity. This level of traffic could easily be accommodated by the existing road network. Further, there will be no disruption to agricultural rail networks, as the site is not adjacent to any rail lines.

2.0 Introduction

The SRLUP (Department of Planning and Infrastructure; DoP&I, 2012a) identifies and protects more than two million hectares of strategic agricultural land and valuable water resources, and aims to provide 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 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 NSW (Eastern) Pty Ltd (a wholly owned subsidiary of Santos Limited) (Santos), as a coal seam gas (CSG) operator on behalf of the titleholders of Petroleum Exploration Licence (PEL) 238, proposes to drill four petroleum exploration pilot wells, known as Dewhurst 26, Dewhurst 27, Dewhurst 28 and Dewhurst 29 (Dewhurst 26 - 29), and carry out ancillary activities within the Pillaga East State Forest off Beehive Road, to the south of Narrabri, NSW (the proposed activity). The purpose of the Dewhurst 26 - 29 pilot wells is to investigate the potential coal seam gas resource of the Gunnedah Basin within Petroleum Exploration Licence (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 Minister 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 Dewhurst 26 – 29 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. This AIS was prepared following the requirements of ‘*Guidelines for agricultural impacts statements at the exploration stage*’ (DoP&I 2012b).

This document is an appendix of the REF and should be read in conjunction with the REF.

3.0 Project Description

3.1 Location

The site is located in the south-eastern section of PEL 238 (refer to **Figure 3.1**). 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 within the Narrabri Shire LGA.

The site is located approximately 36 km west of Boggabri and 41 km south of Narrabri. The site is within the Pilliga East State Forest. A number of State Conservation areas and National Parks are located in the vicinity of the site. These include:

- Pilliga East State Conservation area located approximately 5 km south of the site;
- Willala Aboriginal Area located approximately 12 km south-east of the site;
- Brigalow State Conservation area approximately 32 km and 34 km north of the site; and
- Brigalow Park Nature Reserve approximately 31 km north-west of the site.

3.2 Site Description

The topography of the study area is gently undulating, with no significant topographic features. Three watercourses intersect the site:

- Mount Pleasant Creek; and
- Two unnamed ephemeral watercourses.

The nearest dwelling is located approximately 9 km north of the site.

3.3 Proposed Activities

The proposed activity will occur within the Pilliga East State Forest within PEL 238. Santos will conduct the activities for and on behalf of the titleholders of PEL 238 and is working with Forests NSW, who manages the Forest, to establish a land access agreement.

The scope of the proposed activity includes:

- Clearing a 10 metre wide service corridor between Beehive Road and each well site to accommodate access tracks and the gas and water gathering system;
- Constructing access tracks between Beehive Road and each lease area, within the cleared 10 m wide service corridors;
- Establishing four lease areas each up to approximately 100 by 100 m in size;
- Clearing a 10 m wide right of way for the central gathering system along the eastern side of Beehive Road;
- Drilling a pilot well on each lease area, including two vertical pilot wells (Dewhurst 26 and 28) and two tri-stacked lateral pilots (Dewhurst 27 and 29) to intercept the vertical wells;
- Constructing a buried gas and water gathering system within the cleared right of way;
- Installing surface infrastructure on each lease area to allow operation of the pilot wells;
- Installing a flare and water transfer tank on the Dewhurst 28 lease area to manage gas and water from the wells;

- Rehabilitating the lease areas back to the well head and essential infrastructure;
- Operating the pilot wells for the life of PEL 238 or until critical reservoir data is collected;
- Gas and water management during pilot testing; and
- Where pilot testing indicates that commercial gas production is not viable, decommissioning the wells and ancillary infrastructure, and completely rehabilitating the lease areas.

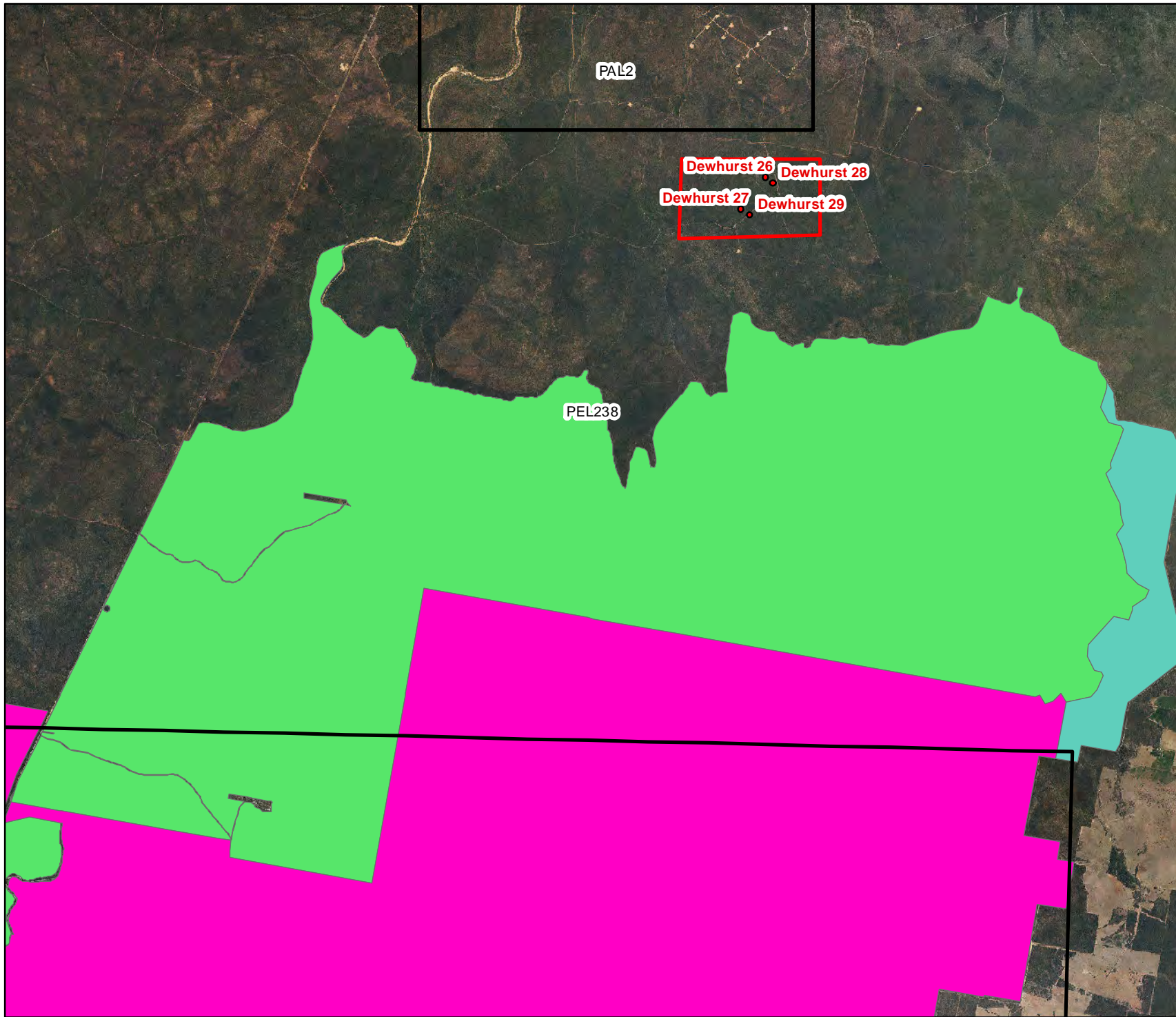
Each lease area will be approximately 100 m by 100 m pad and will be established using a combination, of the following:

- 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 820 m³ and 715 m³ (Dewhurst 26), 270 m³ and 110 m³ (Dewhurst 27), 1900 m³ and 1600 m³ (Dewhurst 28), 640 m³ and 400 m³ (Dewhurst 29), respectively; and
- Apply industrial matting and / or gravel to areas to be trafficked.

Construction of the proposed activity will take approximately three months from site preparation until completion of the pilot wells. Partial rehabilitation of the lease area will occur within approximately six months of completion of the well where practical.

The duration of operation of the pilot wells at this stage is unknown, but the wells will need to be operated until critical reservoir data is obtained which could take a number of years. It is expected that they will continue to operate throughout the duration of the life of PEL 238.

The total area of potential disturbance assessed in this AIS is 5.755 ha. This includes the 4 ha required for the lease pads and 1.755 ha required for the access tracks and gathering system. Reference to 'the site' includes the four lease pads, access tracks and gathering system.



NSW Estates and Petroleum Titles

Figure 3.1

Project:
Dewhurst 26 - 29 AIS

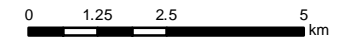
Client:
Santos

Compiled by:	GO	Date:	03/01/2013
Approved by:	DF	Date:	03/01/2013

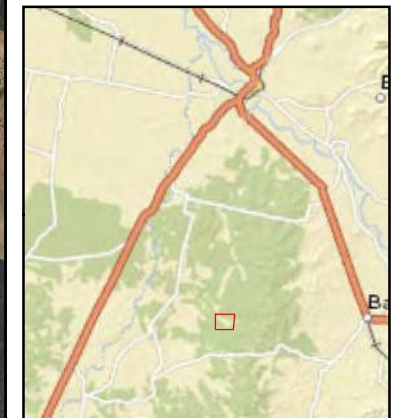
Legend

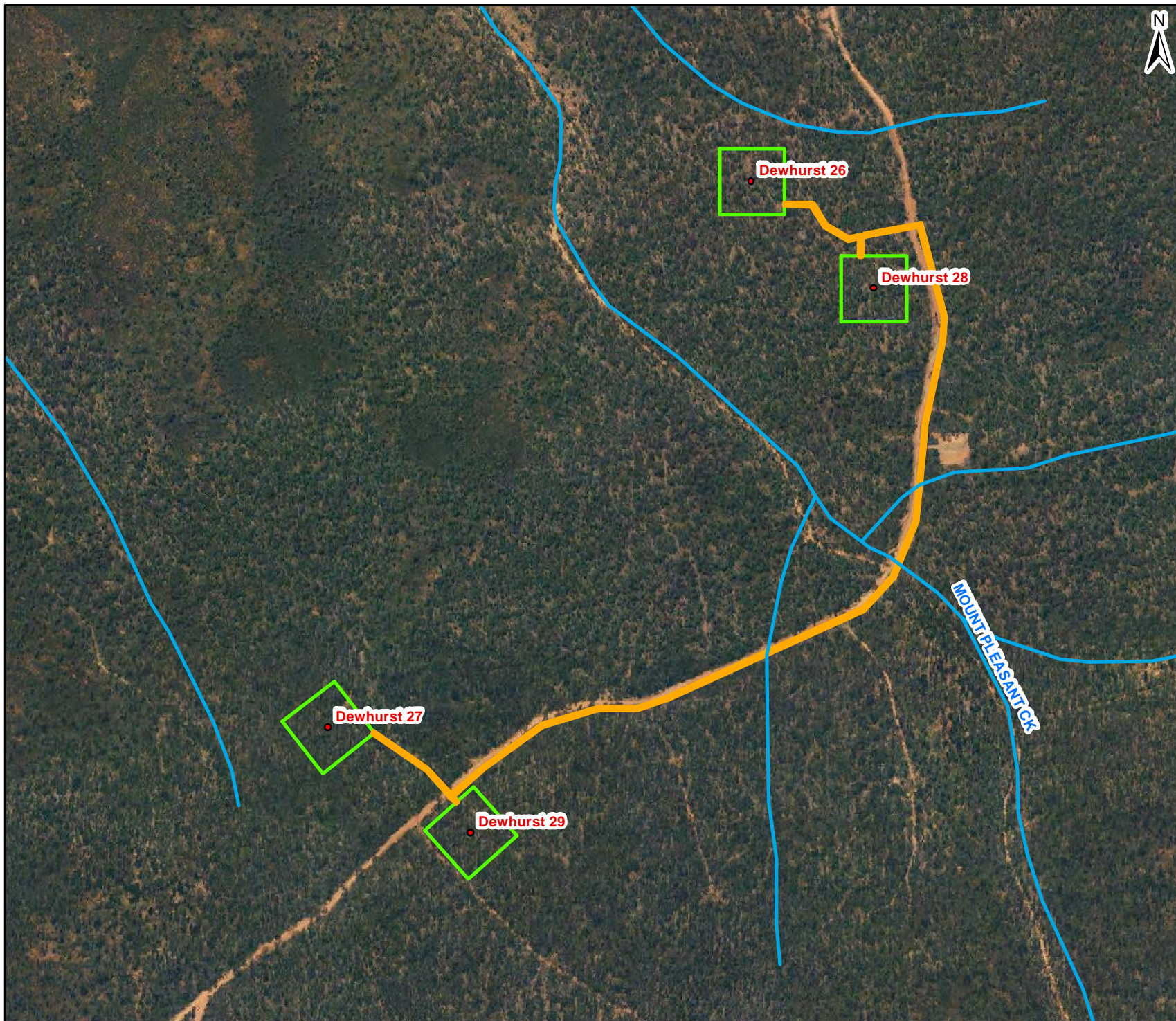
- Pilot Wells
- Study Area
- Petroleum Titles
- NSW Estates**
- ABORIGINAL AREA
- CCA ZONE 1 NATIONAL PARK
- CCA ZONE 2 ABORIGINAL AREA
- CCA ZONE 3 STATE CONSERVATION AREA
- NATIONAL PARK
- NATURE RESERVE
- STATE CONSERVATION AREA

Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2013
other data from OEH 2012



Datum: GDA94
Scale 1:137,000 @ A4





Site Layout

Figure 3.2

Project:
Dewhurst 26 - 29 AIS

Client:
Santos

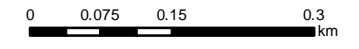
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Approved by:	DF	Date:	27/11/2012
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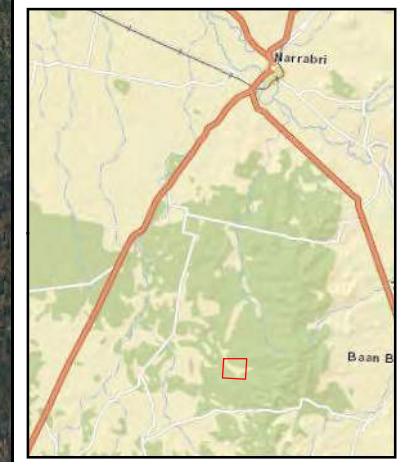
Legend

- Pilot Wells
- Watercourses
- Access Tracks & Gathering Systems
- Lease Pads

Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2013
other data from OEH 2012



Datum: GDA94
Scale 1:8,000 @ A4



4.0 Project Design Review / Alternatives

Alternatives to undertaking the work include:

- Do nothing;
- Reduced scale (less well sets); and
- Alternative location.

4.1 Do nothing option

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. A do nothing option will not enable data to be collected.

4.2 Reduced Scale

Technical studies investigated opportunities to reduce the number of wells required. The provision of vertical wells combined with a tri-stacked option reduced the well sets to a minimum of two sets (four wells). There were no other lower impact alternatives to the proposed activity available that will adequately assess the potential gas resource.

4.3 Alternative location

The site selection process was influenced by:

- The need for a minimum of four wells;
- Underlying geology;
- Minimising the number of creek crossings;
- Minimising the length of access tracks and the amount of vegetation to be cleared; and
- Minimising hollow bearing tree removal and impact on riparian vegetation.

The 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 Forests NSW and with the assistance of cultural heritage, ecological and environmental consultants. Access tracks were located to avoid hollow bearing trees, targeting areas of greatest disturbance.

Dewhurst 28 was selected as the location of the flare and water transfer facility as it provided the most logical tie in to future infrastructure linking the wells to Bibblewindi ponds.

5.0 Agricultural Enterprise and Resources

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

5.1 Agricultural Enterprise

In the Northern Plains, grain and cotton are the most significant crops, while beef and sheep grazing are also important. Moree and Narrabri LGAs produce 66% of NSW cotton from 4% of the state's area. These same LGAs also produce 5% of the gross value of NSW beef cattle. The area known as the Golden Triangle (350,000 ha between Bellata, North Star and Yallaroi), produces consistently high yields of prime hard (high protein) wheat (DoP&I, 2012a).

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

The dominant land use in the Namoi catchment is sheep and cattle grazing which accounts for 61% of land use by area (**Table 5.1** and **Figure 5.1**). 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 natural vegetation 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.

The study area forms part of the Bohena sub-catchment. Cleared areas are mainly in the northern part of the sub-catchment and are predominantly used for sheep and cattle grazing using native and improved pastures. The site is located in the Pilliga East State forest, with much of the surrounding area comprised of similar landscapes. Both the site and its surrounds are not used for high intensity agricultural purposes.

Table 5.1: 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 (km2)	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

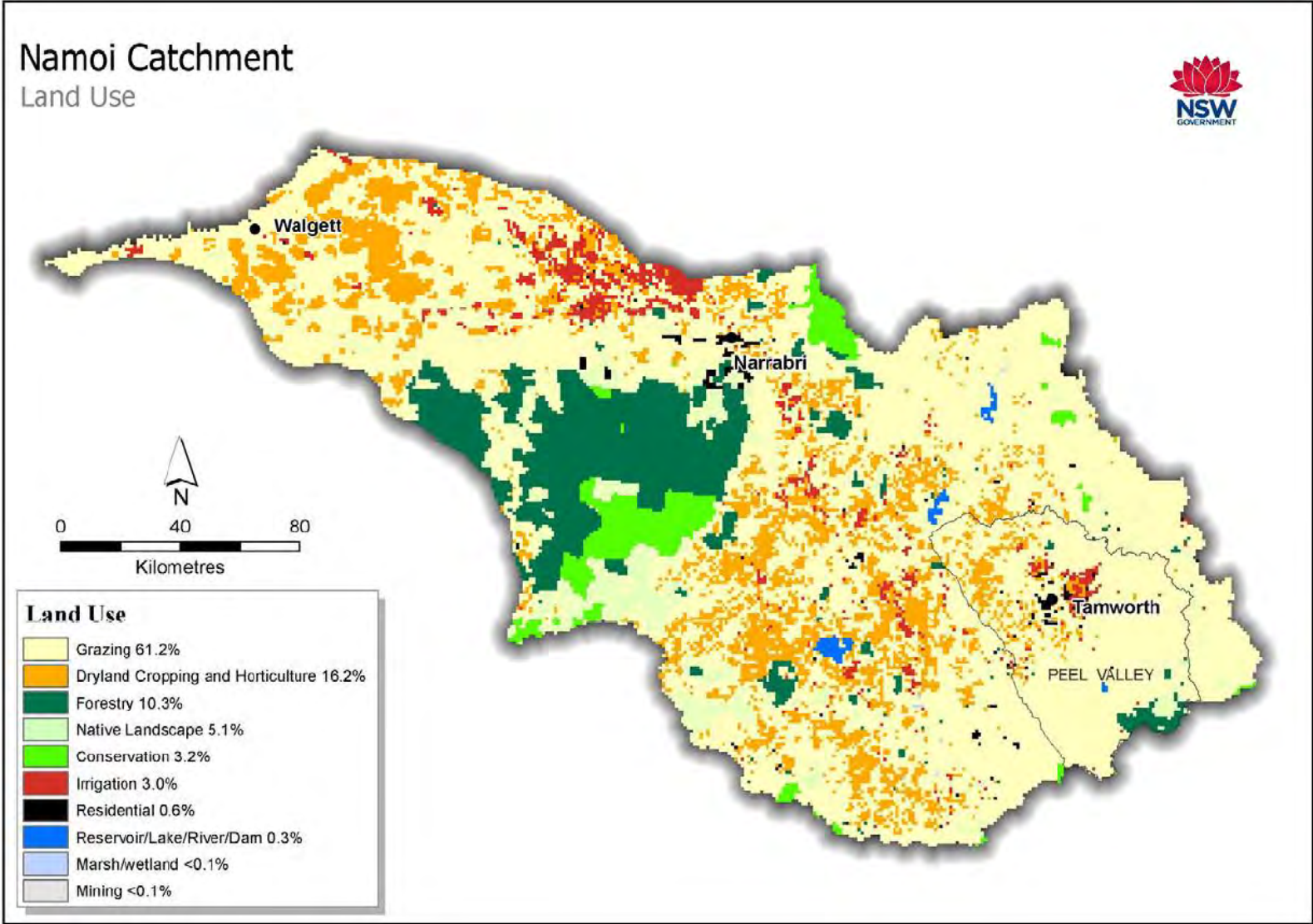


Figure 5.1: Land use in the Naomi Catchment (Green *et al.*, sourced from 2001/02 Land use mapping of Australia, Bureau of Rural Sciences).

5.1.1 Agricultural Production Value

Agriculture and agribusiness is worth \$1.8 billion per annum 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, 2012a).

In 2009 / 2010 the Narrabri Shire recorded a Gross Regional Product (GRP) of \$730 million, with agriculture forestry and fishing contributing \$115.3 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.

5.1.2 Employment

The Narrabri Shire area sustains expansive cropping activities, with the two largest crops produced in the region being cotton and wheat. Other crops grown in the region include sorghum, sunflowers, cereal grains, oilseeds and legumes. Grazing of beef cattle, sheep and pigs is also a significant contributor to the agricultural productivity within the region (AEC, 2011).

Agricultural employment data recorded in 2009 / 2010 has been reproduced below to represent the diversity of agricultural enterprise across the Narrabri Shire (**Figure 5.2**). The data demonstrates that the largest agricultural enterprises in the region are cotton and grain industries, which employ approximately 47% of the agricultural workforce.

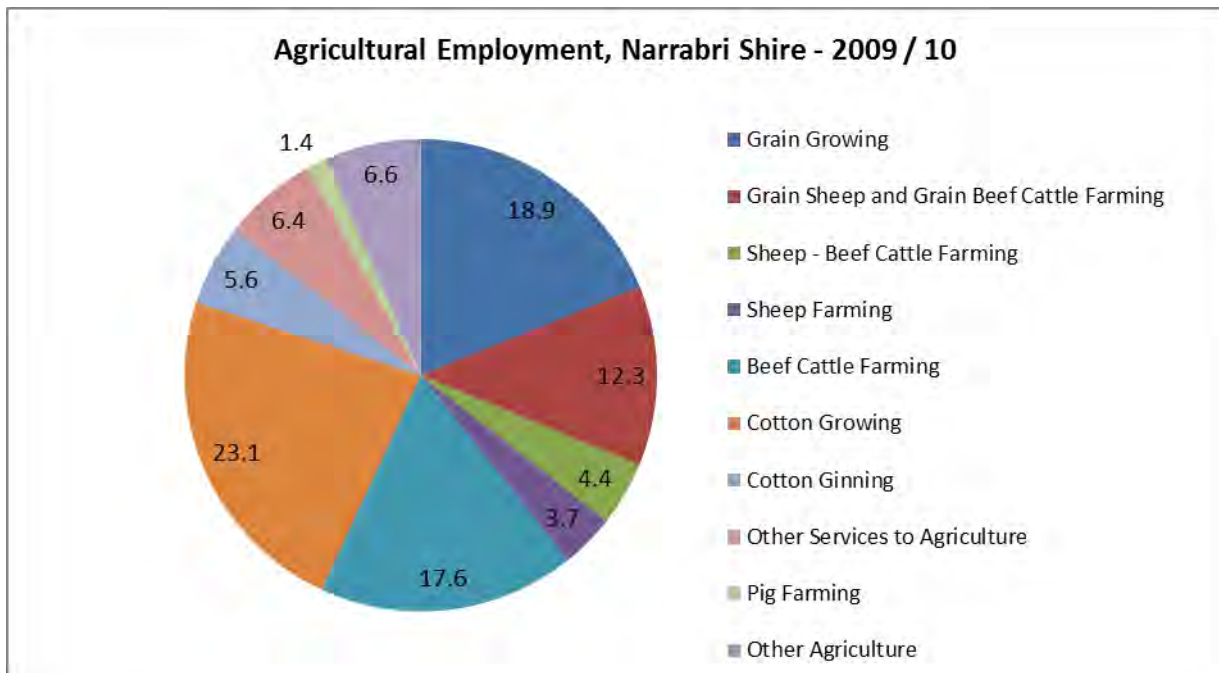


Figure 5.2: Agricultural Employment by Place of Work (Reproduced from AEC, 2011)

As the site is located on a state forest, it does not employ staff for agricultural purposes.

5.2 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 such enterprises (DoP&I, 2012a), including:

- Livestock selling centre;
- Farm management services;
- Grain and field bean merchant wholesalers; and
- Crop harvesting selling centres.

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 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 between 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, 2012a). Approximately half of the traffic which utilises the Newell Highway consists of heavy freight.

The Walgett railway services part of north-western New South Wales. Opened in 1908, it branches from the Main North line at Narrabri and passes through the towns of Wee Waa and Burren before terminating at Walgett. The line is used mainly for wheat haulage and runs adjacent to Culgoora Rd.

There is no agricultural rail infrastructure near the site or in the surrounds of the proposed activity. The nearest railway line is located approximately 32 km east of the site. Further, the site is not located on or in the vicinity of any travelling stock routes (TSR). The nearest TSR is located 21 km east of the site.

5.3 Tourism

Tourism in the Narrabri shire is led by its natural attractions. The Pilliga State Forest and Mt Kaputar National Park are two of the largest tourism interests of the region. Farm holidays, historical museums, Yarrie Lake, artesian bore baths, art shows and visiting cultural production further add to the regions tourism attraction.

5.4 Agricultural Resources

5.4.1 Climate

The closest running weather station is located approximately 16 km west of Boggabri (Boggabri Neotsfield - station 55273). Climate in this area is regarded as semi-arid, due to hot summers and mild winters (**Figure 5.3**). Average (1900 - 2013) monthly maximum temperatures range from 16.6°C (July) to 33.4°C (Jan) (**Table 5.2**). Maximum temperatures have not exceeded 40°C. Frost can occur in all low lying parts of the region. Frost events generally occur between June and August though can begin as early as May.

Average annual rainfall at Boggabri (Neotsfield station) is 594.5 mm. Pan evaporation exceeds rainfall throughout the year (**Figure 5.2**), indicating the regions reliance on irrigation and soil water storage during fallows.

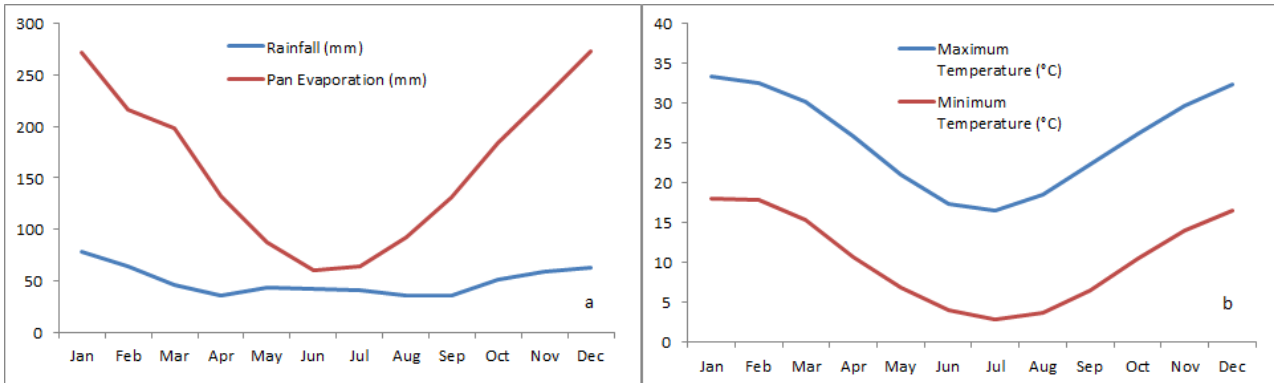


Figure 5.3: Mean maximum and minimum temperatures (°C) (a) and rainfall (mm) and Pan Evaporation (b) of Boggabri (Neotsfield) (1900 to 2013) (SILO 2013).

Table 5.2: Climate statistics Boggabri (Neotsfield) for years 1900 to 2013, weather station 55273 (SILO 2013)

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	77.9	64.3	45.8	36	43.3	41.8	40.7	35.8	35.6	51.4	58.8	63.1
Maximum Temperature (°C)	33.4	32.5	30.2	25.9	21.1	17.4	16.6	18.6	22.4	26.2	29.7	32.4
Minimum Temperature (°C)	18.1	17.9	15.3	10.7	6.9	4.1	2.8	3.7	6.5	10.5	14	16.6
Pan Evaporation (mm)	272	217	198	133	87.1	59.7	64.4	91.8	131	184	228	273

5.4.2 Landscape Units

Landscapes of New South Wales (NSW) are described by Eco Logical (2002) at a 1:250,000 scale.

Eco Logical (2002) indicated that the site is characterised by a single landscape unit (Cubbo Uplands) with the surrounding area consisting of similar landscape formation (**Figure 5.4**). This landscape unit is discussed below.

5.4.2.1 Geology and Topography

The topography of the site is gentle undulating, with no identifying topographic features. Mount Pleasant Creek and two unnamed ephemeral creeks transverse the site.

Cubbo Uplands

Pilliga horizontal Jurassic quartz sandstones, limited shales, tertiary basalt caps and plugs including the sediments derived from these rocks. Stepped sandstone ridges with low cliff faces and high proportion of rock outcrop. Long gentle outwash slopes intersected by sandy streambeds and prior stream channels. General elevation is 400 m to 550 m, with local relief of 50 m.

5.4.2.2 Soils

Cubbo Uplands

Consists of sandstone ridge tops with thin discontinuous soils with stony, sandy profiles which are very low in plant nutrients. Down slopes areas consist of texture-contrast soils, typically with harsh clay subsoils, while valley floors sediments tend to be sorted into deep sands with yellow earthy profiles, harsh grey clays or more texture-contrast soils with a greater concentration of soluble salts.

5.4.3 **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 and immediate surrounds are moderately low to low (**Figure 5.5**).

5.4.4 **Soil Limitations**

Soil characteristics of the site indicate moderate to severe limitations, as the features listed in **Table 5.3** limit agricultural productions.

Table 5.3: Soil limitations of the Dewhurst 26 – 29 project area.

Soil landscape	Salinity	PAWC*	Stoniness	Soil Depth	Nutrients	Sodicity
Cubbo Uplands	✓	✓	✓	-	✓	-

*PAWC – Plant available water capacity



Landscape Units

Figure 5.4

Project:
Dewhurst 26 - 29 AIS

Client:
Santos

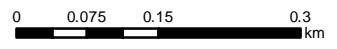
Compiled by: GO Date: 03/01/2013

Approved by: DF Date: 27/11/2012

Legend

- Pilot Wells
 - Access Tracks & Gathering Systems
 - Lease Pads
- LANDSCAPE**
- Cubbo Uplands

Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2013
Other data supplied from OEH 2012



Datum: GDA94
Scale 1:8,000 @ A4





Soil Fertility

Figure 5.5

Project:
Dewhurst 26 - 29 AIS

Client:
Santos

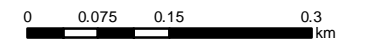
Compiled by: GO Date: 03/01/2013

Approved by: DF Date: 03/01/2013

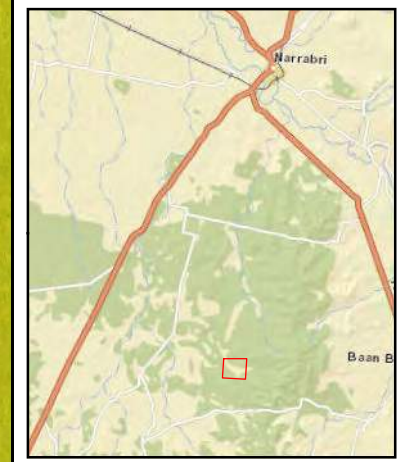
Legend

- Pilot Wells
 - Access Tracks & Gathering Systems
 - ▭ Lease Pads
- Soil Fertility**
- High
 - Moderately High
 - Moderate
 - Moderately Low
 - Low

Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2013
Other data supplied from OEH 2012



Datum: GDA94
Scale 1:8,000 @ A4



5.4.5 Agricultural Land Use Suitability

5.4.5.1 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, 2012a). Based on this definition there are two (2) categories of SAL: Critical Industry Clusters (CIC) and biophysical SAL (BSAL).

A 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, 2012a). No CIC's have been identified in the New England - North West Region.

According to the SAL mapping (DoP&I, 2012a), the site and surrounds are not located on BSAL of the New England - North West region (**Figure 5.6**). The nearest BSAL polygon is located approximately 13 km east of the site.

5.4.5.2 Land and Soil Capability

In NSW, land and soil capability classes (LSC Classes) have been mapped for the New England - North West region (OEH, 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 site and surrounds have been mapped as LSC Class 4 and 5 (**Figure 5.7**). LSC Class 4 includes lands associated with moderate to severe limitation. These lands are generally not capable of sustaining high impact land uses (e.g. regular cultivation) unless using specialised management practices with high level of knowledge, expertise, inputs, investment and technology. Limitations are more easily managed for lower impact land uses (e.g. grazing). LSC Class 5 includes lands associated with severe limitations. These lands are also not capable of sustaining high impact land uses except where resources allow for highly specialised land management practices to overcome limitations (e.g. high value crops). Lower impact land uses (e.g. grazing) can be managed by adopting available best practice although productivity and profitability are likely to be very low.

5.4.6 Water Resources

5.4.6.1 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 (**Figure 5.8**). 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 study area 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.

Three watercourses are mapped as intersecting the site:

- Mount Pleasant Creek; and
- Two unnamed ephemeral watercourses.

These watercourses flow north-west to Cowallah Creek. Cowallah Creek is located approximately 1.6 km east of Dewhurst 27. Cowallah Creek is a tributary of Bohena Creek, which is located approximately 8.1 km north-west of the closest lease pad (Dewhurst 26).

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.

5.4.6.2 Groundwater

Groundwater 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 groundwater use, providing water for stock use, domestic supplies, irrigated crops, industry and town water supplies. There are 700 water license holders in the Namoi River catchment.

The Lower Namoi groundwater 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 groundwater 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 Cocks Creek) upstream of Narrabri. They cover an area of 3,800 km², and are divided into 12 separate groundwater zones based on hydrogeological features.

The CSG pilot wells will be extracting CSG from the Bohena, Namoi and Rutley seams of the Maules Creek Formation. Overlying the Maules Creek Formation are strata belonging to the Middle Permian Porcupine and Watermark Formations of the Millie Group, successively overlain by Late Permian Black Jack Group strata and the Triassic Digby, Napperby and Deriah Formations infilling the Bohena Trough. This is further 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. The aquifers of the Great Artesian Basin have high levels of sodium which make them unsuitable for irrigation use (**Figure 5.9**).

There are four licensed groundwater bores within 9 km of the proposed study area:

- GW021998 (maximum depth 73.8 m) – authorised purpose is oil exploration (water bearing zones are located at a depth of 38.7 m to 43.5 m, 46.3 m to 52.0 m and 56.6 m to 69.7 m);
- GW967923 (maximum depth 90.0 m) – authorised purpose is industrial (water bearing zones located at depths 65.0 m to 73.0 m and 75.0 m to 90.0 m);
- GW970010 (maximum depth 47.0 m) – authorised purpose is test bore (water bearing zones located at a depth of 33.0 m to 47.0 m); and
- GW967935 (maximum depth 93.0 m) – authorised purpose is industrial (low security) (water bearing zones located at a depth of 53.0 m to 56.0 m, 65.0 m to 81.0 m and 81.0 m to 93.0 m).

5.4.6.3 Licensed Water Use

The following outlines the major features of water use, both surface and groundwaters, in the Namoi River catchment.

Surface water

The Namoi catchment uses around 2.5% of the total surface water diverted for irrigation in the Murray-Darling Basin, and around 15% of the total groundwater resource that is extracted in the Basin (CSIRO 2007). The Namoi River and Peel River systems are operated separately from a water resource management perspective. The Namoi River system is regulated to meet the needs of water users and the environment from Split Rock Dam to its confluence with the Barwon-Darling River at Walgett. Split Rock Dam, Keepit Dam and the downstream re-regulating weirs are operated to meet water user needs with the tributary inflows from the Peel River, Mooki River, Coxs Creek and other tributaries utilised before dam releases are made.

The major water users in the Namoi River are generally high security irrigators with an annual entitlement of 254,976 ML (**Table 5.4**), of which 9,724 ML of entitlement is located on the Upper Namoi between Split Rock and Keepit Dams. Total share components issued for the regulated Namoi River is 379,000 ML. When flows in the river are above user requirements supplementary water access is declared so that irrigation users can divert water from the river without debit to their allocation. The valley operates under a total licensed supplementary cap of 110,000 ML per year. Water users situated on the various creeks and tributaries of the Namoi catchment may also extract water with an unregulated water licence. These licences are subject to a range of access conditions that protect the health of the water courses such as cease to pump flow rate triggers.

Table 5.4: Namoi regulated river share components as at 30 June 2010 (Green *et al.*, 2011 sourced from NSW office of Water)

Access Licence Category	Allocation (ML/annum)	
	Upper Namoi	Lower Namoi
Domestic and stock	76	1,745
Domestic and stock (stock)	5	257
Domestic and Stock (domestic)	11	17
Local water utility	150	2,271
General security	9,724	245,222
High security	80	3,418
High security (research)	-	486
Supplementary water	-	115,469
Total	10,046	368,885

Groundwater

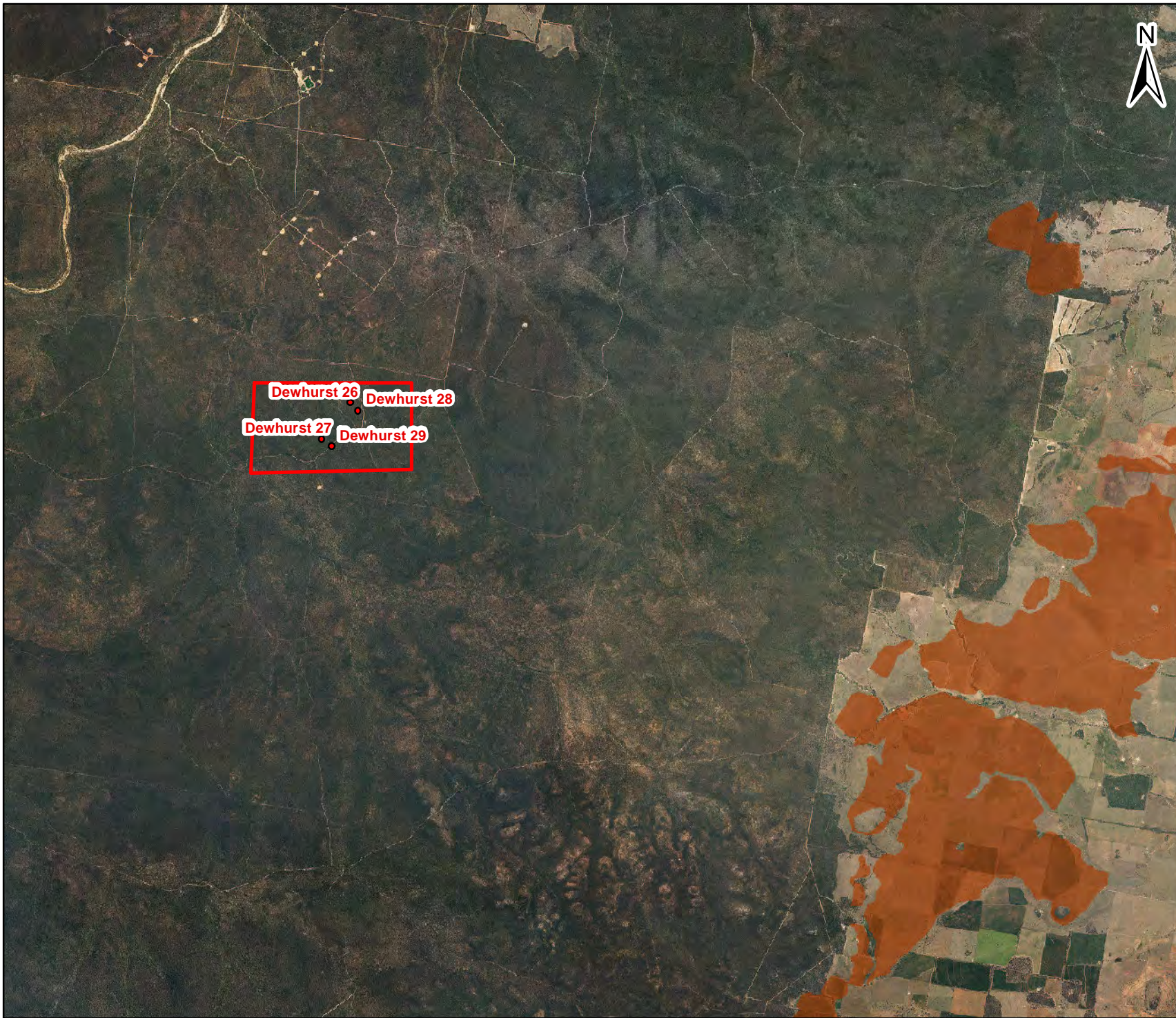
The Namoi catchment has the highest level of groundwater development in NSW, accounting for 15% of all groundwater use in the Murray-Darling Basin (CSIRO 2007). In 2004-05 a total of 255,000 ML of groundwater was extracted which represented approximately half of the total water used within the catchment that year (CSIRO 2007).

There are over 18,000 bores in the Namoi catchment which are licensed to provide over 343,000 ML of groundwater entitlement per year (**Table 5.5**). Of this entitlement 75% is associated with the Upper and Lower Namoi groundwater sources and is therefore subject to a water sharing plan.

Aquifer licences within the water sharing plan area cover a variety of purposes including irrigation, industrial, stock and domestic water. Town water supplies account for 11,752 ML of entitlement within the water sharing plan area. In areas of the catchment not covered by a water sharing plan, the main licensed use of groundwater is for irrigation and stock, which represent 50% and 40% respectively of all groundwater entitlements. Including both licensed and unlicensed groundwater entitlements, a total of 247,480.66 ML was extracted in 2009 for agricultural purposes.

Table 5.5: Namoi catchment groundwater entitlements 2009 (Green *et al.*, 2011 sourced from NSW office of Water)

License Category	Total Share Component (ML)
Upper and Lower Namoi groundwater sources	
Aquifer	188,609.5
Local water utility	11,752
Supplementary water	57,552
Total in Water Share Plan area	257,913.5
Outside water sharing plan areas	
Aquaculture / Pisciculture	44
Commercial	106
Dewatering / mining / industrial	3,691
Domestic	1,688.5
Farming	269
Feedlot / piggery	70
Irrigation	42,862
Recreation	392
Stock	34,507
Local water utility	2,066
Total outside the plan area	85,695.5
TOTAL	343,609



Strategic Agricultural Land

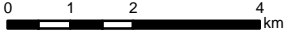
Figure 5.6

Project:		Dewhurst 26 - 29 AIS	
Client:		Santos	
Compiled by:	GO	Date:	03/01/2013
Approved by:	DF	Date:	03/01/2013

Legend

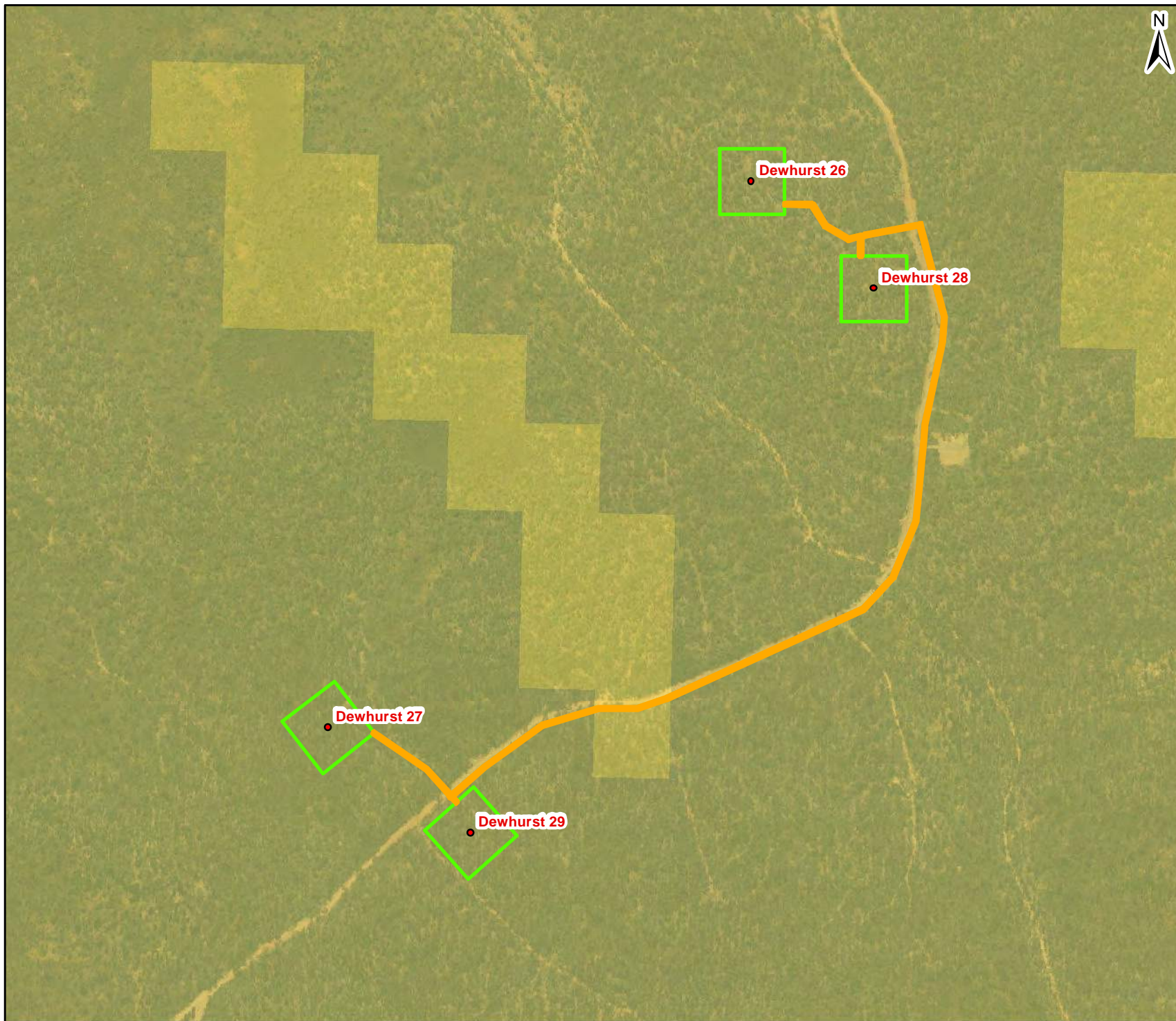
- Pilot Wells
- Study Area
- BSAL

Source: Imagery from Bing Maps 2012
 Infrastructure from Santos 2013
 other data from OEH 2012



Datum: GDA94
 Scale 1:120,000 @ A4





Land and Soil Capability

Figure 5.7

Project:
Dewhurst 26 - 29 AIS

Client:
Santos

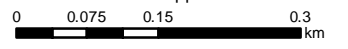
Compiled by: GO Date: 03/01/2013

Approved by: DF Date: 27/11/2012

Legend

- Pilot Wells
 - Access Tracks & Gathering Systems
 - Lease Pads
- Value**
- LSC Class 1 *Very slight to negligible limitations*
 - LSC Class 2 *Slight but significant limitations*
 - LSC Class 3 *Moderate limitations*
 - LSC Class 4 *Moderate to severe limitations*
 - LSC Class 5 *Severe limitations*
 - LSC Class 6 *Very severe limitations*
 - LSC Class 7 *Extremely severe limitations*
 - LSC Class 8 *Extreme limitations*

Source: Imagery from Bing Maps 2012
Infrastructure from Santos 2013
Other data supplied from OEH 2012



Datum: GDA94
Scale 1:8,000 @ A4



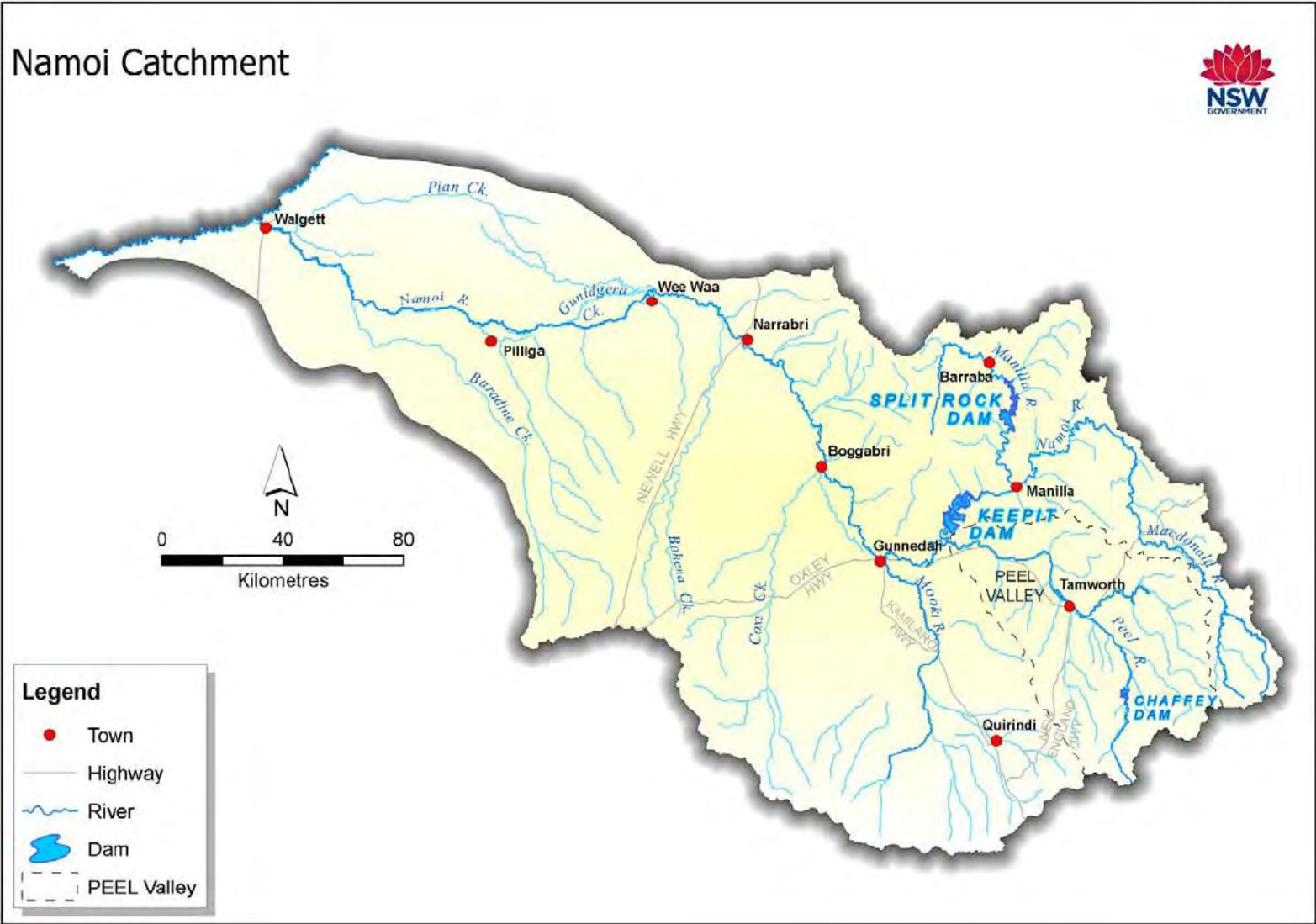


Figure 5.8: Surface waters in the Namoi catchment (Green et al., 2011)

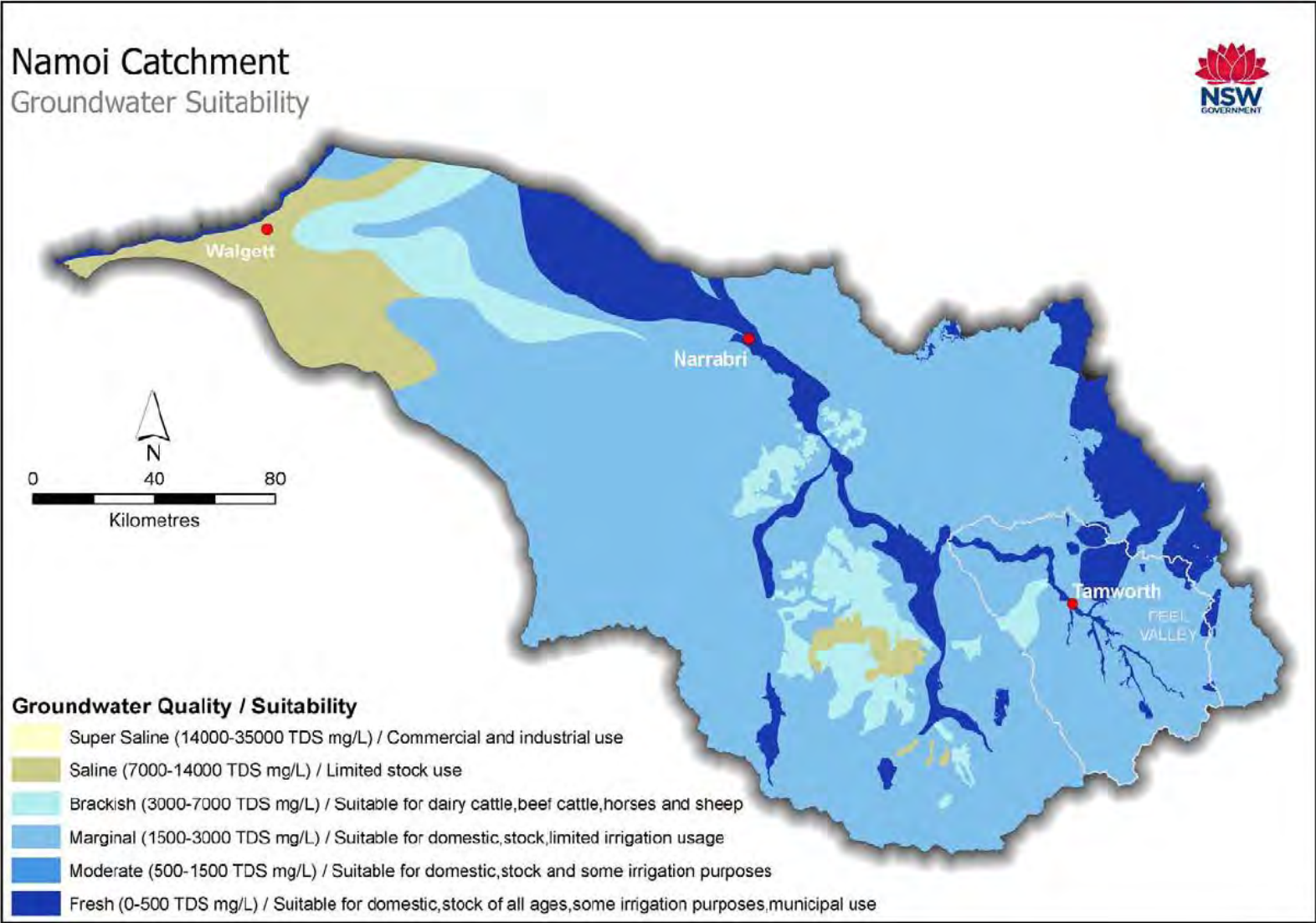


Figure 5.9: Groundwater quality and suitability in the Namoi catchment (Green et al., 2011)

6.0 Agricultural Impact Risk and Potential Consequences

The SRLUP “Guidelines for agricultural impact statement at the exploration stage” has released an agricultural impact risk ranking system. This system is designed to identify the risk of proposed exploration activities on agricultural resources or industries (**Table 6.1**). The risk ranking system includes the probability of the event occurring and the associated consequence of that event. Descriptions of probabilities are provided in **Table 6.2**, while descriptions of consequences are provided in **Table 6.3**.

Table 6.1 indicates that all red and orange areas in the Agricultural Risk Ranking Matrix are high or medium risk activities, respectively. In contrast, the DoP&I (2012b) later states in the “guidelines for agricultural impact statements at the exploration stage” that high or medium risk exploration activities are those defined as risk rankings A1 - A3, B1 - B2, C1 - C2 and D1. At this stage there is some uncertainty as to what is considered a high or moderate risk activity, though for the purpose of this report those risk rankings (A1 - A3, B1 - B2, C1 - C2 and D1) detailed by the DoP&I (2012b) as high or moderate risk activities have been utilised for such categorisation. Other high or moderate risk exploration activities identified by the DoP&I (2012b) include:

- Activities on or near (2 km radius) BSAL or CIC;
- Significant concerns relating to the proposed activities in the agricultural community; and
- Exploration activities which include coal seam gas pilot testing.

Table 6.1: Agricultural Impact Risk Ranking (DoP&I 2012b). Yellow highlight indicates low risk, orange highlight indicates medium risk and red highlight indicates high risk.

		PROBABILITY				
		A Almost Certain	B Likely	C Possible	D Unlikely	E Rare
1.	Severe and/or permanent damage. Irreversible impacts.	A1	B1	C1	D1	E1
2.	Significant and /or long term damage. Long term management implications. Impacts difficult or impractical to reverse.	A2	B2	C2	D2	E2
3.	Moderate damage and/or medium-term impact to agricultural resources or industries. Some ongoing management implications which may be expensive to implement. Minor damage or impacts over the long term.	A3	B3	C3	D3	E3
4.	Minor damage and/or short-term impact to agricultural resources or industries. Can be managed as part of routine operations.	A4	B4	C4	D4	E4
5.	Very minor damage and minor impact to agricultural resources or industries. Can be effectively managed as part of normal operations.	A5	B5	C5	D5	E5

Table 6.2: Agricultural Impact Risk Ranking – probability descriptors (DoP&I 2012b).

Level	Descriptor	Description
A	Almost certain	Common or repeating occurrence
B	Likely	Known to occur or it has happened
C	Possible	Could occur or I've heard of it happening
D	Unlikely	Could occur in some circumstances but not likely to occur
E	Rare	Practically impossible or I've never heard of it happening

Table 6.3: Agricultural Impact Risk Ranking – consequence descriptors (DoP&I 2012b).

Level: 1	Severe Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Severe and/or permanent damage to agricultural resources, or industries Irreversible Severe impact on the community 	<ul style="list-style-type: none"> Long term (eg 20 years) damage to soil or water resources Long term impacts (eg 20 years) on a cluster of agricultural industries or Important agricultural lands
Level: 2	Major Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Significant and/or long-term impact to agricultural resources, or industries Long-term management implications Serious detrimental impact on the community 	<ul style="list-style-type: none"> Water or soil impacted, possibly in the long term (eg 20 years) Long term (eg 20 years) displacement / serious impacts on agricultural industries
Level:3	Moderate Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Moderate and/or medium-term impact to agricultural resources, or industries Some ongoing management implications Minor damage or impacts but over the long term. 	<ul style="list-style-type: none"> Water or soil known to be affected, probably in the short – medium term (eg 1-5 years) Management could include significant change of management needed to agricultural enterprises to continue.
Level: 4	Minor Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Minor damage and/or short-term impact to agricultural resources, or industries Can be effectively managed as part of normal operations 	<ul style="list-style-type: none"> Theoretically could affect the agricultural resource or industry in short term, but no impacts demonstrated Minor erosion, compaction or water quality impacts that can be mitigated. For example, dust and noise impacts in a 12 month period on extensive grazing enterprises.
Level: 5	Negligible Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Very minor damage or impact to agricultural resources, or industries Can be effectively managed as part of normal operations 	<ul style="list-style-type: none"> No measurable or identifiable impact on the agricultural resource or industry

Table 6.4 details the nature of risk, likelihood and consequence of potential impacts on agricultural resources and industries. Based on the Agricultural impact risk ranking system, the proposed activities are expected to have a low risk to agricultural resources and industries due to the following:

- The site is located on land with low potential for commercial agricultural use;
- The site is not located on or near (<2 km radius) BSAL and CIC;
- No intensive agricultural activities are being undertaken on site or in the immediate vicinity;
- The exploration activity is constrained to a small area (approximately 4 ha) of the Pilliga East State Forest;
- All surface disturbance areas will be fully rehabilitated to the pre-existing land condition or better;
- The proposed mitigation, management and monitoring systems will reduce the likelihood of any impacts to agricultural resources or industries as described in **Section 7.0** and **8.0**.
- Although the proposed activity forms part of the larger Santos PEL 238 and PAL 2 exploration project, cumulative impacts to agricultural resources and industries are expected to be minimal due to the following:
 - » The area of land that will be quarantined for exploration activities within PEL 238 and PAL 2 is approximately 32.475 ha, a small area in relation to the regional agricultural resource and the extent of the these petroleum leases (79,1478 ha);

- » Approximately 447,751 ha of agricultural land use (both agricultural land and agricultural infrastructure) are mapped within PEL 238 and PAL 2. Approximately 7.225 ha or 0.002% of land will be quarantined from areas that are currently used for agriculture;
 - » As Dewhurst 26 – 29 will not quarantine any designated BSAL or CIC areas, the proposed activity will not have any cumulative impacts on such designations;
 - » Based on the nominated gross margins (GM) (**Table 6.5**) and potential agricultural land use (LSC classes identified by the DoP&I 2012a for the New England - North West region), the project area has the capacity to generate an estimated gross margin of approximately \$16,264 per annum. However, when the amount is calculated for those well sites with a current agricultural enterprise, the amount reduces to approximately \$4,389 per annum;
 - » All quarantined land will be rehabilitated to the pre-construction scenario;
 - » As defined by Halcrow (2013) “*there will be no decline in water table level, water pressure or change in flux for the majority of the porous rock groundwater source (Black Jack Group and overlaying Triassic strata) of the Gunnedah Basin (GMA604) (NSW MDB Porous Rock groundwater source WSP)*”. Further, ground water quality investigations undertaken in the Namoi and Bohena testing seam indicate that these waters (composite sample) are not suitable for agricultural use. Mean total dissolved solids (TDS) (16,095 mg/L) is outside the general ranges for irrigation (650 – 5,200 mg/L) and livestock (2,000 – 10,000 mg/L) use. No ground water quality data is currently available for the Rutley seam. Therefore, it is not anticipated that the proposed activity will have any cumulative impact on agricultural groundwater resources; and
 - » The proposed mitigation, management and monitoring systems will reduce the likelihood of any impacts to agricultural resources or industries.
- Although the agricultural community may be concerned about potential impact of exploration wells on agricultural resources, the proposed activity is assessed as low risk. The proposed mitigation, management and monitoring systems in place will reduce the likelihood and extent of any impacts to agricultural resources.

However as the Dewhurst 26 – 29 includes pilot testing the associated works are considered moderate to high risk in nature by the DoP&I (2012b).

Table 6.4: Agricultural Impact Risk Ranking of Dewhurst 26 – 29

Potential Impact	Nature of Risk	Likelihood	Consequence level (1 to 5)	Impact Risk Ranking	Potential Consequence
Loss from Agricultural Use	<ul style="list-style-type: none"> Direct surface removal from agricultural use 	Rare (E)	5	E5	<ul style="list-style-type: none"> Negligible consequence as the proposed works will not impact on land utilised for agricultural purposes.
Socio-Economic Impacts					
Agricultural Support Infrastructure	<ul style="list-style-type: none"> Pressure on water supply services Pressure on agricultural railways Pressure on agricultural processing facilities 	Rare (E)	5	E5	<ul style="list-style-type: none"> Negligible consequence as the proposed works will not source or utilise agricultural support infrastructure.
Employment and Economic Development	<ul style="list-style-type: none"> Reduction of agricultural employment on the site Reduction of agricultural employment in the Narrabri LGA 	Rare (E)	5	E5	<ul style="list-style-type: none"> Negligible consequence as the site is located in the Pilliga East State Forest (non-agricultural land use) and therefore will not result in a loss of agricultural employment at the site or in the Narrabri LGA.
Visual Amenity	<ul style="list-style-type: none"> Disturbance of scenic quality and / or visual aesthetics 	Certain (A)	5	A5	<ul style="list-style-type: none"> No consequence to agricultural resources or industries, as the site is located in the Pilliga East State Forest.
Agricultural Resources					
Soil	<ul style="list-style-type: none"> Soil erosion Contamination due to groundwater discharge Chemical spill Soil profile inversion Soil compaction 	Unlikely (D)	4	D4	<ul style="list-style-type: none"> Very minor damage or impact to soils suitable for agricultural use as soils at the site are of low potential for commercial agricultural production.

Potential Impact	Nature of Risk	Likelihood	Consequence level (1 to 5)	Impact Risk Ranking	Potential Consequence
Water use	<ul style="list-style-type: none"> Removal from agricultural supplies 	Unlikely (D)	4	D4	<ul style="list-style-type: none"> Approximately 276 ML of groundwater will be extracted during pilot testing. As there will be no decline in water table, water pressure or change in flux of the Gunnedah Basin no net impact is anticipated to agricultural groundwater resources. The 1 ML required for the proposed activity will not be sourced from agricultural sources.
Surface water	<ul style="list-style-type: none"> Soil erosion Contamination due to groundwater discharge Chemical spills 	Unlikely (D)	4	D4	<ul style="list-style-type: none"> Minor or short term impact to surface water are unlikely as potential impacts would be mitigated as outlined in Dewhurst 26 - 29 REF (RPS, 2013).
Groundwater	<ul style="list-style-type: none"> Cross contamination of aquifers Contamination by drilling fluids or mud Contamination due to spills, fuels or chemicals Reduction of agricultural groundwater sources 	Unlikely (D)	4	D4	<ul style="list-style-type: none"> Potential impacts to groundwater are unlikely as these would be minimised through the implementation of the proposed drilling and well construction and completion method. The proposed activity will not lift ground waters suitable for agricultural use Potential impacts will be mitigated as outlined in Dewhurst 26 - 29 REF (RPS, 2013).
Air and Noise	<ul style="list-style-type: none"> Dust generation Exhaust emissions from, vehicle movements and plant and machinery operations Venting of methane (CH₄) and carbon dioxide (CO₂) during drilling Noise generation above agricultural background level of 30 dB(A) 	Possible (C)	5	C5	<ul style="list-style-type: none"> Minor or short term impact to air and noise given the short duration of the construction works. Impacts would be mitigated by the measures outlined in Dewhurst 26 - 29 REF (RPS, 2013). Minor impact to agricultural enterprises as the study area is not located on or near other agricultural enterprises.

Potential Impact	Nature of Risk	Likelihood	Consequence level (1 to 5)	Impact Risk Ranking	Potential Consequence
Weeds	<ul style="list-style-type: none"> ▪ Displacement of native species by weeds ▪ Land degradation ▪ Reduced agricultural productivity 	Possible (C)	5	C5	<ul style="list-style-type: none"> ▪ Very minor damage or impact to agricultural resources and industries as potential impacts can be remediated in the short term. Impacts will be mitigated by the measures outlined in Dewhurst 26 - 29 REF (RPS, 2013).
Biosecurity	<ul style="list-style-type: none"> ▪ Spread of <i>Phytophthora</i> 	Rare (E)	5	E5	<ul style="list-style-type: none"> ▪ Very minor damage or impact to agricultural resources or industries as potential impacts can be remediated in the short term. Impacts would be mitigated by the measures outlined in Dewhurst 26 - 29 REF (RPS, 2013).

Table 6.5: Agricultural productivity of the Santos exploration project area

LSC Class	\$/ha	Area Quarantined (ha)	GM based on the potential agricultural land use (\$)	GM based on site with a current agricultural enterprise (\$)
2 & 3	Cropping land: Winter crop of short fallow cereal, canola and pulse rotation and summer crop of sorghum			
2	860	1.025	882	882
3		3	2580	2580
4 & 5	Grazing Land: best case scenario - sheep Merino ewes (18 micron) referred to as rams by DTIRIS.			
4	450	16.313	7341	-
5		12.138	5462	927
	Total	32.476	16,264	4389

*Potential agricultural productivity was determined using the DTIRIS agricultural productivity data for agricultural enterprises suitable for each of the DoP&I (2012a) LSC Classes that will be impacted. The most profitable enterprises have been selected to provide best case scenarios under the current economic conditions for the Dryland north-west region.

* The cropping enterprise selected would require average to above average rainfall and would generally be followed by a single crop in the following year.

*The area quarantined in each LSC Class is based on knowledge and understanding at the time of writing (mid-January 2013).The quarantined area does not include flowlines.

7.0 Potential Construction and Operational Phase Impacts

7.1 Agricultural Resources

The term 'agricultural resources' is defined in the SRLUP (DoP&I 2012a) as the land upon which agriculture is dependent and the associated water resources (quality and quantity) which are linked to that land.

7.2 Land Removed from Agricultural Use

The site is located in the Pilliga East State Forest, which has low agricultural production potential (LSC Classes 4 and 5). As the site is located in the Pilliga East State Forest it will not quarantine any land currently used for agricultural purposes.

There will be no permanent land capability reduction. Once the works are completed, the site will be partially rehabilitated. Partial rehabilitation will aim to be completed within six months of completion of the wells. Full rehabilitation will occur only once the wells are no longer required for operation.

7.2.1.1 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
- Where soil is disturbed or compacted, these areas will be partially rehabilitated in the short term with full rehabilitation occurring once the well is no longer required. Rehabilitation efforts are discussed in **Section 8.0**.

7.3 Socio-Economic Impacts

7.3.1 Agricultural Support Infrastructure

In the context of the total area of the site 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 services;
- Railways;
- Travelling stock routes; and
- Processing facilities.

The proposed activity will result in minor increases in traffic along Beehive Road during well construction. This level of traffic could easily be accommodated by the existing road network. Further, there will be no disruption to rail networks or travelling stock routes, as the site is not adjacent to such infrastructure.

7.3.1.1 Mitigation Measures

- No mitigation measures required.

7.3.2 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 project area is not utilised for agricultural purposes and as such the site will not prohibit agricultural activities. Therefore, the proposed activities will not result in a loss of agricultural employment opportunities at the site or in the Narrabri LGA.

As the site is located in the Pilliga East State Forest no agricultural statistics exist. However, if the site was to be cleared for agricultural purposes, the potential gross margin of this area is approximately \$2,590 per annum.

This amount is based on the DTIRIS agricultural productivity data for agricultural enterprises suitable for each of the land classes that have been identified for the site. For this assessment, the most productive agricultural enterprises have been selected to provide a best case scenario prediction for grazing lands with a Land and Soil Capability (LSC) Class of 4 and 5 (**Table 7.1**). Lands associated with LSC Classes 4 and 5 could support merino ewes (18 micron) and generate \$450/ha per annum.

Table 7.1: Agricultural productivity of the study area

Land Capability Classes	Enterprise	Enterprise Assumptions	Gross Margin (\$/ha/yr)	Disturbance Area (ha)	Gross Margin (\$)
4 & 5	Merino ewes (18 micron) (referred to as rams by DTIRIS; however, is mainly stocking of ewes)	2.1 dry sheep equivalent (DSE)/ewe and fodder supplemented	450	5.755	2590

7.3.2.1 Mitigation Measures

- No mitigation measures required.

7.3.3 Tourism

The impact assessment has not identified any tourism infrastructure at the site or surrounding area which agricultural enterprises are reliant. Therefore, it is not anticipated that the site will have any impact on local agriculture-related tourism (e.g. wineries, farm vacation locations).

7.3.3.1 Mitigation Measures

- No mitigation measures required.

7.3.4 Visual Amenity

The site will be visible from Beehive Road. As the site is located in the Pilliga East State Forest it will not be visible from agricultural properties. The nearest sensitive receiver to the site is located approximately 9 km north of the site. Further, the flat terrain of the area does not offer topographic vantage points to the public to view the site.

The proposal may detract from the scenic qualities of the land temporarily during construction and drilling but will be partially rehabilitated following completion of these works, with full rehabilitation occurring once the wells are no longer required. A negligible to low adverse impact is expected, as there will be no permanent 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.

7.3.4.1 Mitigation Measures

- Visual impacts will be mitigated through rehabilitation of the site; and
- The site will be kept in a clean and tidy manner during site preparation, drilling activities and operation of the pilot well.

7.4 **Agricultural Resource Impacts**

7.4.1 **Soils**

The proposed activity will require vegetation clearing and earthworks for establishment of the lease area, access tracks and gathering systems.

There is potential to impact agricultural resources (soil) at the site due to:

- Soil erosion;
- Groundwater discharging to the surface, which might cause flooding or impact on sediment characteristics;
- Chemical spills (e.g. drilling fluid additives, fuels or oil);
- Storage of drill cuttings on-site, prior to disposal;
- Soil profile inversion; and
- Soil compaction.

However, the risk of adverse impact to the agricultural resources is likely to be rare to low with the implementation of standard construction site environmental and engineering controls. The site has low intrinsic risks associated with soil degradation (very low erosion risk, low fertility).

7.4.1.1 Mitigation Measures

- Mitigation measures are outlined in the Dewhurst 26 - 29 REF (RPS, 2013).

7.4.2 **Water use**

Drilling activities will require approximately 1 ML of water. This will be sourced from Narrabri's town water supply or local industrial licensed water bores and trucked to the site. Alternatively, production water from pilot wells will be used when available for the preparation of drilling mud. There will be no extraction from surface waters during both the construction, operational and rehabilitation phases of the project.

Water licensing requirements are discussed in **Section 5.2.8** of the Dewhurst 26 – 29 REF (RPS 2013).

In order to conduct the pilot, water will be extracted from the targeted seams for all four pilot well. The total volume of water anticipated to be lifted throughout the pilot inception and trials is approximately 276 ML. Due to the high recharge rate of the Pilliga, no decline in water table level, water pressure or change in flux is anticipated for the porous rock groundwater source of the Gunnedah Basin (Halcrow 2013). Further, mean TDS levels (16,095 mg/L) identified for the Bohena and Namoi seams (Composite samples) is outside the general ranges for irrigation (650 – 5,200 mg/L) and livestock feed (2,000 – 10,000 mg/L). Hence, negligible impact is anticipated for agricultural groundwater resources.

7.4.2.1 Mitigation measures

- No mitigation measures required.

7.4.3 Surface water

There is potential to impact agricultural resources (surface waters) at the site and in the local area due to:

- Soil erosion;
- Groundwater discharging to the surface, which might cause flooding or impact on surface water quality depending on the discharge and receiving water qualities; and
- Chemical spills (e.g. drilling fluid additives, drilling mud, fuels or oil).

However, the risk of adverse impact to the agricultural resources is considered low with the implementation of current best practice environmental and engineering controls for construction sites. Further, runoff is not expected to be significant given low slopes within the site and permeable soils.

7.4.3.1 Mitigation Measures

- Erosion and sediment controls will be implemented during site preparation activities 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; and
- Further mitigation measures are outlined in the Dewhurst 26 - 29 REF (RPS 2013).

7.4.4 Groundwater

The wells will be designed and constructed in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity*. If wells are not constructed properly, 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; and
- Groundwater contamination due to spills of oil, fuels or chemicals if not cleaned up appropriately.

7.4.4.1 Mitigation Measures

- Mitigation measures are outlined in the Dewhurst 26 – 29 REF (RPS 2013).

7.4.5 Air and noise

There are few sensitive air and noise receptors surrounding the site. The nearest sensitive receiver is located approximately 9 km north of the site.

Regional air quality is likely influenced by mining activities, land clearing and soil preparation, sowing and harvesting of crops, vehicle and heavy machinery movements, bushfires and burn-offs.

The existing noise environment is likely to be influenced by birds, insects and other wildlife. Baseline noise monitoring has not been conducted at the site.

Potential air and noise emissions from the proposed activity will include:

- Dust generated during clearing, access track and well lease excavation and pilot well 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

- Noise generated during site preparation, drilling and completion activities.

As the site is not located on or within the vicinity of any agricultural enterprises the potential air and noise emission impacts on agricultural enterprises are expected to be low.

7.4.5.1 Mitigation Measures

- Mitigation measures are outlined in the Dewhurst 26 – 29 REF (RPS, 2013).

7.4.6 **Weeds**

The proposed activity has the potential to introduce weeds at the site or spread existing weeds on site and in the surrounding area. Activities such as clearing and earthworks may create favourable conditions for weeds and encourage weed growth.

One listed noxious weed, Prickly Pear (*Opuntia stricta*), was identified at 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.

7.4.6.1 Mitigation Measures

The following weed management procedures will be implemented to prevent the spread of weeds both on and off site:

- 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 site, 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;
- Weed infestations identified within and adjacent to access tracks, gathering systems and well leases will be eradicated by hand, with non-residual herbicide, or mechanical removal. Appropriate weed removal techniques are outlined in **Table 7.2**;
- The plant may not be sold, propagated or knowingly distributed; and
- Further mitigation measures are outlined in the Dewhurst 26 – 29 REF (RPS 2013).

Table 7.2: 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.
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.

7.4.7 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 enterprises.

7.4.7.1 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 7.4.6.1**;
- Construction personnel will be trained adequately in pest management and hygiene procedures; and
- All machinery will be cleaned of foreign soil and propogative matter to avoid the importation of *Phytophthora*.

8.0 Post Operational Phase Impacts / Rehabilitation

The pilot wells are proposed to be shut in and suspended in accordance with relevant legislation. The lease facilities (telemetry system, separators, flaring system etc.) will be removed.

Downhole completions will remain in the wells and the area around each wellhead will be rehabilitated except for the immediate area of approximately 5 m by 5 m around each wellhead. The remaining areas immediately surrounding the wellheads are proposed to be maintained by the Operator as a suspended petroleum well lease in accordance with legislative requirements. Isolation padlocks will be installed on wellhead valves to protect against vandalism and gas monitoring will be conducted at each suspended well on each site visit to check for leaks.

Once the pilot wells have reached the end of their functional lives, the wells will be plugged and abandoned and final rehabilitation will take place. This will include removing the well head, cap, surface infrastructure and fencing, revegetation and weed control.

All rehabilitation works will be undertaken with maximum regard to environmental protection and rehabilitation, vegetation, subsoil and topsoil management, weed control, erosion and sedimentation management and revegetation in accordance with the relevant statutory requirements.

8.1 Land Removed from Agricultural Use

At the end of the project life the subject site will be decommissioned and rehabilitated to its pre-operational condition.

8.1.1.1 Mitigation Measures

- No mitigation measures are proposed.

8.2 Socio-Economic Impacts

8.2.1 Agricultural Enterprises and Support Services

Subsequent to on-site infrastructure being decommissioned, the site will be returned to its pre-operational condition.

8.2.1.1 Mitigation Measures

- No mitigation measures required.

8.2.2 Employment and Economic Development

As stated in **Section 7.3.2**, the activities proposed on the site will not result in a loss of agricultural employment opportunities at the site or in the Narrabri LGA.

8.2.2.1 Mitigation Measures

- No mitigation measures required.

8.2.3 Visual Amenity

Following removal of surface infrastructure and adequate rehabilitation of disturbed areas, the presentation of the subject site will be consistent with the existing scenario.

8.2.3.1 Mitigation Measures

- No mitigation measures required.

8.3 Agricultural Resource Impacts

8.3.1 Soils

The subject site will be decommissioned and rehabilitated to its pre-operational condition. During the course of decommissioning works the potential for adverse impacts to the soil resource are as per **Section 7.4.1**.

8.3.1.1 Mitigation Measures

- Mitigation measures for potential soil resource impacts during the course of the decommissioning works are as per **Section 7.4.1.1**.

8.3.2 Surface water

During the course of decommissioning and rehabilitation the potential for adverse impacts on surface waters are as per **Section 7.4.3**.

8.3.2.1 Mitigation Measures

- Mitigation measures for potential surface water impacts during the course of the decommissioning / rehabilitation are as per **Section 7.4.3.1**.

8.3.3 Groundwater

The pilot wells will be plugged and abandoned and final rehabilitation will take place. The pilot well will be plugged and abandoned with permanent casing installed across the shallowest formations. Such activities will be in accordance with current regulatory requirements of the new Well Integrity Code of Practice.

During the course of decommissioning and rehabilitation the potential for adverse impacts on groundwaters are as per **Section 7.4.4**

8.3.3.1 Mitigation Measures

- Mitigation measures during the course of the decommissioning / rehabilitation are as per **Section 7.4.4.1**.

8.3.4 Air and Noise

During the course of decommissioning and rehabilitation the potential for adverse impacts on air and noise are as per **Section 7.4.5**.

8.3.4.1 Mitigation Measures

- Mitigation measures during the course of the decommissioning / rehabilitation are as per **Section 7.4.5.1**.

8.3.5 Weeds

Impacts associated with the spread of weeds during the course of decommissioning and rehabilitation are as per **Section 7.4.6**

8.3.5.1 Mitigation Measures

- Mitigation measures during the course of the decommissioning / rehabilitation are as per **Section 7.4.6.1**; and
- No weed species will be used to rehabilitate the lease area.

8.3.6 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 7.4.7**.

8.3.6.1 Mitigation Measures

- Mitigation measures during the course of the decommissioning / rehabilitation are as per **Section 7.4.7.1**.

8.3.7 Buffers and Offsets

Due to the low impact nature of the proposed works, buffers and / or offsets are not required for the life of the project and therefore no further impact to agricultural enterprises or support infrastructure are predicted.

9.0 Monitoring, Auditing and Trigger Response Plan

The mitigation and monitoring strategy for the proposed activity is described in **Section 2.8** of the Dewhurst 26 – 29 REF (RPS 2013).

The primary trigger response plans are highlighted in **Table 9.1**. Due the low impact nature and relative short duration of the proposed activity, no significant impact to agricultural resources or supporting infrastructure are anticipated. Further, any impacts to the site will be rehabilitated, as discussed in **Section 8.0**.

The pilot well and associated infrastructure will be established following best practice and the mitigation and monitoring program proposed will reduce the likelihood of potential impacts to agricultural resources and supporting infrastructure.

Table 9.1: Trigger Response Plans

Trigger	Response
Pressure testing to identify if aquifers have been isolated	Remedial action to ensure the seal is competent
Loss of excess drilling fluids into the formation	Application of Loss Circulation Material
Spill of chemicals or fuels to land	Immediate application of spill kit and disposal of any contaminated material

10.0 Consultation

Consultation for the proposed activity is described in **Section 2.4** of the Dewhurst 26 – 29 REF (RPS 2013).

11.0 Conclusion

- Santos NSW (Eastern) Pty Limited is proposing to construct four pilot wells and a gathering systems at the 'Dewhurst 26 - 29' site, which are located off Beehive Road in the Pilliga East State Forest, approximately 41 km south of Narrabri;
- The proposed area of disturbance is 5.755 ha, 4 ha for the lease areas and 1.755 ha of constructed access tracks and gathering system;
- The proposed activity was classified as low risk that will not have an adverse impact on the current or future agricultural production capacity or resources in the Narrabri LGA due to the following key points:
 - » There are no intensive agricultural enterprises at the study area or adjoining lands. Therefore, the proposed development does not have an unreasonable impact on agricultural production at the subject site or within the Narrabri LGA;
 - » The site is characterised by a single soil unit, which is more suited to low impact land uses,
 - » The site and surrounds are not classified as BSAL and/or a CIC;
 - » The proposed activity will not lift from surface water;
 - » The proposed activity will not lift ground water that is suitable for agricultural use. Further, the groundwater lifted for pilot testing will not result in water table declines, water pressure or change the flux of the porous rock groundwater source of the Gunnedah Basin; and
 - » The proposed mitigation, management and monitoring systems will reduce the likelihood of any impacts to agricultural resources or industries in the surrounding areas.
- The main adverse cumulative impacts of the proposed activity could include pressure on existing agricultural infrastructure and depletion of agricultural resources. However, the risk of these impacts are considered very low, provided that mitigation measures are followed and applied according to best known methods.

12.0 References

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