

# Santos

## Review of Environmental Factors Core Hole Drilling in PEL 1 Gunnedah Basin

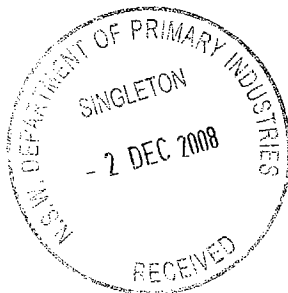
Santos QNT Pty Ltd

ABN: 33 083 077 196

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## Executive Summary

Santos QNT Pty Ltd (Santos QNT) has entered a Farmin Agreement dated 15 June 2007 with the title holder of PEL 1, Australian Coalbed Methane Pty Ltd (ACM) to explore for petroleum (in accordance with the Petroleum (Onshore) Act 1991). Santos QNT has been appointed and is the authorised Operator under the Farmin Agreement.

Condition 1.0 of the PEL 1 licence states that prior to carrying out any drilling activities a Review of Environmental Factors (REF) is required to be submitted to the Department of Primary Industries-Mineral Resources (DPI-MR) to enable a determination to be made under Part 5 of the Environmental Planning and Assessment Act 1979.

Drilling of up to 26 proposed core holes is the second stage in evaluating the hydrocarbon potential of PEL 1. Discovery of gas resources in this area has the potential to increase the state's reserves and revenue from coal seam gas and underpin future exploration or production in the region. This REF covers this activity.

Santos QNT wishes to ensure that its activities have minimal impacts on landholders, and will contact affected landowners and seek to negotiate an agreement regarding land access, compensation and rehabilitation. This step will involve the conducting of various land enquiries and meetings with the landowners in question to address any concerns. Regular contact with landholders will be made as necessary.

It should be noted that an initial assessment of proposed locations has shown that all core holes should be located in cleared grazing land. A final scouting survey will be undertaken prior to drilling taking place to locate sites where minimal environment and landholder impact will occur. The proposed core hole sites will avoid any threatened species and critical habitat identified in the desktop assessment. Core hole sites can be moved to avoid any sensitive areas.

The proposed activities have associated potential environmental impacts, which are common to drilling activities such as those carried out elsewhere in the Gunnedah Basin. It is considered that the potential impacts can be successfully mitigated with the application of the management controls/measures outlined in this document. The controls/measures are consistent with the APPEA Code of Environmental Practice and are typical of good hydrocarbon field practice.

Section 5A of the Environmental Planning and Assessment Act 1979 lists seven factors to be considered, commonly referred to as the seven part test of significance. An assessment was made against the seven factors as provided in Section 2.2 and concluded that:

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

It is not proposed to clear any natural habitat and planned activities will not constitute a threatening process.

If the management strategies are effectively implemented, it is expected that:

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

On completion of the activities, the sites will be rehabilitated to reflect the pre-existing land form and use and this will be undertaken in consultation with relevant landholders. All waste will be disposed of in an appropriate manner.

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# 1 Introduction

## 1.1 Background

This Review of Environmental Factors (REF) has been prepared for the drilling of up to twenty six core hole wells in exploration permit PEL 1 which overlies the Gunnedah Basin. PEL 1 is being explored under the conditions of Petroleum Exploration Licence no 1 (PEL 1) located in the Gunnedah Basin of New South Wales (NSW). The licence for PEL 1 permits exploration for petroleum, including coal seam gas, by methods including the drilling of core hole wells.

Condition 1.0 of the PEL 1 licence instrument states that, prior to carrying out any drilling activities, a Review of Environmental Factors (REF) is required to be submitted to the Department of Primary Industries-Mineral Resources (DPI-MR) to enable a determination to be made under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

## 1.2 Proponent Contact Information

Santos QNT (ABN 33 083 077 196) on behalf of Australian Coalbed Methane Pty Ltd (under a farmin Agreement dated 15/06/2007 and registered with the DPI-MR).

The correspondence address for the Santos QNT is:

Address: Level 14, Santos House, 60 Edward Street, Brisbane, Qld, 4000

Telephone Number: 07 3228 6666

Fax Number: 07 3228 6700

Email: reception.brisbane@Santos.com

Contact Person: Mr S Taylor, Manager-CSG Growth.

## 1.3 Structure

This REF consists of:

- Section 1: Introduction and company details
- Section 2: Summary of relevant regulations applicable to the activity;
- Section 3: Proposed activities including location and timing;
- Section 4: Description of the local environment including its physical, natural and socio-economic overview;
- Section 5: Outline of the potential environmental impacts and mitigation measures; and
- Section 6: Concluding comments on the likely impacts.

## 2 Legislation & Planning Framework

### 2.1 Planning Framework

#### 2.1.1 Overview

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

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

The proposal satisfies the definition of an activity under Part 5 of the Environmental Planning and Assessment Act 1979, because the proposal:

- may be carried out without development consent;
- is not an exempt development; and
- will be approved by a determining authority.

A determining authority, for the purposes of this activity, is defined in Part 5 of the Environmental Planning and Assessment Act 1979 to include, but is not limited to a public authority. In relation to petroleum exploration licences the Department of Primary Industries is the determining authority for approving exploration activities and will, therefore be the determining authority for the activities covered by this Review of Environmental Factors. In determining the proposal and degree of impact, the Operator has considered s.111 of the EP&A Act and Clause 228 of the Environmental Planning Regulation.

#### 2.1.2 Environmental planning instruments

The Environmental Planning Instruments (EPIs) regulate the permissibility to undertake an activity and the type of assessment process that is required. EPI is the generic term used to describe state environmental planning policies, regional environmental plans and local environmental plans. The EPI that applies to this activity being assessed under Part 5 of the EP&A Act and the circumstances in which it applies are outlined below.

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

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

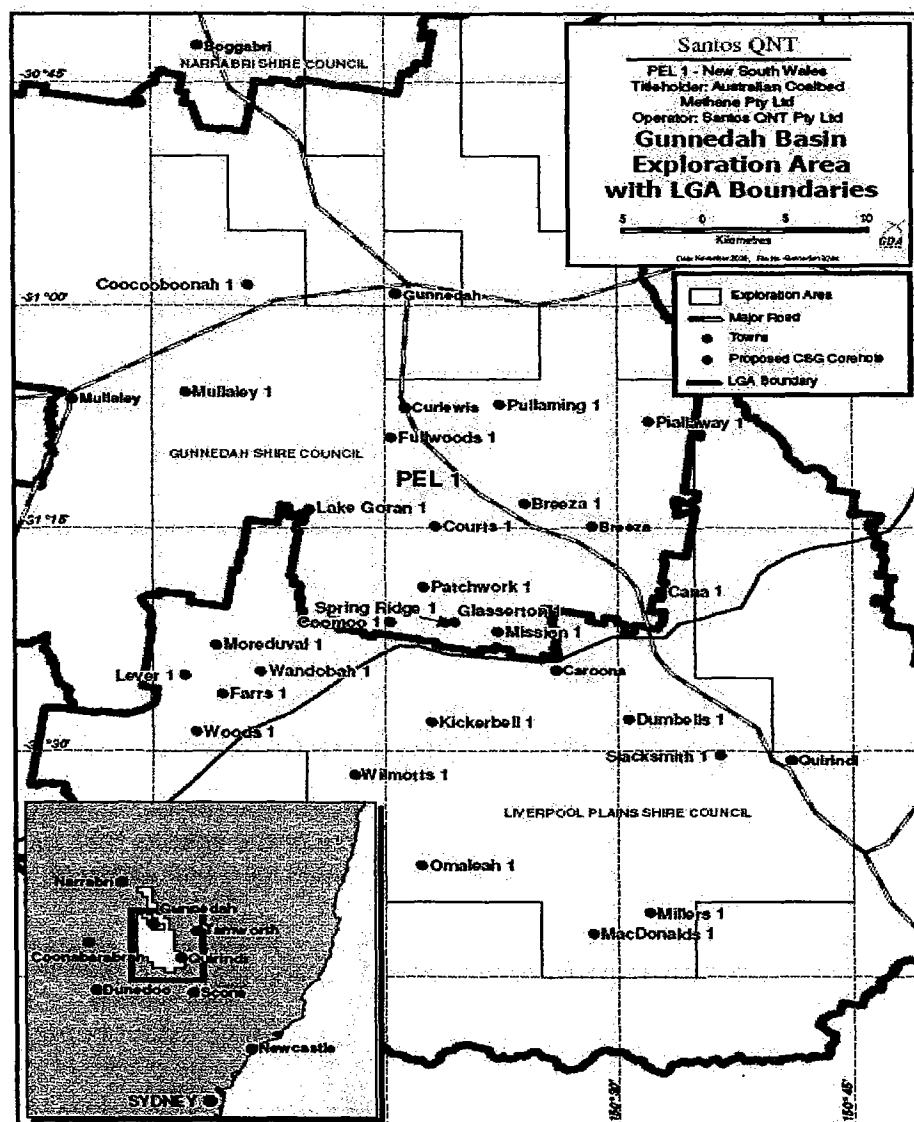
Subject to certain exemptions, SEPP 2007 allows development for the purposes of petroleum exploration to be carried out without consent. The definition of petroleum under SEPP 2007 includes any naturally occurring hydrocarbon, whether in gaseous, liquid or solid state.

### 2.1.3 Local environmental plans

Local environmental plans (LEPs) are developed by Councils (they become law only after Ministerial approval) and guide planning provisions for local government areas. According to the Department of Planning, through zoning and development controls, they allow councils to supervise the ways in which land is used. Council LEPs also list heritage items that are of local heritage significance.

The local environmental plans applicable to this proposed activity cover the Liverpool Plains and Gunnedah Shire Council areas. The application of SEPP 2007 overrides the need to consider zoning controls, as activities covered by SEPP 2007 are permissible without consent. Figure 2.1 shows the location of Liverpool Plains and Gunnedah Shire Councils and relevant core hole sites.

Figure 2-1: Local Government Areas



## 2.2 Legislative Requirements, Petroleum Licenses and Approvals Required

Pursuant to Section 7 of the Petroleum (Onshore) Act 1991, it is an offence to explore for petroleum (which includes coal seam gas) without a Petroleum Title. Santos QNT has entered a Farmin Agreement with the holder of PEL 1, Australian Coalbed Methane Pty Ltd (ACM) which appoints Santos QNT to act as operator of the permit for and on behalf of ACM, the titleholder, to explore for petroleum (Section 7, Petroleum (Onshore) Act 1991) subject to meeting landholder and legislative requirements.

Prior to any exploration on private land, The Petroleum (onshore) Act 1991 stipulates that an access agreement and compensation arrangements must be agreed between the titleholder (or its agent) and the landowner (Petroleum (Onshore) Act 1991, Section 69). The legislation specifies those issues that must be covered by an access arrangement, which include:

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

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

Whilst it is Santos QNT's intention to negotiate an acceptable agreement with any affected landowner, the above legislation also details the mechanisms by which an access and compensation agreement can be sought if a voluntary agreement cannot be obtained.

Operations must not affect any road or track unless with the prior written approval of the Director-General and subject to any conditions he may stipulate. Santos QNT is required to pay to the relevant authority (local council or Roads and Traffic Authority) any costs incurred in fixing any damage to roads caused by its operations.

Santos QNT, on behalf of ACM, must also obtain an approval under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act) from the DPI-MR prior to carrying out core hole drilling activities.

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

- a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;
- b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;
- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
  - i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or

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- 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

Under the Protection of the Environment Operations Act 1997, pollution incidents causing or threatening material harm must be notified. Under Section 147 material harm means:

- harm to the environment is material if:
  - a) it involves actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial; or
  - b) it results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding \$10,000 (or such other amount as is prescribed by the regulations), and loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment.

It does not matter that harm to the environment is caused only in the premises where the pollution incident occurs.

The National Parks and Wildlife Act 1974, protects Aboriginal objects and places (under Part 6) and threatened species, populations and ecological communities, their habitats and critical habitats (Part 8A). Under Section 5A of the EP & A Act, the DPI-MR is required to consider whether the activity is likely to have any impact on these matters.

The Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth) protects matters of national significance. As outlined in section 4.6.5 Santos QNT does not consider that this proposal will trigger this Act, and do not intend to lodge a referral to the Commonwealth Department of Environment, Water, Heritage and Arts.

Under the regulations of the Water Management Act 2000 there is an exemption (regulation 18 (e)) for the need of an access licence if the water is required for petroleum activities.

The relevant State Acts are summarised in Table 2.1 below.

Table 2-1: PEL 1 Licence Conditions and Applicable Legislation

Legislation	Requirements of Schedule 2 PEL 1 Licence Conditions	Administering Authority
<i>Petroleum (Onshore) Act 1991</i>	The activities do not cause other than minimal/nil impact on features listed in Section 75 (i.e. of Aboriginal, Architectural, archaeological, historical or geological interest). Where these are present, an exploration protocol acceptable to the Department must be completed prior to exploration commencing to ensure that exploration activities will not have an adverse impact on these features.  Full rehabilitation in accordance with Department guidelines/standards is carried out after completion of the exploration activities.	Department of Primary Industries – Mineral Resources
<i>Environmental Planning and Assessment Act 1979</i>	Obtain an approval under Part 5 of the Environmental Planning and Assessment Act 1979 (EP & A Act) from the DPI-MP prior to carrying out core hole drilling activities.	Department of Primary Industries – Mineral Resources
<i>Threatened Species Conservation Act 1995</i>	The Licence holder is required to consult the register of Critical Habitat kept by the Director-General, and consider the significance of any notations in respect of the area of any proposed exploration activity	Department of Environment and Climate Change
<i>Fisheries Management Act 1994</i>	Consult the register of critical habitat kept under this Act	Department of Primary Industries – Fisheries
<i>National Parks and Wildlife Act 1974</i>	The activities do not contravene Part 6 (Aboriginal objects and Aboriginal places) of this Act	National Parks and Wildlife Service
<i>Native Vegetation Conservation Act 1997(now 2003)</i>	The licence holder must not cut, destroy, ringbark or remove any timber or other vegetative cover on any land subject of the licence except such as directly obstructs or prevents the carrying on of operations. Any clearing not authorised under the Petroleum (onshore) Act 1991, must comply with the provisions of this Act.	Department of Environment and Climate Change
<i>Rural Fires Act 1997</i>	The operator must take all precautions against causing an outbreak of fire and must comply with the provisions and regulations of the Act and must not burn off any grass, foliage or herbage with out the current consent of the owner or occupier and the local fire authority.	NSW Rural Fires Service

## 2.3 Zoning

Proposed core holes will be located in Gunnedah Shire Council (GSC) (14 core holes) and Liverpool Shire Council (LSC) (12 core holes). Further details are presented in Table 3.1 and Figure 3.1.

The proposed core holes fall either within Zone 1 (a) Rural Agricultural Protection in Gunnedah Shire Council, or in Zone No 1 (a) (Rural A Zone) in Liverpool Plains Shire Council. However, as noted in Section 2.1.3 above, the application of SEPP 2007 overrides the need to consider zoning controls, as activities covered by SEPP 2007 are permissible without consent.

## 2.4 Stakeholder Consultation

Key stakeholders relevant to proposed core holes during the exploration phase include:

- State regulatory agencies (DPI-MR, Department of Water and Energy);
- Local governments (Gunnedah Shire Council and Liverpool Plains Shire Council);
- Landowners/occupiers;
- Aboriginal Groups;
- Community, business and special interest groups, and
- Utility operators.

Santos QNT has commenced (April 2008) a program of community and stakeholder consultation in the region of the proposed coal seam gas (CSG) exploration. This has involved briefings and discussions with a broad range of stakeholders to inform them of Santos QNT and its proposed exploration activities in the Gunnedah Basin.

Groups consulted initially have included the local governments areas relevant to the activities proposed in this REF, relevant Members of Federal and State Parliament, Local Aboriginal Land Councils, senior representatives of relevant government agencies and various business, community and special interest groups (e.g. Gunnedah District Development Board, Liverpool Plains Land Management Committee, NSW Farmers Association, Caroon Coal Action Group, Caroon Coal Community Consultation Committee). Fact sheets on the proposed activities and a map of the areas to be explored are presented on the Operator's website at:

[http://www.Santos.com/library/Santos\\_Gunnedah\\_Basin\\_Project\\_Overview.pdf](http://www.Santos.com/library/Santos_Gunnedah_Basin_Project_Overview.pdf).

Observations from this first phase of consultation indicate that little is known in the community about coal seam gas and the differences between the petroleum exploration legislation and the mining legislation, with which the community was generally more familiar. Future activities will therefore be aimed at increasing the community understanding of the proposed coal seam gas exploration activities.

Santos QNT will also contact and seek to negotiate an access arrangement with affected landowners in respect to land access, compensation and rehabilitation once the proposed sites have been finally selected. This step will involve the conducting of various land enquiries and meetings with the relevant landowners. A notice of intended entry will be provided to each affected landowner. A formal land access arrangement will also be made and Santos QNT will contact landholders as necessary.

Consultation activities will be ongoing through the exploration program. Further consultation with other groups such as any local environmental groups, will occur if the proposed core holes indicate a potentially commercially operation that will trigger a follow-up program. Progression to commercial production would necessitate drilling additional wells and infrastructure. Progress of the project beyond the core hole drilling stage will necessitate additional application to DPI-MR and further consideration of any additional potential environmental impacts.

### 3 Project Description

#### 3.1 Location and Tenure

##### 3.1.1 Location

Santos QNT has entered into a Farmin Agreement with the titleholder of Petroleum Exploration Licence No 1 (PEL 1), Australian Coalbed Methane Pty Ltd, dated 15 June 2007 and has been appointed Operator under that Farmin Agreement.

The aim of the project as described in Section 3.2 is to explore the Gunnedah Basin by drilling up to 26 core holes. Figure 3.1 shows the location of PEL 1 and core hole sites on freehold land with their co-ordinates provided in Table 3.1. The core holes are expected to range from about 200m to 1400m deep.

Figure 3-1: Well Locations

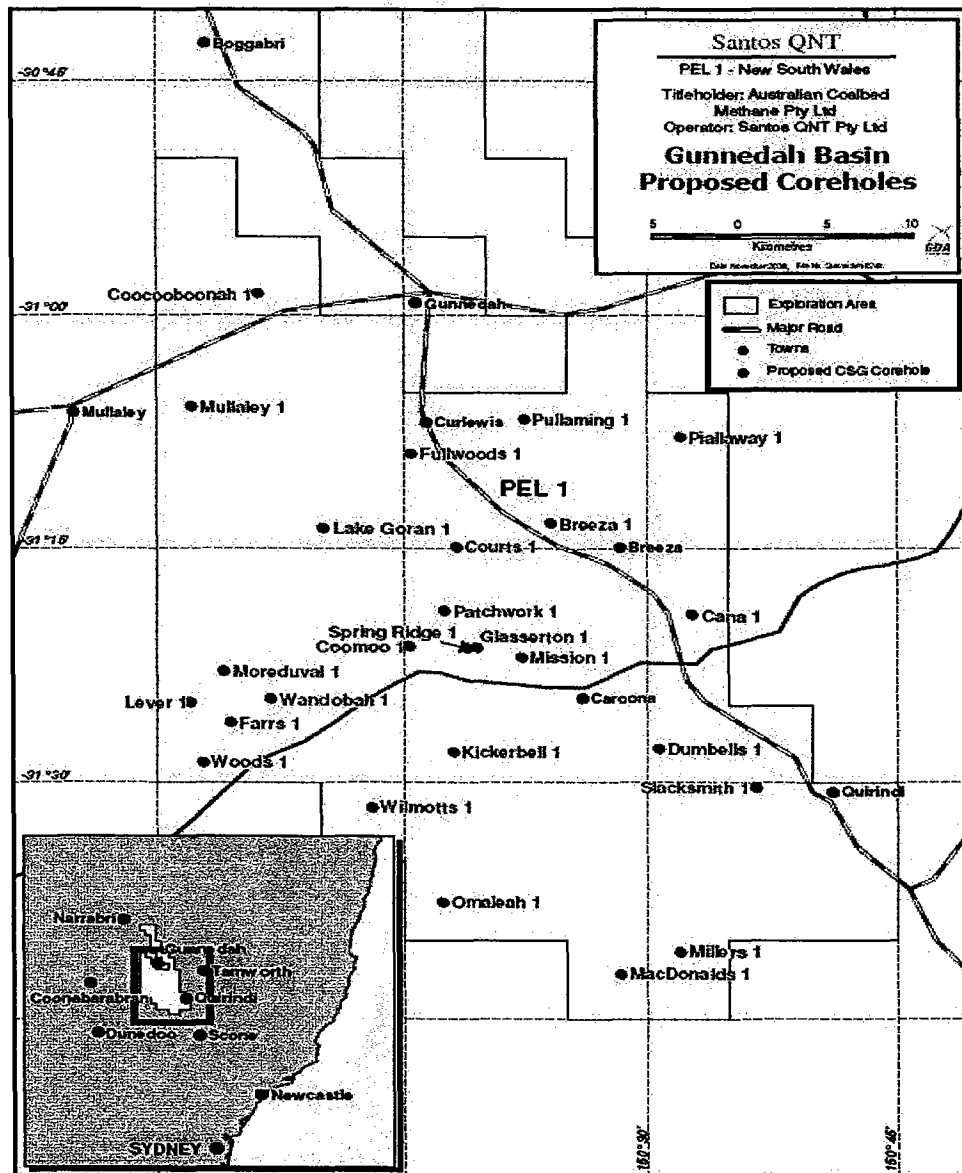




Table 3-1: Co-ordinates of Proposed Core Hole Sites (GDA-Zone 94)

Core Hole Node*	Longitude	Latitude	Local Government Area	Nearest Town
Cana 1	150.546268	-31.320676	Gunnedah	Breeza
Coocooboonah 1	150.104134	-30.977445	Gunnedah	Gunnedah
Coomoo 1	150.255034	-31.354988	Gunnedah	Caroona
Courts 1	150.302943	-31.247992	Gunnedah	Breeza
Dumbells 1	150.511825	-31.464221	Liverpool Plains	Caroona
Farrs 1	150.075735	-31.436737	Liverpool Plains	Caroona
Fullwoods 1	150.256882	-31.148466	Gunnedah	Curlewis
Breeza 1	150.399485	-31.222927	Gunnedah	Breeza
Kickerbell 1	150.299485	-31.467954	Liverpool Plains	Caroona
Lake Goran 1	150.169413	-31.228225	Gunnedah	Curlewis
Lever 1	150.034531	-31.414797	Liverpool Plains	Caroona
MacDonalds 1	150.472275	-31.703411	Liverpool Plains	Quirindi
Millers 1	150.533681	-31.680621	Liverpool Plains	Quirindi
Mission 1	150.369959	-31.366890	Gunnedah	Carooma
Moreduval 1	150.069226	-31.381667	Liverpool Plains	Carooma
Omaleah 1	150.288368	-31.627462	Liverpool Plains	Quirindi
Patchwork 1	150.290447	-31.316641	Gunnedah	Carooma
Piallaway 1	150.533281	-31.130901	Gunnedah	Breeza
Pullaming 1	150.372634	-31.111477	Gunnedah	Curlewis
Slacksmith 1	150.609958	-31.505203	Liverpool Plains	Quirindi
Spring Ridge 1	150.313763	-31.356112	Gunnedah	Carooma
Wandobah 1	150.116532	-31.411355	Liverpool Plains	Carooma
Wilmotts 1	150.217416	-31.526848	Liverpool Plains	Carooma
Woods 1	150.047300	-31.478600	Liverpool Plains	Carooma
Glasserton 1	150.323956	-31.355440	Gunnedah	Carooma
Mullaley 1	150.036206	-31.097890	Gunnedah	Mullaley

Note: Anticipated core holes will be within 4 km of the locations shown

The environmental information in this document is based upon NSW database searches for flora and fauna covering the two local government areas within which the core holes will be drilled. The Commonwealth EPBC database searches were based on a 4 km radius around each proposed core hole location. If there are technical constraints at any particular core hole then the site will be relocated, subject to the necessary landholder approvals, in a similar environmental setting.

The core hole sites proposed in this REF are located on freehold land.

As required to be stated (based on the DPI Guidelines for preparing a REF-see Mineral Resources Division, 2006), the proposed core hole sites are not located in the following areas:

- An area reserved or dedicated under the National Parks and Wildlife Act 1974;
- Land reserved or dedicated within the meaning of the Crown Lands Act 1989 for preservation of other environmental protection purposes;
- A World Heritage Area;
- Environmental Protection Zones in environmental planning instruments;
- Lands protected under SEPP 14 – Coastal Wetlands;
- Lands protected under SEPP 26 – Littoral Rainforests;
- Land identified as wilderness under the Wilderness Act 1987 or declared as wilderness under the National Parks and Wildlife Act 1974;
- Aquatic reserves dedicated under the Fisheries Management Act 1994;
- Wetland areas dedicated under the Ramsar Wetlands Convention;
- Land subject to a conservation agreement under the National Parks and Wildlife Act 1974;
- Western Lands Lease;
- Land identified as State Forest under the Forestry Act 1916; and
- Crown Land.

## 3.2 Planned Activities

To assess the coal seam gas potential of the Gunnedah Basin PEL 1 it is proposed to drill 26 HQ (96 mm) diameter core holes to obtain information on coal depths, seam sizes, continuity and quality. These core holes will also provide data on gas content, gas type, and the porosity and permeability of the coal seams. In addition, tests for desorption isotherm behaviour will be undertaken on selected coal samples recovered during drilling operations to assess the potential flow of gas out of the coal seams.

Santos QNT proposes to carry out the drilling activities for coal seam gas in accordance with the activities described below.

Firstly, Santos QNT will contact and negotiate with landowners on whose land activities are proposed in respect to land access, compensation and rehabilitation. This step will involve meetings with the affected landowners and developing an understanding of the nature of the land and activities undertaken at each site. Only after landowner agreements have been entered into, site preparation and drilling will commence.

Existing access tracks will be used where possible. New tracks required for core hole sites will avoid remnant trees and shrubs. There will be some soil disturbance as a level drilling pad will need to be constructed. Tracks on slopes will have drains cut at regular intervals to reduce the risk of gullying and soil erosion. Vehicular activity will be minimised when the ground is soft after rain. The surface will be rehabilitated.

The major equipment to be used will be a drilling rig. A temporary building will be located at the site. The areas to be disturbed for drilling activities will be approximately 45 by 60 metres for each core hole site plus necessary access track. However, only approximately 30% of the core hole area will be hard stand. Associated sumps and flare pit will also be constructed on site.

Each corehole will have a specific well design developed, compliant with the relevant legislation. In general, an open hole of nominal 200mm diameter will be drilled through any alluvial and/or weathered material into competent rock and a Blow Out Preventer casing cemented in place, which will have a blow out preventer installed on top of it. The hole will be drilled using open hole rotary drilling to the depth at which core drilling will commence (core point). Depending on the local stratigraphy and objectives of the proposed well, casing may be run or the hole left open. Drilling will then carry on using continuous HQ diameter coring techniques for the purposes of recovering core and conducting open hole testing and geophysical logging.

A water-based drilling fluid will be used, which may include potassium chloride as a weighting agent. As it is possible that some water-reactive clays may be found, again potassium chloride may be added to the drilling fluid to control swelling clays and increase the stability of the formations intersected. There will also be a need to add polymers while drilling the core hole. None of these additives are considered harmful to the immediate environment. Water will be generally sourced from nearby dams/bores, in agreement with land owners and/or from local authorities.

A selection of the potential production horizons may be tested for permeability by Drill Stem Test (DST).

In the event that a partially drilled core hole is abandoned a new nearby location will be selected where the alternative core hole can be completed. This will be subject to obtaining the necessary approval of the land holder. This will be within a radius of less than 4 km from the existing core hole site (i.e. within the database search areas already undertaken as part of this REF).

The number of employees present at each site is expected to be in the order of ten persons. The hours of operation will be as negotiated with the landowner. Santos QNT is seeking 24 hour days and 7 days per week operations. If well-sites are less than 1 km from a residence this will be highlighted and noted in the landowner agreements. It is proposed to commence these operations in early 2009.

Core hole drilling activities are temporary and will not have any long term impact on the visual amenity of the area. A typical drilling rig on a location is shown in Figure 3-2.

### 3.3 Abandonment

In the event that it would be worthwhile to undertake on-going monitoring at a selected core hole location acceptance by the landholder and regulatory authority will be sought. Core holes not used for temporary monitoring purposes (e.g. standing water levels) will be abandoned and the area rehabilitated in line with legislative, landowner and licence requirements. Cement plugs will be set to fill the core hole from total depth to the surface, the casing will be cut back and an abandonment plaque placed on the nearest fence line. The area will then be rehabilitated in consultation with the landowner and DPI-MR. The core hole sites will be monitored during this rehabilitation period.

### 3.4 Justification of the Activity

Drilling of the proposed core holes is an essential step in the exploration and evaluation of the hydrocarbon potential in PEL 1 which over lies the Gunnedah Basin, which to date has undergone little petroleum exploration. Discovery of coal seam gas resources in the area has the potential to increase the state's reserves and revenue from gas, and underpin future exploration or production in the region.

The proposed program consists of drilling core holes, geologically logging and sampling cores for gas content etc, conducting drill stem tests, and wireline geophysical logging in

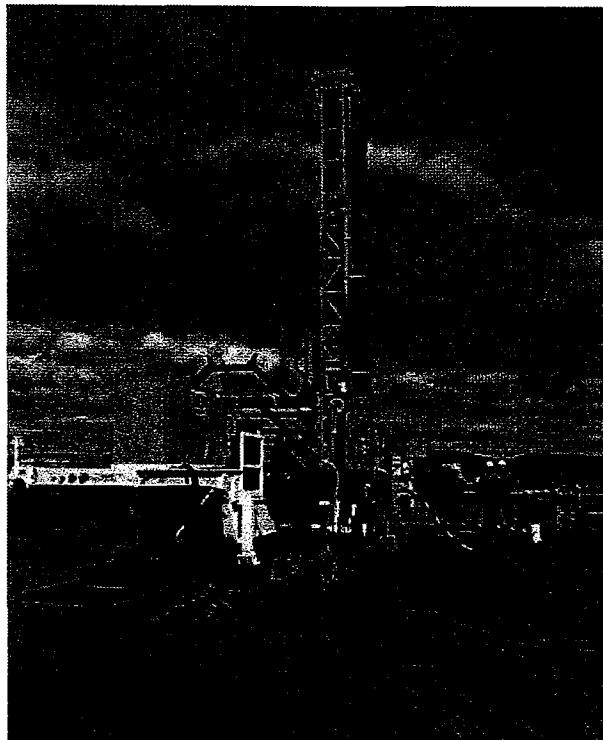
each core hole. All these procedures are required to define and identify commercially useful reserves of coal seam gas.

Santos QNT is committed to undertake this work as part its obligations under the NSW petroleum legislation and its obligations contained in the Farm-in Agreement entered into with ACM.

### 3.5 Evaluation of Alternatives

There are no reasonable industry alternatives to the drilling method proposed in Section 3.3 if commercially useful amounts of coal seam gas are to be located and assessed. There is little previous drilling in this area of the Gunnedah Basin that is sufficiently deep for the purposes of petroleum exploration. Geophysical methods available (e.g. seismic), which could be applied to exploration would show the structure of the basin but would not provide the ability to sample and analyse the stratigraphy of the Gunnedah Basin to quantify coal and coal seam gas potential.

Figure 3-2: Typical Drilling Rig



## 4 Regional Description

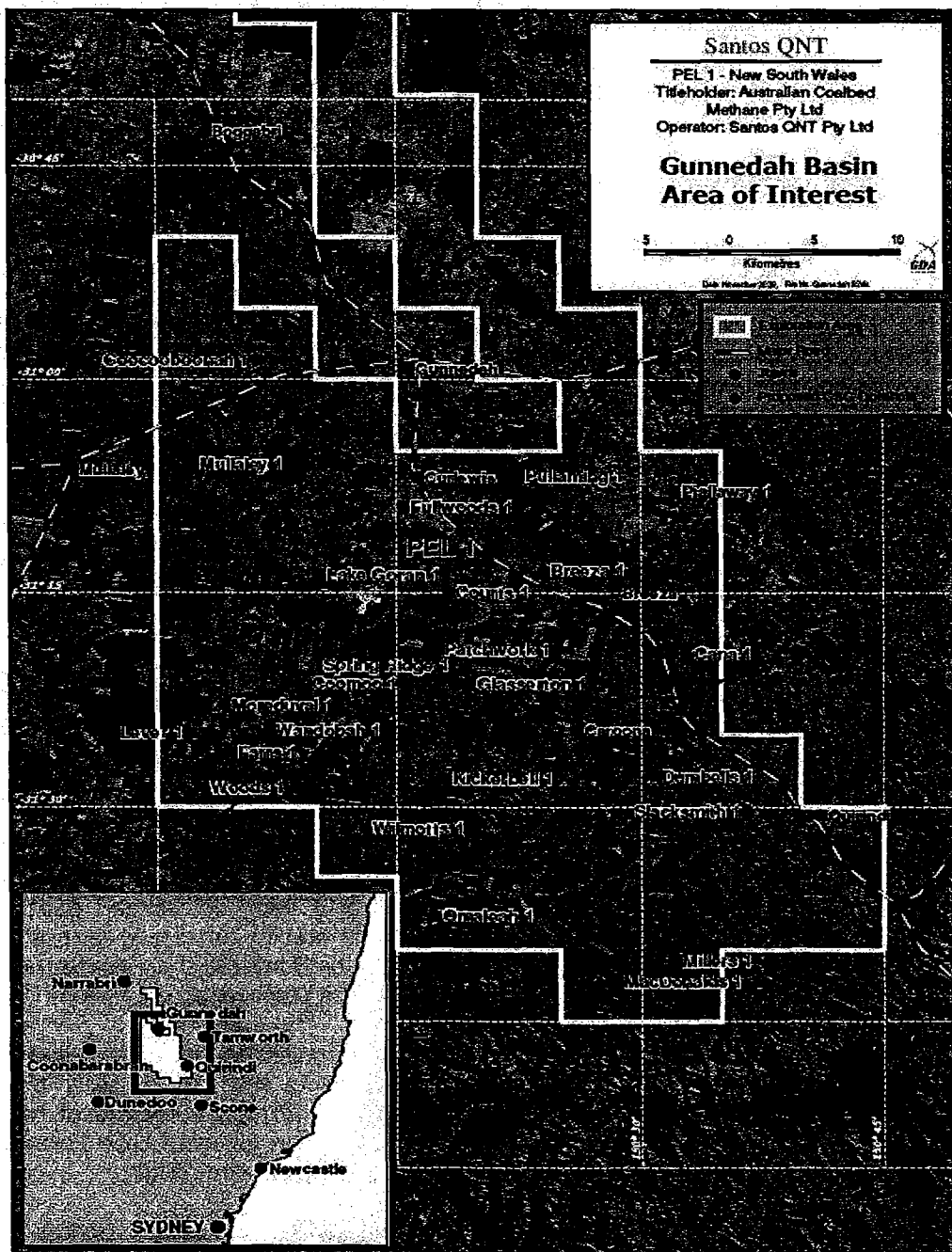
Unless otherwise stated the major source reference for this section is as follows:

NSW National Parks and Wildlife Service, 2003, The Bioregions of New South Wales: their biodiversity, conservation and history, at:

<http://www.environment.nsw.gov.au/bioregions/BrigalowBeltSouthBioregion.htm>

The proposed core hole sites are located within the white box shown in Figure 4.1 below.

Figure 4-1: Regional Map



## 4.1 Bioregion

PEL 1 falls within the Brigalow Belt South Bioregion which extends from south of Dubbo in central-western NSW to mid-Queensland coast, of which about 20% is located in NSW. The towns of Baradine, Binnaway, Coonabarabran, Dubbo, Gunnedah, Merriwa, Moree and Narrabri occur within this bioregion. The nearest towns are Quirindi and Gunnedah which are respectively about 5km and 10km away from the nearest core hole sites.

## 4.2 Geology

### 4.2.1 Regional Geology

PEL 1 is located in the central part of the Permo-Triassic Gunnedah Basin in an area overlain by the Jurassic and Cretaceous of the Surat Basin. The Gunnedah Basin forms the central part of the Sydney-Gunnedah-Bowen Basin system. The eastern edge is overthrust by New England Fold Belt rocks along the Hunter Mooki Thrust Fault System and the western boundary onlaps the Lachlan Fold Belt palaeosurface. The Permian sedimentary basin sequence overlies latest Carboniferous and early Permian volcanics (Boggabri Volcanics and Werrie Basalt) that are related to the volcanic rift origin of the Gunnedah Basin.

The Gunnedah Basin is divided by basement highs into a number of structural compartments of which the Bando Trough is the main feature over much of PEL 1. The Walla Walla Ridge defines the northern extent of the Trough and roughly corresponds to the northern boundary of PEL 1. The southern boundary is poorly defined by the Yarraman High and to the east, the Bando Trough is flanked by the Breeza shelf which onlaps onto the Boggabri Ridge within PEL 1.

The Bando Trough consists of at least 1000m of sedimentary sequence, with minor Jurassic Volcanics and intrusives, ranging through all units of the Gunnedah and Surat sequence from the Leard Formation to the Pilliga Sandstone.

A period of erosion and weathering of the Boggabri Volcanics surface was succeeded by paralic- lacustrine environments in which sediments of the Leard and Goonbri Formations were deposited.

This was followed by low energy fluvial conditions in which the coal measures of the Early Permian 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 culminated in the deposition of the upper Watermark Formation marine claystone.

Marine conditions were terminated by development of a major delta system which deposited the coal bearing Black Jack Group. A short lived but widespread marine transgression occurred prior to development of a very widespread peat swamp which deposited the Hoskissons Coal Member which is readily correlated across the Gunnedah Basin. The thickness of the Hoskissons Coal ranges from less than 1m in the west to more than 12m in the north and greater than 20m in the south-east.

Late Permian explosive volcanic activity and tectonism to the east resulted in renewed deposition of more lithic and tuffaceous sediments with an easterly provenance and consequently the Upper Black Jack Formation was formed. 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.

The Triassic aged Digby Formation is marked by a basal conglomerate that has been derived from the New England Fold Belt and overlying quartz sand facies. This unit

Gunnedah Basin

thickens towards the east and onlaps onto the older sediments and basement to the west. Reservoir quality of the sandstones present in this unit 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.

A major period of uplift and erosion during the Late Triassic ended Gunnedah Basin sediment deposition. The Jurassic period commences in the Garrawilla Volcanics and intrusives and is distinguished by lava flows, pyroclastics and intercalated claystones.

Deposition of the Surat Basin sequence commenced during the Early Jurassic resulting in the deposition of the Purlawaugh Formation and Pilliga Sandstone which covers most of PEL 1. The Tertiary period of tectonism resulted in massive extrusions of basalts forming the Liverpool Ranges which is present in the southern portion of the permit area.

Figure 4-2: Stratigraphy of Gunnedah Basin

**STRATIGRAPHIC TABLE**

AGE	BIOSTRAT ZONE	ROCK UNIT	LITHOLOGY	ENVIRONMENT OF DEPOSITION	MAX THICKNESS (M)	RESERVOIR POTENTIAL		SOURCE POTENTIAL		BASIN		
						POOR	EXCELLENT	POOR	EXCELLENT			
MESOZOIC	CR.	F. WONTHAGGIENSIS	BUNGIL FM							SURAT BASIN		
		C. AUSTRALIENSIS	MOOGA FM		PARALIC							
	JURASSIC	LATE	ORALLO FM		FLUVIAL	15						
			UJ5-6	PILLIGA SANDSTONE	FLOOD PLAIN MEANDERING FLUVIAL							
			LJ5-6		BRAIDED STREAM	213						
		MIDDLE	J4	PURLAWAUGH FORMATION		FLOOD PLAIN OVERBANK & MEANDERING STREAM	76					
			J3									
			J2									
	J1				FLAWS & PYROCLASTICS	39						
	TRIASSIC	LATE		GARRAWILLA VOLCANICS								
			Tr3c-d			REGRESSIVE DELTAIC	215					
		EARLY	Tr3a-b	NAPPERBY FORMATION		LACUSTRINE ?						
			Tr2	DIGBY FORMATION			250					
		LATE	Tr1b			ALLUVIAL FAN						
			Tr1a									
			U5c	BLACK JACK FM		FLUVIO-LACUSTRINE						
			U5b									
	U5a											
	L5c		HOSKISSONS COAL MEMBER WESTERN SANDS ARKARULA SST MBR		PEAT SWAMP FLUVIAL SHALLOW MARINE DELTA PLAIN	460						
	EARLY	L5b			DELTA FRONT							
L5a		WATERMARK AND PORCUPINE FORMATIONS		PRO DELTA								
U4b				MARINE SHELF	360							
U4a												
L4		MAULES CREEK FORMATION		ALLUVIAL PLAIN	100							
3b		LEARD/GOONBRI FORMATIONS		LACUSTRINE	127							
3a	BOGGABRI VOLCANICS/ WERRIE BASALT											

#### 4.2.2 Soils

In Gunnedah Shire the soils were mapped by the Department of Conservation and Management in 1976 into six mapping units which are based on:

- surface cracking of the soil;
- soil texture;
- topography;
- apparent erodability.

The six units, including the dominant soil types found within each, are summarised below (GSC, 2004).

1. Cracking Clay Soils

Black Earths, Red, Brown and Grey Clays.

2. Skeletal Soils (Associated with steep topography)

Lithosols

3. Duplex and "Gravelly Soils"

Solodic soils and gravelly red brown earths.

4. Clay and Loam Soils (Associated with river flood plains)

Red, Brown and Grey clays, covered by a thin layer of recent alluvium.

5. Highly Erodible Hard setting loam soils

Red, Brown Earths, Structured loams and Non Calcic Brown soils.

6. Clay Loam soils with Red Clay subsoils, Neutral to Alkaline pH.

Euchrozems.

There are a number of broad soil types within the Liverpool Plains Shire (LPSC, 2005). These are as follows:

**Alluvial:** These are based on the broad level floodplains of the Liverpool Plains. They are fertile and have few limitations to plant growth.

**Residual:** These are deep soils formed from weathering of the parent material. They are mainly level to undulating landforms and have some erosion hazards but are generally fertile and suited to cropping and grazing. They are located to the north and east of the Melville Range.

**Colluvial:** These are mostly on hill slopes and steep land. They are not very fertile and are located on the Melville Range and associated hills to the north of Tamworth.

**Erosional:** These are downslope of the colluvial soils and consist of steep to undulating hill slopes.

**Transferral:** These are deep deposits of material mostly along the drainage lines. They have good fertility and are suited to cropping and grazing.



## 4.3 Climate

The town Gunnedah, which is representative of the area, has average maximum temperatures varying from 33.7 degrees Celsius in January to 16.8 degrees Celsius in July, while average minima range from 18.2 degrees Celsius in January and February to 2.9 degrees Celsius in July. Extremes exceeding 35 degrees Celsius and as low as minus 5 degrees Celsius have been recorded (GSC, 2004).

Average annual rainfall across the Shire is between 500 and 600 millimetres and tends to be summer dominant with 43% falling in the four months November to February (GSC, 2004).

## 4.4 Hydrology

### 4.4.1 Surface Water

The region lies within the Namoi River catchment. The Namoi Basin can be divided into the following four natural subdivisions (EPA, 1995):

- Upper Catchment - runs north-west from Nundle to Barraba including parts of the Liverpool and Nandewar Ranges; steep to rugged; originally savannah woodland, now cleared;
- Liverpool Plains - mainly the Mooki and Coxs River catchments; flat with slopes rarely exceeding 3°; cracking clays or clay loams with red clay subsoils; naturally a treeless plain dominated by grasses with patches of savannah woodland, now cleared;
- Riverine Zone - follows the Namoi River; extensive flood plains; heavy clay soils and loams; naturally dominated by grassland. Stream banks, anabranches and natural wetlands were originally lined with natural vegetation communities (such as river red gums) but have since been cleared; the river now assumes characteristics of an inland delta; and
- Pilliga - south-west; flat; predominantly State Forest with extensive woodlands dominated by cypress pine and ironbark associations; intermittent streams, only flowing with significant rainfall or heavy falls in the Warrumbungle Ranges.

The core holes locations are in the Liverpool Plains Zone. The hydrology regime is comprised mainly of minor (ephemeral) and medium sized streams flowing from the mountain ranges located directly south, east and north-east of the core hole sites in PEL 1 (refer Figure 4-3). These creeks are among the headwaters of the Namoi River. Whereas the Namoi River is regulated under a Water Sharing Plan administered by the Department of Water and Energy, the minor and medium sized creeks within PEL 1 are not regulated. Surface water in the region is used for irrigation, stock watering and domestic purposes (EPA, 1995).

The core hole sites, are more than 200 m from nearest potential water bodies. The creeks located nearby the various core hole sites that are relevant are summarised in Table 4.1 below.

The core hole, Lake Goran 1 is adjacent to Lake Goran which is an ephemeral lake.

### 4.4.2 Groundwater

PEL 1 lies within the Namoi River Catchment and ground water in the Namoi catchment supports an irrigation industry worth in excess of \$380m as well as being the water supply for many towns and intensive industries such as feedlots (NCMA, 2008). For example, Gunnedah's water requirements are sourced underground from bores located

## Gunnedah Basin

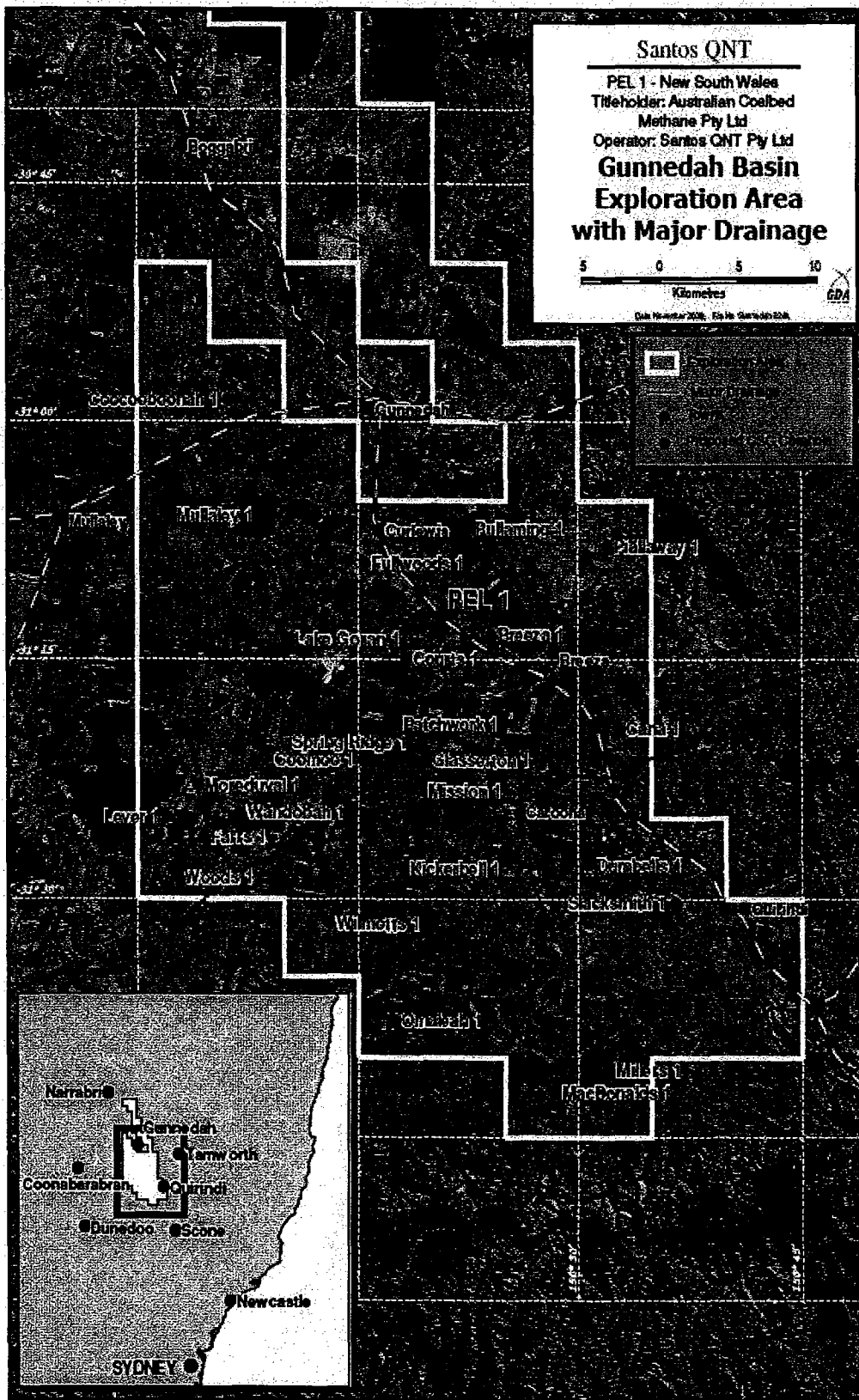
north of the Namoi River. The water-bearing aquifers are at various depths from 26 metres to 120 metres below surface level (GSC, 2004).

The groundwater sources include all water contained in the unconsolidated alluvial sediment aquifers associated with the Namoi River and its tributaries. The upper catchment has 13 discrete zones with the lower catchment treated as 1 separate zone. The water sharing plan for the Upper and Lower Namoi Groundwater Sources covers 12 of the upper zones and the lower Zone. The Peel Valley groundwater source will have its own water sharing plan. Deep bores in the lower Namoi access the Great Artesian Basin water source. The core holes lie in the Upper Namoi Groundwater Sources.

Table 4-1: Nearest Water Courses to the Core Hole Sites

Core Hole Node	Water course	Approximate Distance of nearest water body
Cana 1	Nil in vicinity	NA
Cocoooonah 1	Minor intermittent creek	> 200m
Coomoo 1	Nil in vicinity	NA
Courts 1	Nil in vicinity	NA
Dumbells 1	Nil in Vicinity	NA
Farrs 1	Nil in vicinity	NA
Fullwoods 1	Nil in vicinity	NA
Breeza 1	Nil in vicinity	NA
Kickerbell 1	Yarraman Creek	> 200m
Lake Goran 1	Ephemeral Lake Goran	Adjacent
Lever 1	Lever Gully- a minor intermittent creek	>200 m
MacDonalds 1	Nil in vicinity	NA
Millers 1	Millers creek	>500m
Mission 1	Nil in vicinity	NA
Moreduval 1	Moreduval Hut Gully	> 200m
Omaleah 1	Omaleah Creek	> 500m
Patchwork 1	Nil in vicinity	NA
Piallaway 1	minor intermittent creek	> 200m
Pullaming 1	Nil in vicinity	NA
Slacksmith 1	Borambil Creek	>500m
Spring Ridge 1	Nil in vicinity	NA
Wandobah 1	Nil in vicinity	NA
Wilmotts 1	Yarraman Creek	>200m
Woods 1	Nil in vicinity	NA
Glasserton 1	Nil in vicinity	NA
Mullaley 1	Nil in vicinity	NA

Figure 4-3: Major Drainage



## 4.5 Topography

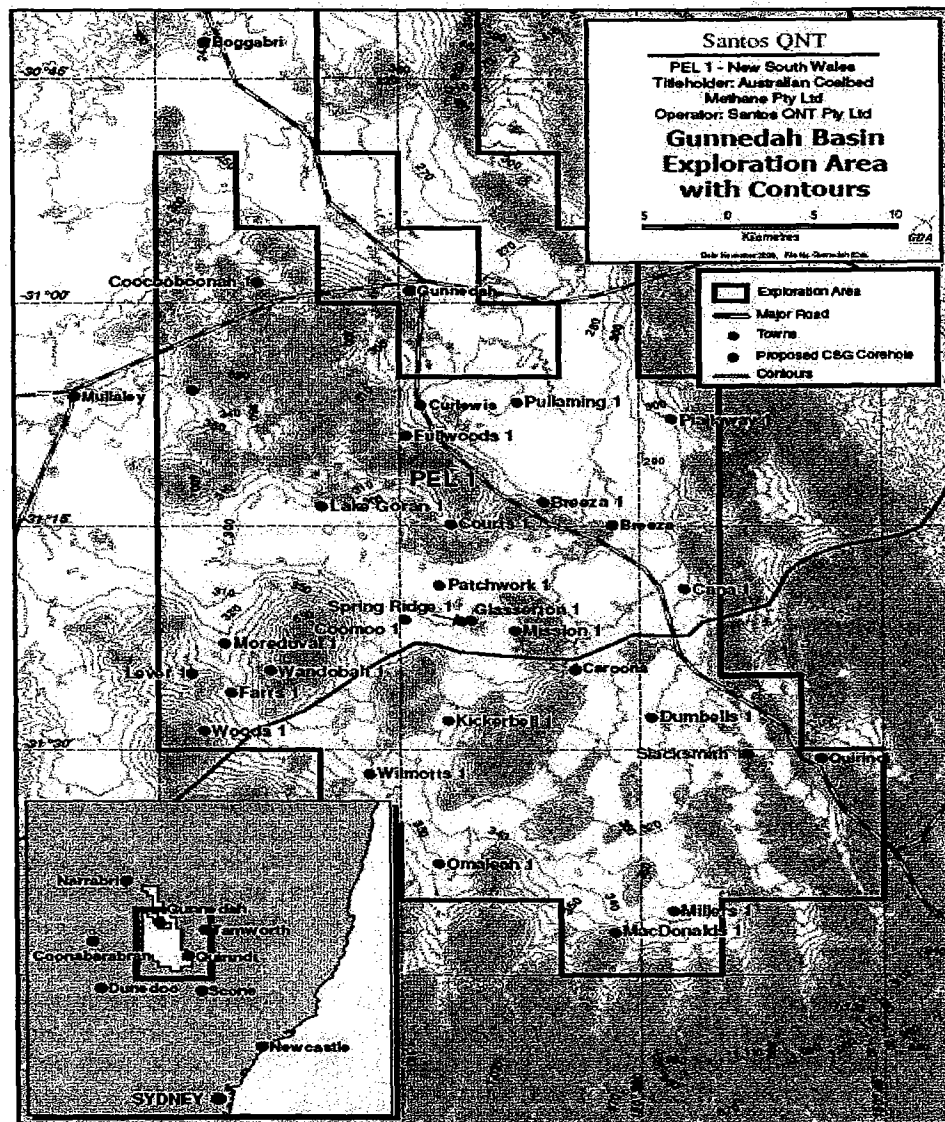
The predominant topographical features in the region are flood plains of the Namoi and Mooki Rivers and Cox's Creek, with 85% of the Gunnedah Shire having a land slope of less than 3 degrees. These plains are in long corridors which range from 15 to 40 kilometres across, before the landform becomes slightly undulating. Three residual hill-ridge systems rise from 300 to 500 metres above sea level, but land slopes of greater than 15 degrees are found on only 1% of the Shire area (GSC, 2004).

The topography of the Liverpool Plains Shire can be described as being in two basic landforms (Edge, 2005):

- Steep to undulating land northeast, east and south; and
- Flat to undulating land to northwest and west.

The topography of the area where the core hole sites are located is flat to undulating (see Figure 4.4). The core hole sites are at elevations ranging from about 300m to 400m above sea level.

Figure 4-4: Local Topography within the Vicinity of the Core Hole Sites



## 4.6 Flora and Fauna

The information presented below is based on a desktop assessment which included searching various published literature, databases and an examination of aerial photographs of the area of interest. It should be noted that an initial assessment of proposed locations has shown that all core holes should be located in cleared grazing land.

The NSW Department of Environment and Climate Change Atlas of NSW Wildlife On-line database was searched for records of threatened ecological communities, plants and animals within the two local government areas of Liverpool Plains and Gunnedah.

Matters of conservation significance listed under the Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth) (EPBC Act) that are known or predicted to occur in the study area was determined using the EPBC Protected Matters search tool based on a 4km radius from each core hole site.

### 4.6.1 Plant Communities

The NSW National Parks and Wildlife Service (2003) has identified the following plant communities in the Brigalow Belt South Bioregion:

- Woodlands dominated by Blue-leaved Ironbark (*Eucalyptus fibrosa*), Scribbly Gum (*Eucalyptus rossii*), Black Cypress Pine (*Callitris endlicheri*), Whitewood (*Atalaya hemiglauca*) and Rough-barked Apple (*Angophora floribunda*) are found on stony sandstone plateau and streams;
- Silver-leaved Ironbark (*Eucalyptus melanophloia*), Spotted Gum (*Eucalyptus maculata*) and Smooth-barked Apple (*Angophora costata*) occur on stony hills in the north of the bioregion. Narrow-leaved Red Ironbark (*Eucalyptus creba*), White Cypress Pine (*Callitris glaucophylla*), Red Stringybark (*Eucalyptus macrorhynca*), patches of Mallee (*Eucalyptus* sp.) and Broom Heath (*Melaleuca uncinata*) occur on gentler sandstone slopes (NPWS, 2003);
- Acacia species are present in rocky outcrops. Grey box (*Eucalyptus microcarpa*), Yellow Box (*Eucalyptus melliodora*) and Rough-barked apple occur on valley floors, while river red gum (*Eucalyptus camaldulensis*) lines larger streams and river oak (*Casuarina cunninghamiana*) the tributaries;
- The vegetation on the northern basalts includes Brigalow (*Acacia harpophylla*), Belah (*Casuarina cristata*), Whitewood, Wilga (*Geijera parviflora*), Budda (*Eremophila mitchellii*) and Poplar Box (*Eucalyptus populnea*) on the hills, with River Red Gum, Belah, Myall (*Acacia pendula*) and Poplar Box on the flats. White box with Silver-leaved Ironbark, White Wood, Bull Oak and Brigalow are present on alluvial clays. River Red Gum occurs on all streams;
- Diverse grasslands dominate the Liverpool Plains. Common species include plains grass (*Stipa* sp.), panic grass (*Panicum* sp.), windmill grass (*Chloris* sp.) and blue grass (*Dicanthium* sp.) on black earths, with the occasional White Box, Yellow Box, Poplar Box and Wilga. On the high (colder) ridge crests, Silvertop Stringybark (*Eucalyptus laevopinea*), Manna Gum (*Eucalyptus viminalis*) and Mountain Gum (*Eucalyptus dalrympleana*) are found with Snow Gum (*Eucalyptus pauciflora*) in cold air drainage hollows;
- Tallowood (*Eucalyptus microcorys*), Blackbutt (*Eucalyptus pilularis*) and Blue Gum (*Eucalyptus saligna*) occur on eastern slopes with small areas of vine forest. On northern slopes, White Box with rough-barked apple occur with belah in the creeks. Yellow box and Blakely's Red Gum are found on slopes with a southerly aspect.

Since European settlement the majority of the Namoi River catchment has been cleared or thinned for cropping and grazing. Except for two state forests within the Maules Creek area, this applies to the proposed core hole locations. Lampert and Short (2004) state that:

- Remnant vegetation is now limited to areas where agriculture is restricted, due to inaccessibility or low soil fertility;
- Along many streamlines riparian vegetation corridors are thin and discontinuous or non-existent; and
- Where a riparian corridor has been maintained it is often structurally compromised and/or dominated by exotics.

The core hole sites are planned to be located in already disturbed areas. Figure 4.5 shows the typical vegetation cover of the area where the core holes are planned to be located.

Figure 4-5: Typical vegetation cover at proposed core hole sites



#### 4.6.2 Significant flora

There are three endangered ecological communities within the bioregion listed under Schedule 1 of the Threatened Species Conservation Act 1995 (TSC Act). These are the Semi-evergreen Vine Thicket (*Cadellia pentastylis*) (Ooline or scrub myrtle), Brigalow, and Carbeen open forest communities. NPWS, 2003, found that the bioregion is important for the long-term viability of these vegetation communities which are predominantly found here, with a small area lying in the Nandewar Bioregion. The Carbeen open forest communities are now restricted to the Brigalow Belt South Bioregion and very limited areas of the Darling Riverine Plains Bioregion. These are known to occur in the Namoi Catchment area. The White Box-Yellow Box-Blakely's Red Gum-Grassy Woodland and Derived Native Grassland threatened ecological community also occurs in this bioregion. It is nationally endangered and protected under the EPBC Act 1999. However, the core hole sites have been cleared for rural activities.

At a species level there are four endangered and twelve vulnerable species listed in the schedules of the TSC Act. Records within the bioregion tend to be concentrated in the major reserves and forests of the bioregion such as Goonoo State Forest, the Warrumbungles, Mt Kaputar and the Pilliga. Mt Kaputar National Park is the only one located in PEL 1 with a small part located within its northern corner (Figure 4.6) but outside the core hole sites which have been cleared.

Based on the TSC Act listings specifically for the Namoi and Gunnedah Shire Council areas, there are 11 threatened plants that are known to occur within the LPSC and GSC areas and these are listed in Appendix B. However, the core hole sites have been cleared for rural activities and do not provide suitable habitat for these species.

#### 4.6.3 Weeds

The noxious weeds that have been declared in the region are provided in Appendix A. In all there are 101 species that are declared.

#### 4.6.4 Fauna

Although few systematic surveys have been conducted in the bioregion, records from a variety of surveys can be used to illustrate the vertebrate fauna of the bioregion, which consists of 18 amphibian species, 68 reptiles, 281 birds and 82 mammal species (see NPWS, 2003). A review of this area by the NPWS, 2003, found that:

- Many of these species are considered threatened, including the endangered mallee fowl (*Leipoa ocellata*), for which the bioregion contains important habitat, and the vulnerable koala (*Phascolarctos cinereus*) which has important populations in the Warrumbungles, the Pilliga and the area around Gunnedah. In this bioregion the tree species often selected by koalas include Blakely's red gum, river red gum and white box, while pilliga box, poplar box, narrow-leaved ironbark and rough-barked apple are occasionally used for food.
- Another significant mammal species in the bioregion is the vulnerable eastern pygmy possum (*Cercartetus nanus*) which has a very patchy distribution, with more than 10 records of the species known from each of only 5 locations in NSW, the Pilliga State Forest being one of them.
- The Pilliga mouse (*Pseudomys pilligaensis*) is known only from the Pilliga State Forest, although its preferred habitat has not yet been established. It is thought to prefer mixed eucalypt forest with a shrubby understorey with logs and litter and may face threat from disturbance of ground storey vegetation.
- The birds of the bioregion are highly diverse, mainly consisting of tropical woodland species and comprising the largest number of Australian resident species of any bioregion. There are no major populations of rare or threatened birds in the bioregion and although many birds within the bioregion have restricted ranges; none are endemic. Exotic species are low in numbers and those present are located mainly around towns.
- Although bird species diversity is high relative to other NSW bioregions, the Brigalow Belt South Bioregion has experienced major declines in ground-nesting, ground-feeding insectivorous and grassland birds, a trend common to many parts of Australia. An increased reporting rate in the bioregion's rainforest and temperate forest taxa may reflect greater survey effort in these habitats. Reduction of bird diversity in habitat fragments and the continued loss of woodland and freshwater birds seem to be the prediction for the future. However, there was an increase in the numbers of mallard (*Anas platyrhynchos*), cattle egret (*Bubulcus ibis*) and the common myna (*Acridotheres tristis*).

A search of the NSW Department of Environment and Climate Change Atlas of NSW on-line data base for NSW listed threatened species was conducted and identified 53 threatened fauna species in the LPSC and GSC. These are listed in Appendix C.

However, the core hole sites have been cleared for rural activities and will not be critical habitat for any of these species.

#### 4.6.5 EPBC Act Due Diligence

The EPBC Database was searched and a Matters of Environmental Significance Report was generated. The results are summarised below in Table 4.2 and show that there are no World Heritage Properties, National Heritage Places, Wetlands of International



Significance (Ramsar Sites), or Commonwealth marine areas located near the core hole sites.

Table 4-2: Matters of Environmental Significance under EPBC Act

World Heritage Properties	None
National Heritage Places	None
Wetlands of International Significance (RAMSAR Sites)	None
Commonwealth Marine Areas	Not applicable
Threatened Ecological Communities	1
Threatened Species	22
Migratory Species	12

#### **4.6.5.1 Threatened Ecological Community**

There is one Threatened Ecological Community (TEC) that could potentially be found within the region where the core hole sites are to be located. This is the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland which is critically endangered. This was formerly widespread along the western slopes and table lands of the Great Dividing Range, throughout southern Queensland, western NSW, ACT and Victoria. Now less than 5% remains in good condition and much of this occurs in small isolated pockets (DEWHA, 2006).

It is expected that the rugged terrain of the Liverpool Ranges in the upper Mooki catchment would still support this community. However, the lower slopes of these hills have been almost completely cleared (Lampert and Short, 2004). Grasslands remain as isolated stands on alluvial fans and in flood-prone areas with most of the region now cleared for cropping (Lampert and Short, 2004).

The proposed core hole sites will be located on land previously cleared for rural activities and as such will not have a significant impact on this TEC.

#### **4.6.5.2 Threatened Species**

There were up to 22 threatened species that could be potentially located in the area of interest within PEL 1. These are summarised in Appendix D. The proposed core hole sites will be located on land previously cleared for rural activities and as such will not provide critical habitat for threatened species.

#### **4.6.5.3 Migratory Terrestrial and Wetland Species**

There are up to 3 migratory terrestrial bird species and a further 4 birds that are wetland species that are listed. However, it is considered that the planned activities will not have any significant impact on these species as the proposed core hole sites will be located on land previously cleared for rural activities which do not provide suitable habitat for these species.

#### **4.6.5.4 Listed Marine Species**

There are 10 species of birds that are listed marine species that may overfly the area. These are 'other matters' protected by the EPBC Act. However, it is considered that the planned activities will not have any significant impact on these species.

## 4.7 Socio-Economic

### 4.7.1 Local Government Area

The planned activities lie within the local government areas of Liverpool Plains and Gunnedah Shire Councils. Population figures below are based on the 2006 census (ABS, 2006).

The Gunnedah Shire Council was formed in 2004 by the amalgamation of Quirindi Shire, substantial parts of Parry and Murrundi Shires, and small parts of Gunnedah Shire. The Gunnedah LGA has a size of about 5,086 sq km. In 2006 there were 11,525 persons usually resident in Gunnedah (A) (Local Government Area). Gunnedah is the largest town servicing the region and had a population of 8044.

The Liverpool Plains Shire Council was formed in 2004 by the amalgamation of Quirindi Shire, substantial parts of Parry and Murrundi Shires, and small parts of Gunnedah Shire. The LGA has a size of about 5,086 sq km with a total population of 7540 persons in the 2006 census. The largest town within the LGA is Quirindi which has population of 2,609 persons. Other towns include Werris Creek, Wallabadah, Willow Tree, Caroonna and Spring Ridge.

### 4.7.2 Landuse

The proposed core hole sites are located within the Namoi River catchment which has been used extensively for agricultural activities since the 1830s. Agricultural activities include mixed farming of sheep, cattle and grain crops with a gradually larger reliance on cattle. Downstream in the Narrabri/Wee Waa districts irrigated cotton is produced.

The primary land uses within the Liverpool Plains Shire are agricultural (64.6%), urban (18.4%), vacant cleared land (6.7%), and native vegetation (3.9%) (Edge, 2005). Agricultural uses include cattle and sheep, cropping, orchards, irrigated cropping, equine, and intensive agricultural (Edge, 2005). Some 51.4% of holdings are >100ha (Edge, 2005).

Coal mining is a significant land use in the broad region of PEL 1. None of proposed core holes are located within operating mine sites (see Figure 4.6).

### 4.7.3 Heritage

#### 4.7.3.1 **Aboriginal Heritage**

The Local Aboriginal Land Council for the area of interest is Red Chief Local Aboriginal Land Council, based in Gunnedah. A search of the NSW Department of Environment and Climate Change (DECC) Aboriginal Heritage Information Management System (AHIMS) was made (DECC, 2008). Details of the results are not to be made available to the public. None of the sites identified in the AHIMS search are in close proximity to the planned core hole sites. The nearest recorded Aboriginal heritage sites are located more than 1km from the closest core hole sites. The proposed core holes are away from the banks of any waterholes, creeks and ridgelines which are generally accepted as having a higher potential for the location of Aboriginal objects and places. As well, core hole sites are proposed on pastoral land which has been disturbed by clearing, grazing, cropping and general agricultural pursuits.

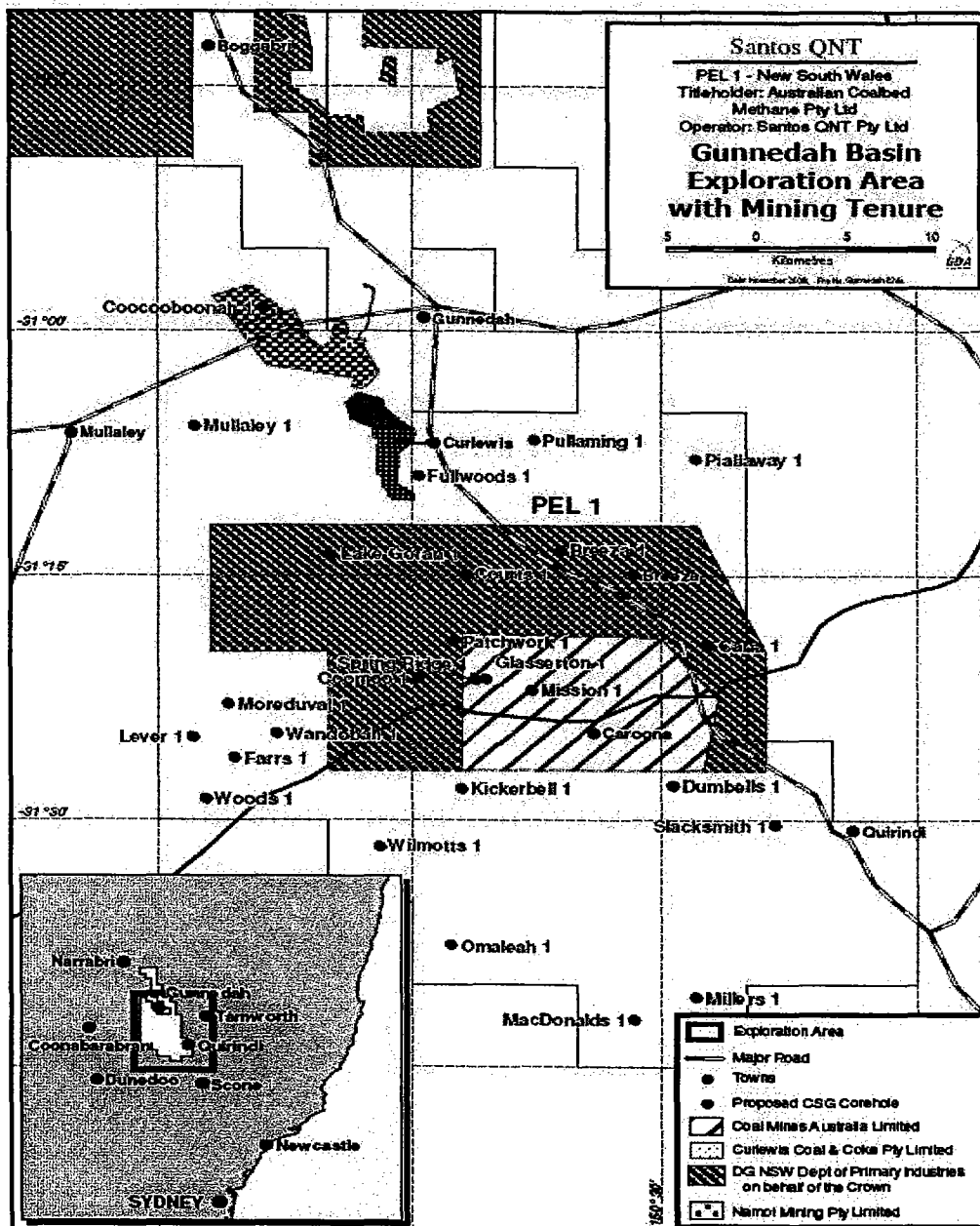
Gunnedah Basin

As of September, 2008 there were no Native Title claims over the proposed well site locations<sup>1</sup>.

**4.7.3.2 Non-Indigenous Cultural Heritage**

A search of the NSW Heritage Office database for the Gunnedah and Liverpool Plains local government areas did not identify any sites of cultural heritage in the vicinity of the proposed core hole sites (see [http://www.heritage.nsw.gov.au/07\\_subnav\\_04\\_1.cfm](http://www.heritage.nsw.gov.au/07_subnav_04_1.cfm) ).

Figure 4-6: PEL 1 and Mining Tenures



<sup>1</sup> See Map at [http://www.nntt.gov.au/publications/data/files/NSW\\_ACT\\_NTDA\\_Schedule.pdf](http://www.nntt.gov.au/publications/data/files/NSW_ACT_NTDA_Schedule.pdf)

## 4.8 National Parks, Reserves and Community Conservation Areas

### 4.8.1 National Parks and Reserves

As shown on Figure 4.7 there are no National Parks or Reserves in the vicinity of the proposed core hole sites.

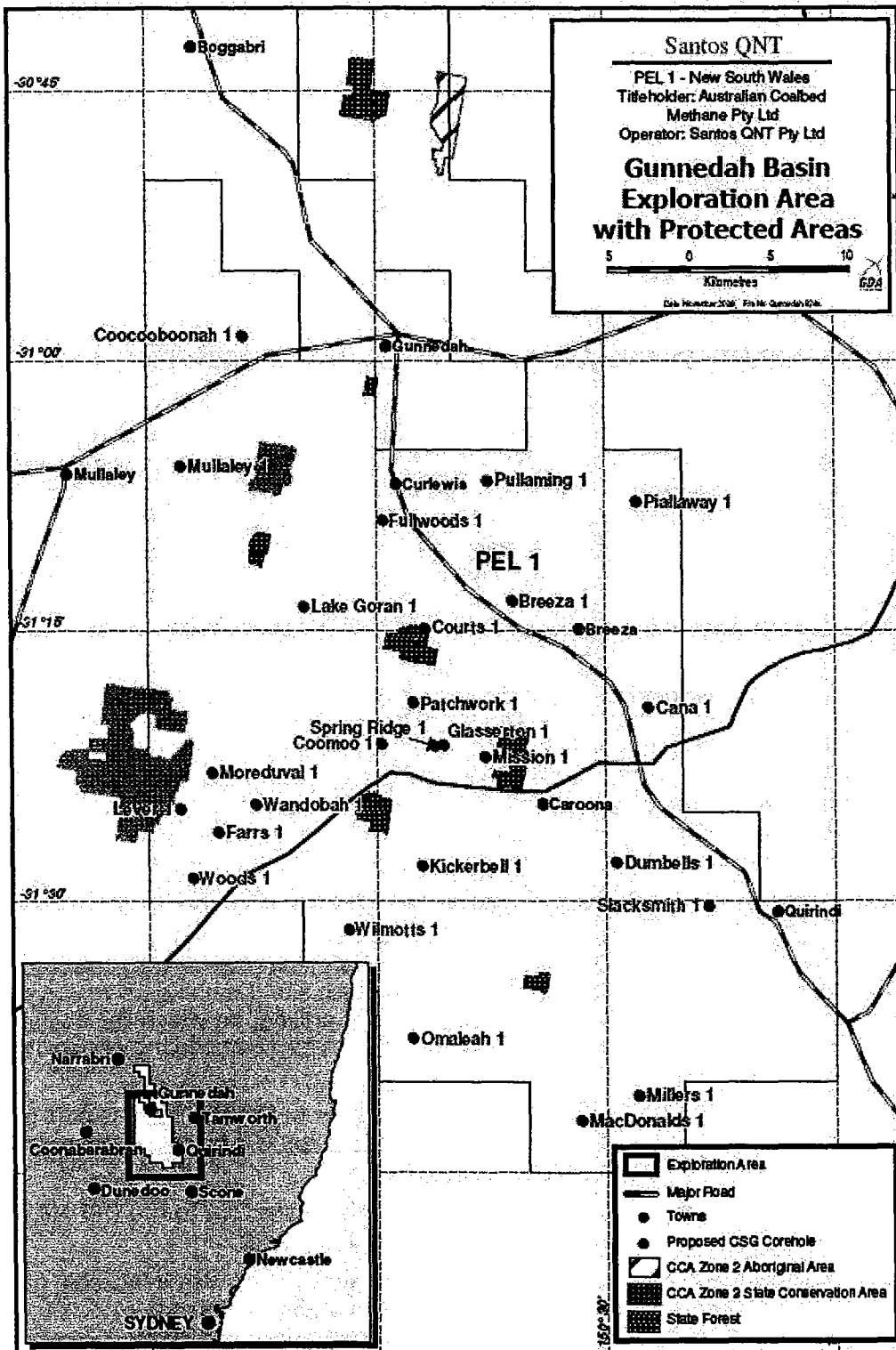
### 4.8.2 Community Conservation Areas

The area where the proposed core holes will be located falls under the Brigalow and Nandewar Community Conservation Area Act 2005. This Act, under its schedules, identifies four types of Community Conservation areas, namely:

- Zone 1 of the Community Conservation Area (CCA) means the land described or referred to in Schedule 1-Conservation and Recreation Zone.
- Zone 2 of the Community Conservation Area means the land described or referred to in Schedule 2-Conservation and Aboriginal Culture Zone.
- Zone 3 of the Community Conservation Area means the land described or referred to in Schedule 3-Conservation, Recreation and Mineral Extraction Zone.
- Zone 4 of the Community Conservation Area means the land described or referred to in Schedule 4-Forestry, Recreation and Mineral Extraction Zone.

None of the proposed core hole sites are located within State Forests or CCA zones (see Figure 4.7. Courts 1 is adjacent to a State Forest.

Figure 4-7: Location of National Parks, Nature Reserves, Community Conservation Areas



## 5 Environmental Impacts and Mitigation Measures

### 5.1 General

The activities will be undertaken in accordance with the APPEA, 2008, Code of Environmental Practice where applicable and the Schedule of Onshore Petroleum Exploration and Production Safety Requirements (DPI, 1992).

### 5.2 Socio-Economic

#### 5.2.1 Existing Environment

The catchment has been used extensively for agricultural activities since the 1830s. The main agricultural activities of irrigated cotton and broadacre cropping (mainly sorghum, sunflower and wheat) occur predominantly along the alluvial floodplains of the Namoi River Valley. Sheep and cattle grazing occur throughout the catchment, but are more widespread in the upper catchment area. There is also logging within the broader region. The particular area of the proposed drilling activities is largely rural with a significant amount of coal mining.

#### 5.2.2 Potential Impacts and Mitigation Measures

Potential impacts include disturbance to farming activities, disturbance to livestock and potential bushfire risks to flora, fauna, stock and personnel. Santos will seek to enter into a Land Access Agreement with affected landowners in respect to land access conditions, compensation, rehabilitation and other matters as required under the Petroleum (Onshore) Act 2007. This consultation will involve the conducting of various land enquiries and meetings with the landowners in question. Regular contact with landholders will be made as necessary. Other matters such as air quality, weeds, water, and noise are addressed in further sections below.

To minimise impacts on landholders the following actions will be undertaken:

- Prior to the commencement of activities at each site, landholders will be provided with a notice of the planned activities, in particular drilling, on which the activities are to take place. Reasonable requests by landholders for rescheduling of activities will be considered;
- If unfenced roads are present on the roads to/from the rig, then as part of the site induction or journey management program, drivers will be made aware of the hazard this presents;
- Access roads will be maintained in a condition satisfactory to the DPI-MR and Landholders until restoration of the lease is completed;
- If fencing is required, the site will be adequately fenced with a lockable gate and adequate signs warning of potential danger will be erected;
- Drilling sites will be selected such that a cleared buffer exists outside the drilling pad area to maintain an effective barrier against bushfires;
- The flare pit will be kept free of grass and leaf litter;
- A fire control water pump and hoses on site will be maintained;
- Liaison will occur with the local rural fire service officer;
- Fires on the surface of the land will be prohibited at each of the well sites;

- Hot work (e.g. welding) specific procedures will be in place;
- The area of land disturbance will be minimised subject to safety constraints; and
- The site will be maintained in a clean and tidy condition.

## 5.3 Air Quality

### 5.3.1 Existing Environment

The existing air quality of the area is generally of good quality. The majority of pollutants, such as plant and vehicle emissions, arise from rural based activities and those associated with nearby coal mine operations.

### 5.3.2 Potential Impacts and Mitigation Measures

The proposed activity has the potential to introduce additional air emissions arising from the sources discussed below.

#### **5.3.2.1 Dust generation**

The dust generated by the mobilisation of the drilling and ancillary equipment travelling to and from a location will vary depending on road and weather conditions. In the case of improved or well compacted roads, dust will not be a significant issue. Occasional dust suppression using a water cart will be used if required to reduce dust generation (see Section 5.5 for details on its source).

Liaison with local homesteads which may be affected by rig traffic will take place, informing occupants of possible high traffic periods (i.e. during transport of the rig and equipment). Speed limits on rig traffic may be imposed to minimise dust when passing homesteads. If speed limits are required the limit imposed will be clearly sign posted.

The movement of rig equipment to and from the proposed drill sites is expected to have more impact than the movements of equipment on sealed and unsealed roads within the district. The rig mobilisation, consisting up to 10 trailer loads, may require additional preparation of access ways. Additional access preparation will take place on external road ways where required to facilitate the safe entry of the drilling rig. Damage to any external/internal access will be repaired as soon as possible after occurrence to minimise any impact on the landholder/ public. Santos QNT will notify LPSC and GSC of the proposed start time of exploration drilling prior to its commencement and will liaise with the appropriate Council representatives should any repairs to Council roads be necessary.

#### **5.3.2.2 Emissions from equipment**

Operation of diesel fuelled vehicular traffic, plant and power generation, will be temporary and the minimal emissions are not expected to impact on air quality or be a major contributor of greenhouse gases.

#### **5.3.2.3 Flaring of gas**

It is considered possible that gas bearing formations will be intersected during core hole drilling. A number of safety precautions and contingencies are therefore incorporated into the program in order to minimise any risks.

An appropriately sized and located flare pit will be installed at the commencement of drilling operations. The drill rig operator will locate the "blooie lines" so that gas is

directed into the flare pit where an ignition source can safely burn/flare any gas that is intersected by drilling.

Approval from the relevant DPI-MR Safety Inspector will be sought prior to any gas flaring other than that occurring as part of drilling safety procedures. There is a well established process for flaring produced gas during Drill Stem Testing.

## 5.4 Hydrology

### 5.4.1 Existing Environment

There are several creeks in the vicinity of the core hole sites that could be potentially affected if there are any incidents such as spills.

### 5.4.2 Potential Impacts and Mitigation Measures

Preference will be to recycle water used at previous sites where possible and procure water supplies from dams or bores located in the vicinity of the core hole sites (with landholder permission) or from municipal supply via a water carter. In order to acquire the water necessary for drilling in situations where water can not be obtained through the above means, approval will be sought from the appropriate authorities and landholder for the installation of a bore to access water from suitable reservoirs. This consent will be sought before the commencement of drilling operations.

There is potential to contaminate surface water or ground water via run off from activities associated with chemical storage & handling, refuelling and drilling fluids and cuttings management. Mitigation measures for these activities are discussed in Section 5.8 and 5.10. Groundwater cross contamination with the drilling fluid will be prevented as the core holes will be cased and completed in accordance with DPI-MR requirements and specific well designs for each planned site.

In the case of a drilling sump, a liner may be used depending on the environment assessment of a given location. If a liner is used it will be removed after drilling with the water re-used or disposed of at an appropriate site. Any waste pits temporarily left open after the rig has left will be fenced to protect livestock and other animals.

Associated water from the coal seams is not expected to be produced as part of the core hole drilling activity and therefore no mitigation measures are presented.

#### **Water Management Plan**

Water with additives dissolved in it (see section 3.2), is used in the drilling process primarily to weight the drilling fluid to control formation pressures and to prevent natural clay minerals in the strata from swelling into the bore hole. The additives added are non hazardous (from MSDS sheets). Approximately 50 to 80 cubic metres of water are expected to be used on a typical well although this will depend on well depth. This water is sourced either from the landholder (with consent) or from the local town supply with council approval. The water is contained in drilling sumps on the site.

The pits are designed and monitored to ensure there is 1 metre of freeboard at any given time, with consideration to a 1 in 20 year storm.

The drilling sumps are fenced with temporary steel rail fencing panels to prevent livestock and animals entering, and to barrier these from personnel working on the site.

During the drilling process, approximately 10 to 15 cubic metres is consumed in the cementing of casings into the well.



No formation water is expected to be produced into the mud system during the drilling of the core hole.

The resulting 40 to 65 cubic metres of fluid remaining in the drilling sumps on completion of the drilling process will either be reused or more likely allowed to evaporate.

In the event that rain continues to fill the sumps and sump water is not evaporated within a reasonable time to allow site rehabilitation, the water will be sampled and analysed for quality. Subject to suitable water quality and with landholder consent the remaining water will be dispersed over the surrounding land surface. Failing this the liquid will be trucked to an appropriately licensed liquid waste disposal facility.

Any sump liner will be removed and remaining contents (drill cuttings) will then be removed or depending on analysis of the cuttings the contents may be buried on site.

## 5.5 Soils, Land use and Rehabilitation

### 5.5.1 Existing Environment

The soils in the vicinity of the core hole sites are a valuable resource to pastoral or agricultural interests.

### 5.5.2 Potential Impacts and Mitigation Process

An area of 45 metres by 60 metres plus access is required to accommodate a fully operational drilling rig and ancillary equipment, access to site, with about 30% of hard stand. A level area is required for the drilling rig pad and associated sumps and flare pit will be constructed on site. These will require topsoil to be removed and stockpiled for replacement during site rehabilitation. If imported soils are required these will be sourced from the local area and if required, permission will be obtained prior to this being undertaken.

Management measures will include:

- Restricting the area to be disturbed to the minimum;
- Stockpiling top soil separately from other spoil and respreading;
- Return of natural/previous land contours;
- Reseeding if required in consultation with landholders; and
- Removal of all imported soil material.

## 5.6 Noise

### 5.6.1 Existing Environment

Noise levels in the location of the proposed core holes are generally low but variable due to periodic rural or coal mining activities.

### 5.6.2 Potential Impacts and Mitigation Measures

The proposed activity is likely to generate noise as a result of the following procedures:

- The drilling activity; and
- The movement of trucks and other vehicles.

The equipment used for the mobilisation and powering of the drilling rigs have mufflers installed on their respective power plants and prime movers. The proposed drilling sites are a significant distance from the nearest dwellings and combined with the muffling of the engines and the short term nature of the drilling activity, operations are unlikely to create any significant noise impacts for residents. Drilling operations will be in accordance with agreements with landowner and DPI-MR requirements. Mitigation Measures will include:

- Identifying all potentially affected noise sensitive receivers (including rural residences, and noise sensitive equipment) that may be affected by the approved activities;
- Undertaking noise monitoring on the drill rig that may be proposed to operate 24hours/7 days per week. The data gathered from this noise survey will allow Santos QNT to predict any potential impact on sensitive receivers at varying distances.
- Predicting potential noise from the proposed operations where appropriate (depending on where nearest sensitive receptors are located relative to the well sites);
- Noise monitoring which may be undertaken subject to the nature of the concern; and
- Appropriately informing affected residences and other relevant parties in advance of any activities and providing those people with updated information as required.

## 5.7 Flora and Fauna

### 5.7.1 Existing Environment

The proposed core hole locations will be on land that has been previously cleared and is unlikely to be of significance to threatened species or communities. Appendix A lists the potential weeds that could be in or near the proposed core hole locations.

### 5.7.2 Potential Impacts and Mitigation Measures

The likelihood of disturbing actual or potential habitats associated with species of significance is low because of the small area and temporary nature of the impact; the extent and duration of clearing and grazing that has occurred locally; and the absence of remnant vegetation at the proposed core hole locations. Scouting will be undertaken prior to drilling commencing to confirm this.

There is a potential for the introduction of weeds and pest species to the site via the entry of vehicles and plant. This shall be mitigated as follows; all vehicles travelling to site will be required to follow the Operators standards. These vehicles will be assessed for weed exposure in the area of origin and if it is deemed required the vehicle, plant or ancillary equipment will be washed and/or brushed down at a suitable site external to the project area. This will entail the complete removal of soils and organic matter from all areas capable of holding such material. This may also be undertaken between core hole locations depending on weed infestations at each site. Scouting of the proposed core hole sites will identify any weeds present and assist in the determination of any additional measures that may be required as a result.

The need for washing and/or brushing down of vehicles and ancillary equipment will depend on the location from which the drilling contractor and other equipment will mobilise.

## 5.8 Chemical and Hazardous Substance Management

### 5.8.1 Existing Environment

The area is rural and there would be a variety of chemicals that could be stored and used through out the region.

### 5.8.2 Potential Impacts and Mitigation Measures

The following management measures will be implemented:

- The amount of hazardous material stored and used on site shall be kept to the minimum practicable;
- Hazardous materials shall be transported, stored and handled in accordance with the requirements of relevant legislation (e.g. Road and Rail Transport (Dangerous Goods) Act 1997, Australian Dangerous Goods Code) and Australian and Industry Standards;
- Fuels, lubricants and chemicals shall be stored and handled within containment areas (such as portable bunding) that are designed to prevent the release of spilt substances to the immediate neighbouring environment, in accordance with relevant legislation and standards. A spill kit appropriate to operations of this size will be available at site; and
- Material Safety Data Sheets and handling procedures for hazardous chemicals and materials shall be kept on site.

Spill prevention and response measures will include:

- Personnel shall be advised of the location and use of the spill containment equipment in the site induction;
- Spills or leaks shall be immediately reported to the senior Santos QNT representative onsite and clean up actions initiated;
- In the event of a spill, the material shall be contained to the smallest area practicable;
- Spilt material and contaminated soils shall be treated on site with landholder acceptance or removed off-site for disposal at an appropriately licensed facility, as determined in consultation with Department of Environment and Climate Change (DECC) and DPI-MR; and
- Spills shall be reported in accordance with regulatory and licensing requirements. There is a duty to notify the appropriate regulatory authority (broadly, the DECC or the local council) of pollution incidents where material harm to the environment is caused or threatened (see Section 2.1 for definition of material harm).

The information about a pollution incident required to be included in a notification consists of the following:

- the time, date, nature, duration and location of the incident;
- the nature, the estimated quantity or volume and the concentration of any pollutants involved;
- the circumstances in which the incident occurred (including the cause of the incident, if known);
- the action taken or proposed to be taken to deal with the incident and any resulting pollution or threatened pollution; and
- other information prescribed by the regulations.

## 5.9 Contaminated Land

### 5.9.1 Existing Environment

The land is currently either used for pastoral or crop production and the core hole sites are not expected to have been previously contaminated.

Core hole drilling will have minimal impact on the site's soils. On completion of core hole activities, all excavated material would be backfilled on site. Santos does not expect that land contamination would be an issue at any proposed core hole site.

### 5.9.2 Potential Impacts and Mitigation Measures

Mitigation measures are discussed in the following sections:

- Hydrology- Section 5.4;
- Soils- Section 5.5;
- Chemicals and Hazardous Substance Management- Section 5.8;
- Waste Minimisation and Management: Section 5.10

## 5.10 Waste Minimisation and Management

### 5.10.1 Existing Environment

No wastes are presently stored at any of the core hole sites. The proposed core hole sites are located on cleared rural lands.

### 5.10.2 Potential Impacts and Mitigation Measures

The worksite will require the provision of systems for the management of sewage wastes. Personnel numbers can reach up to 10 in the case of drilling operations.

All industrial solid wastes created during drilling and well operations will be collected in designated skips for eventual recycling or disposal to an appropriately licensed facility. Water based drilling fluids and associated cuttings, will be stored in an excavated sump. Cuttings and fluid may remain in the sump or be removed, and a liner may or not be utilised depending on an environmental assessment of each core hole location. If cuttings and fluid are removed from a core hole site it is anticipated they will be treated as general waste. This classification will be supported by appropriate analytical tests. Topsoil will be respread over restored surfaces at final abandonment of the site to encourage revegetation of disturbed surfaces.

The following management measures will be implemented:

- Waste material (including domestic waste) shall be collected and stored in suitable bins to prevent loss and scavenging by stock, wildlife and feral animals;
- Where practicable, recyclable material (e.g. glass and cans, scrap metals, used chemical and fuel drums and timber pallets) shall be collected in designated skips for recycling;
- The waste bins shall be removed from the site as necessary following completion of drilling and their contents are to be deposited at a licensed waste management facility for appropriate disposal;

- All wastes are to be transported in covered or sealed containers to prevent the loss of waste materials during transport;
- Waste shall be transported in accordance with appropriate standards and legislative requirements;
- All industrial waste materials (collected in skips) including liquids and solids will be removed for reuse or disposed at an appropriate site;
- Staff will be housed at accommodation in nearby towns; 'portaloos' will be provided at the site and maintained as required by a suitable contractor;
- Pits shall not be established in locations which pose a hazard to stock or wildlife. Any fencing shall be stock proof and, suitable for 'organic beef accredited' properties, steel or untreated timber posts shall be used;
- Flare pits may also be fenced as above;
- Sumps containing waste fluids/cuttings shall be fenced off immediately following the rig moving off the premises;
- If a liner is used it will be removed, and depending on site conditions, cuttings may be disposed of at a suitable location;
- A perimeter fence around the site will be considered at each site, if required to enclose all the above pits, sumps etc;
- Sump waste fluids (see section 3.2) will be representatively sampled and waste disposal undertaken in an appropriate manner.

## 5.11 Visual Amenity

### 5.11.1 Existing Environment

The landscape in the region is dominated by broad views of rural properties, with scattered pastoral infrastructure such as bores, tanks, dams, fences, roads, homesteads and other buildings.

### 5.11.2 Potential Impacts and Mitigation Measures

The visual impacts of drilling will be temporary and relatively insignificant and all equipment will be removed at the end of the coring program. If drilling is operated on a 24 hour a day basis, the site will be sufficiently lit for safe working conditions in accordance with Health & Safety Regulations. Due to the level terrain, this light can be expected to be visible from a reasonable distance, however due to the short duration of each well (approx one month) this is not considered a significant alteration to the visual amenity. Lighting will be kept at a level to ensure safe working operations and will be focused directly on to the working areas only.

- Santos will be undertaking light monitoring on the drill rig that may be proposed to operate 24hours/7 days per week. The data gathered from this survey will allow Santos to predict any potential impact on sensitive receivers at varying distances; and
- If an issue is raised further monitoring will be investigated.

## 5.12 Aboriginal Heritage

### 5.12.1 Existing Environment

The land where the core hole sites are proposed (including access tracks) has been previously disturbed and cleared. A search of the DECC AHIMS database for the general

area of the proposed core hole drilling has been made (DECC, 2008). No Aboriginal objects or places are recorded in close proximity (within 1km) of a proposed core hole site. As well, the general topography of the proposed sites is distant from features that are commonly held to have a higher likelihood of Aboriginal objects and places (e.g. creeks, water holes, ridgelines) being present. Initial consultations with representatives of the Red Chief Local Aboriginal Land Council have commenced.

### 5.12.2 Potential Impacts and Mitigation Measures

Potential impacts include disturbance of unrecorded artefacts or burial sites. However to minimise any potential impacts the following management measures will be implemented:

- Undertaking a pre-preparation heritage site inspection of the proposed drilling site;
- Heritage exclusion zones or sites identified during the heritage site inspection shall be avoided;
- Personnel, vehicles and equipment shall be restricted to designated work areas and access tracks; and
- Aboriginal heritage issues and the potential for discovery of sites shall be covered in site inductions.

If a site is discovered during site preparation works, the following procedure shall be implemented:

- Halt work at this location and establish a 100 metre buffer around the site. Work may continue outside the buffer area;
- Contact the Operator's Cultural Heritage Group relevant Local Aboriginal Land Council and National Parks and Wildlife Service (DECC), so that an evaluation of the nature of the discovery can be undertaken, along with the development of an appropriate course of action;
- The course of action may consist of recording the site location, removal of the cultural material or site protection as appropriate under the relevant legislation; and
- If human remains are encountered, the local Police shall also be notified.

## 5.13 Cumulative Environmental Impacts

The core hole activities are temporary in nature and each site will be restored to enable previous land-uses to continue into the future. The mitigation measures outlined above will ensure that there are no significant cumulative environmental impacts.

## 6 Conclusions

Drilling of the proposed core holes is an essential step in evaluating the hydrocarbon potential of PEL 1 in the Gunnedah Basin. Discovery of coal seam gas resources in this area has the potential to increase the state's reserves and revenue from gas and underpin future exploration or production in the region.

Santos QNT will consult with landholders so as to identify any concerns with regard to planned activities. A Land Access Agreement will be sought with affected landholders and the agreement would address matters such as access, compensation and rehabilitation.

Scouting surveys will be undertaken in consultation with the relevant landholder prior to drilling taking place to locate sites such that impacts are minimal. Desktop assessment has shown that there is minimal risk of affecting potential threatened species and critical habitat identified in the region. It should be noted that an initial assessment of proposed locations has shown that all core holes should be located in cleared grazing land. Proposed core hole sites can be moved to avoid any sensitive areas.

The proposed activities have associated potential environmental impacts, which are common to drilling activities such as those carried out elsewhere in the Gunnedah Basin. It is considered that the potential impacts can be successfully mitigated with the application of the management strategies outlined in this document. The strategies are consistent with the APPEA Code of Environmental Practice and are typical of good hydrocarbon field practice.

Section 5A of the EP Act lists seven factors to be considered, commonly referred to the seven part test of significance. An assessment was made against the seven factors to be considered under Section 5A of the EP &P Act i.e. "seven part test of significance" and concluded that:

- There are no known threatened species that would be impacted by the planned activities. The size and nature of the proposal is unlikely to effect the life cycle of any viable populations of threatened flora/fauna if present;
- There are no known endangered populations that have been identified that would be impacted by this proposal. The size and nature of the proposal is unlikely to effect the life cycle of any viable populations of endangered populations;
- There are no known endangered ecological communities or critically endangered communities that have been identified that would be impacted by this proposal; and
- It is not proposed to clear any critical habitat for this proposal.

If the management strategies are effectively implemented, it is expected that:

- Impacts on landholders will be minimal;
- Impacts to air quality will be minor, localised and insignificant;
- Adverse effects on water resources will be minimal during core hole drilling;
- Off-site impacts to soils will be avoided and on-site impacts will be minor and temporary;
- The potential noise impacts will be short term, and no threatened species or communities are likely to be impacted;
- There will be no significant use of, or impact to, natural resources;
- Impacts on the community and visual amenity will be insignificant and short term, particularly as the core hole sites are in a sparsely populated area ;

- Impacts to heritage places or sites will be avoided;
- Disturbances to pastoral and agricultural land use will be minor and short term and managed in consultation with affected landholder(s); and
- There will be no significant cumulative environmental impacts.

On completion of the activities, the sites will be rehabilitated to reflect the pre-existing land form and use in consultation with relevant landholders. All waste will be disposed of in an appropriate manner.



## 7 References

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Further reading:

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## Abbreviations

ABN	Australian Business Number
ABS	Australian Bureau of Statistics
ACM	Australian Coalbed Methane Pty Ltd`
AGR	AGR Asia Pacific
AHIMS	Aboriginal Heritage Information Management System
APPEA	Australian Petroleum Production & Exploration Association
CCA	Community Conservation Area
CSG	Coal Seam Gas
DECC	NSW Department of Environment and Climate Change
DST	Drill Stem Test
DPI- MR	NSW Department of Primary Industries- Mineral Resources
EPA	Environmental Protection Authority
EP & A	Environmental Planning and Assessment Act 1979
EPI	Environment Planning Instrument
EPBC	The Environmental Protection and Biodiversity Conservation Act 1999
GDA	Geocentric Datum of Australia
GSC	Gunnedah Shire Council
Km	Kilometre
LGA	Local Government Area
LEP	Local Environment Plan
LPSC	Liverpool Plains Shire Council
m	Metre
mm	Millimetre
MSDS	Material Safety Data Sheet
NSW	New South Wales
REF	Review of Environmental Factors
PEL	Petroleum Exploration Licence
SEPP	State Environment Planning Policy
TSC	Threatened Species Conservation Act 1995

## Appendix A.

Noxious weeds likely to be found in region

Source: Gunnedah Shire Council

<b>Weed</b>	<b>Class</b>	<b>Legal requirements</b>
<u>African boxthorn [Lyium ferocissimum ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>African feathergrass [Pennisetum macrourum ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>African turnipweed [Sisymbrium runcinatum ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>African turnipweed [Sisymbrium thellungii ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Alligator weed [Alternanthera philoxeroides ]</u>	2	The plant must be eradicated from the land and the land must be kept free of the plant
<u>Anchored water hyacinth [Eichhornia azurea]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Annual ragweed [Ambrosia artemisiifolia ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Arrowhead [Sagittaria montevidensis ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Artichoke thistle [Cynara cardunculus ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Athel pine [Tamarix aphylla ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Bathurst/Noogoora/Californian/cockle burrs [Xanthium species ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Bear-skin fescue [Festuca gautieri]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with

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Weed	Class	Legal requirements
		This is an <u>All of NSW</u> declaration
<u>Black knapweed [Centaurea nigra]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Blackberry [Rubus fruticosus aggregate species ]</u> ↓ except cultivars Black satin, Chehalem, Chester Thornless, Dirksen Thornless, Loch Ness, Murrindindi, Silvan, Smoothstem, Thornfree	4	The growth and spread of the plant 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
		This is an <u>All of NSW</u> declaration
<u>Blue heliotrope [Heliotropium amplexicaule ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Bridal creeper [Asparagus asparagoides ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <u>All of NSW</u> declaration
<u>Broomrapes [Orobanche species]</u> Includes all Orobanche species except the native O. cernua variety australiana and O. minor	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Burr ragweed [Ambrosia confertiflora ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <u>All of NSW</u> declaration
<u>Cabomba [Cabomba caroliniana ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <u>All of NSW</u> declaration
<u>Cayenne snakeweed [Stachytarpheta cayennensis ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <u>All of NSW</u> declaration
<u>Chilean needle grass [Nassella neesiana ]</u>	4	The growth and spread of the plant 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
<u>Chinese violet [Asystasia gangetica subspecies micrantha]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Clockweed [Gaura lindheimeri ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a

<b>Weed</b>	<b>Class</b>	<b>Legal requirements</b>
		notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Clockweed [Gaura parviflora ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Cockle burrs [Xanthium species ]</u>		See Bathurst/Noogoora/Californian/cockle burrs
<u>Columbus grass [Sorghum x almum ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Corn sowthistle [Sonchus arvensis ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Dodder [Cuscuta species]</u>  Includes All Cuscuta species except the native species C. australis, C. tasmanica and C. victoriana	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>East Indian hygrophila [Hygrophila polysperma] 1</u>		The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Espartillo [Achnatherum brachychaetum ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Eurasian water milfoil [Myriophyllum spicatum] 1</u>		The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Fine-bristled burr grass [Cenchrus brownii ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Fountain grass [Pennisetum setaceum ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Gallon's curse [Cenchrus biflorus ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Galvanised burr [Sclerolaena birchii]</u>	4	The plant must be controlled where it impacts on normal agricultural practices including cropping and pasture

Weed	Class	Legal requirements
		management
<u>Giant Parramatta grass [Sporobolus fertilis ]</u>	3	The plant must be fully and continuously suppressed and destroyed
<u>Glaucous starthistle [Carthamus glaucus ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Golden dodder [Cuscuta campestris]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Golden thistle [Scolymus hispanicus ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Green cestrum [Cestrum parqui ]</u>	3	The plant must be fully and continuously suppressed and destroyed
<u>Harrisia cactus [Harrisia species ]</u>	4	The growth and spread of the plant 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  This is an <u>All of NSW</u> declaration
<u>Hawkweed [Hieracium species]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Hemlock [Conium maculatum ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Horsetail [Equisetum species]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Hymenachne [Hymenachne amplexicaulis]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Italian bugloss [Echium species ]</u>		See Paterson's curse, Vipers bugloss, Italian bugloss
<u>Johnson grass [Sorghum halepense ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Karoo thorn [Acacia karroo]</u>	1	The plant must be eradicated from the land and the land

Weed	Class	Legal requirements
		must be kept free of the plant This is an <u>All of NSW</u> declaration
<u>Kochia [Bassia scoparia]</u> except Bassia scoparia subspecies trichophylla	1	except B.scoparia subspecies trichophylla The plant must be eradicated from the land and the land must be kept free of the plant This is an <u>All of NSW</u> declaration
<u>Lagarosiphon [Lagarosiphon major]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an <u>All of NSW</u> declaration
<u>Lantana [Lantana species ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <u>All of NSW</u> declaration
<u>Leafy elodea [Egeria densa]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <u>All of NSW</u> declaration
<u>Lippia [Phyla species ]</u>	4	The growth and spread of the plant 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
<u>Long-leaf willow primrose [Ludwigia longifolia ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <u>All of NSW</u> declaration
<u>Long-style feather grass [Pennisetum villosum ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Mesquite [Prosopis species ]</u>	2	The plant must be eradicated from the land and the land must be kept free of the plant
<u>Mexican feather grass [Nassella tenuissima ]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an <u>All of NSW</u> declaration
<u>Mexican poppy [Argemone mexicana ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <u>All of NSW</u> declaration
<u>Miconia [Miconia species]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant



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Weed	Class	Legal requirements
		This is an <u>All of NSW</u> declaration
<u>Mimosa [Mimosa pigra]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Mossman River grass [Cenchrus echinatus ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <u>All of NSW</u> declaration
<u>Mother-of-millions [Bryophyllum species and hybrids ]</u>	4	The growth and spread of the plant 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
<u>Onion grass [Romulea species]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Includes all Romulea species and varieties except R. rosea var. australis		This is an <u>All of NSW</u> declaration
<u>Oxalis [Oxalis species and varieties]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
Includes all Oxalis species and varieties except the native species O. chnoodes, O. exilis, O. perennans, O. radicata, O. rubens, and O. thompsoniae		This is an <u>All of NSW</u> declaration
<u>Pampas grass [Cortaderia species ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Parkinsonia [Parkinsonia aculeata ]</u>	2	The plant must be eradicated from the land and the land must be kept free of the plant
<u>Parthenium weed [Parthenium hysterophorus]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Paterson's curse, Vipers bugloss, Italian bugloss [Echium species ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Perennial ragweed [Ambrosia psilostachya ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Pond apple [Annona glabra]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Prickly acacia [Acacia nilotica]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant

Weed	Class	Legal requirements
		This is an <u>All of NSW</u> declaration
<u>Prickly pear [Cylindropuntia species ]</u>	4	The growth and spread of the plant 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
		This is an <u>All of NSW</u> declaration
<u>Prickly pear [Opuntia species except O. ficus-indica ]</u>	4	The growth and spread of the plant 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
		This is an <u>All of NSW</u> declaration
<u>Red rice [Oryza rufipogon ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <u>All of NSW</u> declaration
<u>Rhus tree [Toxicodendron succedaneum]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
		This is an <u>All of NSW</u> declaration
<u>Rubbervine [Cryptostegia grandiflora]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Sagittaria [Sagittaria platyphylla ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <u>All of NSW</u> declaration
<u>Salvinia [Salvinia molesta ]</u>	2	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Sand oat [Avena strigosa ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <u>All of NSW</u> declaration
<u>Senegal tea plant [Gymnocoronis spilanthoides]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <u>All of NSW</u> declaration
<u>Serrated tussock [Nassella trichotoma ]</u>	4	The growth and spread of the plant 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

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Weed	Class	Legal requirements
<u>Siam weed [Chromolaena odorata]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Silk forage sorghum [Sorghum species hybrid cultivar ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Silver-leaf nightshade [Solanum elaeagnifolium ]</u>	3	The plant must be fully and continuously suppressed and destroyed
<u>Smooth-stemmed turnip [Brassica barrelieri subspecies oxyrrhina]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Soldier thistle [Picnomon acarna ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Spiny burrgrass [Cenchrus incertus ]</u>	4	The growth and spread of the plant 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
<u>Spiny burrgrass [Cenchrus longispinus ]</u>	4	The growth and spread of the plant 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
<u>Spotted knapweed [Centaurea maculosa]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>St. John's wort [Hypericum perforatum ]</u>	3	The plant must be fully and continuously suppressed and destroyed
<u>Texas blueweed [Helianthus ciliaris ]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Tree-of-heaven [Ailanthus altissima ]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Water caltrop [Trapa species]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration

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<b>Weed</b>	<b>Class</b>	<b>Legal requirements</b>
<u>Water hyacinth [Eichhornia crassipes]</u>	2	The plant must be eradicated from the land and the land must be kept free of the plant
<u>Water lettuce [Pistia stratiotes]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Water soldier [Stratiotes aloides]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Wild radish [Raphanus raphanistrum]</u>	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
<u>Willows [Salix species]</u>  Includes all Salix species except S. babylonica, S. x reichardtii, S. x calodendron	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration
<u>Witchweed [Striga species]</u>  Includes all Striga species except native species and Striga parviflora	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Yellow burrhead [Limnocharis flava]</u>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <u>All of NSW</u> declaration
<u>Yellow nutgrass [Cyperus esculentus]</u>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <u>All of NSW</u> declaration

## Appendix B.

### Threatened Flora Species located in the Liverpool Plains and Gunnedah Shire Council Areas

## Gunnedah Basin

Species	Common Name	Status	Habitat/foraging/breeding
<i>Burhinus grallarius</i>	Bush Stone-curlew	Endangered	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights.
<i>Calyptorhynchus Iathami</i>	Glossy Black Cockatoo	Vulnerable	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia.  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.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Vulnerable	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin ( <i>Hirundo ariel</i> ), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years.  Found in well-timbered areas containing gullies.
<i>Chalinolobus picatus</i>	Little Pied Bat	Vulnerable	The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria. Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings.
<i>Climacteris picumnus</i>	Brown Treecreeper	Vulnerable	The Brown Treecreeper is endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is less commonly found on coastal plains and ranges.  The Brown Treecreeper climbs up the trunks and branches of trees in search of food. It probes into cavities and under loose bark with its long downward curving bill. In this way it searches for insects and their larvae. The most favoured insects are ants. Some feeding also takes place on the ground on fallen logs. Sometimes, birds can be seen diving on ground-dwelling prey from a perch in a tree. Feeding normally takes place in pairs or small groups.  Brown Treecreepers breed from June to January each year. During this season, pairs often have two broods of

## Gunnedah Basin

Species	Common Name	Status	Habitat/foraging/breeding
			two to three young. The nest is a collection of grasses, feathers and other soft material, placed in a suitable tree hollow or similar site.
<i>Cercartetus nanus</i>	Eastern Pygmy-Possum	Vulnerable	<p>The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pillaga, Dubbo, Parkes and Wagga Wagga on the western slopes.</p> <p>Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest.</p> <p>Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (<i>Pseudocheirus peregrinus</i>) dreys or thickets of vegetation, (eg. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.</p>
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	Vulnerable	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and may raid possum and glider dens and prey on roosting birds.
<i>Grantiella Picta</i>	Painted honey-eater	Vulnerable	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus <i>Amyema</i> . Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	Vulnerable	<p>The Black-breasted Buzzard is found sparsely in areas of less than 500mm rainfall, from north-western NSW and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, avoiding only the Western Australian deserts. Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands.</p> <p>Not a powerful hunter, despite its size, mostly taking reptiles, small mammals, birds, including nestlings, and carrion.</p> <p>Also specialises in feeding on large eggs, including those of emus, which it cracks on a rock.</p>

## Gunnedah Basin

Species	Common Name	Status	Habitat/foraging/breeding
			Breeds from August to October near water in a tall tree. The stick nest is large and flat and lined with green leaves. Normally two eggs are laid.
<i>Hoplovephalus bitorquatus</i>	Pale headed Snake	Vulnerable	The Pale-Headed Snake is a medium-sized largely tree-dwelling snake to 90 cm long. A patchy distribution from north-east Queensland to north-east NSW. In NSW it occurs from the coast to the western side of the Great Divide as far south as Tuggerah. Found mainly in dry eucalypt forests and woodlands, cypress woodland and occasionally in rainforest or moist eucalypt forest. Favours streamside areas, particularly in drier habitats.
<i>Lathamus discolor</i>	Swift Parrot	Endangered	The Swift Parrot is small parrot about 25 cm long. It is bright green with red around the bill, throat and forehead. Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes. Commonly used lerp infested trees include Grey Box <i>E. microcarpa</i> , Grey Box <i>E. moluccana</i> and Blackbutt <i>E. pilularis</i> . Return to home foraging sites on a cyclic basis depending on food availability. Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum <i>E. globulus</i> . Migrates to the Australian south-east mainland between March and October
<i>Leipoa ocellata</i>	Malleefowl	Endangered	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300-450 mm mean annual rainfall) areas. Less frequently found in other eucalypt woodlands (e.g., mixed Western Grey Box and Yellow Gum or Bimble Box, Ironbark-Callitris Pine, Callitris Pine, Mulga ( <i>Acacia aneura</i> ), and Gidgee ( <i>A. cambagei</i> ).
<i>Lophoictinia isura</i>	Square-tailed Kite	Vulnerable	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.
<i>Macropus dorsalis</i>	Black-striped Wallaby	Endangered	From the Townsville area in Queensland to northern NSW where it occurs on both sides of the Great Divide. On the north west slopes of NSW it occurs in Brigalow remnants to south of Narrabri. On the north coast it is confined to the upper catchments of the Clarence and Richmond Rivers. Preferred habitat is characterised by dense woody or shrubby vegetation within three metres of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat.
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south eastern form)	Vulnerable	The Hooded Robin is common in few places, and rarely found on the coast. It is considered a sedentary species, but local seasonal movements are possible. The south-eastern form is found from Brisbane to Adelaide throughout much of inland NSW, with the exception of



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Species	Common Name	Status	Habitat/foraging/breeding
			<p>the north-west. The species is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania.</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.</p>
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	Vulnerable	<p>The subspecies is widespread, from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond River district. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions. Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (<i>Eucalyptus sideroxylon</i>), White Box (<i>Eucalyptus albens</i>), Grey Box (<i>Eucalyptus microcarpa</i>), Yellow Box (<i>Eucalyptus melliodora</i>) and Forest Red Gum (<i>Eucalyptus tereticornis</i>).</p> <p>Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees. A gregarious species usually seen in pairs and small groups of up to 12 birds. Feeding territories are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares.</p>
<i>Neophema pulchella</i>	Turquoise Parrot	Vulnerable	<p>The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter.</p> <p>Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed.</p> <p>Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.</p>
<i>Ninox connivens</i>	Barking Owl	Vulnerable	<p>The Barking Owl is found throughout Australia except for the central arid regions and Tasmania. It is quite common in parts of northern Australia, but is generally considered uncommon in southern Australia. It has declined across much of its distribution across NSW and now occurs only sparsely. It is most frequently recorded on the western slopes and plains. It is rarely recorded in the far west or in coastal and escarpment forests.</p> <p>Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along</p>

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Species	Common Name	Status	Habitat/foraging/breeding
			watercourses. Denser vegetation is used occasionally for roosting. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as Acacia and Casuarina species, or the dense clumps of canopy leaves in large Eucalypts.
<i>Petaurus norfolcensis</i>	Squirrel Glider	Vulnerable	<p>The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas.</p> <p>Prefers mixed species stands with a shrub or Acacia midstorey. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.</p>
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	Vulnerable	<p>Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.</p> <p>Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15 ha.</p>
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	Vulnerable	<p>The Grey-crowned Babbler is found throughout large parts of northern Australia and in south-eastern Australia. In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Hay.</p> <p>Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. 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</p> <p>Build and maintain several conspicuous, dome-shaped stick nests about the size of a football. A nest is used as a dormitory for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. Nests are maintained year round, and old nests are often dismantled to build new ones.</p>
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	Vulnerable	<p>Distribution restricted to the Pilliga region of New South Wales. The Pilliga Mouse is very sparsely distributed and appears to prefer areas with a sparse ground cover. Some evidence exists of marked population fluctuations by this species.</p> <p>The Pilliga Mouse is restricted to an isolated area of low-nutrient deep sand which has long been recognised as supporting a distinctive vegetation type (Pilliga Scrub). Recent studies indicate that the Pilliga Mouse were found in greatest abundance in recently burnt moist gullies, areas dominated by broombush and areas containing an understorey of kurricabah (<i>Acacia burrowii</i>) with a bloodwood (<i>Corymbia trachyphloia</i>) overstorey. Consistent features of the latter two habitats were: a relatively high plant species richness; a moderate to high</p>

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Species	Common Name	Status	Habitat/foraging/breeding
			low shrub cover; and a moist groundcover of plants, litter and fungi. The gully where high rates of capture were encountered had an extensive cover by low grasses and sedges, with little shrub cover and large areas of ash-covered ground. It is nocturnal and appears to live in burrows.
<i>Pyrrholaemus saggitatus</i>	Speckled Warbler	Vulnerable	<p>The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100ha survive.</p> <p>The Speckled Warbler lives 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. Large, relatively undisturbed remnants are required for the species to persist in an area.</p> <p>The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding.</p> <p>The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside.</p>
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	Vulnerable	The Yellow-bellied Sheath-tail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country.
<i>Stagonopleura guttata</i>	Diamond Firetail	Vulnerable	<p>The Diamond Firetail is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species has a scattered distribution over the rest of NSW. Also found in the Australian Capital Territory, Queensland, Victoria and South Australia.</p> <p>Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora Woodlands. Also occurs in open forest, mallee, natural temperate grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.</p> <p>Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season).</p>

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Species	Common Name	Status	Habitat/foraging/breeding
<i>Stictonetta naevosa</i>	Freckled Duck	Vulnerable	The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Generally rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates. Nests are usually located in dense vegetation at or near water level.
<i>Tyto novaehollandiae</i>	Masked Owl	Vulnerable	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. Lives in dry eucalypt forests and woodlands from sea level to 1100 m.  A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1000 hectares. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.
<i>Xanthomyza phrygia</i>	Regent Honeyeater	Endangered	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years non-breeding flocks converge on flowering coastal woodlands and forests.  The Regent Honeyeater is a flagship threatened woodland bird whose conservation will benefit a large suite of other threatened and declining woodland fauna. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species.
<i>Phascolartos cinereus</i>	Koala	Vulnerable	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.  Inactive for most of the day, feeding and moving mostly at night. Spend most of their time in trees, but will descend and traverse open ground to move between trees.
<i>Nyctophilus timorienensis</i>	Eastern Long-Eared Bat	Vulnerable	Inhabits a variety of vegetation types, including mallee, bulloke <i>Allocasuarina leuhmanni</i> and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland.  Roosts in tree hollows, crevices, and under loose bark.

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Species	Common Name	Status	Habitat/foraging/breeding
<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed Gecko	Vulnerable	<p>This species is patchily distributed throughout the north-western slopes and northern tablelands of NSW and the Stanthorpe region of southern Qld. The distribution in NSW is bounded by the top of the Great Dividing Range to the east, the Liverpool Range in the south and Gunnedah in the west</p> <p>Occurs in dry sclerophyll open forest and woodland associated with outcrops of granite, basalt, sandstone and metamorphic rocks. The majority of sites are associated with granite outcrops</p>
<i>Aprasia parapulchella</i>	Pink-tailed Legless Lizard	Vulnerable	<p>Commonly found beneath small, partially-embedded rocks and appear to spend considerable time in burrows below these rocks; the burrows have been constructed by and are often still inhabited by small black ants and termites.</p> <p>Feeds on the larvae and eggs of the ants with which it shares its burrows.</p> <p>It is thought that this species lays 2 eggs inside the ant nests during summer; the young first appear in March.</p> <p>Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (<i>Themeda australis</i>).</p>
<i>Erythrotriorchis radiatus</i>	Red Goshawk	Endangered	<p>Across northern Australian south through eastern Queensland to far north-east NSW. The species is very rare in NSW. Most records are from the Clarence River Catchment, with a few about the lower Richmond and Tweed Rivers.</p> <p>In NSW, the Red Goshawk is mainly found along or near watercourses, in swamp forest and woodlands on the coastal plain.</p> <p>It favours patches of dense forest interspersed with open woodland or cleared land and often frequents forest edges.</p>
<i>Ninox strenua</i>	Powerful Owl	Vulnerable	<p>The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest.</p> <p>The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine <i>Syncarpia glomulifera</i>, Black She-oak <i>Allocasuarina littoralis</i>, Blackwood <i>Acacia melanoxylon</i>, Rough-barked Apple <i>Angorophora floribunda</i>, Cherry Ballart <i>Exocarpus cupressiformis</i> and a number of eucalypt species.</p>
<i>Onychogalea fraenata</i>	Bridled Nailtail Wallaby	Endangered	<p>The preferred habitat is the narrow band of transitional vegetation that separates the dense acacia scrub from open grassy eucalypt woodland. Radio-tracking studies revealed that, by day, wallabies preferred to shelter in young Brigalow regrowth. Wallabies were never observed to shelter in habitat that was not either thickly vegetated or contained fallen logs. The species' core nocturnal feeding range centered on the ecotone between pasture</p>

## Gunnedah Basin

Species	Common Name	Status	Habitat/foraging/breeding
			<p>and young Brigalow regrowth. When feeding in the open pasture, wallabies remain close to the edge of shelter habitat.</p> <p>Older Brigalow regrowth has a more or less closed low canopy yet good visibility underneath in the 0-1 m height range, whereas younger regrowth occurs as isolated patches of small dense bushes, obscuring visibility below 1 m. Small, solitary species, such as Bridled Nail-tail Wallabies, probably best evade detection by predators through the adoption of cryptic behaviour and sheltering out of sight</p>
<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed gecko	Vulnerable	<p>Found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. Most common in the granite country of the New England Tablelands. Preferred habitat includes rocky hills with dry open eucalypt forest or woodland.</p> <p>Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter.</p>
<i>Petaurus australis</i>	Yellow-bellied Glider	Vulnerable	<p>The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein.</p> <p>Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar. Live in small family groups of two - six individuals and are nocturnal. Den, often in family groups, in hollows of large trees.</p>
<i>Petaurus norfolcensis</i>	Squirrel Glider	Vulnerable	<p>The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria.</p> <p>Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Live in family groups of a single adult male one or more adult females and offspring. Require abundant tree hollows for refuge and nest sites.</p>
<i>Rattus villosissimus</i>	Long-haired Rat	Vulnerable	<p>Eats roots, stems and leaves of grasses and herbs, especially the more succulent species. Seeds, flowers and insects (e.g. locust) which become available in better seasons stimulate reproduction.</p> <p>Sustained in mesic, densely vegetated sites. During plagues can be found in virtually all inland habitats.</p> <p>Following extended periods of above average rainfall or</p>

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Species	Common Name	Status	Habitat/foraging/breeding
			flood this species can breed rapidly. Resulting populations disperse widely, then die away abruptly as food is depleted and water evaporates. Predators rely on these rat plagues for their own rapid reproduction.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	Vulnerable	<p>Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.</p> <p>Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.</p> <p>Maternity caves have very specific temperature and humidity regimes.</p> <p>At other times of the year, populations disperse within about 300 km range of maternity caves.</p> <p>Hunt in forested areas, catching moths and other flying insects above the tree tops.</p>

## Appendix D.

### EPBC Threatened Species



## Gunnedah Basin

Species	Common Name	Status	Habitat/foraging/breeding
<b>Birds</b>			
<i>Lathamus discolor</i>	Swift Parrot	Endangered	Breeds in Tasmania; migrates in autumn and winter to mainland; forages in nectar rich iron bark forests
<i>Polytelis swainsonii</i>	Superb Parrot	Vulnerable	<p>The Superb Parrot is a bird found in central woodland areas of southern New South Wales (NSW), the Australian Capital Territory (ACT) and Victoria. Under threat from land clearing, loss of hollows, and lack of regeneration of woodland habitat.</p> <p>Each spring they retreat towards the southwest to breed, mainly in River and Blakely's red gums. They then move further north and east, relying on woodland habitat for flowers, fruits and seed, particularly in box and Blakely's red gum.</p>
<i>Rostratula australis</i>	Australian Painted Snipe	Vulnerable	The Australian Painted Snipe is usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled. It is a cryptic bird that is hard to see and often overlooked. Usually only single birds are seen, though larger groups of up to 30 have been recorded. It nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats, taking invertebrates, such as insects and worms, and seeds.
<i>Xanthomyza phrygia</i>	Regent Honey Eater	Endangered	<p>The Regent Honeyeater was once common in the woodlands of eastern Australia, particularly along the inland slopes of the Great Dividing Range. It once occurred as far west as Adelaide, but has now disappeared from South Australia and western Victoria. Within this reduced range its population is fragmented, and the only breeding habitat is in north-eastern Victoria and the central coast of New South Wales.</p> <p>Regent Honeyeaters feed on nectar and insects within box-ironbark eucalypt forests. When they're not breeding, birds roam widely in search of these unpredictable food sources. Approximately 75% of this habitat has been destroyed by clearing, and the habitat that remains is being degraded by the continuing removal of trees.</p>
<b>Frogs</b>			
<i>Litoria booroolongensis</i>	Booroolong Frog	Endangered	The Booroolong Frog is an amphibious frog known only from the tablelands and slopes of New South Wales. It typically inhabits rocky western-flowing creeks and their

## Gunnedah Basin

Species	Common Name	Status	Habitat/foraging/breeding
			<p>headwaters, although a small number of animals have also been recorded in eastern-flowing streams.</p> <p>It is a seasonal breeder which is found on or under rocks and debris of suitable streams. Although nocturnal, this species can also be found on rocks in or near the water during daylight hours. Surveys of western-flowing streams from the Northern Tablelands conducted over the past 15 years have failed to locate these frogs in all but one locality, although historical records indicate they were once widespread. It is suspected that the species is regionally extinct in all but the south of this area.</p>
<b>Mammals</b>			
<i>Chalinolobus dwyeri</i>	Large eared Pied Bat	Vulnerable	<p>Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes.</p>
<i>Nyctophilus timorienensis</i>	Eastern Long-Eared Bat	Vulnerable	<p>Inhabits a variety of vegetation types, including mallee, bullocke <i>Allocasuarina leuhmanni</i> and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland.</p> <p>Roosts in tree hollows, crevices, and under loose bark.</p>
<i>Petrolegale penicillata</i>	Brush-tailed Rock wallaby	Vulnerable	<p>The range of the Brush-tailed Rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. However the distribution of the species across its original range has declined significantly in the west and south and has become more fragmented. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit.</p> <p>Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north.</p> <p>Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.</p> <p>Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night.</p>

## Gunnedah Basin

Species	Common Name	Status	Habitat/foraging/breeding
<i>Dasyurus maculatus maculatus</i>	Spot-tailed Quoll	Endangered	<p>Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.</p> <p>Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.</p> <p>Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and may raid possum and glider dens and prey on roosting birds.</p>
<b>Ray finned Fishes</b>			
<i>Maccullochella Peelii peelii</i>	Murray Cod, Cod, Goodoo	Vulnerable	Rivers
<b>Reptiles</b>			
<i>Eseya belli</i>	Bells' Turtle Namoi River Turtle	Vulnerable	Sandy banks and pools
<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed Gecko	Vulnerable	<p>This species is patchily distributed throughout the north-western slopes and northern tablelands of NSW and the Stanthorpe region of southern Qld. The distribution in NSW is bounded by the top of the Great Dividing Range to the east, the Liverpool Range in the south and Gunnedah in the west</p> <p>Occurs in dry sclerophyll open forest and woodland associated with outcrops of granite, basalt, sandstone and metamorphic rocks. The majority of sites are associated with granite outcrops</p>
<b>Plants</b>			
<i>Cadellia pentastylis</i>	Ooline	Vulnerable	<p>Ooline is a medium-sized spreading tree usually about 10 m tall, and rarely to 25 m. It is very slow-growing. The glossy green leaves are 2 - 4 cm long and 15 - 20 mm wide, with broadly rounded tips. The upper sides of the leaves are darker and glossier than the undersides. The white flowers are small and usually single. Each flower produces a cluster of up to five rounded, brown berries, 3 - 5 mm wide. <i>Cadellia pentastylis</i> is of considerable biogeographic interest as it is a relic of an extensive rainforest vegetation that covered much of Australia in the past.</p> <p>Occurs along the western edge of the North West Slopes from north of Gunnedah to west of Tenterfield. Also occurs in Queensland. The natural range of Ooline is from 24°S to 30°S</p>

