Review of Environmental Factors Core Hole Drilling of Cuan No. 1 in PEL 456 - Gunnedah Basin

Santos Pty Ltd

ABN: 33 083 077 196

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Executive Summary

Santos Pty Ltd (Santos) has entered into a Farmin Agreement with the titleholder of PEL 456, Macquarie Energy (Macquarie) to explore for petroleum (in accordance with the Petroleum (Onshore) Act 1991). Santos has been appointed the Operator for and on behalf of the titleholder under the Farmin Agreement.

Condition 1.0 of the PEL 456 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 Industry and Investment (DII) to enable a determination to be made under Part 5 of the Environmental Planning and Assessment Act 1979.

The Cuan 1 corehole is designed to investigate the hydrocarbon potential of PEL 456. 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.

The Operator 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 assessment of the proposed location has shown that the Cuan 1 corehole will be located in cleared grazing land. A final scouting survey will be undertaken prior to drilling taking place to locate a specific site within the study area where minimal environment and landholder impact will occur. The proposed core hole site will avoid any threatened species and critical habitat identified in the desktop assessment. The core hole site can be moved to avoid any sensitive areas.

The proposed activities have associated potential environmental impacts, which are common to drilling activities carried out elsewhere in the Gunnedah Basin. It is considered that the potential impacts can be successfully mitigated with the application of the management controls/measures outlined in this document. The controls/measures utilised by Santos and it contractors 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 in relation to potential impacts on threatened species, populations or ecological communities, 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 have been identified that would be impacted by this proposal. The size and nature of the proposal is unlikely to affect the life cycle of any viable populations of endangered populations if present at the sites.
- There are no known endangered ecological communities or critically endangered communities that have been identified that would be impacted by this proposal.

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

With the management strategies, 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;
- 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 environmental impacts.

On completion of the activities, the site 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 one core hole well in the Gunnedah Basin, being explored under the conditions of Petroleum Exploration Licence (PEL 456) located in New South Wales (NSW). The licence for PEL 456 permits exploration for petroleum, including coal seam gas, by methods including the drilling of core hole wells.

Condition 1.0 of the PEL 456 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) section of the Department of Industry & Investment (DII) to enable a determination to be made under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The purpose of this REF is to assess the environmental impacts of the proposal to the fullest extent possible under section 111 of the EP&A Act and clause 228 of the *Environmental Planning and Assessment Regulation.*

1.2 Proponent Contact Information

The correspondence address for the Operator is:

Operator: Santos (ABN 33 083 077 196) for and on behalf of the Titleholder Macquarie Energy Pty Ltd, (under a Farmin Agreement dated 17/08/2007 and registered with the DII).

Address: Level 22, Santos Place, 32 Turbot Street, Brisbane, Qld, 4000

Telephone Number: 07 3838 3676

Email: reception.brisbane@Santos.com

Contact Person: Mr P Lane, Team Leader Appraisal

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 that through their hierarchy, determine the statutory process for environmental impact assessment. Under the EP&A Act there are three distinctive processes, which are:

- Part 3A, regulates specific types of 'projects' and requires an Environmental Assessment report to be prepared and submitted to the Department of Planning for the Planning Minister's approval;
- Part 4, regulates 'development' and requires a development application accompanied by a Statement of Environmental Effects to be submitted to council for development approval; and
- Part 5, regulates 'activities' and requires a Review of Environmental Factors for 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
- requires the approval of 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 DII 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 order to enable the determining authority to comply with its obligations under Part 5 of the EP&A Act, , Santos has considered s.111 of the EP&A Act and Clause 228 of the Environmental Planning Regulation (See Section 5.15) in preparing this REF.

2.1.2 Environmental planning instruments

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

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

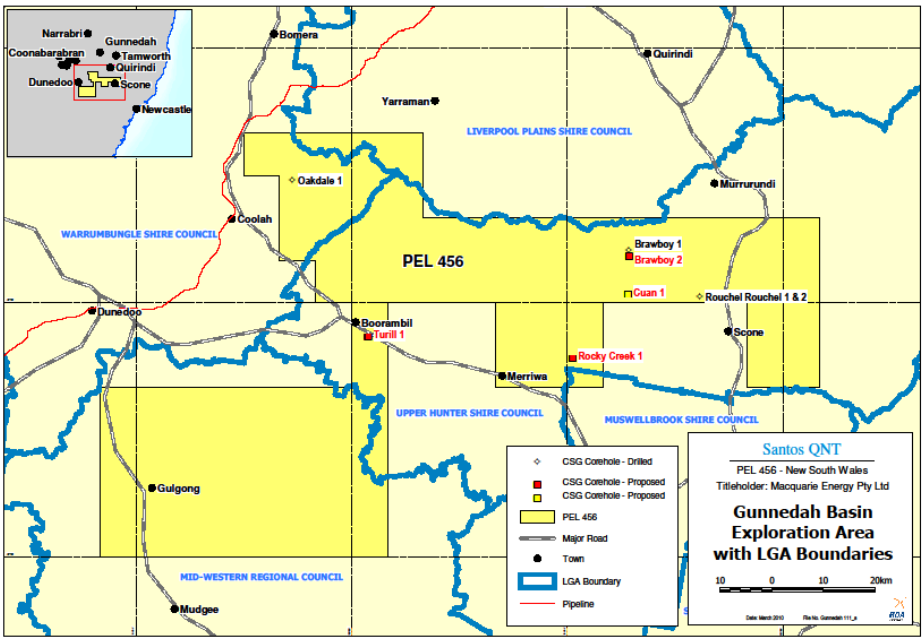
Subject to certain exemptions, SEPP 2007 allows development for the purposes of petroleum exploration to be carried out without development consent under Part 4 of the EP&A Act. The definition of petroleum under SEPP 2007 includes any naturally occurring hydrocarbon, whether in gaseous, liquid or solid state.

2.1.3 Local environmental plans

Local environmental plans (LEPs) are developed by the Council (they become law only after Ministerial approval) and guide planning provisions for the local government area. 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 PEL 456 are regulated by the shire councils of Warrumbungle and Upper Hunter. The application of SEPP 2007 overrides the zoning permissibility controls in the local environmental plans, as activities covered by SEPP 2007 are permissible without development consent. Figure 2.1 shows the location of the various LGA's and relevant core hole sites. Reference to LGAs will be limited in this REF to the Upper Hunter Shire Council area as the proposed core hole site is restricted to this LGA. The proposed core hole falls within Zone no. 1(e) General Agricultural Zone in the Scone Local Environmental Plan.

Figure 2-1: Local Government Areas Covering PEL 456



2.2 Legislative Requirements, Petroleum Licenses and Approvals Required

Petroleum (Onshore) Act 1991 (NSW)

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 has entered a Farmin Agreement with the holder of PEL 456, Macquarie Energy, which grants the right to Santos as Operator to explore for petroleum (Section 7, Petroleum (Onshore) Act 1991) subject to meeting landholder and legislative requirements.

Prior to any exploration on private land, an access agreement and compensation arrangements must be agreed between the titleholder (or its agent) and the landowner (Petroleum (Onshore) Act 1991, 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 DII website at http://www.dpi.nsw.gov.au/minerals/titles/landholders-rights have been considered.

Whilst it is the Santos' 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 will 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.

Environmental Planning and Assessment Act 1979 (NSW)

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

Under Section 5A of the EP&A Act, the DII 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

   ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

d) in relation to the habitat of a threatened species, population or ecological community:

   i. the extent to which habitat is likely to be removed or modified as a result of the action proposed; and

   ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

   iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species population or ecological community in the locality.

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

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

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

Protection of the Environment Operations Act 1997 (NSW)

Under the Protection of the Environment Operations Act 1997, 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.

National Parks and Wildlife Act 1974 (NSW)

The National Parks and Wildlife Act 1974, protects Aboriginal objects and places (under Part 6). The consent of the Director-General is required under section 90 of the NPW Act if the proposed activity will destroy, deface or damage an Aboriginal object.

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

Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The Environment Protection and Biodiversity Conservation Act 1999 (Cth) protects matters of national significance. As outlined in Section 4.6.5 Santos 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.

Water Management Act 2000 (NSW)

Under the regulations of the Water Management Act 2000 there is an exemption (clause 18 (e) of the Water Management (General) Regulation 2004 (NSW)) for the need of an access licence if the water is required for petroleum activities.

The relevant Acts are summarised in Table 2.1.

Table 2-1: PEL 456 Licence Conditions and Applicable Legislation

Legislation	Requirements of Schedule 2 Licence Conditions	Administering Authority
Petroleum (Onshore) Act 1991	The activities do not cause other than minimal/nil impact on features listed in Section 75 (i.e. of Aboriginal, Architectural, archaeological, historical or geological interest). Where these are present, an exploration protocol acceptable to the Department must be completed prior to exploration commencing to ensure that exploration activities will not have an adverse impact on these features. Full rehabilitation in accordance with Department guidelines/standards is carried out after completion of the exploration activities.	Department of Primary Industries – Mineral Resources
Environmental Planning and Assessment Act 1979	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
Threatened Species Conservation Act 1995	The Licence holder is required to consult the register of Critical Habitat kept by the Director–General, and consider the significance of any notations in respect of the area of any proposed exploration activity	Department of Environment and Climate Change
Fisheries Management Act 1994	Consult the register of critical habitat kept under this Act	Department of Primary Industries – Fisheries
National Parks and Wildlife Act 1974	The activities do not contravene Part 6 (Aboriginal objects and Aboriginal places) of this Act	National Parks and Wildlife Service

Legislation	Requirements of Schedule 2 Licence Conditions	Administering Authority
Native Vegetation Conservation Act 1997(now 2003)	The licence holder must not cut, destroy, ringbark or remove any timber or other vegetative cover on any land subject of the licence except such as directly obstructs or prevents the carrying on of operations. Any clearing not authorised under the Petroleum (onshore) Act 1991, must comply with the provisions of this Act.	Department of Environment and Climate Change
Rural Fires Act 1997	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 hole is located in the Upper Hunter Shire Council (UHSC). Further details are presented in Table 3.1 and Figure 3.1.

The proposed core hole falls within Zone no. 1(e) General Agricultural Zone in the Scone Local Environmental Plan. 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 the proposed core holes during the exploration phase include:

- State regulatory agencies (DII, Department of Water and Energy);
- Local governments;
- Landowners/occupiers;
- Aboriginal Groups/ Local Aboriginal Land Councils;
- Community, business and special interest groups, and
- Utilities operators.

In April 2008, Santos commenced a program of community and stakeholder consultation for the proposed coal seam gas (CSG) exploration program in the Upper Hunter Region. This program of consultation has involved briefings and discussions with a broad range of stakeholders to provide them with information on Santos and proposed exploration activities to be undertaken 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, Caroona Coal Action Group, Caroona Coal Community Consultation Committee.

Fact sheets on the proposed activities and a map of the areas to be explored are presented on Santos' website at:

http://www.Santos.com/library/Santos_Gunnedah_Basin_Project_Overview.pdf

Observations indicate that little is known in the community about the coal seam gas industry and the differences between the petroleum exploration legislation under which exploration activities are administered and mining legislation, with which the community is generally more familiar. Future consultation activities will be aimed at increasing the community understanding of coal seam gas exploration activities.

Santos will contact and seek to negotiate an access arrangement with affected landowner in respect to land access, compensation and rehabilitation once the proposed site has been finalised. This step will involve the conducting of various land enquiries and meetings with the relevant landowner. A notice of intended entry will be provided to the affected landowner. A formal land access arrangement will also be made between Santos and the affected landowners. During on site activities, contact with landholders will be made 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 hole indicates 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 DII and further consideration of any additional potential environmental impacts.

3 Project Description

3.1 Location and Tenure

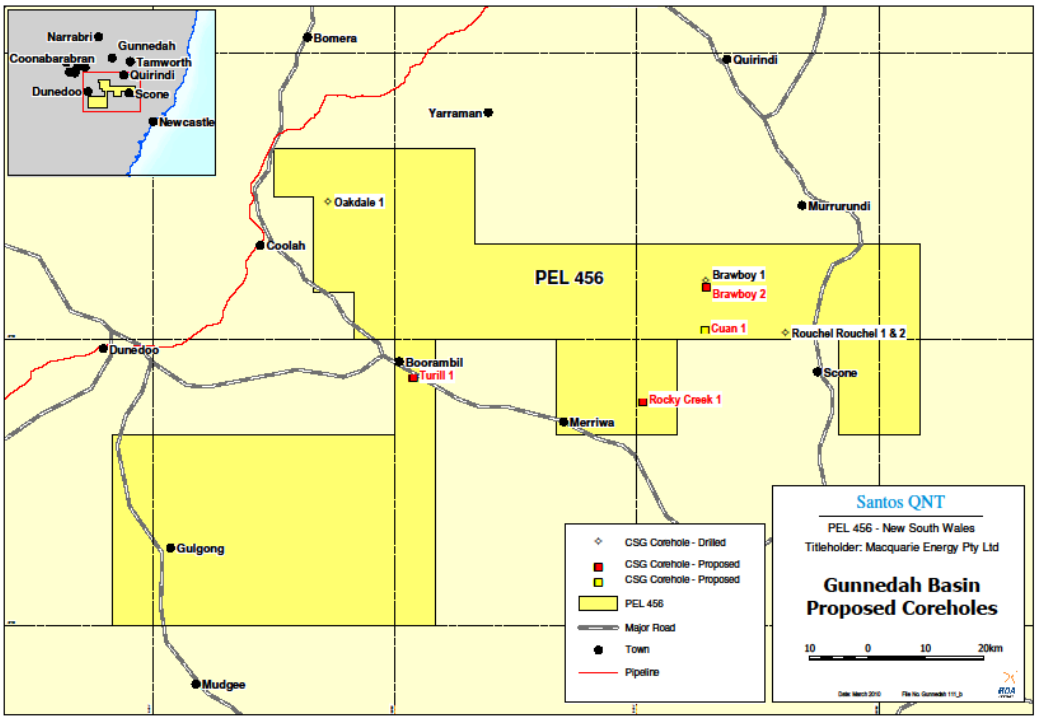
3.1.1 Location

Santos has entered into a Farmin Agreement with the titleholder of Petroleum Exploration Licence No 1 (PEL 456), Macquarie Energy and has been appointed as Operator for and on behalf of the titleholder. The aim of the project described below in Section 3.2 is to explore the Gunnedah Basin by drilling the Cuan 1 core hole. Table 3.1 shows the co-ordinates of the Cuan 1 core hole site. Figure 3.1 shows the location of the core hole site within PEL 456. The core hole is expected to be up to 1600 metres deep.

Table 3-1: Co-ordinates of Proposed Core Hole Sites (GDA-Zone 56)

Core Hole Node*	Longitude	Latitude	Local Government Area	Nearest Town
Cuan 1	150.38.39	-31.58.19	Upper Hunter	Scone

Figure 3-1: Well Locations



The environmental information in this document is based upon NSW database searches for flora and fauna covering the local government area within which the core hole will be drilled. The Commonwealth EPBC database searches were based on a 5 km radius around the proposed core hole location. If there are technical constraints identified at the core hole then the site will be relocated, subject to the necessary landholder approvals, in a similar environmental setting.

The core hole site proposed in this REF is located on freehold land.

The proposed core hole site is not located in:

- 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; or
- Crown Land.

3.2 Planned Activities

To assess the coal seam gas potential of the Gunnedah Basin in PEL 456 it is proposed to drill Cuan 1 as a HQ (96 mm) diameter core hole to obtain information on coal depths, seam sizes, continuity and quality. This core hole will also provide data on gas content, gas type, 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 proposes to carry out the drilling activities for coal seam gas in accordance with the activities described below.

Firstly, Santos will contact and negotiate with the affected landowner in respect to land access, compensation and rehabilitation. This step will involve meetings with the affected landowner and developing an understanding of the nature of the land and activities undertaken the site. Only after a landowner agreement has been entered into, site activities will commence.

Where possible existing access tracks will be used. If new tracks are required for the core hole site the route 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 area to be disturbed for drilling activity will be approximately 100 by 100 metres for the core hole site plus necessary access track. However, only approximately 30% of the core hole area will require hard stand. Associated lined drilling sumps and a flare pit will be constructed on site.

Cuan 1 core hole will have a specific well design developed, compliant with the relevant legislation. 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). 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 calcium carbonate, potassium chloride and/or sodium chloride as weighting agents. As it is possible that some water-reactive clays may be found, 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 sourced from the immediate landholder or 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 from the landholder. This will be within a radius of less than 5 km from the existing core hole site (i.e. within the database search area already undertaken as part of this REF).

The number of employees present at each site is expected to be up to 20 persons. The hours of operation during the drilling of Cuan 1 will be on a 12 hour a day basis which will be negotiated with the landowner. The Cuan site has a residence within 1km of the site, however during the whole period of the drilling activities (i.e. up to 60 days) the residence will be unoccupied.

Core hole drilling activities are temporary and will not have any long term impact on the visual amenity of the area. The duration of the activities to be undertaken for Cuan 1 will be between 25 and 60 Days. A typical drilling rig on a location is shown in Figure 3-2.

3.3 Abandonment

Cuan 1 core hole will not used for temporary monitoring purposes (e.g. standing water levels), therefore will be abandoned and the site 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 DII. The Cuan 1 core hole site will be monitored during this rehabilitation period.

Figure 3-2: Typical Drilling Rig

3.4 Justification of the Activity

Drilling of the Cuan 1 core hole is a necessary step in the ongoing exploration and evaluation of the hydrocarbon potential in PEL 456, which to date has undergone limited petroleum exploration. Discovery of coal seam gas resources in the area has the potential to increase the state's reserves and revenue from gas, and underpin future exploration or production in the region.

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

These procedures are required to define and identify commercially valuable reserves of coal seam gas. Santos 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 Macquarie Energy Pty Ltd.

3.5 Evaluation of Alternatives

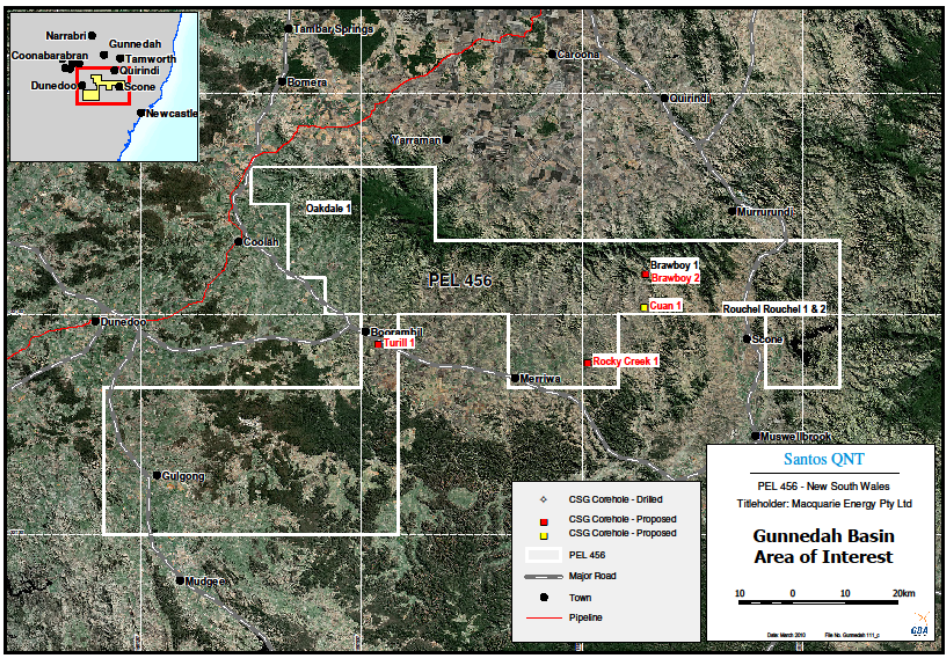
There is no reasonable industry alternatives to the drilling method proposed in Section 3.3 if commercially useful amounts of coal seam gas are to be located and assessed. There is limited previous drilling in this area of the Gunnedah Basin that is sufficiently deep for the purposes of petroleum exploration. 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.

4 Regional Description

Unless otherwise stated the major source reference for this section is the Bioregions of New South Wales: their biodiversity, conservation and history (NSW National Parks and Wildlife Service, 2003) located at http://www.environment.nsw.gov.au/bioregions/BrigalowBeltSouthBioregion.htm

The proposed core hole site is located within the red box shown in Figure 4.1 below.

Figure 4-1: Regional Map



4.1 Bioregion

PEL 456 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 Coolah, Merriwa and Scone which are all about 20 km from the core hole site.

4.2 Geology

4.2.1 Regional Geology

PEL 456 is located in the southern portion of the Gunnedah Basin where Jurassic and Cretaceous Surat Basin sediments unconformably overlie Permo Triassic Gunnedah Basin sediments. The Gunnedah Basin, covers an area of more than 15,000 sq km and is defined in structural terms as being bounded to the east by the Hunter Mooki Thrust Fault System and the New England Fold Belt, and to the west by the Lachlan Fold Belt onto which the Gunnedah Basin sediments gradually onlap.

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

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

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

Deposition of the lower Black Jack Formation sediments was followed by an episode when marine conditions affected the Gunnedah Basin, with the deposition of sandstones of poor to fair reservoir quality. Deposition of the western derived quartzose sandstones was followed by very widespread coal swamp conditions depositing the thick Hoskissons Coal seam that is readily correlated across the Basin. The thickness of the Hoskissons Coal ranges from less than 1m in the west to more than 12m in the north and to 18m in the south-east.

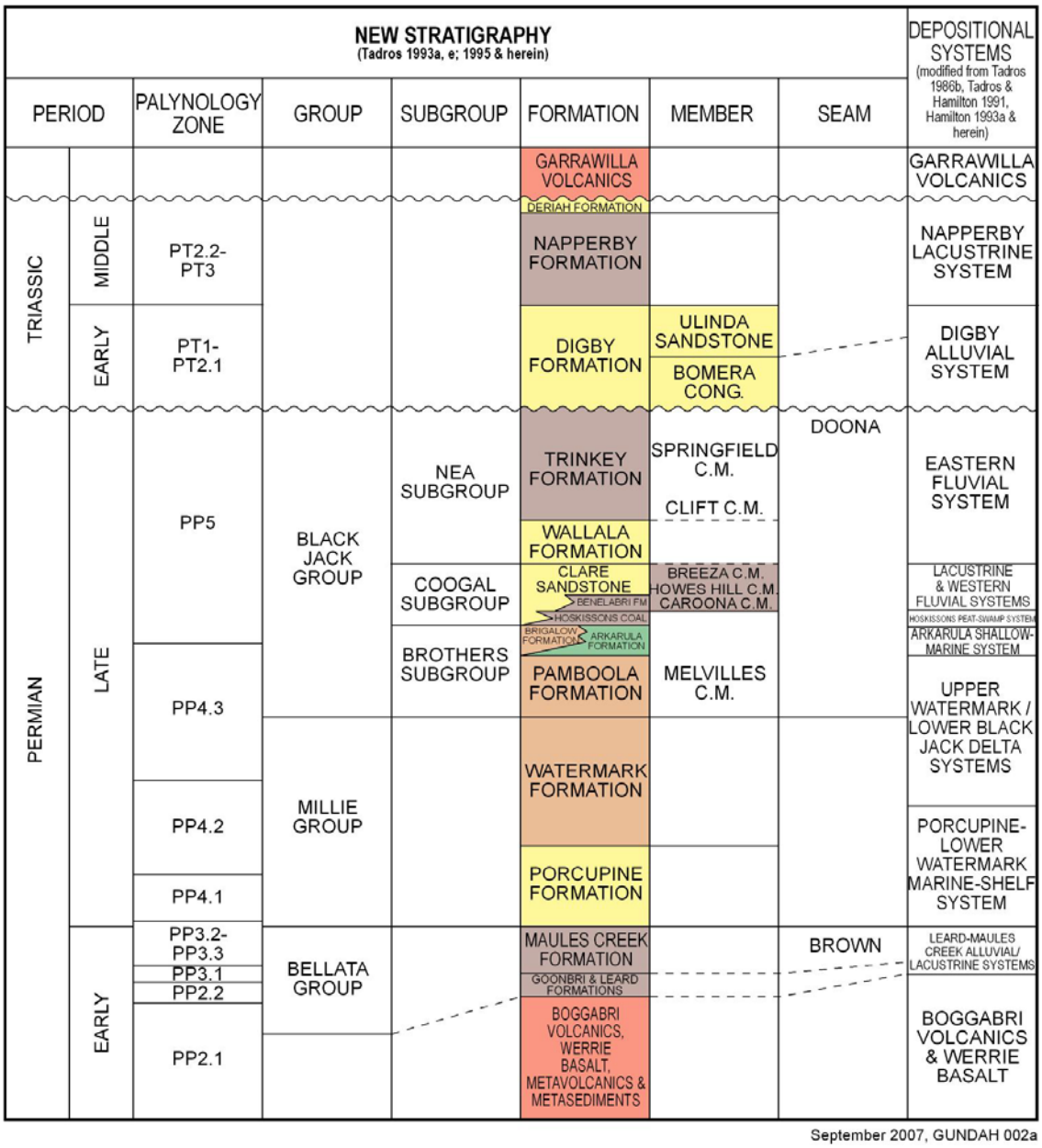
Late Permian volcanic activity and tectonism to the east resulted in renewed deposition of more lithic sediments with an easterly provenance and consequently the upper Black Jack Formation has only limited potential for reservoir development. A period of tectonism, uplift and erosion of variable intensity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

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

A major period of uplift and erosion during the Late Triassic ended Gunnedah Basin deposition. Deposition of the Surat Basin sequence commenced during the Early Jurassic, preceded by lava flows, pyroclastics with intercalated claystones of the Garrawilla Volcanics (Nandewar Range). During the Tertiary period of tectonism, the Liverpool Ranges were formed by massive extrusions of basalts representing the last major depositional episode in PEL 456.

Figure 4-2: Stratigraphy of the Gunnedah Basin

Gunnedah Basin Lithostratigraphy



4.2.2 Soils

The soils across the region vary depending on the local sediment source.

In the Upper Hunter Shire the soils are described as follows (UHSC, 2006):

- Black earths occur on the Tertiary basalt in the west of the Shire and on basic alluvium and colluvium between the Pages River and Kingdon Ponds;
- The Merriwa plateau is characterised by rich dark Vertisols with a uniform profile of well structured clay soil which is generally black, dark red or dark brown in colour. They are reasonably fertile soils and generally do not have trace element deficiencies. The high clay content in black earths results in considerable swelling and shrinking on wetting and drying. Volume changes are typically between 20 and 40 per cent. This does not restrict agricultural development of the soil, but can cause problems such as foundation cracking and underground pipe displacement. Black earths show considerable erodibility under poorly managed pasture or arable conditions even on gentle to moderate slopes;
- In general, alluvial soils are fertile and intensively used for grazing dairy cattle or cropping under irrigation. Erosion potential is low due to the low gradients on which the soil develops;
- The Euchrozem group of soils occur in the central area of the Shire on the slopes to the west and east of the New England Highway as far north as Wingen and to the east of Gundy. Euchrozems are gradational red and red brown clay soils grading from a clay loam or light clay to medium textured clay at depth without any sharp changes in texture. They are moderately fertile. The erodibility of such soils is highly variable, reflecting the complexities of the underlying geology. Under pasture the soils are considered stable but they may be subject to severe erosion when cultivated, if adequate soil conservation measures are not employed;
- Solodic soils are associated with the hilly and rugged land developed on the Devonian and Carboniferous rocks in the eastern half of the Shire and on the belt of Permian, Triassic and Jurassic rocks to the west of Kingdon Ponds. Red solodic soils occur in well drained locations, yellow solodic soils are confined to areas where the water table is high. Solodic soils comprise of loamy A horizon overlying a clay B horizon with a sharp change between horizons. These soils are of low fertility, with deficiencies in nitrogen and phosphorus, and are highly susceptible to erosion when disturbed; and
- A Krasnozem Prairies Soil Complex occurs in the high rainfall areas of the Shire, including the upper slopes of the Mount Royal Range and along the ridge of the Moobi Range to the southwest of Scone. The Krasnozem soils are similar to the Euchrozem soils, with a more friable subsoil horizon. They are generally fertile and of low erodibility.

4.3 Climate

The town of Scone, which is representative of the area, has average maximum temperatures varying from 32.0 degrees Celsius in January to 16.7 degrees Celsius in July, while average minima range from 16.4 degrees Celsius in January and to 3.1 degrees Celsius in July (BOM, 2010).

The Upper Hunter LGA has a temperate climate with a summer dominant rainfall, and annual rainfall of generally 600-800 mm per annum. Climatic conditions vary across the LGA with generally

drier conditions with increasing distance from the coast, and lower elevation areas (UPSC, 2006). Average annual rainfall in Scone is 646 millimetres (BOM, 2010).

4.4 Hydrology

4.4.1 Surface Water

The permit PEL 456 overlies both the Hunter/Central Rivers and Central West catchment management areas.

The Upper Hunter LGA is dissected by a number of rivers and streams running from west to east. The core hole falls within this area. The surface water originates predominantly in the Liverpool and Mount Royal ranges and flow through the escarpments along well defined drainage lines.

The principle river systems are:

- The Pages River;
- The Isis River;
- The Hunter River; and
- The Goulburn River.

However there are a number of other major stream systems that are important water sources, including:

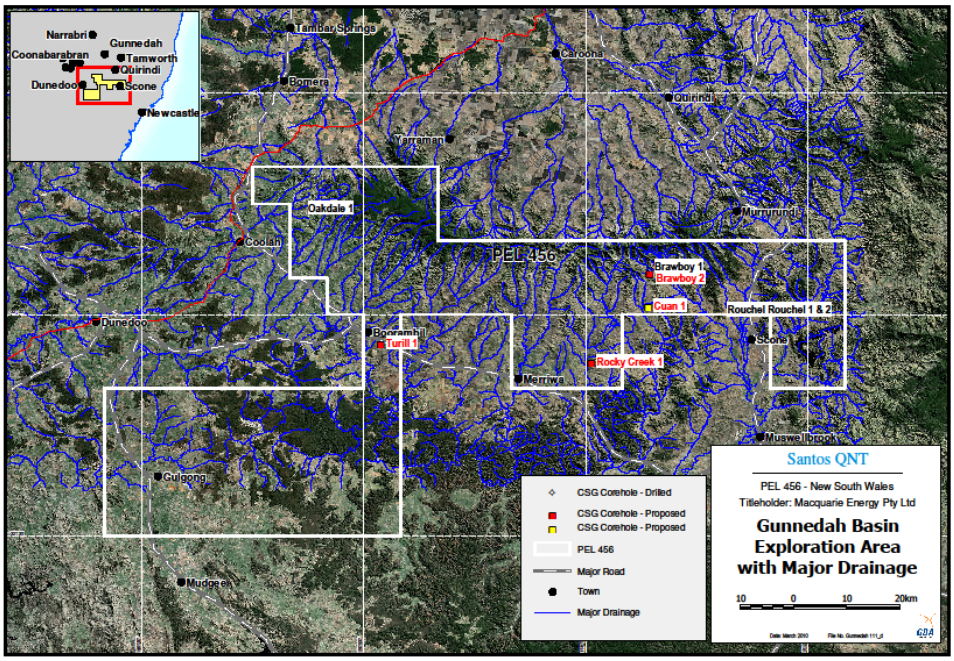
- Dart Brook;
- Middle Brook;
- Wybong Creek;
- Merriwa River;
- Krui River;
- Moonan Brook; and
- Stewarts Brook.

Table 4.1 identifies the nearest surface water body to the core hole location. Figure 4-3 shows the proposed site in a regional context for the surface water drainage system.

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

Core Hole Node	**Water Course**	**Approximate distance of nearest water course**
Cuan 1	Cuan Creek	1500m West

Figure 4-3: Major Drainage



4.4.2 Groundwater

It is expected that groundwater at the core hole site and within surrounding areas will consist of both alluvial and hard rock aquifers. Alluvial aquifers are generally those that are closer to the surface and associated with more porous soil and rock materials. Depending on the topography and climate, they may be connected to surface water features and transmit waters to or receive waters from them. Alternatively, a hard rock aquifer is an aquifer where groundwater is stored and flows through very small (relatively) joints or fractures in bedrock. They generally yield less water than porous rock (alluvial) aquifers but in some cases may provide high yielding bores.

4.5 Topography

In general the topography of the Upper Hunter Shire Council ranges from rugged land with slopes of greater than 30 per cent to flat and plateau lands with slopes of less than 3 per cent; and is closely related to the underlying geology (UHSC, 2006).

Topographical features include (UHSC, 2006):

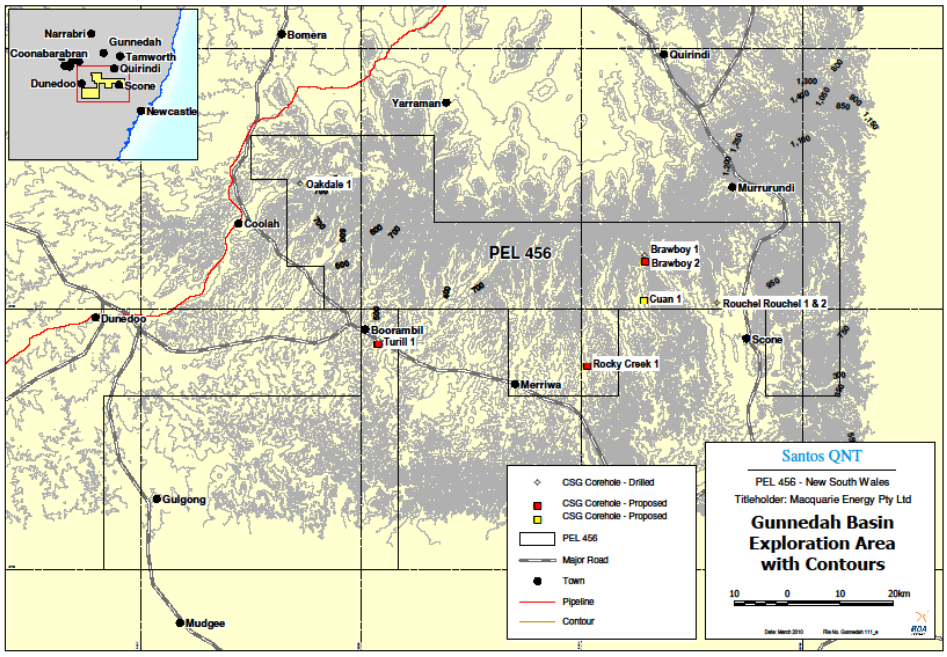
- Rugged land, with mean slopes greater than 30 per cent and local relief exceeding 300 m, is found in the Mount Royal Range in the eastern part of the Shire and in the Liverpool Range to the west of the New England Highway. The location of the rugged

topography is closely related to the presence of hard, erosion resistant rocks which form cliffs and bluffs;

- Areas of flat topography (less than 3 per cent slope) are confined to the flood plains of the Hunter River below Gundy and its tributaries, Pages River, Kingdon Ponds and Dart Brook. These flat areas are characterised by alluvial terraces caused by the action of the watercourses;
- A plateau area with slopes of less than 5 per cent and local relief of less than 50 m occurs in the far east of the Shire in the Mount Royal Range. This topography is controlled by the underlying Tertiary Basalt;
- In between the rugged and flat areas the topography is undulating or hilly, depending on the underlying geology. Undulating topography, characterised by mean maximum slopes less than 15 per cent and local relief less than 30 m, occurs on the Permian shales and sandstones in the central portion of the Shire and adjacent to the major drainage channels of the Merriwa Plateau in the west of the Shire. Elsewhere the topography tends to be hilly, with slopes between 10 per cent and 30 per cent and local relief up to 150 m.

Figure 4.4 shows the topography of the core hole drilling area will be flat to undulating.

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 that 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 the core hole 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 Upper Hunter local government area (DECC 2010).

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 5km radius from each core hole site (DEWHA 2010).

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 Upper Hunter LGA has been cleared or thinned for cropping and grazing. This applies to the proposed core hole location. For the Namoi River catchment to the north of the PEL 456 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 same can be said for the core hole site as it is planned to be located in already heavily disturbed area away from remnant vegetation and streamline riparian vegetation. Figure 4.5 shows the typical vegetation cover of the area where the core hole is planned to be located.

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

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 that 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. 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.

Based on the TSC Act listings specifically for the Upper Hunter LGA, there are 22 threatened plants that are known to occur within the Upper Hunter LGA and these are listed in Appendix A. The core hole site has been cleared for rural activities and does not provide suitable habitat for any of these listed species.

4.6.3 Weeds

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

4.6.4 Significant Fauna

A search of the NSW DECC on-line database Atlas of NSW wildlife listed 49 threatened fauna species within the Upper Hunter LGA (DECC 2010). The species are listed in Appendix C.

The core hole site has been cleared for rural activities and will not be critical habitat for any of these listed species.

4.6.5 EPBC Act Due Diligence

The EPBC Database was searched and a Matters of Environmental Significance Report was generated on the 29 March 2010 (DEWHA 2010). Table 4.2 shows 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 site.

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

Aspect	Presence within vicinity of the core hole
World Heritage Properties	None
National Heritage Places	None
Wetlands of International Significance (RAMSAR Sites)	Within the catchment of Hunter Estuary Wetlands. No potential impact.
Commonwealth Marine Areas	None
Threatened Ecological Communities	3
Threatened Species	12
Migratory Species	12

Other Matters includes:	
• Commonwealth Lands	None
• Commonwealth Heritage Places	None
• Places on the RNE	None
• Listed Marine Species	10 (All Bird Species), No potential impact.
• Whales and Other Cetaceans	None
• Critical Habitats	None
• Commonwealth Reserves	None

4.6.5.1 Threatened Ecological Community

There are three Threatened Ecological Community (TEC) that could potentially be found within the region where the core hole site is to be located. They include the Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern QLD (critically endangered), the Weeping Myall Woodlands and the White Box- Yellow Box-Blakely's Red Gum Grassy Woodland (Endangered) and Derived Native Grassland (critically endangered). These communities were 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% of these TECs remain in good condition and much of this occurs in small isolated pockets (DEWHA, 2006).

The proposed core hole site will be located on land previously cleared for rural activities and as such will not have a significant impact on these TECs.

4.6.5.2 Threatened Species

There were up to 12 threatened species that could be potentially located within 5 km of the proposed core hole site within PEL 456. These are provided in Appendix D. The proposed core hole site 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 5 migratory terrestrial bird species and a further 7 birds that are wetland species or migratory marine birds listed. It is considered that the planned activities will not have any significant impact on these species as the proposed core hole site 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. It is considered that the planned activities will not have any significant impact on these listed species.

4.7 Socio-Economic

4.7.1 Local Government Area

The planned activities lie within the local government areas of Upper Hunter Shire Council. Population figures below are based on the 2006 census (ABS, 2006).

The Upper Hunter LGA comprises the major population centres of Scone, Merriwa, Murrurundi and Aberdeen, plus a number of smaller areas such as Gundy, Moonan Flat, Blandford, Wingen, Parkville and Bunnan. In total the Upper Hunter Shire covers an area of approximately 8060 square kilometres with a population of 12, 976 based on the 2006 census.

4.7.2 Landuse

The proposed core hole site is located 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.

Sheep, beef cattle and grain farming are major rural land uses. Three coal mines are located in PEL 456. However these are not within the vicinity of the proposed core hole site. PEL 456 in relation to the mining leases is shown in Figure 4.6.

4.7.3 Heritage

4.7.3.1 Aboriginal Heritage

The Local Aboriginal Land Council for the area of interest is Walhallow, Nungaroo and Wanaruah Local Aboriginal Land Councils. A search of the NSW Department of Environment and Climate Change (DECC) Aboriginal Heritage Information Management System (AHIMS) was made in 2008 (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 site. The nearest recorded Aboriginal heritage sites are located between 1 and 5 km from the closest core hole sites. The proposed core hole is 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. The core hole site is proposed on pastoral land which has been disturbed by clearing, grazing, cropping and general agricultural pursuits.

As of the 31st December 2009 there were no Native Title claims over the proposed core hole site location[1].

4.7.3.2 Non-Indigenous Cultural Heritage

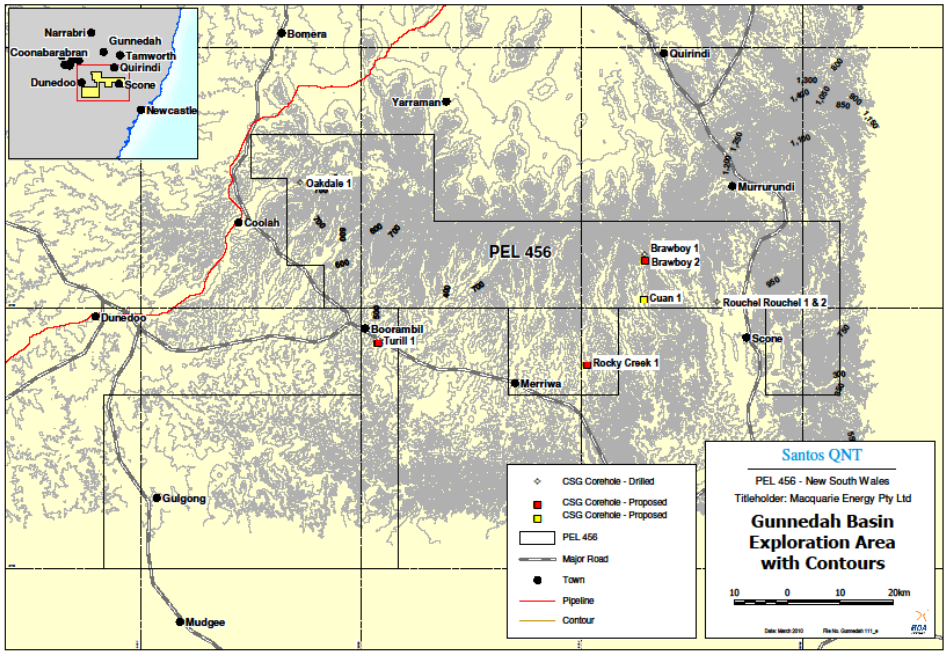
A search of the Commonwealth register of National Estate (DEWHA, 2010) sites found over 40 sites within the Upper Hunter LGA. While the search tool does not provide a specific location of each site,

[1] See Map at http://www.nntt.gov.au/Publications-And-Research/Maps-and-Spatial-Reports/Documents/Quarterly%20Maps/NSW_ACT_JBT_NTDA_Schedule.PDF

the majority of sites listed were most likely within town boundaries or Nature Reserves and National Parks. The proposed core hole site is not located within these locations.

The New South Wales Heritage Register for the Upper Hunter LGA identified over 9 items listed under the New South Wales Heritage Act (NSW Department of Planning, 2010). Like the National Register these items are usually located within town boundaries and therefore will be avoided during the core hole activities.

Figure 4-6: PEL 456 and Mining Tenures



4.8 Protected Areas

4.8.1 National Parks and Reserves

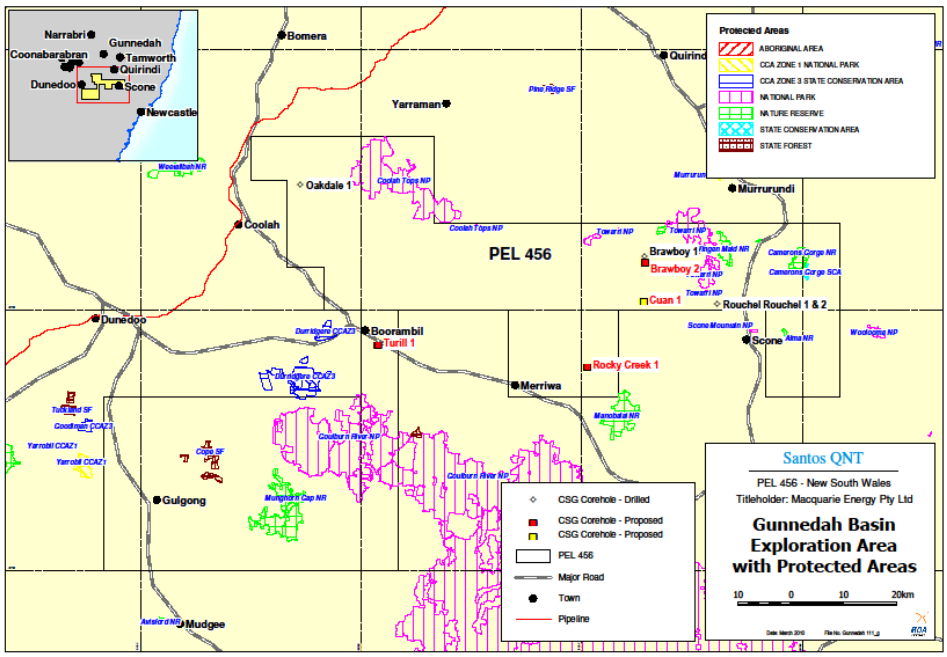
A number of National Parks and Nature Reserves are found in PEL 456. Those of relevance to the core hole location are discussed below:

- Towarri National Park was gazetted in 1998 following the purchase of several key properties that were combined with Vacant Crown Land. The park covers an area of 5,035 hectares fragmented into six separate parcels, being the Washpools Range, Glen Range, Castle Rock, Central, Stringybark Top and Fern Top. The core hole is greater than 10 km from the nearest park boundary.
- Wingen Maid Nature Reserve is one kilometre to the east of Towarri National Park. Part of Wingen Maid Nature Reserve was under Crown lease for 7 years from 1922 and remained as Vacant Crown Land until the first 718 hectares were gazetted as a nature reserve in 1974. Further lots of crown and freehold land were added in 1981, bringing

the total area to 1,095 hectares. Wingen Maid was originally conserved because it is a prominent scenic landmark in the Upper Hunter Valley and contains an interesting mix of vegetation communities. The core hole is more than 10 km from the nearest park boundary.

- Cedar Brush Nature Reserve was gazetted in April 1977 as part of the Governments Rainforest Conservation Policy and is located 200 metres to the west of the central portion of Towarri. The reserve totals 206 hectares and protects one of the most complex western extents of rainforest on the Liverpool Range. The core hole is more than 20 km from the nearest park boundary.
- Coolah Tops National Park was dedicated as a National Park in 1996, after logging had finished. It covers 12,117 hectares on a narrow plateau of the Liverpool Range, and is 30km east of Coolah. The park is a little over 30km long. The core hole is about 20 km southwest of the nearest park boundary.

Figure 4-7: Location of National Parks, and Nature Reserves



5 Environmental Impacts and Mitigation Measures

5.1 General

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

5.2 Socio-Economic

5.2.1 Existing Environment

The catchment has been used extensively for agricultural activities since the early 1800s. The main agricultural activities include sheep, beef cattle and grain crops. The particular area of the proposed drilling activities is largely rural. There is also number of coal mine operations within the broad region.

5.2.2 Potential Impacts and Mitigation Measures

The likelihood that potential impacts including disturbance to farming activities, disturbance to livestock and potential bushfire risks to flora, fauna, stock and personnel occur is low. 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 sections 5.3, 5.4, 5.6 and 5.7.

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, including immediate neighbours of the land 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;
- Internal 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.

5.3.2 Potential Impacts and Mitigation Measures

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 to reduce dust generation (see Section 5.4 for details on its source).

Liaison with local homesteads that 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. It is not expected to have any significant impacts on road side vegetation.

Santos will notify the Upper Hunter Shire Council 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. Santos has a well established process for flaring produced gas during Drill Stem Testing.

5.4 Hydrology

5.4.1 Existing Environment

There are no creeks in the immediate vicinity of the core hole site that could be potentially affected if there are any spill incidents during the proposed activities.

5.4.2 Potential Impacts and Mitigation Measures

Preference will be to procure water supplies from dams or bores located in the vicinity of the core hole site (with landholder permission) or from municipal supply via a water carter. In order to acquire the water necessary for drilling in situations where water cannot 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 spill incidents during associated with chemical storage & handling, refuelling and drilling fluids and cuttings management. Mitigation measures for these activities are discussed in Section 5.8and 5.10. Groundwater cross contamination with the drilling fluid will be prevented as the core hole will be cased and completed in accordance with DPI-MR requirements and specific well design.

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 taken to an appropriate site for disposal. Any waste pits temporarily left open after the rig has left will be fenced to protect livestock and other animals.

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

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 100 metres by 100 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. The potential for significantly disturbing the soil structure or future land use is low. If imported soils are required these will be sourced from the local area and if required, permission will be obtained from the landholder 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 (greater than 1 km to the nearest residence) 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 carried out in accordance with agreements with landowner and DPI-MR requirements.

Mitigation Measures will include:

- Prior to starting the activates Santos will confirm all potentially affected noise and/or vibration sensitive receivers (including rural residences, and noise sensitive equipment);
- Noise and vibration monitoring may be undertaken on receipt of a complaint; 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 location will be on land that has been previously cleared and is unlikely to be of significance to threatened species or communities. Appendix B lists the potential weeds that could be in or near the proposed core hole location.

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 is low. This shall be mitigated as follows; all vehicles travelling to site will be required to follow Santos 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 from.

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 likelihood that a chemical or hazardous substance will impact on the environment is low because all goods will be appropriately handled and stored away from sensitive locations.

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 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 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 site is 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; and

- 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 site. The proposed core hole site is 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 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. The liner, if used, will be removed once the sump is no longer required. 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 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 that 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 a suitable location; and
- A perimeter fence around the site will be considered at each site, if required to enclose all the above pits, sumps etc.

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 insignificant and all equipment will be removed at the end of the coring program. If drilling is operated on a 12 hour a day basis, the site will be sufficiently lit by natural light for safe working conditions.

5.12 Aboriginal Heritage

5.12.1 Existing Environment

The land where the core hole site is 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 the proposed core hole site. Initial consultations with representatives of the Local Aboriginal Land Councils have commenced.

5.12.2 Potential Impacts and Mitigation Measures

The likelihood that potential impacts will occur to known or unrecorded artefacts or burial sites is low.

To minimise any potential impact 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 Operators 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.

5.14 Risk Assessment

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

Table 5-1 shows the risk matrix including the management controls and performance management indicators that will be utilised by Santos during the drilling activities. The focus of environmental management is to avoid where possible, then minimise and mitigate any impacts.

Table 5-1: Risk Assessment for Core Hole Activities

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
Air Quality	• Expected air emissions / air quality issues associated with the short term activities may include: • Combustion exhausts from the flare stack (during testing); • Fugitive emissions from (vehicles); and • Dust emissions from earthworks and vehicular activity. • Fugitive emissions from vehicles used during appraisal activities are anticipated to be minor due to the small scale of activities planned. • Other minor sources of air emissions include exhaust fumes from earthmoving and transport equipment. • These sources are likely to be negligible in the context of existing activities including grazing and transport within the area. • No measurable impact is likely.	**1**	• Reducing the speed of vehicles on field roads. • Watering of roads when appropriate or when agreed. • Investigating dust complaints and responding appropriately. • Planning the location of activities in consultation with landholders should control impacts.	**1**	• Minimal complaints from Landholders regarding dust impacts. • Amicable resolution of complaints	• All complaints made by the Landholder and any subsequent actions are to be recorded in the Complaints Register.

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
Community	• The primary contact during planning and development will be with the Landholder. • The activities have the potential to impact upon landholders. • In general, land access will be addressed in compensation/access agreements prior to the commencement of petroleum activities.	**2**	• Access will be discussed with the Landholder during the field scouting period and compensation finalised. • Land requirements and locations for infrastructure will be discussed during the pilot design period with the Landholder. • Where practical infrastructure will be located within previously disturbed areas. • Land requirements will be minimised to that required for safe operations. • Land no longer required for normal operations will be rehabilitated and where practical returned to its previous use in consultation with the Landholder.	**1**	• All land disturbed by Santos is to be returned to a condition consistent with the adjacent area and in consultation with the landholder.	• Santos records contracts with landholders.
Fire	• Threat to the community, flora and fauna or sensitive areas.	**2**	• Drilling sites will be selected such that a cleared buffer exists outside the drilling pad area to maintain an effective barrier against bushfires. • The flare pit will be kept	**1**	• No fires occur as a result of the proposed activities.	• Incident notification records.

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
			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 site will be cleared to minimise the potential for ignition of surrounding pasture. • Diesel machinery will be utilised for all activities.			
Flora, Fauna and Environmental Sensitive Areas	• The proposed location has previously been highly disturbed by agricultural activities. • No threatened flora or fauna or sensitive areas will be impacted by the proposed core hole activities.	**1**	• Use of areas already disturbed. • No unplanned or unapproved damage to flora and fauna. • Restoration of disturbed areas to commence as soon as practical.	**1**	• Routine work reports will be recorded and reviewed by each supervisor or manager. • Recommendations and corrective actions arising from audits and reviews will be implemented.	• Santos will maintain records during construction and operation of all monitoring and assessment activities.

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
					• Ongoing monitoring to assess the success and integrity of construction and rehabilitation measure and ensure appropriate follow-up rehabilitation measures are implemented.	
Indigenous and Non-Indigenous Cultural Heritage	• Indigenous heritage. Site or artefact of indigenous culture may be inadvertently damaged. • Non-Indigenous Heritage: Sites or artefacts of non-indigenous settlement may be inadvertently damaged. • The proposed site is part of an operating farm on a highly disturbed area that has previously been cleared. • It is not expected that there will be any impact on indigenous and non-	**1**	• Development will occur in cleared/disturbed areas minimising the risk of impact on cultural heritage. • All disturbance activities are reviewed to ensure development avoids impacting on cultural heritage before commencement.	**1**	• Cultural heritage clearance completed prior to ground disturbance. • No indigenous or non-indigenous site is disturbed by the proposed activities.	• Records of any cultural heritage site are maintained.

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
	indigenous cultural heritage values of the area.					
Land, Soils and Terrain	• It is considered that the only potential environmental impact associated with the activity is soil erosion from the disturbed land at the drill site and access tracks.	**2**	• All activities associated with land disturbance will be discussed with the Landholder prior to commencement. • The area of all disturbances will be determined and placed within Santos' Geographic Information System (GIS). • An environmental assessment will be carried out prior to the acceptance of a site for a new activity. • This assessment determines landholder values, habitats, vegetation, and areas of significant environmental/cultural value to be avoided. • The assessment also outlines areas or issues requiring particular environmental management.	**1**	• The site is rehabilitated upon completion of the activities.	• Records of disturbance are maintained within Santos' GIS.

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
Noise	• Activities to be undertaken during drilling operations include drilling, running casing and cementing, DST and geophysical logging. • All activities apart from access to the site are confined to the drill pad with all work carried out during daytime hours only. • Main vehicle movements are based around personnel movements to and from site. There are however the occasional deliveries and other personnel accessing the site outside of these times. • The equipment used for the mobilisation and powering of the drilling rig have mufflers installed on their respective power plants and prime movers. • The proposed drilling site is a distance of greater than 750 m to the nearest dwelling that will be unoccupied during the drilling activities.	2	• To manage noise and minimise impacts the following management strategies/controls will be implemented: • Landholder notification will be given prior to commencement of drilling. • Equipment will be maintained so that noise levels remain constant. • Complaints will be responded to in a timely manner. • Where noise disturbance cannot be avoided, Santos will investigate alternative arrangements to suit the landholder. • Noise barriers will be implemented if necessary	1	• All noise complaints will be recorded in the Complaints Register. • Amicable resolution of complaints	• Maintenance carried out on equipment is to be recorded. • Complaints Register.
Waste	• No waste will be disposed of on site. • Domestic waste including sewage.	1	• General and recyclable wastes (including glass, paper and plastic) generated during construction will be transported to landfill and recycling facilities on a	1	• Post construction checks to ensure all waste has been appropriately removed and	• Waste management records. • Complaints register.

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
			routine basis. • Regulated waste will be collected by licensed contractors for off-site disposal. • Sewage will be collected by licenced contractor for off-site disposal. • Complaints are addressed in a timely manner. • Waste is disposed of at appropriate end point. • All waste management non-compliances are managed in the Incident Management System. • Any complaints from the landholders regarding waste management are recorded in the Complaints Register.		disposed of. • Operational checks to establish that all waste has been appropriately removed from the operational areas, or correctly stored and waiting for removal.	
Water- Surface and Groundwater	• Incident or accident that may result in a release of oils or other chemicals maintenance fluids to the ground. • Transport of sediments disturbed by erosion of soils during construction activities.	**2**	• Water removed from site will be managed by a contractor licensed to carry and handle water. • Bunding of all areas storing or handling fuel,	**1**	• No incidents where substances are released to surface or ground water causing contamination.	• Records of spills, leaks and associated clean ups are to be managed using the Incident

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
			fuel using equipment, and chemicals, in line with Australian Standard 1940 – 1993; The Storage and Handling of Flammable and Combustible Liquids • Where applicable maintenance of roads, drains, bund walls, contour and diversion banks, will occur. All drainage structures are to be maintained for the life of the development. • During rehabilitation, diversion banks and ripping along the contour will be completed to prevent the concentration and momentum of water flow as required.		• Diversion mechanisms in place, regularly checked and maintained to redirect natural stormwater movement where required.	Management System. • Maintenance carried out to remedy any erosion and water channelling is to be recorded using the Incident Management System. • Records of water storage inspections to be maintained.
Weed Management	• Introduction or spread of weeds through earthworks equipment and general traffic.	**3**	• All vehicles coming from declared weed infested to non-declared weed areas are required to utilise vehicle washing facilities or any temporary washing facilities established for this purpose. • All vehicle movements are restricted to defined areas agreed upon with the Landholder/s.	**2**	• Identify and document areas of new weed infestations in the Incident Management System.	• Vehicle Hygiene Records.

Aspect	Potential Impacts	UMRR	Management Controls	RRR	Performance Indicator	Records
			• Land disturbance is to be minimised to prevent the germination of weed seeds that may already exist in the soil. • If a declared weed or weed of concern is discovered, it shall be monitored to ensure it does not spread from the area of infestation. • All land disturbed by Santos is to be returned to a condition consistent with the adjacent area or to landholder requirements at the end of the rehabilitation process.			

UMRR = Unmitigated Risk Rating

RRR = Residual Risk Rating

5.15 Clause 228 Checklist

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

Table 5-2: Clause 228 Checklist

Factor	Positive / Negative Impact
Any environmental impact on the community The proposed site lies approximately west of Scone. Minor short term impacts such as noise would be experienced. Safeguards proposed in Section 5 and Table 5-1 would minimise these impacts.	Short term negative
Any transformation of a locality There would be localised and non-permanent visual impact on the immediate vicinity of the hole for the duration of the programme. Safeguards proposed in Section 5 and Table 5-1 would minimise these impacts.	Short term negative
Any environmental impact on the ecosystems of the locality The area of proposed activities is highly disturbed, no environmental impacts of the ecosystems of the locality would occur as a result of the project.	Nil
Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality During construction there may be a reduction in these values due to affecting visual amenity. Given the short term nature of activities and the safeguards/mitigation detailed in Section 5 and Table 5-1 the potential for a reduction is considered negligible.	Nil
Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations No locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations occur near the proposal area.	Nil
Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974) The proposal would not impact on the habitat of protected fauna.	Nil
Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air	Nil

Factor	Positive / Negative Impact
The proposal would not endanger any species of animal, plant or other form of life, whether living on land, in water or in the air.	
Any long-term effects on the environment The proposal would have no long-term effects on the environment	Nil
Any degradation of the quality of the environment There is potential for minor short term environmental degradation due to noise impacts. Safeguards proposed in Section 5 and Table 5-1 would minimise these impacts.	Minor short term negative
Any risk to the safety of the environment The proposal may result in short term potential risks to the safety of the environment due to potential accidents and spills. The likelihood of incidents occurring would be reduced through the application of Santos's EHSMS Standards and mitigation proposed in Section 5.	Minor short term negative
Any reduction in the range of beneficial uses of the environment The footprint of activities for the proposal would not result in any reduction in the range of beneficial use of the environment.	Nil
Any pollution of the environment There is potential for additional short term negative impacts during activities. However mitigation documented in Section 5 would minimise any potential for impacts.	Nil
Any environmental problems associated with the disposal of waste Drill cuttings would be essentially inert and any drilling fluid conditions would be biodegradable or similarly inert and would be allowed to dry onsite and disposed of in drilling sumps. Any other waste generated by the activities will be collect and removed from site for disposal at approved landfill sites. Given the short term of the propose activity waste production will be minimal.	Nil
Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply Resources required for the proposal are not in limited supply in the area.	Nil

6 Conclusions

Drilling of the proposed core hole is a necessary step in evaluating the hydrocarbon potential of PEL 456. 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 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 the core hole should be located in cleared grazing land. If necessary the proposed core hole site can be moved to avoid any sensitive areas identified during final site scouting.

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 in relation to potential impacts on threatened species, populations or ecological communities, 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.

With the management strategies, 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 environmental impacts.

On completion of the activities, the site 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.

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Further reading:

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Appendix A.

Threatened Flora Species located in the Upper Hunter LGA

Source: DECC, NSW NPWS Atlas of Threatened Species database.

Species	Common Name	Status	Distribution/Habitat/Ecology
Acacia dangarensis		Endangered	*Acacia dangarensis* is endemic to NSW and confined to the summit and surrounding slopes of Mount Dangar south of Merriwa, within Goulburn River National Park. The total population size of *Acacia dangarensis* is estimated to be of the order of 1750 plants extending over an area of about 70 hectares. It is not known to occur in any other location despite considerable survey around the Hunter district in recent years *Acacia dangarensis* occurs in pure stands or as a co-dominant tree in sclerophyll woodland on the edge of dry rainforest on basalt and basalt colluvium.
Chiloglottis platyptera	Barrington Tops Ant Orchid	Vulnerable	Found along the eastern edge of the New England Tablelands, from Ben Halls Gap to east of Tenterfield, and also in the Barrington Tops area. Grows in moist areas in tall open eucalypt forest with a grassy understorey, and also around rainforest edges. It usually flowers from July to October. It generally occurs in rich brown loam soils.
Commersonia rosea		Endangered	Only known from four localities in the Sandy Hollow district of the upper Hunter Valley, New South Wales, all within an 8 km radius of Sandy Hollow. No populations are within a conservation reserve. *Commersonia rosea* occupies relatively small areas at its known sites and has a total population of less than 200 plants. Observed flowering in August, November, January and February. Occurs on skeletal sandy soils in scrub or heath vegetation with occasional emergents of *Eucalyptus crebra, Callitris endlicheri* or *Eucalyptus caleyi subsp. caleyi.*
Cymbidium canaliculatum	*Cymbidium canaliculatum* population in the Hunter Catchment	Endangered	No information available in the Atlas.
Cynanchum elegans	White-flowered Wax Plant	Endangered	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. The White-flowered Wax Plant usually occurs

Species	Common Name	Status	Distribution/Habitat/Ecology
			on the edge of dry rainforest vegetation. Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific.
Diuris venosa	Veined Doubletail	Vulnerable	Veined Doubletail is widespread in sub-alpine areas on Barrington Tops and known from Nowendoc and Brackendale, and possibly extends to southern parts of the New England Tableland. Veined Doubletail grows in moist tussock grassland or open shrubland around the margins of subalpine swamps.
Eucalyptus camaldulensis	*Eucalyptus camaldulensis* population in the Hunter catchment	Endangered	The Hunter population occurs from the west at Bylong, south of Merriwa, to the east at Hinton, on the bank of the Hunter River, in the Port Stephens local government area. It has been recorded in the local government areas of Lithgow, Maitland, Mid-Western Regional, Muswellbrook, Port Stephens, Singleton and Upper Hunter. Prior to European settlement, between 10,000 and 20,000 ha of habitat suitable for the River Red Gum occurred in the Hunter catchment. Today only 19 stands are known, occupying at most c. 100 ha, the largest remnant being 15 - 20 ha in extent. Smaller remnants contain only one to several trees. The total number of individuals is estimated to be between 600 - 1000 mature or semi mature trees. May occur with *Eucalyptus tereticornis, Eucalyptus melliodora, Casuarina cunninghamiana subsp. cunninghamiana and Angophora floribunda* Most of the occurrences are on private land and there are no known occurrences in conservation reserves. Prior to European settlement, it is likely that the species formed extensive stands of woodland and open woodland on the major floodplains of the Hunter and Goulburn rivers, especially in areas where water impoundment occurs after flood. Since settlement, most of the floodplains have been cleared of woody vegetation. Flood mitigation works now prevent most minor floods from inundating floodplains. These flow changes, coupled with the clearing of native vegetation, have greatly reduced the extent of habitat favourable to the River Red Gum in the Hunter catchment.
Eucalyptus oresbia	Small-fruited Mountain Gum	Vulnerable	Restricted to a small area between Nundle and Hanging Rock in the southern section of the New England Tablelands and also north of Murrurundi in the upper Hunter Valley. Steep slopes in wet forest at higher altitudes.
Euphrasia ciliolata	Polblue Eyebright	Vulnerable	Polblue Eyebright is restricted to the northern tablelands of NSW. Major occurrences are on

Species	Common Name	Status	Distribution/Habitat/Ecology
			the Barrington Tops and Gloucester Tops in Barrington Tops NP, but the species also occurs in Werrikimbe NP, near Yarrowitch and in Nowendoc SF. An old collection from near Deepwater has not been relocated. Occurs on the edge of montane and sub-alpine swamps and on open grassy slopes bordering swamps, Snow Grass meadows, Snow Gum woodland, open boggy meadows amidst Black Sallee woodland, and in seasonally inundated upland grassland. Flowers December to May. Polblue Eyebright is an 'annual'. Polblue Eyebright is partly parasitic upon other plants, such as Snow Grass, and may only be able to grow in close proximity to such host plants.
Grevillea obtusiflora		Endangered	Subspecies obtusiflora occurs near Rylstone, while subspecies fecunda occurs in the Capertee Valley, north-west of Lithgow, and in the Gardens of Stone National Park. Occurrences of both subspecies are within the Central Tablelands botanical subdivision.
Homoranthus darwinioides		Vulnerable	Rare in the central tablelands and western slopes of NSW, occurring from Putty to the Dubbo district. It is found west of Muswellbrook between Merriwa and Bylong, and north of Muswellbrook to Goonoo SF. The species has been collected from Lee's Pinch, but not relocated at its original locality north of Mt Coricudgy above the headwaters of Widden Brook. Goonoo SF is established as a definite locality. Grows in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Landforms the species has been recorded growing on include flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes, and a slight depression on a roadside with loamy sand.
Kennedia retrorsa		Vulnerable	Believed to be restricted to the Mount Dangar area and the adjacent Goulburn River catchment, within the Muswellbrook and adjacent Merriwa local government areas. Sites occur within Goulburn River and Wollemi National Parks and nearby private land. Found in a variety of habitats from mountainsides to riparian zones, from sheltered forest to steep, exposed rocky ridgelines. Peak flowering occurs September to December. Seeds are produced October to December and are released at maturity, between December and January.

Species	Common Name	Status	Distribution/Habitat/Ecology
Lasiopetalum longistamineum		Vulnerable	Occurs in the Mt Dangar - Gungal area within Merriwa and Muswellbrook Local Government Areas. A couple of sites are recorded within Goulburn River NP. Flowers in spring and grows in rich alluvial deposits.
Ozothamnus tesselatus		Vulnerable	Restricted to a few locations north of Rylstone. Grows in eucalypt woodland.
Pomaderris brunnea	Brown Pomaderris	Vulnerable	Brown Pomaderris is found in a very limited area around the Nepean and Hawkesbury Rivers, including the Bargo area. It also occurs at Walcha on the New England tablelands and in far eastern Gippsland in Victoria. Brown Pomaderris grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines. Flowers appear in September and October.
Pomaderris queenslandica	Scant Pomaderris	Endangered	Widely scattered but not common in north-east NSW and in Queensland. It is only known from a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolatai, and also from several locations on the NSW north coast. Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.
Prostanthera cineolifera	Singleton Mint Bush	Vulnerable	Restricted to only a few localities near Walcha, Scone and St Albans. Grows in open woodlands on exposed sandstone ridges. Usually found in association with shallow or skeletal sands.
Pterostylis cucullata	Leafy Greenhood	Vulnerable	Occurs in Victoria, with an isolated occurrence on Barrington Tops in NSW. The Barrington Tops populations are considered to represent a new species and are currently referred to as *Pterostylis species D*. Drier subalpine forest and woodland, on moist grassy slopes or in thickets of teatree close to creeks. In the Barrington Tops it occurs on streambanks.
Pterostylis elegans	Elegant Greenhood	Vulnerable	The Elegant Greenhood is known from eight locations, with a restricted distribution from the Barrington Tops to the Walcha district. The species occurs in NSW, and is known to occur on red-brown loams at elevations between 950 m and 1200 m. It is found among grass and shrubs in tall open eucalypt forest and flowers between January and April.
Senecio linearifolius var. dangarensis		Endangered	*Senecio linearifolius var. dangarensis* is restricted to a single known population in the Goulburn River National Park where it has been recorded growing on an open scree slope and in woodland and rainforest communities on basalt. The population is

Species	Common Name	Status	Distribution/Habitat/Ecology
			estimated to contain 500 - 1000 individuals over an area of 20 hectares. Grows in woodlands and rainforest on basalt soils.
Tasmannia glaucifolia	Fragrant Pepperbush	Vulnerable	A scattered distribution on the eastern edge of the New England Tablelands, including Ben Halls Gap and Point Lookout. Also found on Barrington and Gloucester Tops. Usually grows in or near Antarctic Beech *Nothofagus moorei* rainforest along streams in mountain areas at altitudes of between 1200 and 1500 m altitude. Also occurs in tall scrub, on seepage lines in tall eucalypt forest and in grassy woodland.
Tasmannia purpurascens	Broad-leaved Pepperbush	Vulnerable	Restricted to Barrington Tops, Gloucester Tops and Ben Halls Gap on the Northern Tablelands of NSW. Broad-leaved Pepperbush grows in tall, moist eucalypt forest, sub-alpine woodland and cool temperate rainforest.

Appendix B.

Noxious weeds likely to be found in region

Source: DPI Noxious weed declarations for Upper Hunter County Council

Note: this control area includes the local council areas of Muswellbrook, Singleton, Upper Hunter.

Weed	Class	Legal requirements
African boxthorn [Lycium ferocissimum]	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
African feathergrass [Pennisetum macrourum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
African turnipweed [Sisymbrium runcinatum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
African turnipweed [Sisymbrium thellungii]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Alligator weed [Alternanthera philoxeroides]	2	The plant must be eradicated from the land and the land must be kept free of the plant
Anchored water hyacinth [Eichhornia azurea]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Annual ragweed [Ambrosia artemisiifolia]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Arrowhead [Sagittaria montevidensis]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Artichoke thistle [Cynara cardunculus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Athel pine [Tamarix aphylla]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with

		This is an All of NSW declaration
Bathurst/Noogoora/Hunter/South American/Californian/cockle burr [Xanthium species]	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
Bear-skin fescue [Festuca gautieri]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Black knapweed [Centaurea nigra]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Blackberry [Rubus fruticosus aggregate species] 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 All of NSW declaration
Bridal creeper [Asparagus asparagoides]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Broomrapes [Orobanche species] 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 All of NSW declaration
Burr ragweed [Ambrosia confertiflora]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Cabomba [Cabomba caroliniana]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Cape tulip [Moraea species]	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
Cayenne snakeweed [Stachytarpheta cayennensis]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Chilean needle grass [Nassella neesiana]	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
Chinese violet [Asystasia gangetica subspecies micrantha]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Clockweed [Gaura parviflora]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Columbus grass [Sorghum x almum]	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
Corn sowthistle [Sonchus arvensis]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Dodder [Cuscuta species] 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 All of NSW declaration
East Indian hygrophila [Hygrophila polysperma]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
English broom [Cytisus scoparius]		See Scotch broom
Espartillo [Achnatherum brachychaetum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Eurasian water milfoil [Myriophyllum spicatum]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Fine-bristled burr grass [Cenchrus brownii]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Fountain grass [Pennisetum setaceum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Gallon's curse [Cenchrus biflorus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration

Galvanised burr [Sclerolaena birchii]	4	The plant must be controlled where it impacts on normal agricultural practices including cropping and pasture management
Giant Parramatta grass [Sporobolus fertilis]	3	The plant must be fully and continuously suppressed and destroyed
Glaucous starthistle [Carthamus glaucus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Golden dodder [Cuscuta campestris]	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
Golden thistle [Scolymus hispanicus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Green cestrum [Cestrum parqui]	3	The plant must be fully and continuously suppressed and destroyed
Harrisia cactus [Harrisia species]	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 All of NSW declaration
Hawkweed [Hieracium species]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Hemlock [Conium maculatum]	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
Horsetail [Equisetum species]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Hygrophila [Hygrophila costata]	2	The plant must be eradicated from the land and the land must be kept free of the plant
Hymenachne [Hymenachne amplexicaulis]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Italian bugloss [Echium species]		See Paterson's curse, Vipers bugloss, Italian bugloss
Johnson grass [Sorghum halepense]	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
Karoo thorn [Acacia karroo]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
1. Kochia [Bassia scoparia] 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 All of NSW declaration
Lagarosiphon [Lagarosiphon major]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Lantana [Lantana species]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Leafy elodea [Egeria densa]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Long-leaf willow primrose [Ludwigia longifolia]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Mexican feather grass [Nassella tenuissima]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Mexican poppy [Argemone mexicana]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Miconia [Miconia species]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Mimosa [Mimosa pigra]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Mintweed [Salvia reflexa]	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

Mossman River grass [Cenchrus echinatus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Mother-of-millions [Bryophyllum species and hybrids]	3	The plant must be fully and continuously suppressed and destroyed and the plant may not be sold, propagated or knowingly distributed
Nodding thistle [Carduus nutans]	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
Noogoora burr [Xanthium species]		See Bathurst/Noogoora/Hunter/South American/Californian/cockle burr
Onion grass [Romulea species] Includes all Romulea species and varieties except R. rosea var. australis	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Oxalis [Oxalis species and varieties] Includes all Oxalis species and varieties except the native species O. chnoodes, O. exilis, O. perennans, O. radicosa, O. rubens, and O. thompsoniae	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Pampas grass [Cortaderia species]	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
Parthenium weed [Parthenium hysterophorus]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Paterson's curse, Vipers bugloss, Italian bugloss [Echium species]	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
Pond apple [Annona glabra]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Prickly acacia [Acacia nilotica]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Prickly pear [Cylindropuntia species]	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 All of NSW declaration
Prickly pear [Opuntia species except O. ficus-indica]	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 All of NSW declaration
Red rice [Oryza rufipogon]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Rhus tree [Toxicodendron succedaneum]	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 All of NSW declaration
Rubbervine [Cryptostegia grandiflora]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Sagittaria [Sagittaria platyphylla]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Salvinia [Salvinia molesta]	2	The plant must be eradicated from the land and the land must be kept free of the plant
Sand oat [Avena strigosa]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Scotch broom [Cytisus scoparius]	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
Senegal tea plant [Gymnocoronis spilanthoides]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Serrated tussock [Nassella trichotoma]	3	The plant must be fully and continuously suppressed and destroyed and the plant may not be sold, propagated or knowingly distributed
Siam weed [Chromolaena odorata]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration

Silver-leaf nightshade [Solanum elaeagnifolium]	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
Smooth-stemmed turnip [Brassica barrelieri subspecies oxyrrhina]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Soldier thistle [Picnomon acarna]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Spiny burrgrass [Cenchrus incertus]	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
Spiny burrgrass [Cenchrus longispinus]	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
Spotted knapweed [Centaurea maculosa]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
St. John's wort [Hypericum perforatum]	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
Star thistle [Centaurea calcitrapa]	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
Sweet briar [Rosa rubiginosa]	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
Texas blueweed [Helianthus ciliaris]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Tree-of-heaven [Ailanthus altissima]	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
Water caltrop [Trapa species]	1	The plant must be eradicated from the land and the land must be kept free of the plant

		This is an All of NSW declaration
Water hyacinth [Eichhornia crassipes]	2	The plant must be eradicated from the land and the land must be kept free of the plant
Water lettuce [Pistia stratiotes]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Water soldier [Stratiotes aloides]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Willows [Salix species] 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 All of NSW declaration
Witchweed [Striga species] 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 All of NSW declaration
Yellow burrhead [Limnocharis flava]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Yellow nutgrass [Cyperus esculentus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration

Appendix C.

Threatened Fauna Species in Upper Hunter LGA

Source: DECC, NSW NPWS Atlas of Threatened Species database.

Species	Common Name	Status	Distribution / habitat / foraging / breeding
Amphibia			
Litoria booroolongensis	Booralong 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 headwaters, although a small number of animals have also been recorded in eastern-flowing streams. 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.
Litoria daviesae	Davies' Tree Frog	Vulnerable	Davies Tree Frog occurs along the eastern edge of the New England Tablelands from the Hunter Valley to south of the Hastings River in NSW in the headwaters of coastal rivers. Davies Tree Frog occurs in permanently flowing streams above 400 m elevation. Habitat includes streamside vegetation such as rainforest, moist and dry eucalypt forest or heath and tea tree with tussocks and ferns along streams. Breeding occurs in summer, and possibly in spring.
Litoria subglandulosa	Glandular Frog	Vulnerable	The headwaters of coastal rivers in a narrow band along the eastern edge of the New England Tablelands from the Hastings River to south-east Queensland. Glandular Frogs may be found along streams in rainforest, moist and dry eucalypt forest or in subalpine swamps. Breeding occurs in summer, and possibly in spring.
Aves			
Callocephalon fimbriatum	Gang-gang Cockatoo	Vulnerable	The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee.

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. May also occur in sub-alpine Snow Gum Eucalyptus pauciflora woodland and occasionally in temperate rainforests. Move to lower altitudes in winter, preferring more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. Favours old growth attributes for nesting and roosting.
Calyptorhynchus lathami	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 (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur.
Climacteris picumnus	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 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.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Vulnerable	The eastern subspecies lives in eastern NSW in eucalypt woodlands through central NSW and in coastal areas with drier open woodlands such as the Snowy River Valley, Cumberland Plains, Hunter Valley and parts of the Richmond and Clarence Valleys. The population density of this subspecies has been greatly reduced over much of its range,

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			with major declines recorded in central NSW and the northern and southern tablelands. Declines have occurred in remnant vegetation fragments smaller than 300 hectares, that have been isolated or fragmented for more than 50 years.
Daphoenositta chrysoptera	Varied Sittella	Vulnerable	No information available in the Atlas.
Glossopsitta pusilla	Little Lorikeet	Vulnerable	No information available in the Atlas.
Grantiella Picta	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 Amyema. 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.
Hieraaetus morphnoides	Little Eagle	Vulnerable	No information available in the Atlas.
Lathamus discolor	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 *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*. 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 *E. globulus*. Migrates to the Australian south-east mainland between March and October
Leipoa ocellata	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 (*Acacia aneura*), and Gidgee(*A. cambagei)*.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable	The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			southern Queensland to Victoria and Tasmania. Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy. Hibernates in winter. Females are pregnant in late spring to early summer.
Melanodryas cucullata	Hooded Robin	Vulnerable	No information available in the Atlas.
Melanodryas cucullata cucullata	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 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. 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.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	Vulnerable	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 (*Eucalyptus sideroxylon*), White Box (*Eucalyptus albens*), Grey Box (*Eucalyptus microcarpa*), Yellow Box (*Eucalyptus melliodora*) and Forest Red Gum (*Eucalyptus tereticornis*). 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.
Neophema pulchella	Turquoise Parrot	Vulnerable	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

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			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. 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. 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.
Ninox connivens	Barking Owl	Vulnerable	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. Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along 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.
Ninox strenua	Powerful Owl	Vulnerable	The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the western slopes and plains. Now uncommon throughout its range where it occurs at low densities. The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. 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 *Syncarpia glomulifera*, Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angorphora floribunda*, Cherry Ballart *Exocarpus cupressiformis* and a number of eucalypt species. The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			prey taken by Powerful Owls. For example in southern NSW, Ringtail Possum make up the bulk of prey in the lowland or coastal habitat. At higher elevations, such as the tableland forests, the Greater Glider may constitute almost all of the prey for a pair of Powerful Owls. Birds comprise about 10% of the diet, with flying foxes important in some areas. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400-1450 ha. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. During the breeding season, the male Powerful Owl roosts in a "grove" of up to 20-30 trees, situated within 100-200 metres of the nest tree where the female shelters. Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn). Clutches consist of two dull white eggs and incubation lasts approximately 38 days.
Pachycephala olivacea	Olive Whistler	Vulnerable	The Olive Whistler inhabits the wet forests on the ranges of the east coast. It has a disjunct distribution in NSW chiefly occupying the beech forests around Barrington Tops and the MacPherson Ranges in the north and wet forests from Illawarra south to Victoria. In the south it is found inland to the Snowy Mountains and the Brindabella Range. Mostly inhabit wet forests above about 500m. During the winter months they may move to lower altitudes. Forage in trees and shrubs and on the ground, feeding on berries and insects. Make nests of twigs and grass in low forks of shrubs. Lay two or three eggs between September and January
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	Vulnerable	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. 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 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

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			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.
Pyrrholaemus saggitatus	Speckled Warbler	Vulnerable	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. 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. 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. 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.
Stagonopleura guttata	Diamond Firetail	Vulnerable	The Diamond Firetail is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Cental 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. 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. 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).
Tyto novaehollandiae	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

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			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.
Tyto tenebricosa	Sooty Owl	Vulnerable	Occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. There is no seasonal variation in its distribution. Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.
Xanthomyza phyrygia	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.
Mammalian			
Chalinolobus dwyeri	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 (*Hirundo ariel*), 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.
Dasyurus maculates	Spotted-tailed Quoll	Vulnerable	Recorded across a range of habitat types, including rainforest, open forest, woodland,

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			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.
Kerivoula papuensis	Golden-tipped Bat	Vulnerable	The Golden-tipped Bat is distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to Bega in southern NSW. Found in rainforest and adjacent sclerophyll forest. Roost in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests located in rainforest gullies on small first- and second-order streams. Will fly up to two km from roosts to forage in rainforest and sclerophyll forest on upper-slopes. Specialist feeder on small web-building spiders.
Mastacomys fuscus	Broad-toothed Rat	Vulnerable	In NSW the Broad-toothed Rat occurs in two widely separated areas: the wet alpine and subalpine heaths and woodlands in Kosciuszko National Park, adjacent Nature Reserves (Bimberi and Scabby NR) and State Forest (Buccleuch SF) in the south of the State, and on the Barrington Tops, north-west of Newcastle. In Victoria - South Gippsland and the Otways - and western Tasmania, it can be found in wet sedge and grasslands at lower elevations. A male's home range overlaps those of several females. The Broad-toothed Rat lives in a complex of runways through the dense vegetation of its wet grass, sedge or heath environment, and under the snow in winter. This relatively warm under-snow space enables it to be active throughout winter. Sheltering nests of grass are built in the understorey or under logs, where two or three young are born in summer. In winter the rats huddle together in nests, for warmth. Food is mostly, gathered at night, in summer and autumn and during the afternoon and early evening in winter. The diet consists almost solely of greenery - grass and sedge stems, supplemented by seeds and moss spore cases.
Mastacomys fuscus	Broad-toothed Rat at Barrington Tops in the local government areas of Gloucester, Scone and Dungog	Endangered	Found in NSW only in the Australian Alps and Barrington Tops. They are also found in Victoria in the Dandenongs and Otway Ranges and in Tasmania. The Endangered Population is found in the Barrington Tops area west of Gloucester in north-east NSW. The population is restricted to subalpine swamp complexes and associated grassland and streamside heath environments above 1400 metres elevation.

Species	Common Name	Status	Distribution / habitat / foraging / breeding
Nyctophilus timoriensis (South-eastern form)	Greater Long-eared Bat	Vulnerable	Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. Inhabits a variety of vegetation types, including mallee, bulloke Allocasuarina leuhmanni 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. Slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground. Mating takes place in autumn with one or two young born in late spring to early summer.
Petaurus australis	Yellow-bellied Glider	Vulnerable	The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. 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. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Live in small family groups of two - six individuals and are nocturnal. Den, often in family groups, in hollows of large trees. Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources.
Petaurus norfolcensis	Squirrel Glider	Vulnerable	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. 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.
Petrogale penicillata	Brush-tailed Rock Wallaby	Vulnerable	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. 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

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			15 ha.
Phascogale tapoatafa	Brush-tailed Phascogale	Vulnerable	The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is more frequently found in forest on the Great Dividing Range in the north-east and south-east of the State. There are also a few records from central NSW. Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Females have exclusive territories of approximately 20 - 60 ha, while males have overlapping territories of up to 100 ha. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span. Mating occurs May - July; males die soon after the mating season whereas females can live for up to three years but generally only produce one litter.
Phascolarctos cinereus	Koala	Vulnerable	The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the western region. It was historically abundant on the south coast of NSW, but now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands. Inhabit eucalypt woodlands and forests and 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. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery. Females breed at two years of age and produce one young per year.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable	The Yellow-bellied Sheathtail-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

Species	Common Name	Status	Distribution / habitat / foraging / breeding
			insects, flies high and fast over the forest canopy, but lower in more open country.
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable	The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m. Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.
Vespadelus troughtoni	Eastern Cave Bat	Vulnerable	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT.
Miniopterus australis	Little Bentwing-bat	Vulnerable	East coast of Australia from Cape York in Queensland to Wollongong in NSW Moist eucalypt forest, rainforest or dense coastal banksia scrub. Little Bentwing-bats roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters. In NSW the largest maternity colony is in close association with a large maternity colony of Common Bentwing-bats (*M. schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear its young.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Vulnerable	Eastern Bent-wing Bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Hunt in forested areas, catching moths and other flying insects above the tree tops.
Myotis macropus	Southern Myotis	Vulnerable	No information available in the Atlas.

Species	Common Name	Status	Distribution / habitat / foraging / breeding
Potorous tridactylus	Long-nosed Potoroo	Vulnerable	The Long-nosed Potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. There are geographically isolated populations in western Victoria. In NSW it is generally restricted to coastal heaths and forests east of the Great Dividing Range, with an annual rainfall exceeding 760 mm. Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. Often digs small holes in the ground in a similar way to bandicoots. Mainly nocturnal, hiding by day in dense vegetation - however, during the winter months animals may forage during daylight hours. Individuals are mainly solitary, non-territorial and have home range sizes ranging between 2-5 ha. Breeding peaks typically occur in late winter to early summer and a single young is born per litter. Adults are capable of two reproductive bouts per annum.
Pseudomys oralis	Hastings River Mouse	Endangered	A patchy distribution along the east side of the Northern Tablelands and great escarpment of north-east NSW, usually but not always at elevations between 500 m and 1100 m. Also recorded in south-east Queensland. Found in a variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs. Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops. Nests may be in either gully areas or ridges and slopes. They eat seeds, leaves, insects and fungi.
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Annual mating commences in January and a single young is born each October or November. Travel up to 50 km to forage. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops and can inflict severe crop damage.

Appendix D.

EPBC Threatened Species

Species	Common Name	Status	Distribution/habitat/foraging/breeding
Birds			
Lathamus discolor	Swift Parrot	Endangered	Breeds in Tasmania; migrates in autumn and winter to mainland; forages in nectar rich iron bark forests
Rostratula australis	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.
Anthochaera phrygia	Regent Honey Eater	Endangered	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. 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.
Frogs			
Litoria booroolongensis	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 headwaters, although a small number of animals have also been recorded in eastern-flowing streams. 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.

Species	Common Name	Status	Distribution/habitat/foraging/breeding
			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.
Mammals			
Chalinolobus dwyeri	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.
Nyctophilus timorienensis	Eastern Long-Eared Bat	Vulnerable	Inhabits a variety of vegetation types, including mallee, bulloke Allocasuarina leuhmanni 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.
Dasyurus maculates maculates(SE mainland population)	Spot-tailed Quoll	Endangered	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.
Pteropus poliocephalus	Grey-headed flying-fox	Vulnerable	Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Annual mating commences in January and a single young is born each October or November.
Plants			
Digitaria porrecta	Finger Panic grass	Endangered	Finger Panic Grass occurs in NSW and Queensland. In NSW it is found on the North West Slopes and Plains, from near

Species	Common Name	Status	Distribution/habitat/foraging/breeding
			Moree south to Tambar Springs and from Tamworth to Coonabarabran. It largely occurs on private land.
Diuris sheaffiana	Tricolour Diuris Pink Donkey Orchid	Vulnerable	The Pine Donkey Orchid grows in sclerophyll forest among grass, often with native Cypress Pine (Callitris spp.). It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. Usually recorded as common and locally frequent in populations, however only one or two plants have also been observed at sites. The species has been noted as growing in large colonies. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats. Associated species include Callitris glaucophylla, Eucalyptus populnea, Eucalyptus intertexta, Ironbark and Acacia shrubland. The understorey is often grassy with herbaceous plants such as Bulbine species. Flowers from September to November or generally spring. The species is a tuberous, deciduous terrestrial orchid and the flowers have a pleasant, light sweet scent.
Thesium australe	Austral Toadflax	Vulnerable	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (*Themeda australis*). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.
Tylophora linearis		Endangered	Found in the Barraba, Mendooran, Temora and West Wyalong districts in the northern and central western slopes of NSW. Records include Crow Mountain near Barraba, Goonoo SF, Pillaga West SF, Cumbil SF, Eura SF, Coolbaggie NR, Goobang NP and Beni CCA. Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla and Allocasuarina luehmannii*. Flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later.

Appendix E.

Santos Group Risk Assessment Matrix

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

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

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


Nearest dwelling
1km
CUAN 1
350
400
0.25 km
Santos
Cuan 1 - Location
PEL 456
GDA
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Figure 4.8