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

Review of Environmental Factors (REF) - Additional Information

Prepared by:

RPS AUSTRALIA EAST PTY LTD

Level 9, 17 York Street
Sydney NSW 2000

T: +61 2 8270 8300
F: +61 2 8270 8399
E: sydney@rpsgroup.com.au

Report Number: PR113570
Version / Date: Rev 0 / June 2013

Prepared for:

SANTOS NSW (EASTERN) PTY LIMITED

Level 16, 40 Creek Street
Brisbane QLD 4000

Contents

1.0 INTRODUCTION 1

2.0 REHABILITATION 2

2.1 Provide rehabilitation objectives of the pilot well sites and associated infrastructure 3

2.2 Identify rehabilitation completion criteria for disturbed areas covering phases of rehabilitation 3

2.3 Provide details of rehabilitation methods for disturbed areas and expected timeframes 4

2.4 Provide a final landform plan showing final contours and the target vegetation/habitat outcomes 5

3.0 WATER MANAGEMENT STRATEGY 7

3.1 Clarify the proposed management of produced water including the role of the Bibblewindi Water Transfer Facility and storage capabilities 7

4.0 DRILLING FLUID 9

4.1 Provide further information about the storage, treatment and disposal of drilling mud including clarification on the location and approval of the facility proposed at Narrabri 9

5.0 CUMULATIVE IMPACTS – GROUNDWATER AND LAND DISTURBANCE 10

5.1 Provide further information on how many activities will be conducted concurrently 10

5.2 Provide an assessment of cumulative impacts of groundwater extraction 11

5.2.1 Groundwater dependent ecosystems - springs and wetlands 11

5.2.2 Groundwater users 12

5.3 Provide an assessment of cumulative impacts of land disturbance 12

5.3.1 Biodiversity 12

5.3.2 Agricultural resources 13

6.0 FLORA AND FAUNA 14

6.1 Provide further information on flora assessments 14

6.1.1 Survey methodology 14

6.1.2 Survey limitations 14

6.2 Provide further information on fauna assessments 15

6.2.1 Survey methodology 15

6.2.2 Survey limitations 17

6.2.3 Fauna habitat and presence of hollow bearing trees 17

6.3 Provide further information on indirect impacts 17

6.3.1 Site establishment and construction impacts – up to two months 17

6.3.2 Operational impacts – up to three years 18

6.4 Provide consideration of the use of biological controls and foliar spray options for the control of *Opuntia* species 18

7.0 AGRICULTURAL RESOURCES AND INDUSTRIES 19

7.1 Provide consideration of any effects on the apiary industry activities 19

7.2 Provide analyses of the broad positive impacts of the proposed activity on industry activities 19

7.3 Provide additional information on suitability of produced water for agricultural use.....20
8.0 GROUNDWATER MONITORING PROGRAM.....21
8.1 Provide additional details on the proposed groundwater monitoring program including information on potential groundwater monitoring bore locations and monitoring frequency.....21
8.2 Provide details on current yields and water quality characteristics of four registered bores.....22
9.0 WELL CASING REQUIREMENTS.....24
9.1 Provide details on casing and clarification that design and installation will comply with the Code of Practice.....24
10.0 REFERENCES.....25

Tables

Table 1 Rehabilitation standards.....3
Table 2 Rehabilitation milestones.....5
Table 3 Daily Weather Conditions for Narrabri Airport (approximately 25 km north of survey area).....14
Table 4 Impact areas for proposed exploration and appraisal program within PEL 238.....19
Table 5 Produced water quality parameters.....20
Table 6 Existing bores closest to the proposed activity.....22

Figures

Figure 1 Conceptual final landform for a typical well lease.....6
Figure 2 Trapping sites.....16
Figure 3 Groundwater monitoring bores.....23

Appendices

Appendix 1 PEL 238 TSC Act Cumulative Impact Assessment (Eco Logical Australia, 2013)
Appendix 2 Additional assessments of significance – Dewhurst 26-29 Pilot
A2.1 Assessment of significance - Bertya opponens
A2.2 Assessment of Significance - Native Milkwort (*Polygala linariafolia*)
A2.3 Assessment of Significance - Cobar Greenhood Orchid (*Pterostylis cobarensis*)
A2.4 Assessment of Significance - Rulingia procumbens
A2.5 Assessment of Significance - Tylophora linearis

1.0 Introduction

This supplementary information has been prepared by RPS Australia East Pty Ltd (RPS) on behalf of Santos NSW (Eastern) Pty Ltd (a wholly owned subsidiary of Santos Limited) (Santos) at the request of the Office of Coal Seam Gas (OCSG) within the Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS). This information is to support the *Review of Environmental Factors Dewhurst 26-29 Pilot Wells – PEL 238, Gunnedah Basin NSW* (REF) submitted to DTIRIS in March 2013 and should be read in conjunction with the REF.

This information is set out in response to the matters raised by NSW Government agencies.

In addition, the following clarifications to the REF should be noted:

- Section 2.7.5.4, page 37

  Dewhurst 26, 27 and 29 lease areas will be partially rehabilitated to an area of 20 x 20 metres.

- Executive summary page 2 and 3, Section 6 Table 6.1 page 88, section 6.2.1.1 page 106, Table 6-13 page 110, Table 6-14 page 112,and Section 7, Table 7-1 page 124, Table 7-2 page 126

  The total disturbance area is approximately 5.755 hectares of which approximately 5.598 hectares of narrow leafed ironbark woodland will be cleared and 0.157 hectares is already cleared.

- Section , page 33

  The maximum gas flow rates expected per well, will be one million standard cubic feet per day (MMSCFD).

2.0 Rehabilitation

Rehabilitation of the well lease areas and access tracks will occur in two stages.

The first stage will occur following drilling. At this point partial rehabilitation will occur to reduce the size of the lease area to the minimum area to support remaining infrastructure and ongoing maintenance requirements. For Dewhurst 26, Dewhurst 27 and Dewhurst 29 this will ultimately be approximately 20 x 20 metres or 0.04 hectares. The access tracks to the lease areas will remain. For Dewhurst 28 there will be no partial rehabilitation as the full lease area will be required to accommodate the supporting surface infrastructure.

Stage 2 rehabilitation will occur at the completion of operations. Pilot wells and ancillary infrastructure would be decommissioned and lease areas rehabilitated or suspended.

If exploration and appraisal activities confirm the CSG resource as commercially viable, approval may be sought for production. A production project may include the use of the pilot wells, flow lines, supporting facilities and ancillary infrastructure but would be subject to further environmental assessment and government approvals. In the event that Santos decides to seek approval for a production project, the wells would be suspended until determination of the role, if any, the wells would play in a commercial gas production project. If Santos does not pursue a commercial gas production project, or a well or supporting infrastructure is not a part of a commercial gas production project for which approval is sought, then the pilot wells and infrastructure would be decommissioned and rehabilitated. Stage 2 rehabilitated will involve decommissioning the wells in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012), which would generally involve:

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

Surface infrastructure would be removed. Buried surface infrastructure, including flow lines and gathering systems, would be flushed, capped at each end and left in-situ in accordance with legislative requirements.

- Rehabilitation of well leases would include:
- replacing sub-soil across the well leases, contouring to the landscape and partially compacting
- placing top-soil uniformly across the well leases, and grading to natural levels
- revegetating well leases with native species from existing seed bank within top soil
- removing perimeter fencing
- controlling weeds.

Sodicity depth will be determined prior to excavation. Any identified sodic soils will be stockpiled separately from non-sodic soils. Any sodic soils used in rehabilitation will be treated with gypsum and mulch to reduce erosion risk and improve infiltration and plant water associations to promote successful rehabilitation.

A rehabilitation strategy will be developed in conjunction with the landowner, Forest Corporation of NSW (Forestry NSW) and taking into consideration the conditions within the Permit to Occupy.

Further details regarding rehabilitation are provided below.

2.1 Provide rehabilitation objectives of the pilot well sites and associated infrastructure

The objectives for the rehabilitation program are to:

- Stabilise the site to minimise erosion
- Return the disturbed areas to a self-sustaining native forest condition, typical of adjacent reference forest ecosystems
- Rehabilitate the disturbed areas to the satisfaction of the landholder (Forestry NSW).

2.2 Identify rehabilitation completion criteria for disturbed areas covering phases of rehabilitation

Rehabilitation completion criteria derived from the PEL 238 conditions and the Permit to Occupy are summarised in Table 1.

Table 1 Rehabilitation standards

Phase of rehabilitation	Indicator	Criteria
Decommissioning	Infrastructure and buildings	All plant, equipment, containers, waste materials and temporary buildings will be removed from the site.
	Pits	Sumps, pits, slumps and depressions to be backfilled and covered with topsoil.
	Fencing	Fencing will be removed from perimeter of lease area.
	Waste	All waste to be removed from site and disposed of in an appropriately licenced facility.
	Access tracks	Access tracks nominated by Forestry NSW for retention shall be left in an operational condition with all drainage structures fully operational and road surface in good condition and correctly shaped.
	Gathering system	Pipes flushed and capped each end.
Landform establishment	Topography	Site to be graded and reshaped to reinstate, as far as practicable, the original contour and drainage. Note if industrial matting is used during drilling, site grading will not be required as there will be no change to the landform.
		Topography to mimic the micro topographical undulations of the surrounding area.
	Erosion and sediment control	Any cleared land should be deep ripped on the contour to minimise runoff channelling / erosion.
Growth media development	Soil quality	Spread retained topsoil. If required, any imported soil to be from Forestry NSW approved sources and be stored in appropriately located stockpiles.
Ecosystem establishment	Species type	Respreading of vegetation, brush and woody material retained from the clearing activity.
	Species composition	Tree and shrub population to be similar to that of surrounding undisturbed areas.

Phase of rehabilitation	Indicator	Criteria
	Plant selection	In most cases, the rehabilitated sites will be left to revegetate naturally. In cases where this approach fails to deliver the required results, assisted re-vegetation may be undertaken. Any assisted revegetation will utilise species that: ▪ Are locally available to eliminate the introduction and establishment of foreign species from other areas of the Pilliga and/or weeds. ▪ Reduce erosion of sediment by wind or water by root mass created in rehabilitated soils. ▪ Enhance the speed of plant colonisation of rehabilitated soils beyond that expected from surrounding areas alone. ▪ Provide microsites for further natural species ingress into the rehabilitated areas, especially tree species which require some immediate low-level shelter, soil moisture and organic content. ▪ Provide wildlife habitat in the rehabilitated areas.
Ecosystem development	Stability	Provide a ground cover to reduce erosion of soils, contribute organic material to the site and to act as a "nurse" cover for incoming shrub and tree seedlings.
	Coverage	Within five to ten growing seasons, shrub and tree species saplings should be populating rehabilitated areas if ground cover species have established.
	Land use	Area accomplishes and remains as a healthy native woodland
	Resilience to Disturbance	Established species survive and/or regenerate after disturbance. Weeds do not dominate native species after disturbance or after rain. Pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Sustainability	Species are capable of setting viable seed, flowering or otherwise reproducing. Evidence of second generation of shrub and understorey species.
Monitoring and reporting	Reporting to regulator	Report to be submitted to Office of Coal Seam Gas (OCSG) within DTIRIS following the completion of all rehabilitation activities (civil works, waste removal etc.) in accordance with condition 34 of PEL 238
	Monitoring	Species density, distribution and mortality will be monitored, as well as ingress of additional species (native or weedy) onto the site.

2.3 Provide details of rehabilitation methods for disturbed areas and expected timeframes

Section 2.7.6.2 of the REF (page 37) summarises the rehabilitation activities that will take place.

Further detail of the activities that will occur includes:

- Construction of erosion and sediment control measures which may include the placement of a surface layer of mulch across the top of the treated soils to minimise erosion. This will be assessed on a site by site basis and agreed with Forestry NSW.
- Surface contouring of the rehabilitation areas, such as contour ploughing and creation of "hummock" and low relief features.
- Spreading of retained woody material.
- Access tracks will be blocked by timber to minimise disturbance of the site by vehicles and to maximise natural regeneration.

The timing of rehabilitation activities is summarised in Table 2.

Table 2 Rehabilitation milestones

Milestone	Timing relative to well plug & abandon
Scope development and procurement for surface rehabilitation works	1-3 months prior to well plugging and abandonment (P&A) completion
Well plug and abandon complete	0
Bubble test to confirm plug and abandon process completed	1-2 weeks
Rehabilitation report submitted outlining program of rehabilitation works	3 months
Rehabilitation complete	3-6 months
Post rehabilitation completion report submitted	6-9 months following completion of works

2.4 Provide a final landform plan showing final contours and the target vegetation/habitat outcomes

The potential impacts on landform from the proposed activity are expected to be relatively minor and limited to small scale surface disturbances. Due to the relatively flat nature of the lease areas, only minor reshaping will occur. The conceptual final landform will mimic the micro topographical undulations of the surrounding area.

As part of the design of the lease area, changes to surface levels will be minimised with opportunity to utilise above ground tanks rather than pits fully investigated. Further, the use of industrial matting will eliminate any changes to landform (Page 21-22 of the REF).

Figure 1 provides a concept of a typical well lease area and access track.

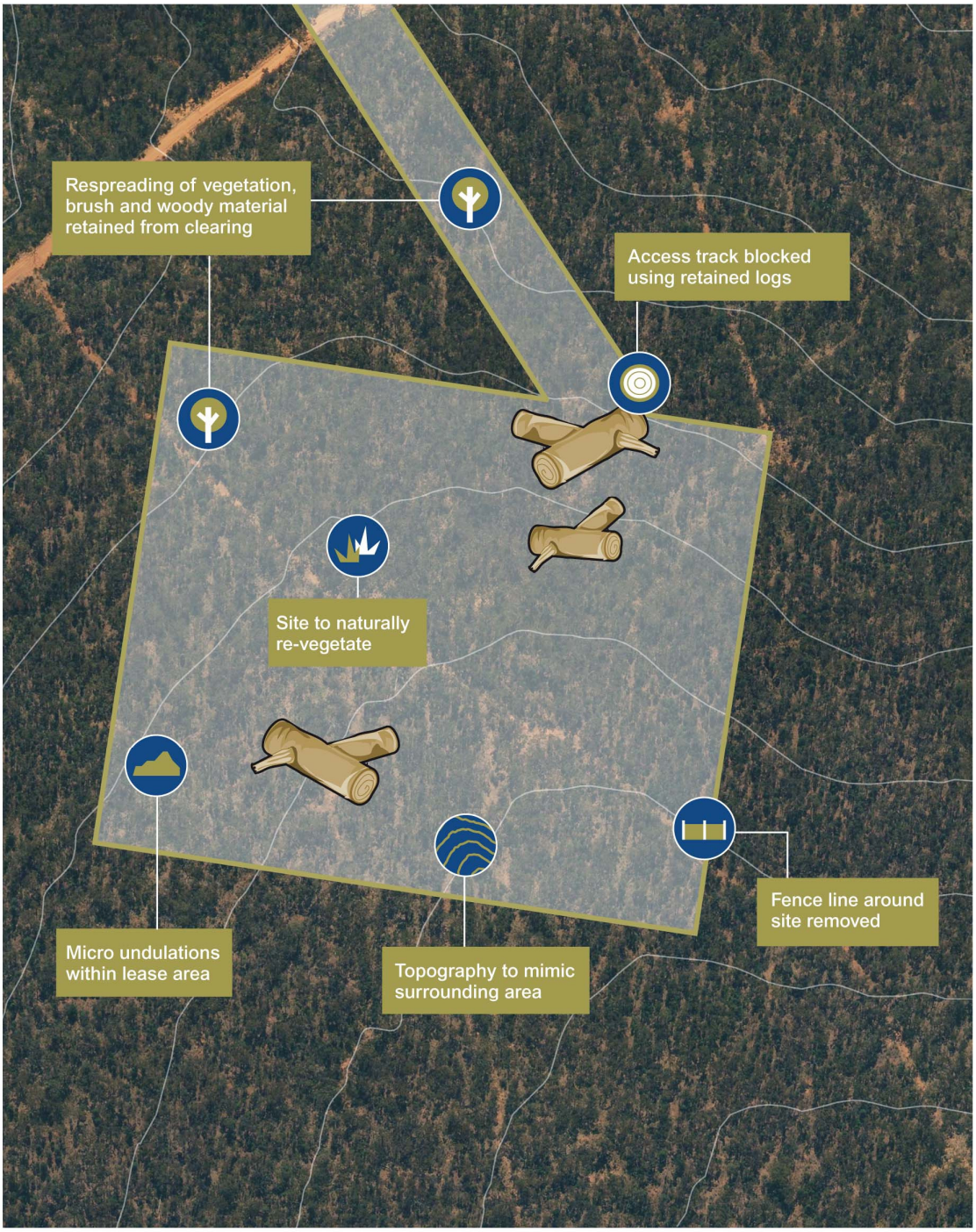

Figure 1 Conceptual final landform for a typical well lease

3.0 Water management strategy

3.1 Clarify the proposed management of produced water including the role of the Bibblewindi Water Transfer Facility and storage capabilities

The water management process will be as follows:

- At each pilot, water produced from the wells will be pumped through the water gathering system to the balance tank (capacity 40 m^3) at the Dewhurst 28 lease area, before being pumped to the Bibblewindi Water Transfer Facility, via the Dewhurst Southern Water Flow Line.
- No produced water from this pilot will be transferred to the existing ponds at the Bibblewindi Water Transfer Facility. The produced water will flow to the Bibblewindi Water Transfer Tank (5ML) which is used to provide a consistent supply of produced water to the Leewood facility via the Leewood Water Pipeline. This tank has been sized to accept produced water from this pilot and a number of other current and proposed pilots. The pumps and Leewood pipeline are designed to transfer up to 8.4 ML of produced water per day, whilst the topography from Bibblewindi to Leewood allows for gravity flow of up to 4 ML per day. The control system is designed with a target tank level and desired water flow that determines the pump's operation; pumps will speed up or slow down to maintain the target level. The facility will be monitored using the supervisory control and data acquisition (SCADA) telemetry system which includes high level and pump fault alarms. Pilot wells can also be turned off remotely via the SCADA telemetry system. The tank is contained within an earthen bund with a volume of 110% of the tank's storage volume.
- Once at the Leewood Produced Water Facility, produced water will be stored in a 300 ML pond. The pond will be double lined and have a leak collection system. The liner system will comprise a primary polyethylene geomembrane liner, underlain by a leak detection system, underlain by a secondary liner. The secondary liner will be underlain by 300 millimetres of smooth clayey material, free from obstructions or protrusions
- Produced water from the Leewood Produced Water Facility will be transported by road tankers to an appropriately licensed facility in the Sydney metropolitan area for treatment, reuse and/or disposal. An average of 35 truckloads per day is estimated to be required.

Since the preparation of the Review of Environmental Factors, Santos has decided that extraction of water from the pilots will not occur until the Dewhurst Southern Water Flow Line is operational. Therefore, there will be no need to transport water between Dewhurst 26-29 pilot activity and the Bibblewindi Water Transfer Facility by road.

Santos is currently investigating the economic and technical feasibility of treating the produced water at the Leewood Produced Water Facility by reverse osmosis or other methods instead of transporting produced water from the Leewood Water Facility to a licensed facility. If Santos decides to operate a water treatment facility at Leewood, this would be the subject of further applications for approvals from the NSW Government

The Bibblewindi Water Transfer Tank, Leewood Water Pipeline and Leewood Produced Water Facility were approved by the NSW Division of Resources and Energy, DTIRIS under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A) in March 2013. The Produced Water Management Plan, prepared by Santos in consultation with the NSW Office of Water (NOW) and approved by the (then) Division of Resources and Energy, sets out the proposed use of a produced water storage facility at Leewood to allow appraisal activities to recommence.

The Leewood Produced Water Facility was designed using water balance modelling to enable acceptance of produced water from both existing and proposed pilot wells and this was contemplated in the Review of Environmental Factors for the Leewood facility (see page 13 of that REF). The Dewhurst 26-29 Pilot was

considered as part of the overall water production contribution used in the model based on estimated water production volumes for the exploration and appraisal program and likely operational periods for each of the pilots. The model results in a storage capacity duration estimate of approximately 300 days based on the total available storage.

The leak collection system at the Leewood Produced Water Facility will transfer any produced water collected below the liner directly back into the pond. The system will include an alarm to notify operational staff of any sudden changes in pump operational trends. The water level of each pond will be monitored continuously. Level sensors shall be installed for management of pump controls and to provide protection against pond overflow. It is expected the sensor system will be monitored by means of telemetry.

4.0 Drilling fluid

4.1 Provide further information about the storage, treatment and disposal of drilling mud including clarification on the location and approval of the facility proposed at Narrabri

Santos has plans to develop a fluids recycling and treatment facility at its existing operations centre, located at 300 Yarrie Lake Road, Narrabri. The Narrabri Shire approved a development application (DA) for the expansion of the operations centre in March of 2012. A second DA to include a fluids treatment facility and a cement bulk facility was submitted to Narrabri Shire Council on 8 April 2013. The Council is undertaking its assessment of the DA, which includes details regarding the storage and treatment facilities proposed.

The facility will require an environmental protection licence (EPL) under section 48 of the *Protection of the Environment Operations Act 1997*. Reuse of treated drilling fluids will also require a specific resource recovery exemption under clause 51 and clause 51A of the *Protection of the Environment Operations (Waste) Regulation 2005.* Santos has been in discussions with the Environment Protection Authority (EPA) about obtaining an EPL and a specific resource recovery exemption. Details of the storage and treatment of fluids at the facility and a proposal for the disposal of waste from the facility is part of the discussions and any EPL granted by the EPA for the facility is likely to contain conditions addressing these matters.

It is expected that the drilling fluids treatment facility will be fully licenced and operational by the time Dewhurst 26-29 is drilled. Drilling fluids will be mixed at the drilling fluids treatment facility and then transported to site. Approximately six tankers will be required to transport the drilling fluid to site prior to drilling each well.

In the event that the drilling fluids treatment facility at the Narrabri Operations Centre is not approved or operational, drilling fluid will be mixed in tanks on the well lease sites prior to drilling. Make-up water will be transported to the site from a licensed source in the area. Additives (potassium sulphate or potassium chloride, and polymers) will be transported to site from the supplier's warehouse in Roma or Brisbane. Approximately six tankers will be required to truck the make-up water from its source to the site prior to drilling each well. One truck will be required to transport drilling additives from the warehouse to site at the start of drilling each well.

Additional tankers will be required to truck either drilling fluids or make-up water throughout the drilling of each well (equivalent to approximately three to seven tankers, well design dependant, over the 15-40 day drilling period). Where practicable, deliveries to the site will occur during day time hours.

Once the well has been drilled the drilling fluid is displaced from the well by the cementation process or by production fluids. Where the fluids treatment facility is operational and a resource recovery exemption is in place, the drilling fluid will be tested prior to being transported to a subsequent well for re-use or back to the fluids treatment facility for storage and treatment. Before drilling fluid is used on a subsequent well the chemical and physical properties are tested and the fluid amended as required. This process will be tracked and recorded.

If the drilling fluids treatment facility is not licenced and operational, or there is no resource recovery exemption in place, used drilling fluids will be disposed of at Transpacific Industries' liquid and hazardous waste management facility in the Newcastle, NSW, area or another appropriately licensed facility. Approximately eight tankers will be required to transport the used drilling fluid from each well to the facility and required waste tracking requirements will be undertaken.

5.0 Cumulative impacts – groundwater and land disturbance

5.1 Provide further information on how many activities will be conducted concurrently

The Narrabri Shire has been recognised for its coal seam gas and mining resources through the *Strategic Regional Land Use Plan New England North West* (SRLUP). A number of mining exploration and production licences cover the area. Existing mining occurs at the Whitehaven coal mine approximately 28 kilometres south of Narrabri and Boggabri Coal mine, approximately 15 kilometres north of Boggabri. The Whitehaven coal mine has commenced an approval process to support a 20 year mine life with a production of three million tonnes per annum. Expansion plans for both mines include a rail spur and coal handling facility. These will not impact the proposed activity.

Exploration within PEL 238, PAL 2 and Petroleum Production Lease (PPL) 3 has occurred over a number of years by a variety of organisations including Amoseas, PetSec, Eastern Star Gas, Eastern Energy, Force Energy, Hartogen Energy, Mid Eastern Oil and Consolidated petroleum focussed on gas or oil and gas. Force Energy, First source, Eastern Star Gas and more recently Santos have focussed on the CSG reserve.

Approximately 90 existing exploration and appraisal wells are located within PEL 238, PAL 2 and PPL 3. The majority of these have either been plugged and abandoned and rehabilitated, or suspended for future use.

Santos is proposing to undertake the Energy NSW Coal Seam Gas (CSG) Exploration and Appraisal Program in the Narrabri area within Petroleum Exploration Licence (PEL) 238 and Petroleum Assessment Lease (PAL) 2 (referred to as the program). The program has replaced the '50 well drilling program' that was proposed at the time of preparation of the REF (refer to section 2.3.1 of the REF). The program is scheduled to commence in 2013 and will take two to three years. The program consists of a series of CSG exploration and appraisal activities including recommencing operation of a number of existing pilot wells, drilling and operating new pilot wells and constructing and operating water and gas management facilities to support the program. No proposed sites within the program are mapped as Biophysical Strategic Agricultural Land or Critical Industry Clusters under the SRLUP.

The activities included as part of the program are:

- operation of the existing Bibblewindi Multi-Lateral Pilot (Bibblewindi 12, 13, 14, 15, 16, 17, 18H, 19H, 21H, 27, 28H and 29), construction, drilling and operation of two additional pilot wells (Bibblewindi 31 and 32), and the operation of existing water flow lines from Bibblewindi Multi-Lateral Pilot to the Bibblewindi Water Transfer Facility
- operation of the existing Bibblewindi West Pilot (Bibblewindi 22, 23, 24, 25 and 26) and operation of existing water flow lines from the Bibblewindi West Pilot to the Bibblewindi Water Transfer Facility
- operation of the existing Dewhurst 13-18H Pilot (Dewhurst 13, 14, 15, 16H, 17H and 18H) and the construction, drilling and operation of additional lateral wells from well casing within Dewhurst 16H, 17H and 18H
- construction, drilling and operation of the Dewhurst 22-25 Pilot (Dewhurst 6, 22, 23, 24 and 25)
- construction and drilling of the Dewhurst 26-29 Pilot (Dewhurst 26, 27, 28 and 29)
- construction and drilling of Dewhurst 30-31 to supplement the Dewhurst 26-29 Pilot
- operation of the Dewhurst 26-29 Pilot (Dewhurst 26, 27, 28, 29, 30 and 31)
- construction of the Dewhurst Northern Water and Gas Flow Lines and operation the Dewhurst Northern Water Flow Line

- construction of the Dewhurst Southern Water and Gas Flow Lines and operation of the Dewhurst Southern Water Flow Line
- operation of a produced water tank at the Bibblewindi Water Transfer Facility (Bibblewindi Water Transfer Tank) to facilitate the transfer of produced water from the pilot wells to the Leewood Produced Water Facility
- operation of the Leewood Water Pipeline to transfer water produced by the operation of the above pilot wells from the Bibblewindi Water Transfer Facility to the Leewood Produced Water Facility
- operation of the Leewood Produced Water Facility to store water produced by the operation of the above pilot wells
- transport of produced water from Leewood Produced Water Facility to an appropriately licensed facility
- construction and operation of ancillary and supporting infrastructure to facilitate the above activities and ongoing maintenance.

The proposed activities are necessary for the ongoing exploration/appraisal and evaluation of the CSG hydrocarbon potential in PEL 238/PAL 2. The program will assist in gaining further knowledge of coal fines, gas composition and flow rates, the deliverability of the reservoir, and investigating well design, drilling and completion technologies. This information is essential to determine whether a commercial gas production project is viable and would be used in development planning for any gas production project.

CSG exploration, appraisal and production planning is an iterative process whereby the results of early stage activities are used to inform later stages of project development. As such, any future exploration, appraisal or production activities will be proposed and assessed at a later stage.

5.2 Provide an assessment of cumulative impacts of groundwater extraction

A cumulative groundwater impact assessment has been undertaken for the program. This assessment included groundwater modelling to provide a quantitative estimate of inter-aquifer fluxes and predict the level of drawdown arising from extraction of CSG water during appraisal activities. The groundwater model used was a quasi-3-dimensional numerical groundwater flow model constructed and calibrated using MODFLOW-2005.

Up to 1408 ML of CSG water will be extracted during operation of the pilot appraisal wells over three years. Potential impacts associated with this extraction relate to the drawdown/depressurisation of overlying groundwater sources and subsequent reduction in the quantity of water held within the overlying rock strata.

The findings of the cumulative groundwater impact assessment show that depressurisation of the target coal seam as a result of pilot activities indicate a negligible decline in water levels (less than 0.5 m) within the Namoi Alluvium and the Pilliga Sandstone groundwater sources. This impact is generally not manifested for a considerable amount of time (>500 years), by which time the calculated fluxes generating these impacts and the extents of drawdown are diminished to magnitudes undetectable within the natural range of annual fluctuations.

The groundwater modelling also indicates that the late Triassic to early Jurassic strata, including the Triassic Napperby and Deriah Formations and the Jurassic Garrawilla Volcanics, may experience very localised maximum drawdown in the range of 1.4 to 3.8 metres occurring after at least 400 years from inception of CSG water extraction. Water quality and accessibility within these formations is considered poor, and there are no known beneficial use abstractions within the program area. Modelling of the CSG produced water extraction from the target coal seams is required to depressurise the coal seams. Inevitably this results in higher hydraulic head reduction in the corresponding and overlying model layers surrounding the targeted coal seams.

5.2.1 Groundwater dependent ecosystems - springs and wetlands

The nearest Groundwater Dependent Ecosystems (GDEs) are:

- Eather Spring, approximately 10 kilometres from Dewhurst 22 to 25 Pilot
- Hardys Spring, approximately 9 kilometres from Dewhurst 22 to 25 Pilot
- Mayfield Spring, approximately 9.5 kilometres from Dewhurst 13 to 18 Pilot.

These springs are understood to comprise recharge rejection springs associated with the junction of the unconfined Pilliga Sandstone and the underlying Purlewaugh Formation. The Purlewaugh Formation acts as a barrier to further percolation of groundwater within the Pilliga Sandstone and thus groundwater discharges to surface at this interface (Appendix 7 of the REF). As the modelling of cumulative impacts has demonstrated that there is no impact to the Upper and Lower Namoi alluvium or the Pilliga Sandstone associated with operation of the pilots, there is also expected to be no impact to the GDEs.

Stygofauna communities (fauna which occur in groundwater) may exist within subsurface waters and thus can also be classed as a GDE (NSW Office of Water, 2012). Slight changes in groundwater attributes (quality or quantity) may result in changes to the population assemblage. Recent investigation by Eco Logical has not identified significant stygofauna populations within groundwater sampled from monitoring wells located in similar groundwater sources. However, it is considered feasible that stygofauna populations may exist and as such, additional sampling will be undertaken to investigate presence or absence of stygofauna populations within PEL 238 during operation of pilots for the program.

5.2.2 Groundwater users

Groundwater use within the exploration area is limited. This is attributed to most activities occurring within the footprint of the Pilliga Forest and lower bore yields associated with the consolidated rock units.

It is understood from the PINNEENA database[1] maintained by the Office of Water and limited bore inventory data obtained within PEL238 that there are no extractions from formations deeper than the Pilliga Sandstone. The majority of bores are utilised for stock and domestic purposes. A town water supply is provided from extraction bores in Narrabri, to the north of the project area.

The target strata for CSG extraction are the principal coal seams of the Maules Creek Formation, which is not currently utilised for water supply due to depth, water quality and availability of better quality groundwater near the surface.

5.3 Provide an assessment of cumulative impacts of land disturbance

5.3.1 Biodiversity

EcoLogical Australia assessed the cumulative impacts of existing coal seam gas (CSG) exploration and appraisal activities, undertaken from 2002 to the present, and the proposed Energy NSW CSG Exploration and Appraisal program (the 'program') on ecological values listed under the *Threatened Species Conservation Act 1995* (TSC Act). The cumulative impact assessment report is included as Appendix 1.

[1] The PINNEA database maintained by the Office of Water includes the location of approximately 126,900 groundwater works, ground water levels, drillers and geologists logs and information on various bores

The cumulative impact assessment indicates that the existing CSG activities and the proposed program are unlikely to significantly impact on any threatened species, population or ecological community, or their habitats, within PEL 238, PAL 2 and PPL 3.

5.3.1.1 Offsetting of cumulative impacts

The cumulative impact assessment indicates that the proposed program (which includes the proposed activity) will be unlikely to have a significant impact on any TSC Act listed ecological values even when taking into consideration impacts from historical CSG activities undertaken between 2002 to present (refer Appendix 1). No specific offsets are proposed for the Dewhurst 26-29 Pilot.

5.3.2 Agricultural resources

The current extent of agricultural land use within PEL 238 and PAL 2 is approximately 791,478 ha. None of the activities planned as part of the proposed program are located on agricultural land (major agricultural industries identified in PEL 238 and PAL 2 e.g. cropping, grazing, horticulture and plantations). Although production forestry is mapped within PEL 238 and PAL 2, there is little evidence of exotic plantations. Rather, these areas include State forest used for timber harvesting and nature reserves (accounting for an additional 190,462 ha). Timber harvesting within the Pilliga has been reduced largely due to conservation efforts; therefore any impact on such enterprises are not considered significant.

Cumulative impacts of the exploration and appraisal program to natural resources will be negligible as the majority of agricultural land would be fully rehabilitated and available for agricultural activities following completion of exploration activities. Proposed activities will also not quarantine any Critical Industry Cluster (CIC) areas.

The AIS (Appendix 8 of the REF) concluded that proposed CSG activities will have a low risk to agricultural resources or industries.

6.0 Flora and Fauna

6.1 Provide further information on flora assessments

Five threatened flora species listed under the TSC Act were identified during data base searches of a ten kilometre radius from the proposed activity (Table 4-4, page 72 of the REF). These include *Bertya opponens, Polygala linariifolia, Pterostylis cobarensis, Rulingia procumbens* and *Tylophora linearis*. Detailed flora surveys were undertaken within the disturbance area for each of these species.

6.1.1 Survey methodology

Survey methods targeting threatened species included searches within the groundcover of each well lease to determine the presence or absence of each species. Transects were walked within the area to be disturbed at ten metre spacing to ensure thorough coverage of each well lease and access track. In addition, random meanders were conducted in adjacent areas of suitable habitat to increase the spatial coverage of the surveys. In the absence of each species being present, an assessment of habitat suitability was undertaken to determine whether the area provides suitable habitat for species that may be dormant due to environmental and temporal factors.

Weather conditions during the surveys, recorded from the nearest weather station (located at Narrabri airport), are presented in Table 3. Temperatures were hotter than average for November (mean maximum temperature measured between 2001 and 2013 is 30.1^{0}C, and mean minimum temperature is 14.8^{0}C) during surveys.

Despite high rainfall experienced during July 2012 and average rainfall during August 2012, conditions at the time of the surveys were predominantly dry. September received a monthly total of 0.2 millimetres of rain; compared with the monthly average of 34 millimetres (measured between 2001 and 2013). The beginning of October was also very dry, with no rain experienced except some small showers over the last two days of the survey period. The dry conditions may therefore have contributed to the absence of *Polygala linariifolia* during the surveys.

Table 3 Daily Weather Conditions for Narrabri Airport (approximately 25 km north of survey area)

Parameter	12 Nov 2012	13 Nov 2012	14 Nov 2012	15 Nov 2012	16 Nov 2012
Daily Rainfall (ml)	0	0	0	0	0
Max Temp (^{0}C)	30.3	33.6	36.2	37.3	29.1
Min Temp (^{0}C)	9.2	17.5	16.0	17.0	18.2

Source: BOM 2013

6.1.2 Survey limitations

Despite detailed surveys, none of the five threatened flora species were recorded within the survey area. This may reflect that these species do not occur; however, limitations of the survey may also have resulted in false-absence records (i.e. a species is present, but not detected). Limitations specific to the flora species targeted by this survey include:

- Low rainfall conditions experienced prior to and during survey may have reduced the likelihood of detecting threatened species. For example, EcoLogical (2011) noted (correspondence with OEH) that some known populations of *Polygala linariifolia* could not be located in spring after a period of below average rainfall and therefore these populations may only exist in the seed bank.

- The survey occurred outside the flowering time for three of the target species, meaning they would be difficult to detect. This includes for *Bertya opponens*, which flowers in July/August prior to the survey taking place; *Polygala linariifolia*, which flowers from spring to summer; and *Tylophora linearis*, which flowers during spring.
- *Rulingia procumbens*, *Tylophora linearis* and *Pterostylis cobarensis* are all cryptic species that are especially difficult to detect without targeted surveys during suitable periods where the species are evident (i.e. following recent fire or optimal weather conditions such as rainfall).
- Recent fire history may influence the likelihood of detection of some species, for example large numbers of *Rulinga procumbens* seedings have been observed germinating after fire. OEH records indicate the last wildfire to impact the survey areas was in 1983. There is no evidence to suggest that hazard reduction burning has occurred in the study areas since, based on literature review and site condition. Certain species may remain dormant within the seed bank, however fire would be required to provide optimal germination and growing conditions.

Review of the EcoLogical Australia (October 2011) report and GIS data has identified that *P. linariifolia* has been previously recorded adjacent to the proposed site of Dewhurst 28. Further correspondence between EcoLogical and OEH indicated that populations recorded in summer / autumn could not be relocated in spring potentially due to below average rainfall. The surveys undertaken to support the REF were also undertaken following below average rainfall. A review of EcoLogical data has indicated that 29 individuals were recorded within the disturbance footprint of Dewhurst 28, with a further 49 occurring adjacent to the lease area.

Given the above limitations, Assessments of Significance have been completed for each of the flora species, and are included in Appendix 2. The Assessment if Significance has determined that a significant impact upon the threatened flora species is considered unlikely.

In addition, EcoLogical has assessed the cumulative impacts of the proposed activity with the Energy NSW CSG Exploration and Appraisal program, as well as existing vegetation clearing from historical CSG activities from 2002 to present (assessment contained in Appendix 1).

6.2 Provide further information on fauna assessments

6.2.1 Survey methodology

The specific trapping sites for Dewhurst 26-29 are as follows:

- Site 1 is located approximately 1.7 kilometres north of the Dewhurst 26 and 28 lease areas
- Site 2 is approximately half way along the gathering system between the lease areas for Dewhurst 26 and 28 and Dewhurst 27 and 29
- Site 3 is located immediately north of the Dewhurst 27 and 29 lease areas
- Site 4 is located approximately 1.7 kilometres from the Dewhurst 27 and 29 lease areas
- Site 5 is located approximately 2.2 kilometres from the Dewhurst 27 and 29 lease areas.

The location of these sites are identified in Figure 2.

Trapping was undertaken in accordance with the DEC Draft Biodiversity Survey Guidelines over a five day / four night period, between the 12 and 16 November 2012.

While not located within the disturbance areas, these sites are within habitat that is considered to be the same quality or better than within the lease areas, and therefore the results from these trapping sites have been included in the assessment.

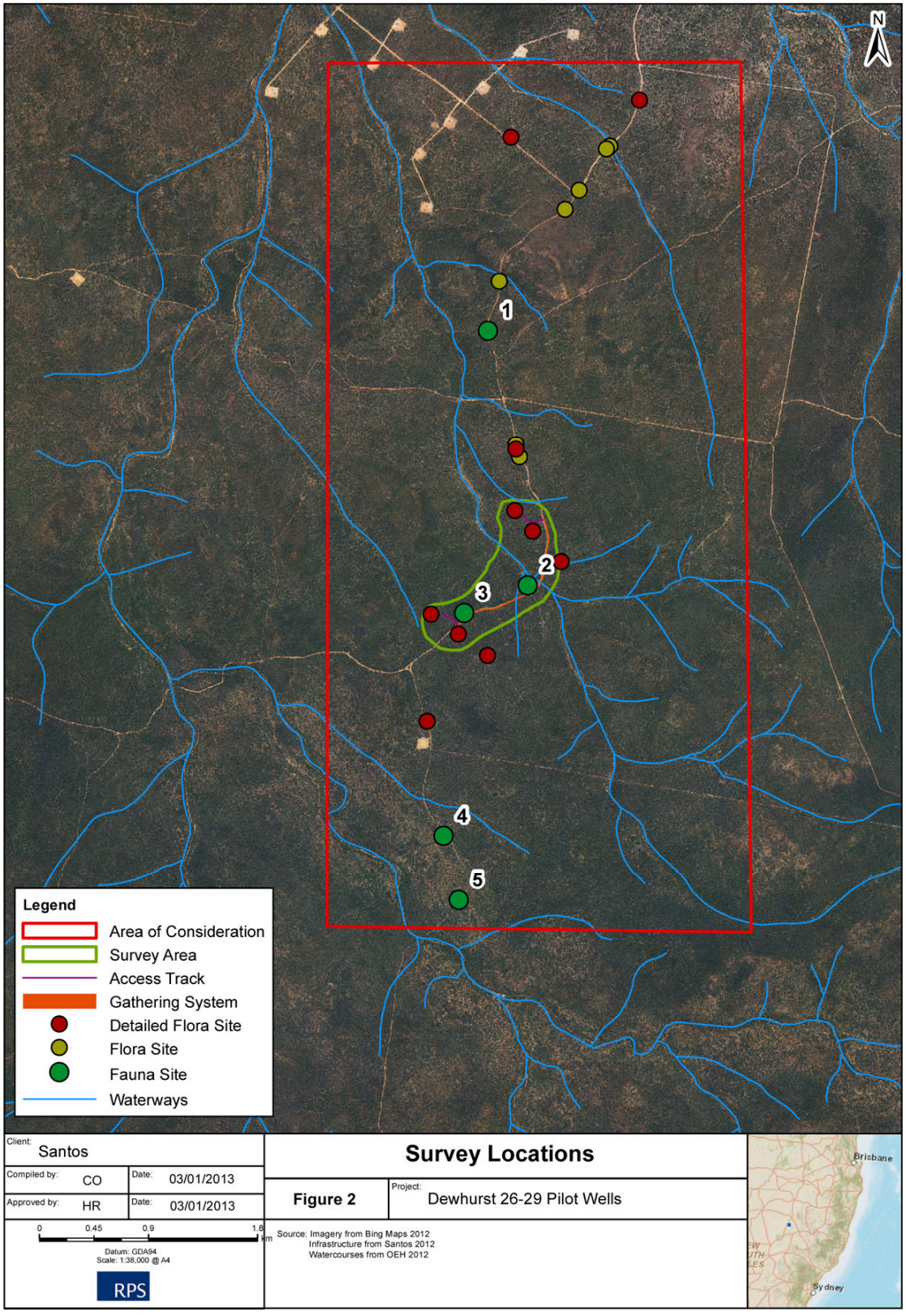

Figure 2 Trapping sites

6.2.2 Survey limitations

General limitations of the fauna survey were outlined within the Ecological Assessment (Appendix 5, page 15 of the REF). Limitations specific to the fauna survey include:

- Dry weather conditions experienced during and prior to the survey were unfavourable for detecting fauna species, especially frogs. The small amount of rain experienced towards the end of the survey period was not sufficient to offset these effects.
- The survey period did not coincide with the period that some migratory or nomadic species occur in the locality. For example, the Swift Parrot breeds in Tasmania from mid-September to late January and only moves to mainland Australia during the non-breeding season.

It is considered unlikely that the sensitivity of the traps resulted in the lack of small mammals captured throughout the survey. All traps were in good working order, and tested using light pressure on the treadle when setting and checking traps.

It should be noted that a significant amount of survey work has been undertaken throughout the Pilliga Scrub (over 3000 person hours) which has provided a good understanding of habitats and species within the Pilliga Scrub to help counter the above mentioned survey limitations.

6.2.3 Fauna habitat and presence of hollow bearing trees

Within the well lease areas for Dewhurst 26-29, a total of 18 hollow-bearing trees will require removal. A further 14 hollow-bearing trees occur along the proposed access tracks and gathering system corridor and may be impacted by the proposed activity. However some avoidance is likely to be possible but cannot be confirmed until construction commences.

Hollow-bearing trees have been avoided where possible through micro-siting of well leases and access tracks to minimise fauna impacts.

6.3 Provide further information on indirect impacts

The AOS presented in the Ecological Assessment (Appendix 5 of the REF) took into consideration the direct and indirect impacts and survey results to assess potential for impact.

Indirect impacts are likely to be temporary and are not expected to lead to a long-term decrease in the size of a viable local population of any threatened species. They generally occur during site establishment and construction. The AOS describes in detail the direct impacts.

Indirect impacts associated with the proposed activity is discussed below.

6.3.1 Site establishment and construction impacts – up to two months

Potential indirect impacts to flora and fauna during the construction phase may result from: erosion and sedimentation; soil contamination, introduction and spread of weeds, introduction of pest animals; dust and vibrations, noise and light pollution and vehicle strikes along access tracks.

Vegetation clearing, top soil removal and earthworks for the establishment of the lease areas and construction of the access tracks and gathering system corridors have potential to cause erosion and sedimentation at the site. There is also a risk of soil contamination resulting from spilled or leaked chemicals, fuel or oil. Associated impacts to flora and fauna may include exposure of tree roots, smothering of vegetation and degradation of downstream aquatic habitat. However, the extent of impact would be localised and it is unlikely that any threatened species would be affected.

Soil, seed or vegetation adherence to machinery, vehicles or personnel involved in construction activities can lead to the spread or introduction of weeds to the site. Activities such as clearing and earthworks can also create favourable conditions for weed establishment, however mitigation measures to prevent the introduction of weeds will be implemented. The abundance of weeds in the study area is extremely low and therefore the likelihood of exporting weeds offsite is considered to be low.

Dust would be generated during clearing, drilling and well lease excavation activities, as well as along access tracks. Vibration would be generated during earthworks and drilling activities. Excessive dust from the proposed activities could potentially disrupt the pollination cycle and ability of native plants to regenerate (i.e. germination, revegetation and re-colonisation of existing plants), while vibration could disturb resident fauna.

Noise associated with vehicles, machinery and drilling may deter native fauna from utilising the site and surrounding areas as habitat. Noise also has potential to affect the migration and dispersal ability of native fauna particularly in relation to vehicular movements. Increased noise and light pollution can also disrupt the breeding cycle and the foraging and roosting behaviour of some native fauna species.

Temporary impacts associated dust, vibration, noise and light pollution would most likely impact on philopatric species and species with small home ranges, including threatened fauna such as Eastern Pygmy Possum, Masked and Barking Owls, as well as smaller birds such as Brown Tree-creeper and Grey-crowned Babbler. Ground-dwelling species, such as the Pale-headed Snake, are also potentially at risk from vehicle-strike due to construction of access tracks and increased traffic.

Impacts to flora and fauna during the construction phase (up to 40 days) are unlikely to be significant provided appropriate mitigation measures are implemented (Section 6 and 9 of the REF). If measures are put in place, the extents of indirect impacts are likely to be localised and temporary.

6.3.2 Operational impacts – up to three years

Potential indirect impacts to flora and fauna during the operation phase are minimal and are mostly associated with access tracks. For example, there is potential for edge effects to occur along access tracks which would reduce habitat value in these areas. There is also some risk of vehicle strikes, although this risk is small given the expected low traffic volume during operation (estimated as one vehicle per day). Access tracks may also present a barrier to the movements of some small ground-dwelling species which would then become subject to fragmentation effects. Given the large area of habitat available within the broader landscape these impacts are not considered to be significant.

Bushfires, especially those of high intensity, can have negative consequences for biodiversity as fire can modify habitat and alter the availability of food, water and shelter. Fire also has potential to incinerate important microhabitat features, such as fallen logs and deep leaf litter, which are critical for species such as Pale-headed Snake. A safety exclusion sterile zone will surround the flare and the surface will be covered with compacted soil and blue metal aggregate to minimise the chance of ignition (Section 2.7.5.3 of the REF, pages 36 and 37). The risk of the proposed activity generating a fire will be very small.

6.4 Provide consideration of the use of biological controls and foliar spray options for the control of *Opuntia* species

Given the short time frame for the construction of the lease pad, biological controls and herbicides to control Prickly Pear are not viable options. The Narrabri Shire Prickly Pears Class 4 Weed Control Management Plan states that manual/mechanical removal and burning of plants is the most effective method of control. This method would be most suitable given the short time frame.

7.0 Agricultural resources and industries

7.1 Provide consideration of any effects on the apiary industry activities

There are approximately 3,195 registered beekeepers in the state of NSW. Amateur beekeepers account for 77% of registrations. Beekeepers owning over 500 hives (148) may be termed professional beekeepers and constitute 4.6% of total apiary registrations in NSW (RIRDC 2007). Current estimates with the Narrabri and Gunnedah LGAs indicate that a total of 7 people are employed as beekeepers (ABS 2010).

The most utilised beekeeping area is the temperate land stretching from southern Queensland to central Victoria. This area contains about 80% of the nation's hives and 80% of its beekeepers. Beekeepers in NSW depend on a combination of both public and private land. The Pilliga State forest provides areas for beekeepers to carry out apiary activities. No artificial nesting hives were identified at any sites within the exploration and appraisal program in the Pilliga; however some of these locations contain Pilliga Box, Yellow Box and Narrow Leaved Ironbark species which may yield honey from time to time. Yellow Box and Pilliga Box do not provide adequate pollen on their own and require supporting pollens at honey sites or specific pollen management to correct protein inadequacies.

Narrow leaved Ironbark is considered dominant in the Pilliga, while Yellow Box and Pilliga Box have smaller distributions (Table 4). Narrow-leaved Ironbark communities account for 198,219 hectares of the Pilliga Scrub. The program disturbance footprint accounts for approximately 0.02% of Narrow-leaved Ironbark in the Pilliga Scrub.

Due to the minimal disturbance of potential honey trees within the Pilliga Forest a low to negligible impact is anticipated on the apiary industry.

Santos provides weekly and monthly activity updates to Forestry NSW and regularly meets with Forestry NSW as part of their commitment to communication with landholders. Forestry NSW manages the leases within the forest and provides a communication interface between different users and leaseholders. Santos will be advised if any issues arise with beekeepers (or any other leaseholders). It is noted that none have occurred to date.

Table 4 Impact areas for proposed exploration and appraisal program within PEL 238

Species	Potential Impact as a result of the exploration and appraisal program
Narrow-leaved Ironbark	Dominant species across 25-30 ha
Pilliga Box	Potential to impact upon 4 – 6 trees
Yellow Box	Occurs at very low densities across less than 1 hectare

7.2 Provide analyses of the broad positive impacts of the proposed activity on industry activities

An assessment for the disturbance footprint (area) and its potential value has been provided in the Agricultural Impact Statement in Appendix 8 to the REF. As noted in Table 6.5 of that assessment, for the purposes of the assessment, the most profitable enterprises were selected to provide 'best case' scenarios under the current economic conditions for Dryland north-west region for lands with a Class 4 and 5 Land and Soil Capability (LSC). By taking this approach, rather than using the likely agricultural enterprise, the results provide a conservative assessment of impact on agricultural productivity.

7.3 Provide additional information on suitability of produced water for agricultural use

Water quality information for the target seams is not suitable for agricultural purposes due to its saline nature. The Dewhurst 26-29 pilot wells will target the Bohena, Namoi and Rutley seams. Table 5 provides a summary of expected water quality for those seams. These are outside the general total dissolved solids (TDS) ranges for irrigation (650 – 5,200 mg/L) and livestock (2,000 – 10,000 mg/L) use.

Table 5 Produced water quality parameters

Total dissolved solids (TDS)	Units	Average	Maximum	Minimum
Bohena Seam	mg/L	18,700	22,000	13,200
Namoi Seam	mg/L	14,100	15,700	13,200
Rutley Seam		Unknown		

8.0 Groundwater monitoring program

8.1 Provide additional details on the proposed groundwater monitoring program including information on potential groundwater monitoring bore locations and monitoring frequency

The monitoring of groundwater is required to confirm the absence or onset (and magnitude) of any impact associated with CSG activities at both the deep and shallow aquifer level. Registered bore users extract water from the shallow aquifers and whilst modelling has concluded that this will not be impacted, long-term monitoring over the duration of the CSG operations is still appropriate and proposed.

Santos is currently implementing a comprehensive groundwater and surface water monitoring program. This program was presented and discussed with the NSW Office of Water and was submitted to the (then) Division of Resources and Energy on 18 December 2012 in accordance with condition 13 (c) of PEL 238.

Surface water monitoring has commenced with baseline data samples collected monthly within the Upper Namoi Catchment. The sampling program consists of grab samples being undertaken at a monthly frequency. This sampling will be undertaken for a period of twelve months, after which the frequency and locality of the sampling will be reviewed. It is anticipated that surface water sampling will continue for the life of the CSG exploration program.

Reporting is undertaken monthly following completion of the laboratory analysis and an annual characteristic report is completed. Approximately 29 sites are sampled across the area on a monthly basis including areas upstream and downstream of existing and proposed activities within PEL 238.

The groundwater water monitoring program will include installation of eight shallow monitoring bores and one deep aquifer monitoring bore over the next 12 months. Proposed locations are provided in Figure 3. Some locations are still subject to the assessment and approval of landholder and regulatory bodies, whilst others have already had relevant licences issued by the NSW Office of Water under the *Water Act 1912*.

Once installed, these monitoring bores will measure groundwater pressure and temperature within various strata and enable groundwater levels and flows to be monitored. Information will be transmitted via telemetry to a production database. The bores will not extract any groundwater beyond what is extracted during drilling and required for water quality sampling, where this occurs.

Baseline data gathered will include groundwater heads (pressures) within the hydraulically confined strata of the Gunnedah Basin and groundwater levels within these unconfined Permo-Triassic strata at or close to outcrop and subcrop. This will help to establish the baseline conditions prevailing before the commencement of any pilot trials within the wider region. The shallow monitoring bores will focus on

- Demonstrating the baseline groundwater levels and the background flow pattern within the Pilliga Sandstone
- Confirming the groundwater pressure in the Purlawaugh Formation
- Verifying the confining characteristics of the Keelindi Beds overlying the Pilliga Sandstone and hence the hydraulic segregation of the Pilliga Sandstone from the Great Artesian Basin (GAB) alluvials.

The deep monitoring bore will focus on:

- Demonstrating the baseline groundwater pressures and the background flow patterns / existing hydraulic gradients within the hydrostratigraphic units of the Gunnedah Basin
- Illustrating the absence or otherwise of vertical hydraulic continuity within the Gunnedah Basin strata

- Enabling elaboration of the migration of groundwater depressurisation both laterally in the target seam and vertically above and below the target seam, following the commencement of CSG water abstraction.

The location of the monitoring network (Figure 3) has been arranged to maximise the acquisition of beneficial data which:

- Can inform the absence or otherwise of potential impact to the regional GAB aquifers
- Act as sentinel monitoring locations between the Narrabri Gas Field Area and groundwater abstractions in the Gunnedah Basin domain
- Yield essential hydrogeological data comprising additional stratigraphic data, remote head and field testing data and cores for laboratory testing of hydraulic parameters.

The location of the monitoring network (Figure 3) has been arranged to maximise the acquisition of beneficial data which:

- Can inform the absence or otherwise of potential impact to the regional GAB aquifers
- Act as sentinel monitoring locations between the Narrabri Gas Field Area and groundwater abstractions in the Gunnedah Basin domain
- Yield essential hydrogeological data comprising additional stratigraphic data, remote head and field testing data and cores for laboratory testing of hydraulic parameters.

8.2 Provide details on current yields and water quality characteristics of four registered bores

There are no registered bores nearby (within 6km) to the proposed activity. Table 6 provides details for the existing bores that are located the closest to the activity.

Table 6 Existing bores closest to the proposed activity

Bore ID	Easting	Northing	Distance from proposed activity (km)	Max Depth (m)	GWMA	Authorised purpose	Water Bearing Zone	Yield	Salinity
GW021998	749825	6605167	6.8	73.8	GAB	Oil exploration	38.7-43.5	-	-
							46.3-52	-	-
							56.6-69.7	1.52	-
GW967923	754004	6607915	7.3	90	GAB	Industrial	65-73	-	-
							75-90	-	-
GW970010	Not found in database								
GW967935	754134	6609085	8.5	93	GAB	Industrial (low security)	53-56	-	-
							65-81	-	-
							81-93	-	-

Source: PINNEA Database

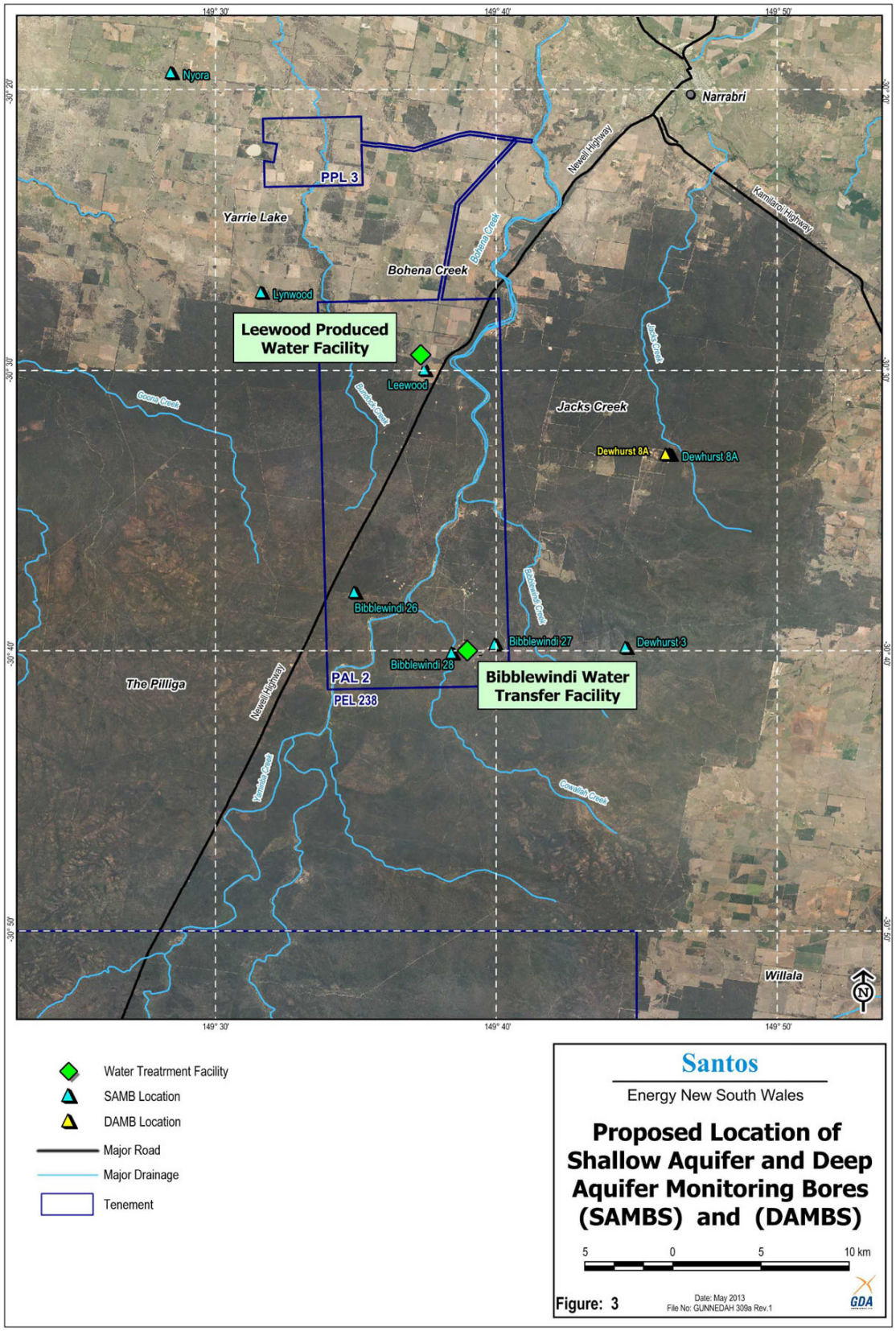

Figure 3 Groundwater monitoring bores

9.0 Well casing requirements

9.1 Provide details on casing and clarification that design and installation will comply with the Code of Practice

Wells will be designed and constructed, including cementing operations, in accordance with the NSW Code of Practice for Coal Seam Gas Well Integrity (the Code of Practice).

The Code of Practice provides a practical guide for CSG titleholders on how to comply with a condition of title for CSG exploration, extraction or production. CSG titleholders are required to comply with this Code to ensure that any activities relating to coal seam gas well integrity are compliant with a title issued under the *Petroleum (Onshore) Act 1991*.

To ensure compliance with the Code of Practice, all casing strings will be cemented to surface. All batches of cement used in the cementing operation and associated chemicals for the recipe are tested prior to use in the wells to ensure that the cement has the right properties (i.e. setting time and compressive strength) for the job, whether it is for cementing casing or abandoning wells.

All cementing programs are designed, reviewed and signed-off by senior Santos drilling personnel and submitted as part of the Well Drilling Programme (Notification to Drill) provided to the Office of Coal Seam Gas for approval more than 30 days before the well can be commenced.

In addition, cementing reports, including all materials and compressive strength versus time graphs, cement pump charts and pressure records, logging reports and details of centraliser placing must be completed and submitted to the Office of Coal Seam Gas with the Well Completion Reports. The wells are designed according to Section 4.1.2 Mandatory Requirements in the Code of Practice.

All casing design complies with the Santos Drilling Operations Manual in accordance to Santos (and other) oil industry standards to cater for potential casing failure mechanisms.

10.0 References

Office of Environment and Heritage (OEH) 2013, *Atlas of NSW Wildlife* (online)

Department of Trade & Investment Resources & Energy(DTIRE) *NSW Code of Practice for Coal Seam Gas Well Integrity 2012*

RPS Review of Environmental Factors – Leewood – Produced Water and Brine Management Ponds. Report prepared for Santos

RPS Expansion of Santos Operations Centre, 300 Yarrie Lake Road, Narrabri. Report prepared for Santos

Appendix 1

PEL 238 TSC Act Cumulative Impact Assessment (Eco Logical Australia, 2013)

PEL 238

TSC Act Cumulative Impact Assessment

Prepared for
Santos Limited

June 2013

DOCUMENT TRACKING

Item	Detail
Project Name	PEL 238 – TSC Act Cumulative Impact Assessment
Project Number	13NEWECO-0017
Project Manager	Martin Sullivan 02 4910 3405 PO Box 1056, Newcastle NSW 2300
Prepared by	Matt Dowle and Andrea Sabella
Approved by	Martin Sullivan
Status	FINAL
Version Number	4
Last saved on	12 June 2013

This report should be cited as 'Eco Logical Australia 2013. Narrabri Gas Development Project – TSC Act Cumulative Impact Assessment. Prepared for Santos Limited'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd

Contents

1 Introduction 1
1.1 Energy NSW Coal Seam Gas (CSG) Exploration and Appraisal Program 1
1.2 Purpose of this report 1

2 Description of activities 3
2.1 General locality 3
2.2 Exploration activities 3
2.2.1 Reconnaissance and exploration activities undertaken to date 3

3 Legislative and planning history 9
3.1 NSW planning and approvals 9

4 Potential impacts 10
4.1 Ecological surveys and consultant advice 10
4.2 NSW listed threatened species and ecological communities 12
4.3 Impacts of exploration activities 15
4.3.1 Impacts to vegetation 15
4.3.2 Impacts to fauna habitat 17
4.3.3 Limitations 19
4.4 Key Threatening Processes 19

5 Significance assessment under the TSC Act 22
5.1 Birds 24
5.1.1 Parrots 24
5.1.2 Owls 25
5.1.3 Birds of prey 26
5.1.4 Woodland birds – large ground foraging 27
5.1.5 Woodland birds – ground and mid-storey foraging (passerines) 28
5.1.6 Woodland birds – canopy foraging (excluding parrots) 29
5.2 Mammals 31
5.2.1 Arboreal mammals and megabats: 31
5.2.2 Ground and log dependent mammals: 32
5.2.3 Grassy woodland mammals: 34
5.2.4 Predominantly tree-roosting bats: 34
5.2.5 Predominantly cave-roosting bats: 36
5.3 Reptiles 37
5.3.1 Tree and log dependent reptiles 37
5.4 Plants 38

5.4.1 Threatened flora 38
5.5 Endangered Ecological Communities 39
5.5.1 Brigalow – Belah Woodland on alluvial often gilgaied clay soil, mainly Brigalow Belt South 39
5.5.2 White Box-Yellow Box-Blakely's Red Gum Grassy Woodland 40
5.5.3 Fuzzy Box Woodland on alluvial soils 41

6 Rehabilitation 42
6.1 Vegetation dieback 42

7 Conclusion 43

References 44

Appendix A: 47

List of figures

Figure 1: Cumulative CSG footprint within PEL 238 area 8

List of tables

Table 1: Ecological assessments, survey dates and effort for the proposed program 10

Table 2: NSW TSC Act threatened species and ecological communities listed as having a likelihood of occurrence of ‘known’, ‘likely’ or ‘potential’. 13

Table 3: Areas of clearing for exploration activities within PEL 238, PAL 2 and PPL 3 undertaken from 2002 to present 16

Table 4: Areas of clearing of proposed exploration activities (2013 onwards) 16

Table 5: Cumulative direct impacts areas to potential threatened fauna habitat 17

Table 6: NSW TSC Act threatened species and ecological communities likelihood of occurrence within the study area. 48

Abbreviations

ABBREVIATION	DESCRIPTION
BWTP	Bibblewindi Water Treatment Plant
CEEC	Critically Endangered Ecological Community
CSG	Coal Seam Gas
CUCCLG	Coonabarabran and Upper Castlereagh Catchment and Landcare Group
DTIRIS	NSW Department of Trade & Investment, Regional Infrastructure and Services
ELA	Eco Logical Australia Pty Ltd
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ESG	Eastern Star Gas (now Santos Limited)
Ha	Hectares
HBT	Hollow Bearing Tree
NGDP	Narrabri Gas Development Project
NES	National Environmental Significance
NICE	Northern Inland Council for the Environment
NPWS	NSW National Parks and Wildlife Service
NW Act	NSW *Noxious Weeds Act 1993*
OEH	NSW Office of Environment and Heritage
P&Ad	Plugged and abandoned
PAL	Petroleum Assessment Lease
PEL	Petroleum Exploration Licence
PPL	Petroleum Production Lease
REF	Review of Environmental Factors (Under Part 5 of the NSW EP&A Act)
RVC	Regional Vegetation Community
SCA	State Conservation Area
SSD	State Significant Development
TSC Act	NSW *Threatened Species Conservation Act 1995*

1 Introduction

1.1 Energy NSW Coal Seam Gas (CSG) Exploration and Appraisal Program

Santos NSW (Eastern) Pty Ltd is proposing to undertake the Energy NSW Coal Seam Gas (CSG) Exploration and Appraisal Program in the Narrabri area within Petroleum Exploration Licence (PEL) 238 and Petroleum Assessment Lease (PAL) 2 (hereafter referred to as the program). The program is scheduled to commence in 2013 and will take two to three years. The program includes recommencing operation of a number of existing pilot wells, drilling and operating new pilot wells and constructing and operating water and gas management facilities to support the program.

PEL 238 wholly contains Petroleum Assessment Lease 2 (PAL 2) and Petroleum Production Lease 3 (PPL 3) which are collectively referred to as 'PEL 238 area' for the purposes of this assessment (**Figure 1)**.

Eastern Star Gas (ESG) was the operator of the PEL 238 from 2002 to 2011 on the back of early stage exploration undertaken by various US based companies in the period 1998-2002. During that period, ESG carried out exploration and appraisal activities across much of PEL 238 and PAL 2, which in the period 2006 to 2011 focused more closely on the CSG resources underlying Pilliga East and Bibblewindi State Forests and surrounding freehold lands. The impacts associated with these early stage reconnaissance and exploration and appraisal activities were assessed under Part 5 of the *Environmental Planning and Assessment Act 1979 (NSW).*

In 2011, ESG lodged a major project application for up to 550 well sets within PEL 238 and PAL 2, known previously as the Narrabri Gas Development Project (NGDP), to the NSW State Government. Following a series of field based ecological surveys in late 2010 and early 2011, the production project was referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 12 April 2011 (EPBC 2011/5914).

Santos acquired ESG in November 2011 and commenced a full review of ESG's operations. Following the acquisition of ESG, Santos withdrew both the major project application and referral for the NGDP and commenced the decommissioning and progressive rehabilitation at thirty two well sites, the Bibblewindi Water Treatment Plant (BWTP) and a number of ponds within PEL 238. The objective of the rehabilitation activities is to rehabilitate these sites to natural pre-disturbance vegetation condition and improve the ecological values of the PEL 238 area.

Santos is now proposing to undertake an exploration and appraisal program to determine the viability of a gas production project in PEL 238 and PAL 2. This is dependent on geology, resource availability, environmental and land access constraints which will be investigated through early stage exploration and appraisal activities.

1.2 Purpose of this report

This report brings together and updates information from a variety of sources to document the exploration activities and cumulative impacts associated with all existing and proposed exploration and production appraisal activities associated with the program, based on current knowledge of the area for ecological values listed under the TSC Act. This report places the program within a regional context,

with impact assessment focussed on state listed ecological values. An equivalent report has also been compiled for matters of national environmental significance (MNES) listed under the Commonwealth's EPBC Act (ELA 2013).

2 Description of activities

2.1 General locality

PEL 238 (incorporating PAL 2 and PPL 3) covers approximately 820,578 ha and includes the townships of Narrabri, Wee Waa, Edgeroi, Baan Baa and Baradine (**Figure 1**). The PEL 238 area includes (in part) numerous conservation areas and state forests such as Pilliga East, Euligal, Cumbil, Kerringle, Bibblewindi, Baradine, Cubbo and Jacks Creek State Forests, Pilliga State Conservation Area (SCA), Pilliga East SCA, Pilliga Nature Reserve and Pilliga National Park which, together represent the largest stand of intact vegetation in western NSW, known collectively as the 'Pilliga Forests'. The PEL 238 area also includes significant areas of crown and leasehold land.

For the purposes of this report, the study area is defined as an area covering approximately 48,000 ha which is wholly contained within the PEL 238 area and includes areas of Pilliga East State Forest, Bibblewindi State Forest, Jacks Creek State Forest and Pilliga East State Conservation Area. The study area is being utilised for this report as it is the boundary of ESG's former NGDP (and contains all proposed infrastructure in the program), within which detailed studies into the biodiversity values of the north-east Pilliga Forest were conducted. Impacts to threatened species and ecological communities are assessed against those values contained within both the study area and the broader PEL 238 area.

2.2 Exploration activities

In order to determine the design and layout of gas wells and associated infrastructure, exploration and appraisal of aspects such as geology, resource availability, environmental and land access constraints are necessary.

Existing exploration activities undertaken within the study area have included seismic surveys, stratigraphic corehole drilling, pilot well drilling and production appraisal activities including management of water and gas products. Existing disturbance associated with these works includes vegetation clearing for coreholes, well leases, water and gas flow lines and water management (ponds).

Figure 1 details the location of all previous works (undertaken by ESG) and proposed exploration activities within the PEL 238 area as follows:

- Existing exploration activities – activities undertaken by ESG between 2002 and 2012
- Proposed exploration activities – activities scheduled to occur during 2013 and 2014
- Indicative area for pilot production wells – activities scheduled to occur during 2013 and 2014 which are still undergoing detailed design.

2.2.1 Reconnaissance and exploration activities undertaken to date

The following reconnaissance and exploration activities have been undertaken to date within PEL 238. REFs were submitted to the NSW State Government regulators for all of the activities listed below (**Section 4.1**) and undertaken in accordance with the consent of that agency and the landholder, the Forestry Corporation of NSW.

2002 - 2006		
Coonarah 1B ST	2002	production pilot well

2002 - 2006		
Coonarah 5	2002	production pilot well
Coonarah 3	2002	production pilot well
Dampier Seismic Survey	May-04	seismic survey
Bohena South-1C	Jul-04	appraisal well
Bohena-4L	Jul-04	appraisal well
Bohena-9	Aug-04	appraisal well
Coonarah 6L	Aug-04	production pilot well
Bohena South-1	Sep-04	appraisal well
Brigalow Park 1	Oct-04	corehole
Coonarah 8	Mar-05	production pilot well
Coonarah 7	Apr-05	production pilot well
Bibblewindi CSG Pilot	Mar-06	production pilot wells

2007 - 2008		
Bibblewindi North-1C	Mar-07	corehole
Bohena-12C	May-07	corehole
Bohena South-2C	Jul-07	corehole
Bibblewindi West-1C	Aug-07	corehole
Bohena-13C	Aug-07	corehole
Bibblewindi-11	Oct-07	corehole
Dewhurst-2	Mar-08	corehole
Dewhurst-3	Apr-08	corehole
Dewhurst-4	May-08	corehole
Dewhurst-7	Jul-08	corehole
Dewhurst Seismic Survey	Aug-08	seismic survey
Dewhurst-5	Sep-08	corehole
Edgeroi 1	Oct-08	corehole
Blue Hills (NSW 1)	Dec-08	corehole
Bibblewindi Multilateral pilot	Dec-08	production pilot wells

2009 - 2010		
Coonarah 9	09	corehole, plugged and abandoned (P&A)

2009 - 2010		
Bibblewindi Multilateral Pilot (cont'd)	Jan-09	production pilot wells
Dewhurst-6	Apr-09	appraisal well
Bibblewindi-19H	Apr-09	production pilot well
Dewhurst-8	May-09	appraisal well
Bibblewindi West Pilot	May-09	production pilot wells
Dewhurst-9	Jul-09	appraisal well
Dewhurst-10	Jul-09	appraisal well
Bibblewindi-20	Jul-09	appraisal well
Bibblewindi Multilateral Pilot (cont'd)	Aug-09	production pilot well
Tintsfield 1	Aug-09	production pilot well
Bibblewindi-21H	Sep-09	corehole
Dewhurst 8 Pilot	Oct-09	production pilot wells
Coogal 2	Oct-09	corehole
Rosevale 1	Nov-09	corehole

2010 - 2011		
Tintsfield 5	Jan-10	production pilot well
Tintsfield 6	Feb-10	production pilot well
Tintsfield 7	Feb-10	production pilot well
Bohena-14	Feb-10	corehole
Tintsfield 3H	Feb-10	production pilot well
Tintsfield 2H	Mar-10	production pilot well
Tintsfield 4H	Mar-10	production pilot well
Edgeroi 2	Mar-10	corehole
Dewhurst/Coghill Seismic Survey	Apr-10	seismic survey
Blue Hills 2	Apr-10	corehole
Culgoora 1	Sep-10	corehole
Culgoora 1a	Sep-10	corehole
Brigalow Park 2	Oct-10	corehole
Culgoora 2	Nov-10	corehole
Rosevale	Nov-10	corehole
Willala 1	Jan-11	corehole

2010 - 2011		
Strathmore 2ST1	Feb-11	corehole
Yallambee 2	Mar-11	corehole
Dewhurst-19	Apr-11	corehole
Strathmore 2	2011	corehole
Leewood Produced Water Facility	2013	Produced Water Facility

PROPOSED*		
Bibblewindi Multi-Lateral Pilot	Existing/ Proposed	operation of the existing Bibblewindi Multi-Lateral Pilot (Bibblewindi 12, 13, 14, 15, 16, 17, 18H, 19H, 21H, 27, 28H and 29), construction, drilling and operation of two additional pilot wells (Bibblewindi 31 and 32), and the operation of existing water flow lines from Bibblewindi Multi-Lateral Pilot to the Bibblewindi Water Transfer Facility
Bibblewindi West Pilot	Existing	operation of the existing Bibblewindi West Pilot (Bibblewindi 22, 23, 24, 25 and 26) and operation of existing water flow lines from the Bibblewindi West Pilot to the Bibblewindi Water Transfer Facility
Dewhurst 13-18H Pilot	Proposed	operation of the existing Dewhurst 13-18H Pilot (Dewhurst 13, 14, 15, 16H, 17H and 18H) including construction, drilling and operation of additional lateral wells from well casing within Dewhurst 16H, 17H and 18H
Dewhurst 22-25 Pilot	Proposed	construction, drilling and operation of the Dewhurst 22-25 Pilot (Dewhurst 6, 22, 23, 24 and 25)
Dewhurst 26-31 Pilot	Proposed	construction, drilling and operation of the Dewhurst 26-31 Pilot (Dewhurst 26, 27, 28, 29, 30 and 31)
Dewhurst Northern Water and Gas Flow Lines	Proposed	construction of the Dewhurst Northern Water and Gas Flow Lines and operation the Dewhurst Northern Water Flow Line
Dewhurst Northern Water and Gas Flow Lines	Proposed	construction of the Dewhurst Southern Water and Gas Flow Lines and operation of the Dewhurst Southern Water Flow Line
Bibblewindi Water Transfer Facility	Existing	operation of the Bibblewindi Water Transfer Facility
Leewood Pipeline	Existing	operation of the Leewood Water Pipeline
Leewood Produced Water Facility	Existing	operation of the Leewood Produced Water Facility
transport of produced water	Proposed	transport of produced water from Leewood Produced Water Facility to an appropriately licensed facility at Homebush Bay, NSW

PROPOSED*		
ancillary and supporting infrastructure	Proposed	construction and operation of ancillary and supporting infrastructure to facilitate the above activities and ongoing maintenance

*all proposed areas include surface facilities that include gathering lines

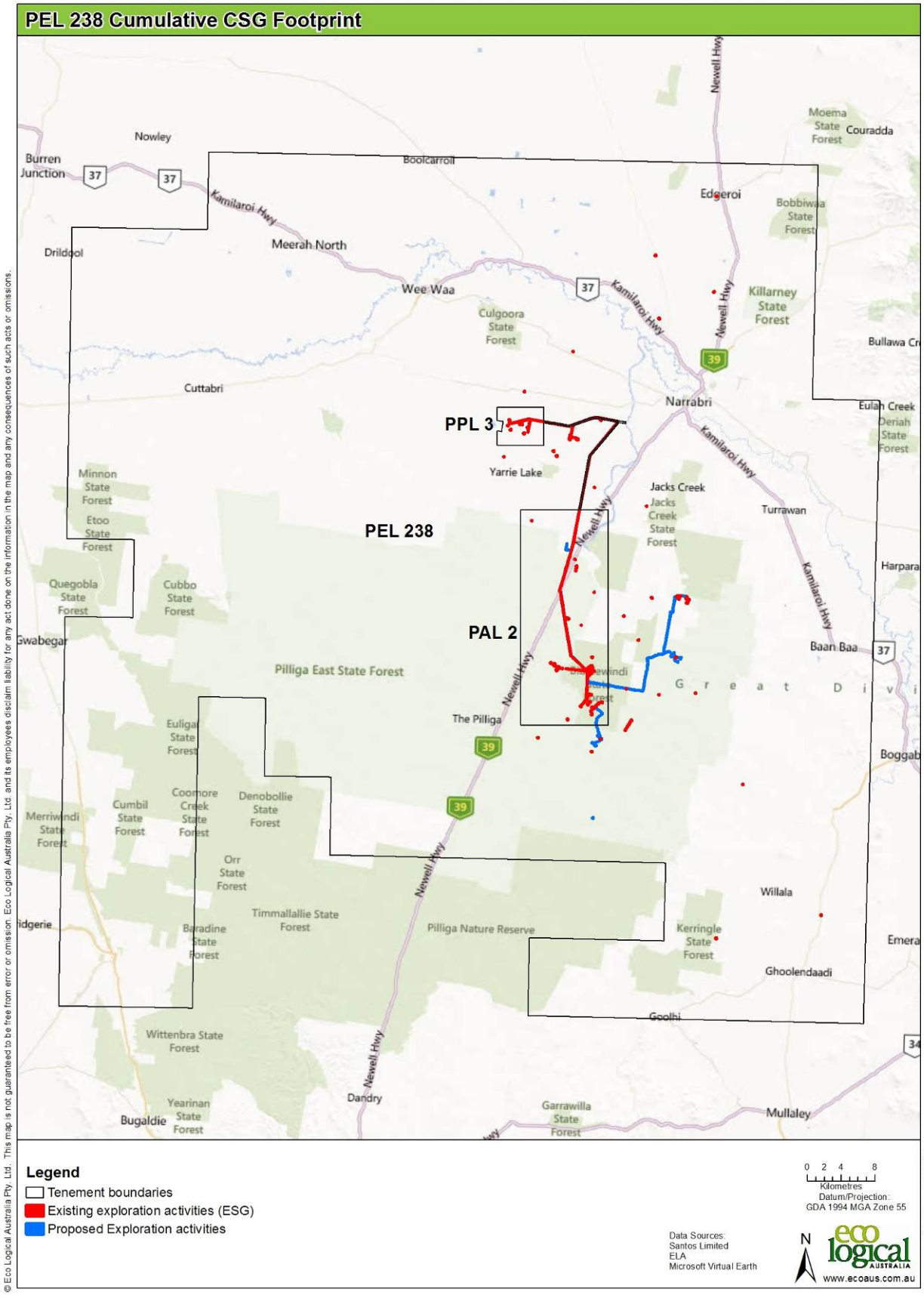

Figure 1: Cumulative CSG footprint within PEL 238 area

3 Legislative and planning history

3.1 NSW planning and approvals

Exploration and production appraisal activities require environmental assessment under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Part 5 of the EP&A Act applies to most exploration and appraisal activities, with assessments undertaken by the NSW Department of Trade & Investment, Regional Infrastructure and Services (DTIRIS, formerly I&I NSW, Department of Primary Industries and other iterations). DTIRIS is responsible for assessing the environmental impacts of activities within titles issued under the *Petroleum (Onshore) Act 1991* that fall under Part 5 of the EP&A Act.

To assess the impacts, DTIRIS requires the titleholder to undertake an activity specific environmental assessment such as an REF. A REF details the environmental impact assessment of activities taking place within petroleum title and the measures taken to avoid, minimise and mitigate impacts. The consent of the agency is required prior to any activity being undertaken.

Some exploration activities require assessment and approval by the Minister for Planning and Infrastructure as State Significant Development (SSD) under Part 4 of the EP&A Act. These exploration activities include the drilling or operating petroleum exploration wells not including:

a) stratigraphic boreholes

b) monitoring wells

c) a set of 5 or fewer wells that is more than 3 kilometres from any other petroleum well (other than an abandoned petroleum well) in the same petroleum title.

Santos is proposing to seek development consent under Part 4 of the EP&A Act for the drilling and operation of sets of more than 5 wells proposed to be undertaken as part of the program.

REFs have been, or are in the process of being, prepared for each other activity within the program as required under Part 5 of the EP&A Act.

4 Potential impacts

4.1 Ecological surveys and consultant advice

A number of flora and fauna surveys and assessments have been undertaken in PEL 238 since 2002, totalling more than 3,000 person-hours in the field.

Recent flora and fauna assessments undertaken (RPS 2012a-c; 2013a-c), address potential impacts of proposed exploration activities. An outline of survey undertaken for each activity and relevant survey dates is included in **Table 1**. The advice from these surveys is that the proposed exploration activities are unlikely to have a significant impact on TSC Act listed ecological values.

Table 1: Ecological assessments, survey dates and effort for the proposed program

ACTIVITY	SURVEY DATES	SURVEY EFFORT
Bibblewindi Multi-Lateral Pilot	27 November 2012	Bibblewindi 31 and 32: • Flora survey • Fauna habitat assessment • Targeted survey for threatened flora species Supplementary survey was not required for existing infrastructure as no additional habitat disturbance is proposed.
Bibblewindi West Pilot	N/A	• N/A – survey was not required for existing infrastructure as no additional habitat disturbance is proposed.
Dewhurst 13-18H Pilot	24 January 2013	Water and gas gathering system: • Flora survey • Fauna habitat assessment • Targeted survey for threatened flora species Supplementary survey was not required for existing infrastructure as no additional habitat disturbance is proposed.

Dewhurst 22-25 Pilot	17 and 19 September 2012
	8 – 12 October 2012
	24 January 2013
		• Flora survey
		• Fauna habitat assessment
		• Detailed fauna trapping program
		  o Diurnal bird surveys
		  o Spotlighting
		  o Active searches

ACTIVITY	SURVEY DATES	SURVEY EFFORT
		○ Anabat detection ○ Terrestrial trapping (Elliot, Cage, Camera and Hair Tube) • Targeted survey for threatened flora species
Dewhurst 26-31 Pilot	12 - 16 November 2012	• Flora survey • Fauna habitat assessment • Detailed fauna trapping program ○ Diurnal bird surveys ○ Spotlighting ○ Active searches ○ Anabat detection ○ Terrestrial trapping (Elliot, Cage, Camera and Hair Tube) • Targeted survey for threatened flora species
Dewhurst Northern Water and Gas Flow Lines	8 - 12 October 2012 4 – 9 November 2012	• Flora survey • Fauna habitat assessment • Detailed fauna trapping program ○ Diurnal bird surveys ○ Spotlighting ○ Active searches ○ Anabat detection ○ Terrestrial trapping (Elliot, Snake Funnel, Camera, Hair Tube and Pitfall) • Targeted survey for threatened flora species
Dewhurst Southern Water and Gas Flow Lines	11 – 16 November 2012	• Flora survey • Fauna habitat assessment • Detailed fauna trapping program ○ Diurnal bird surveys ○ Spotlighting ○ Active searches ○ Anabat detection ○ Terrestrial trapping (Elliot, Snake Funnel, Camera, Hair

ACTIVITY	SURVEY DATES	SURVEY EFFORT
		Tube and Pitfall) • Targeted survey for threatened flora species

4.2 NSW listed threatened species and ecological communities

Based on searches of the Atlas of NSW Wildlife (OEH 2013a), review of relevant literature, vegetation mapping, constraints analysis, results of flora and fauna surveys, presence of suitable habitat and professional judgement, a number of TSC Act listed species and ecological communities have been identified as having the potential to be impacted within PEL 238 (within all existing and currently planned early-stage exploration and production appraisal sites – known for this report as 'exploration activity areas').

The likelihood of presence or absence of species and ecological communities has been assessed with full details provided in **Appendix A**.

A summary of this likelihood of occurrence has been present below for the ecological values defined as known, likely or potential to occur within the exploration activity areas. These terms are defined as follows:

Likelihood of occurrence	Definition
Known	the species was or has been observed in the area
Likely	a medium to high probability that a species uses the area
Potential	suitable habitat for a species occurs, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur

Twenty-four bird species, fourteen mammals, one reptile, eight plants and three ecological communities which are listed under the NSW TSC Act are determined to have a likelihood of occurrence of 'known', 'likely', or 'potential' within the exploration activity areas (**Table 2**).

Impacts to these (and other) species have been considered in the various ecological reports and REFs for existing and planned exploration activities. A number of other species have been considered in relation to their likelihood of occurrence within the exploration activity areas and determined to be unlikely to occur, as the area is outside of their distribution, and/or suitable habitat is not present. These species are not addressed in detail in this report, but have been considered in supporting ecological reports and are outlined in a full likelihood of occurrence table in **Appendix A**.

Table 2: NSW TSC Act threatened species and ecological communities listed as having a likelihood of occurrence of 'known', 'likely' or 'potential'.

SCIENTIFIC NAME	COMMON NAME	TSC ACT STATUS	LIKELIHOOD OF OCCURRENCE IN PROGRAM AREA
Birds			
Anthochaera phrygia	Regent Honeyeater	Critically Endangered	Potential
Ardeotis australis	Australian Bustard	Endangered	Potential
Burhinus grallarius	Bush Stone-curlew	Endangered	Known
Calyptorhynchus lathami	Glossy Black-Cockatoo	Vulnerable	Known
Chthonicola sagittata	Speckled Warbler	Vulnerable	Known
Circus assimilis	Spotted Harrier	Vulnerable	Potential
Daphoenositta chrysoptera	Varied Sittella	Vulnerable	Known
Falco hypoleucos	Grey Falcon	Endangered	Potential
Glossopsitta pusilla	Little Lorikeet	Vulnerable	Known
Grantiella picta	Painted Honeyeater	Vulnerable	Likely
Hamirostra melanosternon	Black-breasted Buzzard	Vulnerable	Potential
Hieraaetus morphnoides	Little Eagle	Vulnerable	Potential
Lathamus discolor	Swift Parrot	Endangered	Potential
Lophoictinia isura	Square-tailed Kite	Vulnerable	Likely
Melanodryas cucullata	Hooded Robin	Vulnerable	Known
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	Vulnerable	Likely
Neophema pulchella	Turquoise Parrot	Vulnerable	Known
Ninox connivens	Barking Owl	Vulnerable	Known
Pachycephala inornata	Gilbert's Whistler	Vulnerable	Potential
Petroica boodang	Scarlet Robin	Vulnerable	Potential
Polytelis swainsonii	Superb Parrot	Vulnerable	Potential
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	Vulnerable	Known
Stagonopleura guttata	Diamond Firetail	Vulnerable	Known
Tyto novaehollandiae	Masked Owl	Vulnerable	Likely
Reptiles			
Hoplocephalus bitorquatus	Pale-headed Snake	Vulnerable	Likely

SCIENTIFIC NAME	COMMON NAME	TSC ACT STATUS	LIKELIHOOD OF OCCURRENCE IN PROGRAM AREA
Mammals			
Aepyprymnus rufescens	Rufous Bettong	Vulnerable	Potential
Cercartetus nanus	Eastern Pygmy-possum	Vulnerable	Known
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	Potential
Chalinolobus picatus	Little Pied Bat	Vulnerable	Known
Dasyurus maculatus	Spotted-tailed Quoll	Vulnerable	Potential
Macropus dorsalis	Black-striped Wallaby	Endangered	Known
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Vulnerable	Known
Nyctophilus timoriensis / Nyctophilus corbeni	Greater Long-eared Bat / South-eastern Long eared Bat	Vulnerable	Known
Petaurus norfolcensis	Squirrel Glider	Vulnerable	Likely
Phascolarctos cinereus	Koala	Vulnerable	Known
Pseudomys pilligaensis	Pilliga Mouse	Vulnerable	Known
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Potential
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable	Known
Vespadelus troughtoni	Eastern Cave Bat	Vulnerable	Known
Flora			
Bertya opponens	Coolabah Bertya	Vulnerable	Potential
Diuris tricolor	Painted Diuris	Vulnerable	Likely
Lepidium monoplocoides	Winged Peppercress	Endangered	Potential
Polygala linariifolia	Native Milkwort	Endangered	Known
Pomaderris queenslandica	Scant Pomaderris	Endangered	Potential
Pterostylis cobarensis	Greenhood Orchid	Vulnerable	Known
Rulingia procumbens	-	Vulnerable	Potential
Tylophora linearis	-	Vulnerable	Known
Endangered Ecological Communities			
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions		Endangered	Known
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland		Endangered	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT STATUS	LIKELIHOOD OF OCCURRENCE IN PROGRAM AREA
Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions		Endangered	Known

4.3 Impacts of exploration activities

4.3.1 Impacts to vegetation

The impact associated with CSG exploration activities in PEL 238 from 2002 to present is 200.94 ha (excluding 12.2 ha within the Pilliga Forest as a result of exploration activities pre-ESG prior to 2002) (**Table 3**). This represents a loss of approximately 0.42% of consolidated vegetation within the study area and 0.04% of all vegetation within the PEL 238 area.

The proposed exploration activities will contribute an additional 58.5 ha of vegetation clearing which includes 36.42 ha in remnant woodland and 22.08 ha to be located within previously disturbed flowline corridors (**Table 4**). The previously disturbed woodland has not been included in the calculations for the impact assessments as part of the proposed exploration activities due to its highly disturbed nature and its inclusion in the cleared areas to date. The proposed exploration activities therefore represent approximately 0.08% of consolidated vegetation within the study area and less than 0.01% of all vegetation within the PEL 238 area.

This equates to a cumulative impact from the exploration activities (combining existing and proposed activities) of 237.36 ha, representing approximately 0.50% of consolidated vegetation within the study area and 0.045% of all vegetation within the PEL 238 area.

Impacts associated with exploration activities have occurred in a staged manner with progressive regeneration and rehabilitation of components of the activities. For temporary exploration works (core holes and seismic lines) and flowlines, works are generally completed within a short period (approximately 6 weeks) following which the vegetation is allowed to naturally regenerate. For more permanent exploration activities (e.g. pilot wells) topsoil has been stockpiled and the well sites will be rehabilitated on completion of the pilot programs.

Wherever possible, the exploration activities have utilised existing tracks for access, for conducting surveys and for the installation of flowline infrastructure. Some of the exploration has taken place in areas that have previously been cleared and are used for activities such as farming and grazing. Impacts are largely linear in nature within the context of a well vegetated landscape predominately managed for forestry. Given the relatively small amount of clearing as a proportion of available habitat, the current land uses and extent of rehabilitation, exploration impacts are generally not expected to significantly fragment or reduce the availability of habitat in a way which will adversely affect species within the PEL 238 area.

Table 3: Areas of clearing for exploration activities within PEL 238, PAL 2 and PPL 3 undertaken from 2002 to present

VEGETATION TYPE	AREA OF CLEARING (HA)
Brigalow - Belah woodland on alluvial often gilgaied clay soil mainly in the Brigalow Belt South Bioregion (Benson 35)	10.22
Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	9.08
Derived Grassland[#]	74.89
Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion (Benson 202)	1.77
Native Millet – Cup grassland of the Darling Riverine Plain Bioregion (Benson 214)	1.94
Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88)[#]	11.77
Plains Grass grassland on basaltic black earth soils mainly on the Liverpool Plains in the Brigalow Belt South Bioregion	0.38
Red Ironbark - Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion	1.66
Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	10.90
Semi-permanent open freshwater wetlands of the inland slopes and plains (Benson 238)	0.25
White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	78.08
Total	**200.94**

The Leewood Produced Water Facility will result in the removal of 48.2 ha of vegetation, 41.4 ha of which is derived native grassland, the remaining 6.8 ha consists of scattered paddock trees conforming with Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland. Construction of the Leewood Produced Water Facility has commenced, but vegetation has not yet been cleared.

Table 4: Areas of clearing of proposed exploration activities (2013 onwards)

VEGETATION TYPE	AREA OF CLEARING (HA)
Areas of clearing within remnant vegetation	
Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	3.36
Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	1.37

VEGETATION TYPE	AREA OF CLEARING (HA)
White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	31.69
Total	**36.42**
Areas of clearing within previously cleared CSG areas (regenerating)#	
Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	1.20
Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88)	2.14
Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion	3.90
White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	14.84
Total	**22.08**

These areas were cleared approximately 5 years ago and have since been allowed to naturally regenerate. The current condition of these areas approximates 50% of values in adjoining areas. Due to previous clearing, these areas support little to no potential habitat for TSC Act listed ecological values.

4.3.2 Impacts to fauna habitat

The total amount of potential foraging, breeding and roosting/sheltering habitat has been calculated for the disturbance areas of the existing and proposed exploration activities, to inform the significant impact assessments for the cumulative impacts from all CSG activities (**Table 5**). The amount of loss of potential habitat in relation to the vegetation present within the PEL 238 area has also been calculated.

Determination of the different types of habitat (foraging, breeding, roosting/sheltering) for individual threatened fauna species was made by first allocating vegetation types that would be used for foraging, breeding, and roosting/sheltering to individual species. The areas impacted were then summed for all vegetation types representing the type of habitat used by individual species.

The calculations include areas of clearing for exploration activities undertaken from 2002 to present and proposed exploration activities within remnant vegetation only.

Table 5: Cumulative direct impacts areas to potential threatened fauna habitat

SPECIES	FORAGING (HA) / LOSS IN PEL 238 (%)	BREEDING (HA) / LOSS IN PEL 238 (%)	ROOSTING (HA) / LOSS IN PEL 238 (%)
Glossy Black-Cockatoo	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05
Little Lorikeet	237.1 / 0.08	159.9 / 0.05	159.9 / 0.05
Superb Parrot	237.1 / 0.08	n/a	159.9 / 0.05
Swift Parrot	237.1 / 0.08	n/a	159.9 / 0.05

SPECIES	FORAGING (HA) / LOSS IN PEL 238 (%)	BREEDING (HA) / LOSS IN PEL 238 (%)	ROOSTING (HA) / LOSS IN PEL 238 (%)
Turquoise Parrot	237.1 / 0.08	159.9 / 0.05	159.9 / 0.03
Barking Owl	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05
Masked Owl	237.1 / 0.08	n/a	n/a
Black-breasted Buzzard	113.5 / 0.63	n/a	12.3 / 0.09
Grey Falcon	113.5 / 0.63	n/a	12.3 / 0.09
Little Eagle	237.1 / 0.08	159.9 / 0.05	159.9 / 0.05
Spotted Harrier	110.9 / 0.36	36.0 / 0.20	36.0 / 0.20
Square-tailed Kite	237.1 / 0.05	12.3 / 0.09	12.3 / 0.09
Australian Bustard	220.7 / 0.17	n/a	145.8 / 0.11
Bush Stone-curlew	220.7 / 0.17	145.8 / 0.11	145.8 / 0.11
Diamond Firetail	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Gilbert's Whistler	223.0 / 0.17	145.8 / 0.11	145.8 / 0.11
Grey-crowned Babbler (eastern subspecies)	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Hooded Robin	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05
Scarlet Robin	237.1 / 0.08	n/a	159.9 / 0.05
Speckled Warbler	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05
Varied Sittella	237.1 / 0.08	159.9 / 0.05	159.9 / 0.05
Black-chinned Honeyeater (eastern subspecies)	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Painted Honeyeater	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Regent Honeyeater	159.9 / 0.05	n/a	159.9 / 0.05
Yellow-bellied Sheathtail-bat	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Greater Long-eared Bat	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Eastern Bentwing-bat	237.1 / 0.05	n/a	n/a
Eastern Cave Bat	237.1 / 0.05	n/a	n/a
Large-eared Pied Bat	237.1 / 0.05	n/a	n/a
Little Pied Bat	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Grey-headed Flying-fox	159.9 / 0.05	n/a	n/a
Koala	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05

SPECIES	FORAGING (HA) / LOSS IN PEL 238 (%)	BREEDING (HA) / LOSS IN PEL 238 (%)	ROOSTING (HA) / LOSS IN PEL 238 (%)
Squirrel Glider	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Black-striped Wallaby	224.9 / 0.05	147.6 / 0.03	147.6 / 0.03
Eastern Pygmy-possum	159.9 / 0.05	147.6 / 0.05	147.6 / 0.05
Pilliga Mouse	26.3 / 0.01	n/a	n/a
Spotted-tailed Quoll	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Rufous Bettong	212.8 / 0.16	135.6 / 0.10	135.6 / 0.10
Pale-headed Snake	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05

4.3.3 Limitations

The regional vegetation class data utilised in this report is derived from a regional scale map that contains a proportion of modelling. Other datasets utilised are of varying scales and accuracies.

4.4 Key Threatening Processes

The following Key Threatening Processes (KTP) shown with a response following are considered relevant to the exploration activities include:

- Clearing of native vegetation (TSC Act)

Impacts of the exploration activities within PEL 238 on native vegetation in terms of clearing have been outlined in **Section 4.3**. Given that the cumulative impact associated with existing and proposed exploration activities totals 237.36 ha, this KTP is likely to be exacerbated. However, the amount of vegetation to be cleared has been minimised, with clearing of EECs and rare vegetation types avoided as far as practicable. Offsets will be provided to compensate for vegetation loss. Furthermore, vegetation temporarily slashed and mulched will be allowed to regenerate and infrastructure will be progressively rehabilitated as it is decommissioned.

- Competition and grazing by the feral European rabbit (TSC Act)

The European Rabbit currently inhabits PEL 238 area in low numbers. The existing exploration activities have disturbed soils and stockpiled materials (including soil and logs) which have the potential to encourage feral species such as European Rabbit. As such, the exploration activities have the potential to further exacerbate this KTP, although provided rehabilitation and feral animal control programs are implemented correctly, increases in this KTP due to the exploration activities are likely to be low.

- Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758 (TSC Act)

Feral Goats currently inhabit PEL 238. The proposed exploration activities would not create additional conditions that would favour the species and as such, it is unlikely that the proposed exploration activities would exacerbate this KTP.

- Degradation of native riparian vegetation along NSW watercourses (FM Act)

The exploration activities have been developed in a manner which minimises the potential impact on Bohena Creek and other drainage lines throughout the PEL 238 area. The number of creek crossings have been minimised and riparian zones have been avoided, where possible.

The proposed exploration activities would avoid riparian areas for the most part, and would seek to minimise impacts on core riparian zones. Sediment controls would be placed around construction work areas where there is a risk of sedimentation of creeks. Therefore it is considered unlikely that the proposed exploration activities would result in the degradation of native riparian vegetation.

- Ecological consequences of high frequency fires (TSC Act)

There is potential for fire during the construction and operation phases of the exploration activities, particularly given the flammability of CSG, which could greater fuel a fire should there be any gas leaks near ignition sources. Provided bushfire prevention and mitigation measures (e.g. adequate asset protection zones) are implemented, it is unlikely that the exploration activities would alter current fire regimes across the site.

- Infection of native plants by *Phytophthora cinnamomi* (TSC Act)

The exploration activities would clear vegetation for gas wells, flowlines and associated infrastructure, and the machinery used could carry the spores of the root-rot fungus, *Phytophthora cinnamomi*, which could result in the infection of native plants. Provided adequate controls (pre-start checks and vehicle cleaning protocols) are implemented to ensure machinery entering the PEL 238 area has been decontaminated, it is unlikely that native plants would be infected by this fungus.

- Invasion of native plant communities by exotic perennial grasses (TSC Act)

There is the potential for the exploration activities to result in the spread of exotic perennial grasses. Provided mitigation measures to prevent the spread of weeds and exotic perennial grasses are implemented (pre-start checks, vehicle cleaning protocols and weed control measures), the spread of weeds within PEL 238 area is likely to be minimal.

- Loss of hollow-bearing trees (TSC Act)

The exploration activities are likely to result in the removal of hollow-bearing trees and therefore this KTP would be exacerbated. Despite the removal of hollow-bearing trees, the majority of hollow-bearing trees within the study area would be retained and felled trees (apart from merchantable trees within State Forests which will be provided to Forests NSW in accordance with Santos' Occupation Permit) will be utilised for fauna habitat reconstruction.

- Predation by feral cats (TSC Act)

Feral cats are likely to be present within the PEL 238 area, and have been recorded during previous surveys of East Pilliga (NPWS 2000). The proposed flowlines and access roads could increase the access of this species to additional areas and hence exacerbate this KTP. A feral animal control strategy will be prepared and implemented throughout the life of the program to minimise potential impacts from feral cats.

- Predation by the European Red Fox (TSC Act)

The European Red Fox is present across the PEL 238 area. The proposed flowlines and access roads are likely to increase the access of this species to additional areas and exacerbate this KTP.

A feral animal control strategy will be prepared and implemented throughout the life of the program to minimise potential impacts from the European Red Fox

- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) (TSC Act)

The Feral Pig is present across PEL 238 and has impacted on flora and fauna habitats throughout this area. However, given that the exploration activities are unlikely to create additional conditions that would favour the species, it is considered unlikely that the exploration activities would further exacerbate this KTP. A feral animal control strategy will be prepared and implemented throughout the life of the program to minimise potential impacts from the Feral Pig.

- Removal of dead wood and dead trees (TSC Act)

Dead wood is present across the PEL 238 area and provides habitat for a number of reptile and small mammal species. Dead trees are also present across the study area, and many of the dead trees also support hollows, providing habitat for some hollow-dependent species including bird, bat, mammal and reptile species. Where dead wood and trees are removed for the exploration activities they are stockpiled and utilised in the rehabilitation process and hence the exploration activities are unlikely to exacerbate this KTP.

5 Significance assessment under the TSC Act

The following section provides an assessment of the potential significance of the cumulative impacts from exploration activities on ecological values listed under the TSC Act. The ecological values considered relevant to this assessment are identified in **Section 4.2** of this report and consider both the existing and planned exploration activities.

The ecological values have been grouped for the assessment process with other values that contain similar characteristics and those that are likely to be impacted in a similar manner.

The assessment of impact has been conducted where necessary with consideration to the 7-part test criteria (or assessment of significance), as outlined in the text box below:

7-Part Test Assessment of Significance

1. *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.*
2. *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.*
3. *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,*
4. *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, an*
    - *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*
5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).*
6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*
7. *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.*

The fauna groupings for the assessment of significance for TSC ecological values include:

Birds

- Parrots:
  - Glossy Black-Cockatoo, Little Lorikeet, Superb Parrot, Swift Parrot & Turquoise Parrot
- Owls:
  - Barking Owl & Masked Owl
- Birds of prey:
  - Spotted Harrier, Grey Falcon, Black-breasted Buzzard, Little Eagle & Square-tailed Kite
- Woodland birds – large ground foraging:
  - Australian Bustard & Bush Stone-curlew
- Woodland birds – ground and mid-storey foraging (passerines):
  - Grey-crowned Babbler, Diamond Firetail, Gilbert's Whistler, Scarlet Robin, Speckled Warbler, Varied Sittella and Hooded Robin
- Woodland birds – canopy foraging (excluding parrots):
  - Regent Honeyeater, Painted Honeyeater and Black-chinned Honeyeater

Mammals

- Arboreal mammals and megabats*:*
  - Grey-headed Flying Fox, Koala & Squirrel Glider
- Mid-storey and log dependent mammals*:*
  - Black-striped Wallaby, Eastern Pygmy-possum, Pilliga Mouse & Spotted-tailed Quoll
- Grassy woodland mammals*:*
  - Rufous Bettong
- Predominantly tree-roosting bats*:*
  - Yellow-bellied Sheathtail-bat & Greater Long-eared Bat
- Predominantly cave-roosting bats*:*
  - Eastern Bentwing-bat, Eastern Cave Bat, Large-eared Pied Bat & Little Pied Bat

Reptiles

- Tree and log dependent reptiles
  - Pale-headed Snake

Plants

- *Bertya opponens, Diuris tricolor, Lepidium monoplocoides, Polygala linariifolia, Pomaderris queenslandica, Pterostylis cobarensis, Rulingia procumbens* and *Tylophora linearis*

Ecological Communities

- *Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions*
- *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland*
- *Fuzzy Box Woodland on alluvial soils*

5.1 Birds

5.1.1 Parrots

The Glossy Black-Cockatoo, Little Lorikeet, Superb Parrot, Swift Parrot and Turquoise Parrot are considered in this impact assessment. Only the Glossy Black Cockatoo, Little Lorikeet and Turquoise Parrot have been recorded in the exploration activity areas.

The exploration activities could potentially impact on the life cycles of these threatened parrots by reducing the amount of foraging, roosting and breeding habitat available to the species, by increasing mortality rates via vehicle collisions and by spreading weeds. Superb Parrots do not breed in the study area, and Swift Parrots breed in Tasmania. Thus, only potential foraging and roosting habitat would be reduced by the exploration works for these species. Glossy Black Cockatoos, Little Lorikeets, and Turquoise Parrots forage, roost and potentially breed across the exploration activity areas.

The exploration activities have resulted in the removal and/or modification of up to 200.6 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened parrot species with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impact as a result of the exploration activities is 237.1 ha (**Table 5**). However, this loss is considered relatively minor in the context of similar habitats within PEL 238, constituting up to 0.05% of available habitat for the threatened parrot species.

The disturbance from the exploration activities is considered unlikely to isolate larger areas of potential habitat or impact on important habitat for the threatened parrot species. This is especially true given the highly mobile nature of these parrots. Superb and Swift Parrots are able to migrate large distances from their breeding habitats in southern NSW to northern NSW, and from Tasmania to northern NSW, respectively. Glossy Black Cockatoos, Little Lorikeets, and Turquoise Parrots also move distances to access their foraging resources, although Little Lorikeets have been found to be less nomadic during breeding periods (SEWPaC 2013).

The scale of the fragmentation in relation to the total area of potential habitat and individual fragments of habitat within PEL 238 is considered relatively minor in relation to these highly mobile species. In addition, following the construction of linear infrastructure for the exploration activities, vegetation above the buried flowlines (ground and shrub layers) would be largely rehabilitated, reducing the width of the disturbed habitat between undisturbed habitat fragments and thus, limiting the level of habitat fragmentation.

Although the number of hollow bearing trees (HBTs) to be impacted by the exploration activities has not been calculated within the exploration activity areas, it can be assumed that the scale of loss in the context of the HBTs available in the broader study area is not significant based on the extent of habitat present. In addition, no critical habitat, recovery plans or threat abatement plans exist or are relevant for the Glossy Black-Cockatoo, Little Lorikeet, Superb Parrot, Swift Parrot or Turquoise Parrot in the study area.

The exploration activities are unlikely to constitute a significant impact on the threatened parrot species given that the extent of the activities:

- Have been designed to minimise the total area of habitat to be impacted
- Would only remove a small proportion of the total area of habitat available to these species
- Would not isolate or significantly fragment areas of potential habitat given the highly mobile nature of these species.

On the basis of the above considerations, it is unlikely that the activities will result in a significant impact on the survival of the Glossy Black-Cockatoo, Little Lorikeet, Superb Parrot, Swift Parrot or Turquoise Parrot.

5.1.2 Owls

The Barking Owl and Masked Owl are considered in this impact assessment. These species predominately inhabit woodland and/or dry eucalypt forest where there are suitable hollow-bearing trees for nesting. They both have large home ranges (up to 2,000 ha of Barking Owl and 1,000 ha for Masked Owl) and use a variety of habitats to forage, including closed forest and more open areas.

Despite only the Barking Owl having been recorded in the exploration activities area, the activities could potentially impact on the life cycles of the two owl species by reducing the amount of foraging, roosting and breeding habitat available to the Barking Owl and known foraging habitat for the Masked Owl. The Pilliga Forest, particularly the western Pilliga, is a stronghold of the Barking Owl which supports the largest remaining population of the species in NSW (NPWS 2003; Kavanagh and Stanton 2009).

The exploration activities have resulted in the removal and/or modification of up to 200.7 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened owl species with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impacts as a result of the exploration activities is 237.1 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitat within PEL 238, constituting up to 0.08% of available habitat for the threatened owl species.

However, the greatest concern resulting from the exploration activities is the potential removal of breeding habitat (HBTs) for the Barking Owl and whether breeding pairs are present or near vegetation to be removed. The cumulative impact to potential breeding habitat for the Barking Owl is 159.9 ha (as part of the larger 237.1 ha foraging habitat). Barking Owls nest in areas that are less disturbed than surrounding areas, and are highly susceptible to disturbance during the breeding season. If breeding sites are disturbed, this could lead to the abandonment of the breeding site by a nesting pair of birds. Barking Owls predominately use large Red Gum and Narrow-leafed Ironbark HBTs for nesting, but can use large dead ringbarked trees (Kavanagh and Stanton 2009). Masked Owls are unlikely to use the study area to breed as this species roosts and breeds in moist eucalypt forested gullies (SEWPaC 2013).

A number of measures have been implemented to minimise the impact area. The activities have been designed and micro-sited to minimise the number of HBTs which would be removed. As such, it is unlikely that the activities would significantly impact Masked Owls. For this species, only foraging habitat would be lost. This removal of foraging habitat would not represent a significant loss to Masked Owls, as the species is highly mobile with the ability to hunt over areas of between 500 and 1000 ha, and the total impact areas are much less than the species' territory.

Remnant vegetation would be cleared as a result of the proposed exploration activities (**Table 3** & **4**), including an unspecified number of HBTs. However, if known breeding sites for the Barking Owl are avoided, the scale of these impacts in the context of the habitat and HBTs available within PEL 238 is considered relatively minor. In consideration of the above, the exploration activities are unlikely to constitute a significant impact on the Barking Owl, if areas of breeding pairs are avoided. Furthermore, the activities:

- Have been designed to minimise the total area of foraging and roosting habitat to be impacted including the number of HBTs to be removed

- Would only impact upon foraging and roosting habitat, which is widespread within the exploration activities area and the broader PEL 238, and as such constitutes the removal of only a very minor proportion of this habitat
- Would not isolate areas of potential habitat from currently interconnecting areas of potential habitat for these highly mobile species.

5.1.3 Birds of prey

The Spotted Harrier, Grey Falcon, Black-breasted Buzzard, Little Eagle and Square-tailed Kite are considered in this impact assessment. These species are found in a range of woodland, forest and open habitats, however, all have been associated with some form of riparian habitat, such as timbered watercourses or inland wetlands that can be used for breeding or foraging.

None of these species have been recorded within the exploration activity areas. However, the activities could potentially impact on the life cycles of the bird of prey species by reducing the amount of potential foraging, breeding or roosting habitat available to these species. All of the birds of prey are highly mobile species that have extensive home ranges. Black-breasted Buzzard, Grey Falcon, Spotted Harrier, and Square-tailed Kite have been identified as species that are negatively impacted by land clearing, with Black-breasted Buzzard, Grey Falcon, and Square-tailed Kite also negatively impacted by river/stream modification (and therefore habitat loss) in the Brigalow Belt South Bioregion (Biosis 2002).

The exploration activities have resulted in the removal and/or modification of up to 200.7 ha of potential habitat (primarily foraging habitat) for the Little Eagle and Square-tailed Kite with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impact as a result of the exploration activities for these two species is 237.1 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitats within PEL 238, constituting up to 0.08% of available habitat for the birds of prey.

The exploration activities have resulted in the removal and/or modification of up to 112.1 ha of potential habitat (primarily foraging habitat) for the Spotted Harrier, Grey Falcon and Black-breasted Buzzard with a further 1.4 ha of potential habitat proposed to be removed. The cumulative impact as a result of the exploration activities for these three species is up to 113.5 ha (**Table 5**). This is minor when considered in the context of the habitat available within PEL 238, constituting up to 0.63% of available foraging habitat.

In addition, the proposed activities involve relatively small impacts to remnant riparian vegetation (primarily the Pilliga Box – Poplar Box – White Cypress, Rough-barked Apple and Fuzzy Box vegetation types), which are used most commonly by these species for foraging, breeding or roosting, and is the most important habitat type for these species (**Table 5**). The exploration activities will only involve minor impacts upon the larger riparian corridors in the broader PEL 238, thus retaining extensive areas of similar riparian woodland habitats in the locality. As such the small area to be impacted by the activities is not considered to be of high importance for the birds of prey. Furthermore, no critical habitat has been declared for these threatened birds of prey.

As the areas most frequently used by birds of prey would be predominately avoided, the majority of these birds would also be less likely to be impacted by indirect disturbance from noise or traffic, and by habitat degradation through weed invasion. No new major creek crossings traversing potential foraging, breeding and roosting habitat would be constructed, and no in stream devices would be installed which would impact on the hydrology of creek lines and the integrity of riparian vegetation. In addition, indirect impacts have and will been minimised through appropriate controls, best-practice construction techniques, rehabilitation of disturbed areas and weed control programs.

With consideration to the above, the exploration activities are considered unlikely to constitute a significant impact on the Black-breasted Buzzard, Grey Falcon, Little Eagle, Spotted Harrier and Square-tailed Kite as they:

- Would predominantly avoid the most important habitat areas for these species (riparian habitats and timbered watercourses)
- Have been designed to minimise the total area of foraging and roosting habitat to be impacted
- Would only remove a small proportion of the total area of habitat available to these species in PEL 238
- Would not isolate areas of potential habitat from currently interconnecting areas of potential habitat for these highly mobile species.

5.1.4 Woodland birds – large ground foraging

The Australian Bustard and Bush Stone-curlew are considered in this impact assessment. The Australia Bustard mainly inhabits tussock and hummock grasslands while the Bush Stone-curlew inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.

Only the Bush Stone-curlew has been recorded within exploration activity areas. However, the activities could potentially impact on the life cycles of both these threatened woodland birds by reducing the amount of foraging, roosting and breeding habitat available to the species. Australian Bustards do are unlikely to breed within the exploration areas, so only potential foraging and roosting habitat would be reduced by the activities for this species. Bush Stone-curlews forage and potentially breed across the exploration activity areas.

The exploration activities have resulted in the removal and/or modification of up to 189.9 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened woodland birds with a further 33.1 ha of potential habitat proposed to be removed. The cumulative impacts as a result of the exploration activities is 220.7 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitat within PEL 238, constituting up to 0.17% of available habitat for these threatened woodland birds.

The area of habitat to be impacted by the activities has been minimised through modifications to the design of the impact footprints and micro-siting of any well sites. Furthermore, extensive areas of similar habitat (vegetation representative of foraging and/or breeding habitat) to those which would be impacted from the exploration activities would be retained both in the exploration activities area and PEL 238.

Areas of habitat that would not be removed could be indirectly impacted by disturbance to the point that Australian Bustards and Bush Stone-curlews could avoid these areas of potential habitat. Indirect impacts could include noise, edge effects, increased traffic volumes, and incursion of weeds that effectively reduces the foraging resources of these two species. The implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these indirect impacts. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, weed and feral animal control programs.

A recovery plan has been prepared for the Bush Stone-curlew (NPWS 2006) which has the overall objective of managing at least five populations of the species across NSW to ensure they are secure and consistently increasing in both extent of occurrence and area of occupancy. The exploration activities are being conducted in a manner than is not inconsistent with the objectives of the recovery

plan. In addition, the activities are not inconsistent with the objectives of the threat abatement plans relevant to the two species.

It is considered unlikely that the exploration activities will constitute a significant impact on the Australian Bustard or Bush Stone Curlew as:

- The woodland areas which would be impacted by the activities are widespread within PEL 238. Therefore, the impact area is not considered to be of high importance for the two species. In addition, no critical habitat has been declared by the Director General for Australian Bustards or Bush Stone Curlews
- The activities have been designed to minimise the total area of foraging and roosting habitat to be impacted
- The implementation of mitigation measures is considered sufficient to manage the threat of indirect impacts.

5.1.5 Woodland birds – ground and mid-storey foraging (passerines)

The Grey-crowned Babbler, Diamond Firetail, Gilbert's Whistler, Scarlet Robin, Speckled Warbler, Varied Sittella and Hooded Robin are considered in this impact assessment. These species inhabit a range of woodland habitats associated with the exploration activities and within the broader study area. The habitats also range in structural density and complexity.

Only the Grey-crowned Babbler, Speckled Warbler, Diamond Firetail and Hooded Robin have been recorded in the exploration activity areas.

The exploration activities could potentially impact on the life cycles of these woodland birds by reducing the amount of foraging, sheltering and breeding habitat available to the species. Scarlet Robins do not breed in the area. Diamond Firetails, Gilbert's Whistlers, Grey-crowned Babblers, Hooded Robins, Speckled Warblers, and Varied Sittellas forage and potentially breed across the areas impacted by the exploration activities. These species have also been identified as species that are negatively impacted by land clearing, with Diamond Firetails, Gilbert's Whistler, and Speckled Warblers also negatively impacted by inappropriate fire regimes (and therefore habitat loss) (Biosis 2002).

The exploration activities have resulted in the removal and/or modification of up to 200.7 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened ground and mid-storey foraging woodland birds with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impacts as a result of the exploration activities is 237.1 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitat within PEL 238, constituting up to 0.05% of available habitat for these threatened birds.

The exploration activities would not involve significant impacts upon the larger riparian corridors in the broader study area, thus retaining the majority of riparian woodland habitats, which are considered to represent the areas most frequently used by these species for foraging and/or breeding and roosting. The woodland areas away from the riparian corridors, which would be impacted by the activities, are widespread within the broader study area. As such the small area to be impacted by the exploration activities is not considered to be of high importance for ground and mid-storey foraging woodland birds.

In addition, no critical habitat has been declared by the Director General for Brown Treecreepers, Diamond Firetails, Gilbert's Whistlers, Grey-crowned Babblers, Hooded Robins, Scarlet Robins, Speckled Warblers, or Varied Sittellas.

Many of the ground and mid-storey foraging woodland birds require remnants of minimum sizes. Diamond Firetails appear unable to persist in areas which lack remnants larger than 200 ha. Hooded Robins appear unable to survive in remnants smaller than 100-200 ha. Scarlet Robins are less common in isolated patches of 30 ha or less where there is no tree cover within 200 m and less than 20% cover within 1 km. Speckled Warblers require remnants larger than 100 ha in size (NSW Scientific Committee 2001). Isolation of populations in small remnants increases vulnerability to local extinction as a result of stochastic events and can decrease their genetic viability in the long term.

Nevertheless, the design of the exploration activities is considered unlikely to isolate large areas of potential habitat from one another. While some species, such as Grey-crowned Babblers which have laborious flight, may be unable to fly across well pads, vegetation surrounding these sites would be retained and allow for these species to move between the exploration activity areas. Vegetation above any linear infrastructure would be rehabilitated, reducing the width of the disturbed habitat type and thus, reducing the level of fragmentation.

Areas of habitat that would not be removed could be indirectly impacted by disturbance to the point that ground and mid-storey foraging woodland birds could avoid these areas of potential habitat. Habitats fragmented by new access roads, or well pad and other exploration activity areas, would experience increased edge effects, including increased traffic volumes, which ground and mid-storey foraging woodland birds could avoid. Weeds could invade remaining areas of habitat reducing the foraging resources of Diamond Firetail, Gilbert's Whistler, and Speckled Warbler, which amongst other food resources, feed on native grasses, vegetative material and seeds. However, the implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these indirect impacts. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, weed and feral animal control programs. Furthermore, the exploration activities are not inconsistent with the objectives of any threat abatement plan relevant to ground and mid-storey foraging woodland species.

In conclusion, the exploration activities are unlikely to constitute a significant impact on, Grey-crowned Babbler, Diamond Firetail, Gilbert's Whistler, Scarlet Robin, Speckled Warbler, Varied Sittella and Hooded Robin as the proposed activities:

- Would minimise impacts on the most important habitat areas for these species (large alluvial woodland areas)
- Have been designed to minimise the total area of foraging, roosting and breeding habitat to be impacted
- Would only remove a minor proportion of the total area of habitat available to these species. In addition, the activities will retain significant proportions of grassy woodland habitats in PEL 238
- Are unlikely to isolate or reduce areas of potential habitat from interconnecting areas of similar habitat to the point that thresholds for remnants of minimum sizes for these species are met.

5.1.6 Woodland birds – canopy foraging (excluding parrots)

The Black-chinned Honeyeater, Regent Honeyeater and Painted Honeyeater are considered in this impact assessment. The Black-chinned Honeyeater occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark, White Box, Inland Grey Box, Yellow Box and Forest Red Gum. The Painted Honeyeater inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. The Regent Honeyeater inhabits dry open forest and

woodland, particularly Box-Ironbark woodland, and riparian forests of *Casuarina cunninghamiana* (River Oak).

None of these species have been recorded within the exploration activity areas. However, the activities could potentially impact on the life cycles of Black-chinned, Painted, and Regent Honeyeaters by reducing the amount of foraging, roosting and breeding habitat available to the species (**Table 5**). Regent Honeyeaters are not considered likely to breed in PEL 238. Black-chinned and Painted Honeyeaters forage, roost and breed across the PEL 238 area. All three of the species have been identified as species that are negatively impacted by land clearing (and therefore habitat loss) (Biosis 2002).

The exploration activities have resulted in the removal and/or modification of up to 123.5 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened canopy feeding woodland birds with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impacts as a result of the exploration activities is 159.9 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitat within PEL 238, constituting up to 0.05% of available habitat for these threatened woodland birds.

The exploration activities would largely avoid riparian vegetation communities (primarily the Pilliga Box – Poplar Box – White Cypress, Rough-barked Apple and Fuzzy Box), thus retaining grassy woodland habitats used by Black-chinned, Painted, and Regent Honeyeaters. No new major creek crossings traversing potential foraging and/or breeding habitat would be constructed, and no in stream devices would be installed which would impact on the natural hydrology of creek lines and the integrity of riparian vegetation. The woodland areas which would be impacted by the exploration activities are widespread within PEL 238 and the locality. As such the small area to be impacted by the exploration activities is not considered to be of high importance for the canopy foraging woodland birds. In addition, no critical habitat has been declared for the Black-chinned, Painted, or Regent Honeyeaters.

The exploration activities could also impact on the life cycles of Black-chinned Honeyeaters through decreases in the sizes of intact habitat. Similar to some ground and mid-storey foraging woodland birds, Black-chinned Honeyeater does not persist in remnants less than 200 ha in area (NSW Scientific Committee 2001b). However, while locally nomadic, they tend to forage in home ranges of around 5 ha (OEH 2013b).

The exploration activities would also retain the majority of vegetation representing foraging, roosting and/or breeding habitat for these species. Thus, the remaining habitat remnants would not be completely fragmented from other remnants. Adjacent patches would together form larger patches of vegetation that Black-chinned, Painted, and Regent Honeyeaters would be able to use, provided these species did not avoid areas degraded by noise and light disturbance.

Areas of habitat that would not be removed could be indirectly impacted by disturbance to the point that Black-chinned, Painted and Regent Honeyeaters could avoid these areas of potential habitat. However, the implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these indirect impacts. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, weed and feral animal control programs.

Furthermore, the exploration activities are not inconsistent with the objectives of any threat abatement plan relevant to these species, nor the recovery plan prepared for the Regent Honeyeater (DNRE 1999), which has the overall objective of ensuring the species persists in the wild and is down-listed from endangered to vulnerable.

The exploration activities are unlikely to constitute a significant impact on the Black-chinned, Painted, or Regent Honeyeaters as the proposed exploration activities:

- Have been designed to minimise the total area of foraging, roosting and breeding habitat to be impacted
- Would only remove a minor proportion of the total area of habitat available to these species within PEL 238
- Would not isolate areas of potential habitat from currently interconnecting areas of habitat or reduce intact habitat to the point that Black-chinned, Painted, and Regent Honeyeaters can no longer persist.

5.2 Mammals

5.2.1 Arboreal mammals and megabats:

The Grey-headed Flying Fox, Koala and Squirrel Glider are considered in this impact assessment. Koala's inhabit eucalypt woodlands and forests. The Squirrel Glider inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest with a shrubby or *Acacia* midstorey. Grey-headed Flying-foxes forage over a range of habitats, and Koalas and Squirrel Gliders occur in a number of open Eucalypt woodland communities supporting preferred feed trees and habitat elements such as tree hollows and a shrub mid-storey layer in the case of Squirrel Gliders (OEH 2013b).

Only the Koala has been recorded within the exploration activity areas. However, the exploration activities could impact on the life cycles of Grey-headed Flying-foxes, Koalas and Squirrel Gliders by reducing the amount of foraging, roosting and breeding habitat available to the species, or degrading their habitat (**Table 5**). Grey-headed Flying-foxes do not roost or breed in the exploration activity areas, but may use it to forage, while Koalas and Squirrel Gliders forage and potentially breed across the exploration activity areas. The potential habitats of these species would be reduced directly through the clearing of vegetation, including, HBTs that could be used by Squirrel Gliders to breed and shelter. No critical habitat has been declared for these species.

The exploration activities have resulted in the removal and/or modification of up to 123.5 ha of potential habitat (foraging, breeding or roosting/sheltering) for these threatened arboreal mammal and megabat species with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impact as a result of the exploration activities is up to 159.9 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitats within PEL 238, constituting up to 0.05% of available habitat for these species.

While the exploration activities would result in the removal of some habitat, the activities have sought to avoid riparian vegetation communities (e.g. Pilliga Box – Poplar Box – White Cypress, Rough-barked Apple and Fuzzy Box) with high densities of HBTs, thus retaining the majority of hollows in this area for Squirrel Gliders, and foraging habitat for Grey-headed Flying-foxes and Koalas. In addition, the locations of the exploration activities have been flexible where possible and conducted in areas with lower densities of hollow-bearing/mature trees further supporting foraging and/or breeding resources. Other habitat elements such as logs would be stockpiled and redistributed during rehabilitation works, or would be relocated to surrounding areas.

Areas of habitat that would not be removed could be indirectly reduced/affected by fragmentation and disturbance (i.e. habitat could be degraded) impacting on Grey-headed Flying-foxes, Koalas and Squirrel Gliders. The exploration activities could also directly impact Koalas by increasing the mortality

rates of the species through increased collisions with vehicles and increased predation by feral or domestic dogs. Furthermore, Squirrel Gliders could be affected by the presence of barbed wire fences around gas well pads, as individuals can get caught on such fences when gliding (OEH 2013b).

Many of the disturbances that could potentially result from the exploration activities are listed as key threats to Grey-headed Flying Foxes, Koalas and Squirrel Gliders, such as the loss and modification of habitat. Furthermore, disturbance to roosting sites, unregulated shooting, and electrocution on powerlines are listed as key threats to Grey-headed Flying Fox. Human-induced climate change, especially drought, fragmentation of habitat, predation by feral and domestic dogs, intense fires that scorch or kill the tree canopy, and collisions with vehicles are key threats to Koalas. Fragmentation of habitat, loss of hollow-bearing trees and flowering understorey and mid-storey shrubs, and barbed wire fences in which individuals can get caught are key threats to Squirrel Glider (OEH 2013b).

The implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these indirect impacts and disturbances outlined above. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation, fauna friendly fencing (in accordance with Santos' Fencing Standard). and weed and feral animal control initiatives. Furthermore, the exploration activities are not inconsistent with the objectives of any recovery plans (Koala and Grey-headed Flying Fox) and threat abatement plans relevant to these species.

In consideration of the above, the exploration activities are not likely to have a significant impact on Grey-headed Flying-foxes, Koalas and Squirrel Gliders in the exploration activity areas.

5.2.2 Ground and log dependent mammals:

The mid-storey and log dependent mammals considered in this impact assessment are the Black-striped Wallaby, Eastern Pygmy-possum, Pilliga Mouse and Spotted-tailed Quoll.

It is important to note that the Pilliga Mouse is now considered a southern population of the widespread *Pseudomys delicatulus* (Delicate Mouse) based on genetic analyses, morphological studies and recent surveys which revealed a continuous distribution of the Delicate Mouse to the Pilliga region (Breed and Ford 2007; Ford 2008, as cited in SEWPaC 2012). It is important to note that this taxonomic change has not yet been formally recognised; hence this assessment considers the Pilliga Mouse as currently listed.

The Black-striped Wallaby prefers habitat characterised by dense woody or shrubby vegetation within three metres of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat. The Eastern Pygmy-possum appears to prefer woodland and heath habitat types, but can also be found in a rainforest and sclerophyll forests. The Pilliga Mouse is restricted to an isolated area of low-nutrient deep sand which has long been recognised as supporting a distinctive vegetation community (Pilliga Scrub), but may forage outside this vegetation type. The Spotted-tailed Quoll is found in a variety of habitats, including sclerophyll forest and woodlands, coastal heathlands and rainforests. No critical habitat has been declared for these species.

Of these species, only the Pilliga Mouse, Black-striped Wallaby and Eastern Pygmy-possum have been recorded within the exploration activity areas.

The cumulative impact from the exploration activities to Pilliga Mouse breeding habitat is up to 26.3 ha (21.6 ha previously cleared and 4.7 ha is proposed to be cleared). This represents 0.1% of all potential habitat within the study area and less than 0.01% of potential habitat within PEL 238. As such, the

clearing of up to 26.3 ha of Pilliga Mouse breeding habitat is not considered likely to have a significant impact on the Pilliga Mouse.

In addition to the direct impacts to the Pilliga Mouse habitat described above, the exploration activities (all existing and proposed) could impact on the life cycles of the other three mammal species by reducing the amount of foraging, sheltering and breeding habitat available (through clearing of vegetation), or degradation of habitat. Of particular importance is the potential removal of HBTs that could be used by Eastern Pygmy-possums and Spotted-tailed Quolls to breed and shelter.

The exploration activities have resulted in the removal and/or modification of up to 189.8 ha of potential habitat (foraging, breeding or roosting/sheltering) for Black-striped Wallaby, Eastern Pygmy-possum and Spotted-tailed Quoll with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impact as a result of the exploration activities is up to 224.9 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitats within PEL 238, constituting up to 0.05% of available habitat for these species.

The exploration activities largely avoid vegetation communities with high densities of hollows (e.g. primarily the Pilliga Box – Poplar Box – White Cypress, Rough-barked Apple and Fuzzy Box vegetation types), thus retaining hollows for Eastern Pygmy-possums to shelter and breed in, and grassy woodland habitat for Black-striped Wallabies and Spotted-tailed Quolls to forage. No new major creek crossings traversing potential foraging and/or breeding habitat would be constructed, and no in stream devices would be installed which would impact on the natural hydrology of creek lines and the integrity of riparian vegetation. Further, the locations of the exploration activities have been flexible and designed to be located in areas with lower densities of HBTs.

Areas of habitat that would not be removed could be indirectly reduced/affected by fragmentation and disturbance (i.e. habitat could be degraded) impacting on these species and/or creating barrier effects at the local level for Eastern Pygmy-possums and Pilliga Mice. Black-striped Wallabies are mobile with home ranges of 90 ha and Spotted-tailed Quolls are highly mobile with ranges between 2,000 and 5,000 ha.

Eastern Pygmy-possums have small home ranges, with males having non-exclusive home-ranges of about 0.68 ha and females about 0.35 ha (OEH 2013b), but have been recorded moving 450 m in overnight movements (Bladon *et al.* 2002). Following construction, linear infrastructure will be partially rehabilitated, reducing the width of the disturbed habitat and thus any level of fragmentation. Furthermore, habitat connectivity would be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the broader study area, limiting any fragmentation impact on the Eastern Pygmy-possum or Pilliga Mouse.

Many of the disturbances that could potentially result from the exploration activities are listed as key threats to the ground and log dependent mammals. Clearing and fragmentation of habitat and degradation of habitat (through grazing, weeds, collection of firewood, or inappropriate levels of Broombush harvesting) are listed as key threats to these species. Inappropriate fire regimes affecting habitat elements and predation by introduced animals including cats, foxes, and dogs are key threats to Black-striped Wallabies, Eastern Pygmy-possums and Pilliga Mice. Deliberate or accidental killing by poisoning or shooting/trapping are threats to Black-striped Wallabies and Spotted-tailed Quolls. Further, risk of local extinction because populations are small and isolated is a key threat to Black-striped Wallaby. Declining shrub diversity in forests and woodlands due to overgrazing by stock and rabbits is a key threat to Eastern Pygmy-possums. Competition from House Mice is a key threat to Pilliga Mice. Competition with introduced predators such as cats and foxes is a key threat to Spotted-tailed Quoll (OEH 2013b).

The implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these indirect impacts and disturbances outlined above. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation, and weed and feral animal control initiatives. Furthermore, the exploration activities are not inconsistent with the objectives of the threat abatement plans relevant to these mid-storey and log dependent mammals.

In respect to the above, it is considered that the explorative activities will not have a significant impact on the Black-striped Wallaby, Eastern Pygmy-possum, Pilliga Mouse and Spotted-tailed Quoll in the exploration activity areas.

5.2.3 Grassy woodland mammals:

The grassy woodland mammal considered in this impact assessment is the Rufous Bettong. This species inhabits a variety of forests from tall, moist eucalypt forest to open woodland, with a sparse or tussock grass understorey. No critical habitat has been declared for this species.

This species has not been recorded in the exploration activity areas, however the activities could impact on the life cycle of Rufous Bettongs by reducing the amount of foraging, sheltering and breeding habitat (clearing of vegetation) available to the species, or degrading its habitat (**Table 5**). The species is highly mobile, requiring large areas of habitat with foraging movements recorded as 2 to 4.5 km a night.

The exploration activities have resulted in the removal and/or modification of up to 179.7 ha of potential habitat (foraging, breeding or roosting/sheltering) for the Rufous Bettong with a further 33.1 ha of potential habitat proposed to be removed. The cumulative impacts as a result of the exploration activities is 212.8 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitats within PEL 238, constituting up to 0.16 % of available habitat for this species.

The woodland areas which would be impacted by the exploration activities are widespread within PEL 238. As such the small area to be impacted by the exploration activities is not considered to be of high importance for the Rufous Bettong. In addition, habitat elements within impacted areas such as logs would be stockpiled and redistributed during partial rehabilitation works, or would be relocated to surrounding areas.

Habitat connectivity for the Rufous Bettong would be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the exploration activity areas. This greatly mitigates against a number of disturbances (such as fragmentation and degradation of foraging habitat due to weeds or introduced predators) that would otherwise impact species that are restricted in range and not highly mobile. In addition, the implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these disturbances. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation, and weed and feral animal control initiatives.

In consideration of the above, it is unlikely that the explorative activities will not have a significant impact on the Rufous Bettong in the exploration activity areas.

5.2.4 Predominantly tree-roosting bats:

The predominantly tree-roosting bats considered in this impact assessment are the Yellow-bellied Sheathtail-bat and Greater Long-eared Bat. Both the Yellow-bellied Sheathtail-bat and Greater Long-eared Bat have been recorded within the exploration activity areas.

The Yellow-bellied Sheathtail-bat roosts singly or in groups of up to six, in tree hollows and buildings. The Greater Long-eared Bat inhabits a variety of vegetation types, including mallee, Bulloak and box eucalypt dominated communities. The Greater Long-eared Bat roosts in tree hollows, crevices, and under loose bark. No critical habitat has been determined for either species.

Both species of bat are likely to forage, roost and breed in the area, with the Yellow-bellied Sheathtail-bats migrating to the southern parts of Australia during late summer or autumn months. The Pilliga area is considered a strong-hold for the Greater Long-eared Bats (Churchill 1998). The exploration activities largely avoids vegetation communities with high densities of hollows (primarily the Pilliga Box – Poplar Box – White Cypress, Rough-barked Apple and Fuzzy Box vegetation types), retaining areas with higher densities of potential roosting and breeding sites for both species. No new major creek crossings traversing potential foraging and/or breeding habitat would be constructed, and no in stream devices would be installed which would impact on the natural hydrology of creek lines and the integrity of riparian vegetation. Furthermore, the locations of the exploration activities have been flexible and designed to be located in areas with lower densities of HBTs.

The exploration activities have resulted in the removal and/or modification of up to 200.7 ha of potential habitat (foraging, breeding or roosting/sheltering) for the two bat species with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impacts as a result of the exploration activities is 237.1 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitats within PEL 238, constituting up to 0.05% of available habitat for these species.

Indirect impacts on these bat species, including disturbance from noise and or light could add to the impacts associated with habitat loss and or modification. It is possible that Greater Long-eared Bats would avoid areas of noise disturbance while foraging. Yellow-bellied Sheathtail-bats are considered less likely to be affected by noise as the species forages aerially, above the canopy. However, bats of many species have been found roosting in areas disturbed by noise (Schaub *et al.* 2008); thus, it is unlikely that these bat species would be disturbed by noise while roosting. In addition, indirect impacts have largely been minimised through appropriate management controls and best-practice construction techniques. Following construction, linear infrastructure will be partially rehabilitated, reducing the width of the disturbed habitat and thus any level of fragmentation. Weed spread would be controlled to limit the potential for habitat degradation and therefore limit impacts on habitat containing bat prey. More importantly, noise would largely be kept to a minimum and constant, rather than intermittent.

The exploration activities are unlikely to constitute a significant impact on the Yellow-bellied Sheathtail-bat or the Greater Long-eared Bat as they:

- Would minimise impacts on the most important habitat areas for these species (large alluvial woodland areas and riparian habitats containing roosting sites)
- Have been designed to minimise the total area of foraging, roosting and breeding habitat to be impacted including the number of hollow bearing trees to be removed
- Would only remove a small proportion of the total area of habitat available to these species.
- Indirect disturbances have / will be adequately managed to mitigate potential impacts relating to noise, light, and habitat degradation.

5.2.5 Predominantly cave-roosting bats:

The Eastern Bentwing-bat, Eastern Cave Bat, Large-eared Pied Bat and Little Pied Bat are considered in this impact assessment. Only the Little Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat have been recorded within the exploration activity areas.

The Eastern Bentwing-bat occupies a range of forested environments (including wet and dry sclerophyll forests). The Eastern Cave Bat is usually found in dry open forest and woodland, near cliffs or rocky overhangs. The Large-eared Pied Bat is found in well-timbered areas containing gullies in dry open forest and woodland close to caves or other roost sites. The Little-Pied Bat occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. No critical habitat has been declared for these species.

The exploration activities could potentially impact on the life cycles of the bat species by reducing the amount of foraging and roosting and breeding habitat available for the Little Pied Bat and the amount of foraging habitat for the Eastern Bentwing-bats, Eastern Cave Bats and Large-eared Pied Bats (**Table 5**). However, these species are predominantly cave-roosting and breeding (Churchill 1998) and since the activities do not impact on caves, it is predominantly foraging habitat that would be reduced by the activities. An exception exists for the Little Pied Bat that can also use tree hollows for roosting.

The exploration activities have resulted in the removal and/or modification of up to 200.7 ha of potential foraging habitat for these four bat species with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impacts as a result of the exploration activities is 237.1 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitats within PEL 238, constituting up to 0.05% of available habitat for these species. The small area to be impacted by the exploration activities compared to the available habitat is not considered to be of high importance for the bat species.

Retention of vegetation outside the impact areas would continue to support these bat species in the study area. No new major creek crossings traversing potential foraging and/or roosting habitat would be constructed, and no in stream devices would be installed which would impact on the natural hydrology of creek lines and the integrity of riparian vegetation. Furthermore, the locations of the exploration activities have been flexible and designed to be located in areas with lower densities of HBTs and away from prime foraging habitat such as near water sources.

The exploration activities could impact the predominantly cave-roosting species through decreases in the sizes of intact habitat. Little Pied Bats, when roosting in trees, have been found to maintain roosts within 200 m of each other. Eastern Cave Bats have been recorded using only 33 ha over 5 consecutive days (Churchill 1998). Eastern Bentwing Bat, Eastern Cave Bat and Little Pied Bat could also be impacted through the potential increases in the numbers of introduced predators as a result of the exploration activities. These species are threatened by predation by cats and foxes.

Further, indirect impacts on these bat species, including disturbance from noise and or light could add to the impacts associated with foraging habitat loss and / or modification. However, overseas studies on bats that listen for their prey in addition to using echolocation have found that these bats avoid areas with noise disturbance while foraging (Schaub *et al.* 2008). It is possible that Large-eared Pied Bats forage in a similar manner to the bat species investigated as they forage under the canopy and close to the ground. As such, it is possible that Large-eared Pied Bats would avoid areas of noise disturbance while foraging. Eastern Bentwing-bats, Eastern Cave Bats and Little Pied Bats are considered less likely to be affected by noise as these species forage aerially, above or within the canopy, or catch their prey from water.

Following construction, linear infrastructure will be partially rehabilitated, reducing the level of habitat

fragmentation and maintaining a suitable size of intact foraging habitat for the bat species. Weed spread would be controlled to limit the potential for habitat degradation and therefore limit impacts on habitat containing bat prey. More importantly, noise would largely be kept to a minimum and constant, rather than intermittent.

The exploration activities are unlikely to constitute a significant impact on the Eastern Bentwing-bat, Eastern Cave Bat, Large-eared Pied Bat, or the Little Pied Bat as they:

- Largely do not impact breeding / roosting habitat as no caves fall within the exploration activity areas
- Have been designed to minimise the total area of foraging habitat to be impacted
- Would only remove a small proportion of the total area of habitat available to these species in PEL 238
- Have been designed and managed in a way to limit the impact of indirect impacts
- Would not isolate areas of potential foraging habitat from currently interconnecting areas of potential habitat for these species.

5.3 Reptiles

5.3.1 Tree and log dependent reptiles

The Pale-headed Snake is considered in this impact assessment. It has not been recorded within the exploration activity areas.

The species is found mainly in dry eucalypt forests and woodlands, cypress woodland and occasionally in rainforest or moist eucalypt forest. It favours streamside areas, particularly in drier habitats. It shelters during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees. No critical habitat has been declared for this species.

The exploration activities could impact on the life cycle of the Pale-headed Snake by reducing the amount of foraging, sheltering and breeding habitat available to the species (**Table 5**). The exploration activities largely avoids riparian vegetation communities with high densities of hollows that can be used for sheltering and breeding (primarily the Pilliga Box – Poplar Box – White Cypress, Rough-barked Apple and Fuzzy Box vegetation types) and retain grassy woodland habitats.

The exploration activities have resulted in the removal and/or modification of up to 200.7 ha of potential habitat (foraging, breeding or roosting/sheltering) for the Pale-headed Snake with a further 36.4 ha of potential habitat proposed to be removed. The cumulative impacts as a result of the exploration activities is 237.1 ha (**Table 5**). This loss is considered relatively minor in the context of similar habitats within PEL 238, constituting up to 0.05% of available habitat for this species. The small area to be impacted by the activities compared to the available habitat is not considered to be of high importance for the bat species.

Areas of habitat that would not be removed could be indirectly reduced by disturbance to the point that Pale-headed Snake could avoid these areas of potential habitat. Habitats fragmented by linear infrastructure would experience edge effects, including increased traffic volumes, which Pale-headed Snakes could avoid. Weeds could potentially invade remaining areas of habitat reducing the foraging resources of prey species. However, the implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these indirect impacts and disturbances.

Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation and weed and feral animal control initiatives.

In addition, the exploration activities would retain the majority of foraging and/or breeding habitat for the Pale-headed Snake in PEL 238. The remaining vegetation remnants would not be completely fragmented from other remnants with adjacent patches forming larger areas that Pale-headed Snakes would be able to use.

The exploration activities are unlikely to constitute a significant impact on the Pale-headed Snake as they:

- Have been designed to minimise the total area of foraging, roosting and breeding habitat to be impacted including the number of hollow bearing trees to be removed
- Would only remove a small proportion of the total area of habitat available to this species in PEL 238
- Have been designed and managed in a way to limit the impact of indirect impacts
- Would not isolate areas of potential habitat from currently interconnecting areas of potential habitat for the Pale-headed Snake.

5.4 Plants

5.4.1 Threatened flora

The following impact assessment includes *Bertya opponens, Diuris tricolor, Lepidium monoplocoides, Polygala linariifolia, Pomaderris queenslandica, Pterostylis cobarensis, Rulingia procumbens, and Tylophora linearis*.

Significant impacts for these threatened species are assessed on the number individuals or populations directly impacted by the exploration activities relative to the broader PEL 238 area. Considerations are also given to important and critical habitat, as well as likely indirect impacts on potential habitat. No critical habitat under the TSC Act has been declared for these species.

Detailed targeted surveys within the exploration activity areas and broader Pilliga region have identified populations of these threatened species. The exploration activity areas and PEL 238 is known to support each of the threatened flora species identified above, however, only *Tylophora linearis, Pterostylis cobarensis*, *Polygala linariifolia* and *Diuris tricolor* have been recorded in or within close proximity to the exploration activity areas.

The magnitude of the impacts resulting from the exploration activities can be inferred from habitat modelling using the details of the targeted surveys (ELA 2012). There are a number of considerations relevant to the habitat modelling and the assessment of significance of impacts to flora species from exploration activities. Taking into account the ecology of the species and the habitat information collected from the targeted surveys, the number of individuals potentially impacted by the proposed exploration activities was only calculated for *Tylophora linearis* and *Pterostylis cobarensis.*

- *Tylophora linearis*: The habitat modelling for *Tylophora linearis* has predicted a cumulative impact to 59 individuals, with 30 individuals from existing exploration activities and 29 from proposed exploration activities. This accounts for 0.34% of the individuals predicted to occur within the study area.

- *Pterostylis cobarensis*: The habitat modelling for *Pterostylis cobarensis* has predicted a cumulative impact to 656 individuals, with 471 individuals from existing exploration activities and 185 from proposed exploration activities. This accounts for 0.19% of the individuals predicted to occur within the study area.

Reliable modelling has yet to be developed for the other two species (*Polygala linariifolia* and *Diuris tricolor*) that are known to occur within the exploration activity areas. Considering no direct impacts are likely to occur for *Pomaderris queenslandica, Bertya opponens, Rulingia procumbens* or *Lepidium monoplocoides* as a result of the exploration activities, habitat modelling for these species has not been developed.

As with the threatened fauna species, only a very small proportion of potential habitat for these species has been impacted relative to available habitat in the PEL 238. Habitat for these species is widespread across the Pilliga region, with significant populations of some species, *Bertya opponens, Lepidium monoplocoides, Pterostylis cobarensis*, *Rulingia procumbens* and *Tylophora linearis* identified outside of the study area including populations within State Forests, National Parks, Nature Reserves and State Conservation Areas. Therefore, significant impacts to the lifecycle and important habitat to these species are unlikely to result from the exploration activities.

The exploration activities have the potential to increase the spread of weed species through the introduction of plant and/or seed material from vehicles and other equipment or through increased penetration of the forest along new access tracks and other disturbed areas. Weed and fungal invasion has the potential to degrade the habitat of these species and weed species may directly compete with them. To address these potential threats, Santos has prepared a weed management strategy and a comprehensive rehabilitation strategy will be prepared which will address issues of restoration, weed invasion and feral animal invasion over the life of the program.

Significant impacts on the threatened flora species are considered unlikely given:

- The small extent of impacts from proposed exploration activities relative to available habitat in PEL 238
- That available potential habitat will not been significantly reduced to an extent likely to cause a significant decline in the species populations
- The demonstrated and anticipated rehabilitation of many areas of impact
- Potential indirect impacts, such as weed invasion are being actively managed.

5.5 Endangered Ecological Communities

5.5.1 Brigalow – Belah Woodland on alluvial often gilgaied clay soil, mainly Brigalow Belt South

Brigalow – Belah Woodland on alluvial often gilgaied clay soil, mainly Brigalow Belt South (Brigalow – Belah Woodland) is part of the TSC Act listed endangered ecological community known as *Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregion*. It is an open forest or woodland up to 25 m high dominated by *Acacia harpophylla* (Brigalow) often with *Casuarina cristata* (Belah) on less gilgaied clays. It usually contains a sparse shrub layer and ground layer with a lot of leaf litter.

This community has been extensively cleared for agriculture, with most of the remaining remnants existing along roadsides and paddock edges (OEH 2013b). The listed threats to this community include clearing and fragmentation, road works and maintenance activities and weed invasion.

Previous exploration activities have required the clearing of approximately 10.22 ha the Brigalow – Belah Woodland (**Table 3**) within PEL 238. However the majority of this EEC (99.9%) has been retained within the broader PEL 238 area.

The exploration activities have the potential to increase existing disturbance regimes, many of which are listed as key threats to Brigalow – Belah Woodland. These include:

- Clearing of remaining remnants and isolated paddock trees
- Senescence and lack of regeneration
- Inappropriate fire regimes
- Invasion of weeds.

However, the implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these disturbances. Such measures include best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation and weed control initiatives.

In respect to the information presented above, it is considered unlikely that the exploration activities will have had a significant impact on this EEC.

5.5.2 White Box-Yellow Box-Blakely's Red Gum Grassy Woodland

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland (Box Gum Woodland) is an EEC. The community is characterised by an overstorey dominated, or was once dominated by *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box) or *E. blakelyi* (Blakely's Red Gum). It contains a species-rich understorey of native tussock grasses, herbs and forbs. The tree-cover is generally discontinuous and consists of widely-spaced trees of medium height in which the canopies are clearly separated. In NSW the community is found from the Queensland border in the north, to the Victorian border in the south along the tablelands and western slopes areas.

Much of the woodlands with a canopy dominated or co-dominated by *Eucalyptus blakelyi* (Blakely's Red Gum) within the study area typically have dense shrub and midstorey layers, have very sparse ground layers and are located on poor sandy or rocky soils and do not qualify as the TSC Act listed EEC.

There is potential for areas of Box Gum Woodland (those dominated or co-dominated by *E. blakleyi* with an open grassy understorey) to occur within the mapped *Rough-barked Apple riparian forb/grass open forest* vegetation type, particularly along the larger floodplain of Bohena Creek and its tributaries, however these areas will require assessment based on the floristic, soil and structural characteristics to determine the presence of this community.

Approximately 0.26 ha (an area of 200 m x 12 m width) of Box Gum Woodland in the vicinity of Bohena Creek in the central portion of the study area may have been impacted by exploration activities to date, however further assessment of this vegetation is required to determine its status as an EEC due to the factors mentioned above.

It is considered unlikely that the cumulative impacts of exploration activities have significantly reduced or adversely affected Box Gum Woodland, given its currently undetermined status.

5.5.3 Fuzzy Box Woodland on alluvial soils

Fuzzy Box Woodland is a tall woodland or open forest with a canopy dominated by *Eucalyptus conica* (Fuzzy Box) and associated species such as *E. microcarpa*, *E. melliodora*, *Brachychiton populneus* (Kurrajong) and *Allocasuarina luehmannii* (OEH 2013b).

Within the study area, Fuzzy Box Woodland has been identified on the floodplain of Bohena Creek and its tributaries. Within this area, Fuzzy Box Woodland generally occurs upslope of Rough-barked Apple Riparian Forb/grass Open Forest.

Existing exploration activities have required the clearing of approximately 1.8 ha of Fuzzy Box Woodland (**Table 3**) in the study area. However the majority of this EEC (99.39%) has been retained within the study area as part of the exploration activities. Therefore, the amount of vegetation directly impacted comprises only a small portion of the total Fuzzy Box Woodland in the study area. The proportion of this impacted EEC within PEL 238 has not been calculated as the regional mapping available does not map this community at a fine enough scale.

The exploration activities have the potential to increase existing disturbance regimes, many of which are listed as key threats to Fuzzy Box Woodland. These include:

- Removal of vegetation and potential habitat
- Fragmentation of habitat
- Infection of native plants by *Phytophthora cinnamomi*
- Invasion of weeds
- Increases in fire.

However, the implementation of mitigation and management measures for the exploration activities is considered sufficient in reducing these disturbances. Such measures include best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation and weed control initiatives.

Therefore, the removal of only 1.8 ha of Fuzzy Box Woodland is unlikely to place this EEC at risk of extinction in the study area or in PEL 238, and thus a significant impact resulting from the exploration activities is considered unlikely.

6 Rehabilitation

Rehabilitation of existing exploration and appraisal activities is currently being undertaken. These activities provide a benchmark for understanding the potential reduction in impact as a result of rehabilitation works identified for the proposed program.

Santos has commenced a program of rehabilitation works throughout PEL 238 and PAL 2. Rehabilitation works include:

- reducing the size of existing well leases back to the minimum area required for operations
- plugging and abandoning, according to legislative requirements, wells that are no longer required for exploration and appraisal and rehabilitating associated well leases
- rehabilitating a number of water storage ponds that are no longer required for exploration and appraisal activities.

Actions undertaken during the clearing of vegetation include stockpiling 'waste' timber from felled trees not suitable for forestry activities, fallen logs and bush rock for later use in habitat restoration; low vegetation is slashed and mulched on site; and topsoil is striped and stockpiled. Rehabilitation actions include; replacing topsoil; re-installing habitat features such as fallen timber and bush rock; natural re-establishment of slashed and cleared native vegetation; and direct seeding where required.

Monitoring of rehabilitation activities has shown an overall site value close to 45% of nearby reference sites after two years. The replacement of topsoil is producing encouraging results, with sites showing a high number of native species when compared to reference sites. Rehabilitation measures undertaken have been considered using adaptive management principles with monitoring informing future modifications to works and methodology.

Rehabilitation works associated with the proposed program will follow the methods developed for the existing exploration and appraisal activities.

6.1 Vegetation dieback

Santos has identified approximately six hectares of vegetation dieback which has resulted from ESG's previous operations. The affected areas occur within the White Cypress Pine – Bulloak – Ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion vegetation type adjacent to areas cleared for infrastructure. Santos has progressed rehabilitation of these areas in consultation with the NSW Government. The vegetation dieback areas are not included in the cumulative clearing areas presented in Table 6.

To date, rehabilitation of approximately 28 hectares of land, including the vegetation dieback areas, has commenced.

7 Conclusion

Early stage exploration and production appraisal activities are not considered likely to have had a significant impact on ecological values listed under the TSC Act or the environment more broadly.

Measures have been taken in planning for and undertaking these works to minimise impacts. Existing tracks, roads and previously cleared areas have been utilised wherever possible and a strategy for managing the spread of exotic species has been developed.

This report has brought together information from a variety of sources to document the exploration activities and cumulative impacts associated with all existing and planned early-stage exploration and production appraisal activities within PEL 238 in relation to ecological values listed under the NSW TSC Act.

An assessment of the significance of cumulative impacts of the exploration activities under the TSC Act has been undertaken. Given the relatively small extent of clearing resulting from the exploration activities as a proportion of available habitat in PEL 238, the implementation of mitigation and management measures and the extent of rehabilitation, the exploration activities are not expected to significantly affect listed ecological values under the TSC Act. As such, a Species Impact Statement (SIS) is not likely to be required.

References

Allison, F. R. & Hoye, G. A., 1998. Eastern Freetail-bat pp. 484-485 in The Mammals of Australia (ed. By Strahan, R.). Australian Museum/ Reed Publications, Sydney

Biosis 2002. Brigalow Belt South: Response to Disturbances and Land Management Practices. Report prepared for the Resource and Conservation Assessment Council, NSW Western Regional Assessments

Bladon, R., Dickman, C and Hume I 2002. Effects of habitat fragmentation on the demography, movements and social organisation of the eastern pygmy possum *Cercartetus nanus*) in northern New South Wales. *Wildlife Research* **29**: 105-116

Blakers, M., Davies, S., and Reilly, P.N 1984. *The Atlas of Australian Birds*. RAOU Melbourne University Press

Breed, B. And Ford, F. 2007. *Native Mice and Rats*. CSIRO Publishing, Victoria

Burbidge, A. A., K. A. Jonhson, et al. 1988. "Aboriginal knowledge of the mammals of the central deserts of Australia." *Australian Wildlife Research* 15(1): 9-39

Churchill, S. 1998. *Australian Bats*, Reed New Holland, Sydney

Cogger, H.G. 2000. *Reptiles and Amphibians of Australia*, 6th ed. Reed Books, Sydney

Cole, J.R. & J.C.Z. Woinarski 2000. 'Rodents of the arid Northern Territory: conservation status and distribution'. *Wildlife Research*. 27:437-449

Davidson, C. (1993). Recovery Plan for the Collared Legless Lizard (Delma torquata). Page(s) 1-10. Brisbane, Queensland: Department of Environment and Heritage

Department of Environment and Climate Change (DECC) 2007. *Striped Legless Lizard Delmar impar species profile*. DECC, Hurstville

Department of Natural Resources and Environment (DNRE) 1999. Regent Honeyeater Recovery Plan 1999-2003. Prepared on behalf of the Regent Honeyeater Recovery Team, East Melbourne

Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC) 2012. *Survey guidelines for Australia's threatened mammals*. Australian Government, Canberra

Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC) 2013. Species Profile and Threats Database. Available: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Dwyer, P.D. 1981 'Common Bent-wing Bat, Miniopterus schreibersii', *ANH*, 20(6):187-190

Dwyer, P.D. 1995 'Common Bent-wing Bat (Miniopterus schreibersii)', In: R. Strahan (Ed.) *The Australian Museum Complete Book of Australian Mammals*, pp494-495, Angus and Robertson Publishers, Sydney

Eco Logical Australia (ELA) 2013. *Energy NSW Coal Seam Gas (CSG) Exploration and appraisal program – Impact Assessment under the EPBC Act*. Prepared for Santos Limited

Eco Logical Australia 2012. *Narrabri Gas Project targeted threatened flora survey.* Report prepared for Santos Limited. Unpublished report

Environment Australia (2000) *Comprehensive and Regional Assessments for North-East NSW*. Report to National Parks and Wildlife Service

Finlayson, H.H. 1961. 'On central Australian mammals, IV, The distribution and status of central Australian species'. *Records of the South Australian Museum*. 14:141-191

Ford, F. 2008. Delicate Mouse *Pseudomys delicatulus*. In '*The Mammals of Australia'* (Eds. S. Van Dyck and R. Strahan) pp. 623-624. (Reed New Holland: Sydney)

Forshaw, J.M. and Cooper, W.T. 1981. *Australian Parrots*, (2nd Ed.). Lansdowne Press, Melbourne

Fox, B.J. & D.A. Briscoe 1980. 'Pseudomys pilligaensis, a new species of murid rodent from the Pilliga Scrub, northern New South Wales'. *Australian Mammalogy*. 3:109-126

Garnett, S.T., ed. 1993. *Threatened and Extinct Birds of Australia*. Royal Australasian Ornithologists Union Report 82 2nd (corrected) Edition. Melbourne: Royal Australian Ornithology Union and Canberra: Australian National Parks and Wildlife Service

Kavanagh, R.P and Stanton, M.A. 2009. Conserving Barking Owls in the Pilliga Forests. *Wingspan* **19**, 28-30

Kavanagh, R.P. and Peake, P. 1993 'Distribution and habitats of nocturnal forest birds in south-eastern New South Wales', In: Olsen, P. (Ed.). *Proceedings of the 10th Anniversary Conference*, Canberra, pp 86-100, Australian Raptor Association, Royal Ornithologists Union, Sydney

Marchant and Higgins 1993. *Handbook of Australian, New Zealand and Antarctic Birds*. Oxford University Press, Melbourne

Menkhorst, P. and Knight, F. 2004. *A Field Guide to the Mammals of Australia*, 2nd Edn., Oxford University Press, South Melbourne

National Parks and Wildlife Service (NPWS) 1995. *Threatened Species Information: Regent Honeyeater Xanthomyza phrygia (Shaw, 1794)*. NPWS, Hurstville.

National Parks and Wildlife Service (NPWS) 2000. *Brigalow Belt South: Regional Assessment (Stage 1) - Report on Preliminary Fauna Survey of Pilliga and Goonoo Forests, November 1999 to January 2000*. Report prepared for the Resource and Conservation Assessment Council, NSW Western Regional Assessments

National Parks and Wildlife Service (NPWS) 2003. *Draft Recovery Plan for Barking Owl, Ninox connivens*. National Parks and Wildlife Service

National Parks and Wildlife Service (NPWS) 2006. *Recovery Plan for the Bush Stone-curlew Burhinus grallarius*. National Parks and Wildlife Service

NSW Scientific Committee 2001a. Speckled warbler - vulnerable species listing. Available: http://www.environment.nsw.gov.au/determinations/SpeckledWarblerVulSpListing.htm

NSW Scientific Committee 2001b. Black-chinned honeyeater (eastern subspecies) - vulnerable species listing. Available: http://www.environment.nsw.gov.au/determinations/BlackchinnedHoneyeaterVulSpListing.htm

Office of Environment and Heritage (OEH) 2013a. *Atlas of NSW Wildlife*. (online). Available: http://wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp

Office of Environment and Heritage (OEH) 2013b. *Threatened species profiles*. Available: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_scientificname.aspx

Pittwater Council 2000. *Management Plan for Threatened Fauna and Flora in Pittwater*. Prepared for Pittwater Council by Smith, J. and Smith, P

Quinn, D.G. 1995. 'Population ecology of the Squirrel Glider and the Sugar Glider at Limeburners Creek, on the Central North Coast of NSW', *Wildlife Research*. 22: 471-505

Reed, P.C., Lunney, D. and Walker, P. 1990. 'A 1986-7 survey of the Koala *Phascolarctos cinereus* in NSW and an ecological interpretation of its distribution', In: *Biology of the Koala*, pp: 55-74

RPS 2012a. *Ecological Assessment – Dewhurst 22 - 25 – PEL 238, Narrabri.* Report Prepared for Santos Limited

RPS 2012b. *Ecological Assessment - Leewood - Produced Water and Brine Management Project (Phase 1).* Report Prepared for Santos Limited

RPS 2012c. *DRAFT Ecological Assessment - Dewhurst Northern Flowlines – PEL 238, Narrabri.* Report Prepared for Santos Limited. Unpublished report

RPS 2013a. *DRAFT Ecological Assessment - Dewhurst Southern Flowlines – PEL 238, Narrabri.* Report Prepared for Santos Limited. Unpublished report

RPS 2013b. *Ecological Assessment - Dewhurst 26 – 29 Pilot Wells – PEL 238, Narrabri.* Report Prepared for Santos Limited

RPS 2013c. *Scout Reports for Bibblewindi 31 and 32.* Reports prepared for Santos Limited. Unpublished reports

Ryan, S. 2006a. *Conservation Management Profile: Collared Delma Delma torquata*. Ecosystem Conservation Branch, Queensland Environmental Protection Agency

Schaub, A., Ostwald J. and Siemers B. 2008. Foraging bats avoid noise. *Journal of Experimental Biology*, **211**: 3174-3180

Schodde, R. and Tidemann, S. (Eds) 1986. *Readers Digest complete book of Australian Birds*, 2nd Edn., Reader's Digest Services Pty Ltd, Sydney. SEWPaC 2011b

Simpson, K. and Day N. 1999. Field Guide to the Birds of Australia. Lloyd O'Niel, Melbourne

State Forests of NSW 1995. *Environmental Impact Statement: Proposed forestry operations in Casino Management Area*. Volume A: Main report. State Forests of NSW, Pennant

Strahan, R. (Ed.) (1998) The Australian Museum Complete Book of Australian Mammals, Angus and Robertson Publishers, Sydney. Turner & Ward 1995

Turner, V and Ward, S. 1995. Eastern pygmy-possum Cercartetus nanus. Pp. 217-18 in *The Mammals of Australia* ed by R Strahan. Reed Books, Chatswood

Appendix A:

Provided below (**Table 6**) is the likelihood table for ecological values listed under the NSW TSC Act. Species, populations and communities considered to have the potential to occur are highlighted in yellow, those likely to occur are highlighted in brown, and those which are known occur are highlighted in green.

The likelihood of occurrence table includes an analysis of previous reports conducted by Eco Logical Australia (ELA) and RPS.

Key to the table:

- TSC Status = Listing under the *Threatened Species Conservation Act 1995*
- EPBC Status = Listing under the *Environment Protection and Biodiversity Conservation Act 1999*
- CE = Critically Endangered
- E = Endangered (EPBC Act)
- E1 = Endangered (TSC Act)
- E2 = Endangered Population (TSC Act)
- E4 = Extinct (TSC Act)
- V = Vulnerable

Table 6: NSW TSC Act threatened species and ecological communities likelihood of occurrence within the study area.

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
FAUNA							
Aepyprymnus rufescens	Rufous Bettong	V	~	The original range from Coen in north Queensland to central Victoria has been reduced to a patchy distribution from Cooktown, Queensland, to north-eastern NSW as far south as Mt Royal National Park. In NSW it has largely vanished from inland areas but there are sporadic, unconfirmed records from the Pilliga and Torrington districts. (OEH 2013b)	Prefer forests with a grassy to sparse understorey including coastal forest, tall wet sclerophyll forest and dry forests west of GDR (OEH 2013b). It is most commonly found on sites derived from sedimentary rock and in north eastern NSW in forests characterised by *Corymbia maculata* (Spotted Gum) and *C. henryi* (OEH 2013b). It has been known to feed on introduced pasture species (OEH 2013b).	Moderate	Potential
Alectura lathami	Australian Brush-turkey	E2	~	The Australian Brush-turkey has a largely coastal distribution from Cape York south as far as the Illawarra in NSW. A population of the Australian Brush-turkey is known from the Nandewar and Brigalow Belt South Bioregions. Recent records for the species show the population to range from north east of Warialda, to Narrabri, approximately 115 km to the south-west, and occur within the local government areas of Yallaroi, Bingara, Narrabri, Barraba and Moree Plains. (OEH 2013b)	It occurs in forested and wooded areas of tropical and warm-temperate districts, particularly above 300 m to at least 1200 m altitude. In NSW the inland vegetation type preferred by the Australian Brush-turkey is a dry rainforest community that is found within the Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions Endangered Ecological Community.(OEH 2013b)	No habitat	No
Anomalopus mackayi	Five-clawed Worm-skink	E1	V	Patchy distribution on the North West Slopes and Plains of north-east NSW and south-east Queensland, from the Ashford area west to Mungindi and Walgett in NSW and north to Dalby in Queensland.(OEH 2013b)	Close to or on the lower slopes of slight rises in grassy White Box woodland on moist black soils, and River Red Gum-Coolibah-Bimble Box woodland on deep cracking loose clay soils. May also occur in grassland areas and open paddocks with scattered trees. Live in permanent deep tunnel-like burrows and deep soil cracks, coming close to the surface under fallen timber and litter, especially partially buried logs.(OEH 2013b)	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Anseranas semipalmata	Magpie Goose	V	~	The Magpie Goose is still relatively common in the Australian northern tropics, but had disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s there have been an increasing number of records in central and northern NSW. Vagrants can follow food sources to south-eastern NSW.(OEH 2013b)	Activities centred on terrestrial sedge-dominated wetlands; mainly those on floodplains of rivers (Marchant & Higgins 1993 Simpson & Day 1999).	Low	Unlikely
Anthochaera phrygia	Regent Honeyeater	CE	E,M, JAMBA	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. Once recorded between Adelaide and the central coast of Queensland, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland (OEH 2013b)	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of *Casuarina cunninghamiana* (River Oak) (Garnett 1993). Areas containing *Eucalyptus robusta* (Swamp Mahogany) in coastal areas have been observed to be utilised. The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).	High	Potential
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	It is known only to occur in the Central and Southern Tablelands and South Western Slopes of NSW. Populations have been recorded in the Queanbeyan/Canberra district, Cooma, Yass, Bathurst, Albury and West Wyalong areas.(DECC 2007)	It inhabits open woodland that has a predominately native grass understorey that is situated on sloping, well-drained soils with rocky outcrops or scattered partially buried rocks present. Burrows are formed beneath small, partially embedded rocks that are often inhabited by small black ants and termites. The Pink-tailed Worm-lizard feeds on the larvae and eggs of the ants with which it shares its burrows. In the summer months 2 eggs are laid inside the ant nests with the young first appearing in March. (DECC 2007)	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Ardeotis australis	Australian Bustard	E1	~	The Australian Bustard mainly occurs in inland Australia and is now scarce or absent from southern and south-eastern Australia. In NSW, they are mainly found in the north-west corner and less often recorded in the lower western and central west plains regions. Occasional vagrants are still seen as far east as the western slopes and Riverine plain. Breeding now only occurs in the north-west region of NSW.(OEH 2013b)	Mainly inhabits tussock and hummock grasslands, though prefers tussock grasses to hummock grasses; also occurs in low shrublands and low open grassy woodlands; occasionally seen in pastoral and cropping country, golf courses and near dams.(OEH 2013b)	High	Potential
Botaurus poiciloptilus	Australasian Bittern	V	~	Australasian Bitterns are widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west (OEH 2013b)	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats (Marchant & Higgins 1993). Reedbeds, swamps, streams, estuaries (Simpson & Day 1999).	Low	Unlikely
Burhinus grallarius	Bush Stone-curlew	E1	~	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range.	Associated with dry open woodland with grassy areas, dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland (Pittwater Council 2000; Marchant & Higgins 1993). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Environment Australia 2000; Marchant & Higgins 1993). Is thought to require large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed in lightly disturbed	High	Known
Cacatua leadbeateri	Pink Cockatoo	V	~	Found across the arid and semi-arid inland, from south-western Queensland south to north-west Victoria, through most of South Australia, north into the south-west Northern Territory and across to the west coast between Shark Bay and about Jurien. In NSW it is found regularly as far east as about Bourke and Griffith, and sporadically further east than that. (OEH 2013b)	Inhabits a wide range of tree and treeless inland habitats, always within easy reach of water. Feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines. (OEH 2013b)	Moderate	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Calyptorhynchus banksii	Red-tailed Black-Cockatoo	V	E, M, JAMBA	The Red-tailed Black-Cockatoo is the most widespread of the Black-Cockatoos, ranging broadly across much of northern and western Australia as well as western Victoria. In NSW, one population occurs on the north-western slopes and plains but another small isolated population is found in the coastal north-east. (OEH 2013b).	Occurs in coastal forests and woodlands or inland open shrubland near water (Simpson & Day 1999). This species is noted to feed mainly on seeds, especially of eucalypts, casuarinas, acacia and banksias. May also take berries, nectar, flowers and occasionally insects and their larvae (Marchant & Higgins 1993).	Low	Unlikely
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	~	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.(OEH 2013b)	Associated with a variety of forest types containing *Allocasuarina* species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; OEH 2013b). Intact drier forest types with less rugged landscapes are preferred (OEH 2013b). Nests in large trees with large hollows (Environment Australia 2000).	High	Known
Cercartetus nanus	Eastern Pygmy-possum	V	~	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes . (OEH 2013b). It occupies small home ranges, rarely greater than 1 ha.	Found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight 2004). Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit (Turner & Ward 1995). The presence of *Banksia* sp. and *Leptospermum* sp. are an important habitat feature (OEH 2013b). Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds nests and in the branch forks of tea-trees (Turner & Ward 1995).	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Certhionyx variegatus	Pied Honeyeater	V	~	Widespread throughout acacia, mallee and Spinifex scrubs of arid and semi-arid Australia. Occasionally occurs further east, on the slopes and plains and the Hunter Valley, typically during periods of drought (OEH 2013b).	Inhabits wattle shrub (primarily Mulga, *Acacia aneura*), mallee, Spinifex and eucalypt woodlands, usually when shrubs are flowering; feeds on nectar, predominantly from various species of emu-bushes (*Eremophila* spp.); also from mistletoes and various other shrubs (e.g. *Brachystema* spp. and *Grevillea* spp.); also eats saltbush fruit, berries, seed, flowers and insects. Highly nomadic, following the erratic flowering of shrubs; can be locally common at times.(OEH 2013b)	Low	Unlikely
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	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. (OEH 2013b)	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECC 2007). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998).	High	Potential
Chalinolobus picatus	Little Pied Bat	V	~	The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria.	The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria. Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. Feeds on moths and possibly other flying invertebrates.	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Chthonicola sagittata	Speckled Warbler	V	~	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. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100ha survive. (OEH 2013b)	Occupies a wide range of eucalypt dominated communities with a grassy understorey, often on rocky ridges or in gullies (OEH 2013b). Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy (OEH 2013b). Large, relatively undisturbed remnants are required for the species to persist in an area (OEH 2013b). Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding (OEH 2013b)	High	Known
Circus assimilis	Spotted Harrier	V	~	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. (OEH 2013b)	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months. Preys on terrestrial mammals (eg bandicoots, bettongs, and rodents), birds and reptile, occasionally insects and rarely carrion.	Moderate	Potential
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	~	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 western boundary of the range of Climacteris picumnus victoriae runs approximately through Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell and along this line the subspecies intergrades with the arid zone subspecies of Brown Treecreeper Climacteris picumnus picumnus which then occupies the remaining parts of the state (OEH 2013b)	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range. It mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and *Eucalyptus camaldulensis* (River Red Gum) Forest. Generally not found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging. It is sedentary and nests in tree hollows within permanent territories (OEH 2013b).	High	Unlikely (the study area lies outside of the geographically defined area for the eastern subspecies)

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Crinia sloanei	Sloane's Froglet	V	~	Sloane's Froglet has been recorded from widely scattered sites in the floodplains of the Murray-Darling Basin, with the majority of records in the Darling Riverine Plains, NSW South Western Slopes and Riverina bioregions in New South Wales. It has not been recorded recently in the northern part of its range and has only been recorded infrequently in the southern part of its range in NSW (OEH 2013b)	It is typically associated with periodically inundated areas in grassland, woodland and disturbed habitats.	Low	Unlikely
Daphoenositta chrysoptera	Varied Sittella	V	~	Varied Sittellas are endemic and widespread in mainland Australia. (OEH 2013b)	Varied Sittellas are found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbarks or mature trees with hollows or dead branches (OEH 2013b)	High	Known
Dasyurus maculatus	Spotted-tailed Quoll	V	E	The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. (OEH 2013b)	It inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are found in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, which are usually traversed along densely vegetated creek lines. (OEH 2013b).	Low	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Delma torquata	Collared Delma	V	V	The main concentrations of records are from the western suburbs of Brisbane. Urban development in these suburbs has resulted in a contraction of previously recorded populations in this area (Ryan 2006a). The species is also known from the following sites: the Bunya Mountains; Blackdown Tableland National Park (NP); Bullyard Conservation Park (CP); D'Aquilar Range NP, Expedition NP; Naumgna and Lockyer Forest Reserves (inside Bunya Mountains NP; Western Creek, near Millmerran; and the Toowoomba Range (Davidson 1993; Ryan 2006a).	The Collared Delma normally inhabits eucalypt or acacia dominated woodland and open forest where it is associated with suitable microhabitats (exposed rocky outcrops, or a sparse understorey of tussock grass, shrubs or semi-evergreen vine thickets). *Corymbia citriodora* (Lemon-scented Gum) is typically the dominant canopy species. Other dominant canopy species include *Eucalyptus crebra*, E. melanophloia, *E. tessellaris*, *E. moluccana*, *E. microcorys*, *E. tereticornis*, *Angophora* sp. and *Acacia harpophylla* (Brigalow) (Peck 2003, cited in Peck & Hobson 2007; Ryan 2006a). Leaf Litter appears to be an essential part of the microhabitat and is always present. (SEWPaC 2013)	Low	Unlikely
Drymodes brunneopygia	Southern Scrub-robin	V	~	This species is restricted to mallees and shrublands across southern Australia and in NSW is confined to two main areas. The first is in central NSW and is centred on Round Hill and Nombinnie Nature Reserves, though suitable habitat probably exists on adjoining leasehold lands. The other population occurs in the far south west of NSW, mainly within the Scotia mallee centred on Tarawi NR and Scotia Sanctuary	Inhabits mallee and acacia scrub, particularly with dense sub-shrubs in the understorey, including Broombush and other dry shrubs	Moderate	Unlikely
Ephippiorhynchus asiaticus	Black-necked Stork	E1	~	In Australia, Black-necked Storks are widespread in coastal and subcoastal northern and eastern Australia, south to central-eastern NSW and with vagrants recorded at scattered sites well away from the coast (for example, near Moree, north-east of Hay and in Victoria). In NSW, the species becomes more uncommon south of the Northern Rivers region, and rarely occurs south of Sydney (OEH 2013b)	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; OEH 2013b).	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Epthianura albifrons	White-fronted Chat	V	~	The White-fronted Chat is found across the southern half of Australia, It is found mostly in temperate to arid climates and very rarely sub-tropical areas, it occupies foothills and lowlands up to 1000 m above sea level. In NSW, it occurs mostly in the southern half of the state, in damp open habitats along the coast, and near waterways in the west. Along the coast, it is found mostly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. (OEH 2013b)	Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground. Have been observed breeding from late July through to early March, with 'open-cup' nests built in low vegetation. Nests in the Sydney region have also been seen in low isolated mangroves. Nests are usually built about 23 cm above the ground (but have been found up to 2.5 m above the ground). (OEH 2013b)	Low	No
Erythrotriorchis radiatus	Red Goshawk	E1	V	Red Goshawks are found from across northern Australia, down the east coast of Qld and into the northern coast of NSW. In NSW records are rare. Listed as having occurred south to Port Stephens.	Its habitat consists of wooded and forested areas. Prefers forest and woodland with a mosaic of vegetation types, large populations of birds for prey and permanent water. Riverine vegetation is highly utilised by this species. Its habits are not well known, but it is considered to be a solitary, sedentary bird. They nest in tree forks of *Eucalypt* sp. and *Melaleuca* sp. or those nests of other large birds such as Magpies or Crows. The nests are generally built of sticks, which are lined with soft twigs and leaves	Moderate	Unlikely
Falco hypoleucos	Grey Falcon	E1	~	The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. The breeding range has contracted since the 1950s with most breeding now confined to arid parts of the range. There are possibly less than 5000 individuals left. Population trends are unclear, though it is believed to be extinct in areas with more than 500 mm rainfall in NSW.(OEH 2013b)	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.(OEH 2013b)	Moderate	Potential

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Geophaps scripta scripta	Squatter Pigeon	E1	V	The Squatter Pigeon (southern) occurs on the inland slopes of the Great Dividing Range. Its distribution extends from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coastline between Proserpine and Port Curtis (near Gladstone), and south to scattered sites though out south-eastern Queensland. It's distribution historically extended into NSW, however, there have been no confirmed records of the species in NSW since the 1970s.	The Squatter Pigeon (southern) occurs mainly in grassy woodlands and open forests that are dominated by eucalypts . It has also been recorded in sown grasslands with scattered remnant trees, disturbed habitats (i.e. around stockyards, along roads and railways, and around settlements, in scrub and acacia growth, and remains common in heavily-grazed country north of the Tropic of Capricorn (EPA 2006). The species is commonly observed in habitats that are located close to bodies of water.	Low	Unlikely
Glossopsitta pusilla	Little Lorikeet	V	~	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs (OEH 2013b).	Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands *Eucalyptus albens* and *E. melliodora* are important food sources for pollen and nectar respectively.	High	Known
Grantiella picta	Painted Honeyeater	V	~	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 QLD. During the winter it is more likely to be found in the north of its distribution.(OEH 2013b)	The Painted Honeyeater inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. It feeds on mistletoes growing on woodland eucalypts and acacias. It nests from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.	High	Likely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Grus rubicunda	Brolga	V	~	The Brolga was formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. It still abundant in the northern tropics, but very sparse across the southern part of its range (OEH 2013b).	The Brolga was formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. It still abundant in the northern tropics, but very sparse across the southern part of its range (OEH 2013b).	Low	Unlikely
Hamirostra melanosternon	Black-breasted Buzzard	V	~	The Black-breasted Buzzard is found sparsely in areas of less than 500 mm rainfall, from north-western NSW and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, avoiding only the Western Australian deserts (OEH 2013b)	This species lives in a range of inland habitats including open forests, riverine woodlands, scrubs and heathlands. It is often found along timbered watercourses, which is preferred breeding habitat. It can also hunt over grasslands and includes reptiles, small mammals, birds and large eggs in its prey.	Low	Potential
Hieraaetus morphnoides	Little Eagle	V	~	The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW.	The Little Eagle is seen over woodland and forested lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest (OEH 2013b)	High	Potential
Hoplocephalus bitorquatus	Pale-headed Snake	V	~	A patchy distribution from north-east Queensland to north-east NSW. In NSW it occurs from the coast to the western side of the Great Divide as far south as Tuggerah (OEH 2013b).	Wide range of habitats from rain or wet sclerophyll forest to drier eucalypt forests (OEH 2013b).	High	Likely
Jalmenus eubulus	Pale Imperial Hairstreak	CE	E	It is found in Queensland and NSW. In Queensland it is restricted to the seasonally sub-humid central and southern areas of the state. In NSW it is found only in Brigalow -dominated open forests and woodlands in northern areas of the state.	Suitable habitat is dominated by *Acacia harpophylla* (Brigalow) and *Casuarina cristata* (Buloke) on clay soils on flat to gently undulating plants, usually with scattered emergent eucalypts. It is only known to breed in old-growth forest or woodland and does not appear to colonise regrowth habitats after clearing	Low	Unlikely
Lagorchestes leporides	Eastern Hare-wallaby	E4	Ex	The Eastern Hare-wallaby was common in open plains country around the Murray River and in the grasslands and woodlands of western Victoria and southeastern South Australia, but it has not been seen alive this century. Last South Australian record: Lucindale, 1892 (South Australia Museum n.d)	This species generally spent the day sheltering and foraged at night, it sheltered under large tussocks which it excavated itself.	Low	No

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Lathamus discolor	Swift Parrot	E1	E	Breeds in Tasmania between September and January. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts (Blakers et al. 1984; Schodde and Tidemann 1986; Forshaw and Cooper 1981).	On mainland, autumn and winter flowering eucalypts are important for this species. Favoured feed trees include winter flowering species such as *Eucalyptus robusta*, *Corymbia maculata*, *C. gummifera* (Red Bloodwood), *E. sideroxylon* (Mugga Ironbark and *E. albens* (OEH 2013b).	High	Potential
Leipoa ocellata	Malleefowl	E1	V,M	The stronghold for this species in NSW is the mallee in the south west centred on Mallee Cliffs NP and extending east to near Balranald and as far north as Mungo NP. In central NSW it has been significantly reduced through land clearance and fox predation and now occurs chiefly in Yathong, Nombinnie and Round Hill NRs and surrounding areas, though birds continue to survive in Loughnan NR (OEH 2013b).	Dry inland scrub, mallee. Males tend large sand nest-mound (Simpson & Day 1999).	Low	Unlikely
Leporillus apicalis	Lesser Stick-nest Rat	E4	Ex	The last specimen of the Lesser Stick-nest Rat was captured near Mt Crombie. south-west of the present Amata settlement, South Australia in 1933. However, in the nineteenth century it occupied a broad area stretching from the Riverina in New South Wales, through most of inland South Australia and into the Gibson Desert, reaching the Western Australian coast in the Gascoyne region (Burbidge et al. 1988; Cole & Woinarski 2000; Finlayson 1961).	The Lesser Stick-nest Rat occupied arid and semi-arid lands (Burbidge et al. 1988; Cole & Woinarski 2000).	No habitat	No
Limosa limosa	Black-tailed Godwit	V	~	In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary). Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. It has been recorded within the Murray-Darling Basin, on the western slopes of the Northern Tablelands and in far north-western NSW.	The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia (Palaearctic) and flies to Australia for the southern summer, arriving in August and leaving in March. Primarily a coastal species, it is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps.	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Litoria booroolongensis	Booroolong Frog	E1	E	It is restricted to the tablelands and slopes from 200 to 1300 m above sea level in NSW and north eastern Victoria. The species is mostly found along the western-flowing streams and their headwaters of the Great Dividing Range. Catchments drain from the Northern Tablelands to the Tumut River in the Southern Highlands, and other tributaries of the Murrumbidgee River. The only records of the species in northern NSW outside the Northern Tablelands are from two streams near Tamworth, NSW.	Typically inhabits rocky western-flowing creeks and their headwaters, although a small number of animals have also been recorded in eastern-flowing streams. along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses (SEWPaC 2013)	No habitat	No
Lophoictinia isura	Square-tailed Kite	V	~	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that it is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, from September to March	In coastal areas, this species is associated with tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant & Higgins 1993, OEH 2013b). May be recorded inland along timbered watercourses (OEH 2013b). In NSW it is commonly associated with ridge or gully forests dominated by *Eucalyptus longiflora* (Woollybutt), C. *maculata*, or *E. elata* and *E. smithii* (OEH 2013b).	High	Likely
Macropus dorsalis	Black-striped Wallaby	E1	~	From the Townsville area in Queensland to northern NSW where it occurs on both sides of the Great Divide. On the North West Slopes of NSW it occurs in Brigalow remnants to south of Narrabri. On the north coast it is confined to the upper catchments of the Clarence and Richmond Rivers	Preferred habitat is characterised by dense woody or shrubby vegetation within three metres of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat. On the North West Slopes, it is associated with dense vegetation, including brigalow, ooline and semi-evergreen vine thicket. On the north coast, it is closely associated with dry rainforest but also occur in moist eucalypt forest with a rainforest understorey or a dense shrub layer.	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Melanodryas cucullata	Hooded Robin	V	~	The Hooded Robin is, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. However, it is common in few places, and rarely found on the coast. The south-eastern form (subspecies *cucullata* is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west, where it is replaced by subsp. *picata*	Associated with a wide range of Eucalypt woodlands, Acacia shrubland and open forests. In temperate woodlands, the species favours open areas adjoining large woodland blocks, with areas of dead timber and sparse shrub cover. Hooded Robin home ranges are relatively large, averaging 18ha for birds from the New England Tableland. It is considered a sedentary species, but local seasonal movements are possible.	High	Known
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	~	This subspecies extends south from central Queensland, through NSW, Victoria into south eastern SA. In NSW it is widespread, with records 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 and Clarence River areas. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions	Predominantly associated with box-ironbark association woodlands, especially *Eucalyptus sideroxylon*, *E. albens*, *E. microcarpa* and *E. tereticornis*. Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees, and River Red Gum (OEH 2013b).	High	Likely
Miniopterus australis	Little Bentwing-bat	V	~	This species occurs along the East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW.	Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 1998). This species shelters in a range of structures including culverts, drains, mines and caves (Environment Australia 2000). Relatively large areas of dense vegetation of either wet sclerophyll forest, rainforest or dense coastal banksia scrub are usually found adjacent to caves in which this species is found (OEH 2013b). Breeding occurs in caves, usually in association with *M. schreibersii* (OEH 2013b).	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	~	Eastern Bentwing-bats occur along the east and north-west coasts of Australia	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).	High	Known
Mormopterus norfolkensis	Eastern Freetail-bat	V	~	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW.	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000; Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000; Allison & Hoye 1998).	Low	Unlikely
Myotis macropus	Large-footed / Southern Myotis	V	~	The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers	Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface	Low	Unlikely
Neophema pulchella	Turquoise Parrot	V	~	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.(OEH 2013b)	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species (Marchant & Higgins 1993). Spends much of the time on the ground foraging on seed and grasses (OEH 2013b). It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs (Environment Australia 2000).	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Ninox connivens	Barking Owl	V	~	The Barking Owl is found throughout continental Australia except for the central arid regions. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains (especially the Pilliga) and in some northeast coastal and escarpment forests (OEH 2013b)	Associated with a variety of habitats such as savanna woodland, open eucalypt forests, wetland and Riverine forest. Habitat is typically dominated by Eucalypts (often Redgum species), but can also be dominated by *Melaleuca* species in the tropics (OEH 2013b). It usually roosts in dense foliage in large trees such as *Casuarina cunninghamiana*, other *Casuarina* and *Allocasuarina*, eucalypts, *Angophora*, *Acacia* and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground.	High	Known
Ninox strenua	Powerful Owl	V		It 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	It inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. 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, Black She-oak, Blackwood, Rough-barked Apple, Cherry Ballart and a number of eucalypt species	Low	Unlikely
Nyctophilus timoriensis (South-eastern form) *Nyctophilus corbeni*	Greater Long-eared Bat South-eastern Long eared Bat	V	V	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.(OEH 2013b)	It inhabits a variety of vegetation types including mallee, bulloke and box eucalypt dominated communities. However, it is 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.	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Oxyura australis	Blue-billed Duck	V	~	The Blue-billed Duck is endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 km away. It is generally only during summer or in drier years that they are seen in coastal areas. (OEH 2013b)	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation (OEH 2013b). The species is completely aquatic, swimming low in the water along the edge of dense cover (OEH 2013b). They are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer (OEH 2013b).	Low	Unlikely
Pachycephala inornata	Gilbert's Whistler	V	~	This species occurs across most of NSW's semi-arid and arid regions. The eastern population extends from the central NSW mallee (Yathong, Nombinnie and Round Hill NRs), south and east through the Cocoparra Range to Pomingalama Reserve (near Wagga Wagga) then north through the South West Slopes east as far as Cowra and Burrendong Dam, to the Goonoo reserves (with scattered records as far north as Pilliga (OEH 2013b).	This species occurs in arid and semi-arid timbered habitats in mallee shrubland, and occasionally in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests. Within mallee the species often occurs in association with an understorey of Spinifex and low shrubs of acacias, hakeas, sennas and grevilleas. In woodland habitats, the understorey contains areas of dense shrubbery (OEH 2013b).	Moderate	Potential
Petaurus australis	Yellow-bellied Glider	V		This species is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland, through NSW to Victoria	This species occurs in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary, with mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Their den sites are in hollows of large trees. They can occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources	Low	Unlikely
Petaurus norfolcensis	Squirrel Glider	V	~	The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. (OEH 2013b)	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988; Quin 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995).	High	Likely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Petrogale penicillata	Brush-tailed Rock-wallaby	E1	V	The range of this species extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. However the distribution across its original range has declined significantly in the west and south and has become more fragmented. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit (OEH 2013b).	This species occupies rocky areas (escarpments and outcrops) in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995). They generally browse on vegetation in and adjacent to rocky areas, eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	Moderate	Unlikely
Petroica boodang	Scarlet Robin	V	~	The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter.	The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. It lives in dry eucalypt forests and woodlands with an understorey that is usually open and grassy with few scattered shrubs. It can live in both mature and regrowth vegetation with an abundance of logs and fallen timber an important component of its habitat.	High	Potential
Petroica phoenicea	Flame Robin	V	Mar	The Flame Robin is endemic to SE Australia, and ranges from near the Queensland border to SE South Australia and also in Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands (OEH 2013b).	It breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. The species prefers clearings or areas with open understoreys. The ground layer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. It occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes (OEH 2013b).	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Phaethon rubricauda	Red-tailed Tropicbird	V	Mar	This species of Marine bird occurs throughout tropical and subtropical zones of the Indian and West Pacific Oceans. Breeding occurs on oceanic islands, with the largest breeding site occurring on Lord Howe Island. Vagrant birds occur in coastal water of NSW, and occasionally inland, particularly after storm events (OEH 2013b)	It is a Marine species that breeds in coastal cliffs and under bushes in tropical Australia. It nests on cliffs of the northern hills and southern mountains on the main island at Lord Howe Island (OEH 2013b)	Low	Unlikely
Phascolarctos cinereus	Koala	V	~	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 west of the Great Dividing Range. It was briefly historically abundant in the 1890s in the Bega District on the south coast of NSW, although not elsewhere, but it now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands (OEH 2013b).	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees. Some preferred *Eucalyptus* species are: *Eucalyptus tereticornis*, *E. punctata*, *E. cypellocarpa* and *E. viminalis.*	High	Known
Phascogale tapoatafa	Brush-tailed Phascogale	V		The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are some records west of the divide (OEH 2013b).	It prefers dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter, but can also inhabit heath, swamps, rainforest and wet sclerophyll forest. It nests and shelters in tree hollows, with entrances 2.5 - 4 cm wide and can use many hollows over a short time span (OEH 2013b).	Low	Unlikely
Polytelis anthopeplus	Regent Parrot			Once recorded between Adelaide and the central coast of QLD, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. 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 woodlands.	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. It is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. (OEH 2013b)	Moderate	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Polytelis swainsonii	Superb Parrot	V	V	The Superb Parrot is found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round.	The Superb Parrot inhabits box-gum woodland, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. It forages at or near the ground and nest in hollows in small colonies (OEH 2013b).	Moderate	Potential
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	~	This species has two distinctive subspecies that intergrade to the south of the Gulf of Carpentaria. West of here the subspecies *rubeculus*, formerly considered a separate species (Red-breasted Babbler) is still widespread and common. The eastern subspecies (*temporalis*) occurs from Cape York south through QLD, NSW and Vic and formerly to the south east of SA. This subspecies also occurs in the Trans-Fly Region in southern New Guinea. 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 Balranald. It also occurs in woodlands in the Hunter Valley and in some locations on the north coast.	This species is found in open woodlands dominated by mature eucalypts with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs (OEH 2013b). This species avoids very wet areas (Blakers et al. 1984).	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Pseudomys pilligaensis	Pilliga Mouse	V	V	Distribution restricted to the Pilliga region of New South Wales. Fox and Briscoe first described this species in 1980 (Fox and Briscoe 1980).	This species of small rodent occurs in Pilliga Scrub on an isolated area of low-nutrient deep sand predominantly in recently burnt moist gullies, areas dominated by Broombush and areas containing an understorey of Kurricabah (Acacia burrowii) with a *Corymbia trachyphloia* overstorey in the Pilliga region of NSW. They seem to prefer areas with a high species diversity and dense low shrub layer. The species is thought to live in burrows and is nocturnal. (OEH 2013b).	High	Known
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. They show a regular pattern of seasonal movement with much of the population moving to northern NSW and QLD during May and June where they exploit the winter flowering trees such as *Eucalyptus robusta*, *E. tereticornis* and Paperbark (OEH 2013b).	This species roosts in camps generally located within 20 km of a regular food source and are commonly found in gullies, close to water and in vegetation with a dense canopy. This species is known to forage in areas supporting subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps on the nectar and pollen of native trees, in particular eucalypts, melaleucas and banksias.	Moderate	Potential
Rostratula benghalensis australis	Painted Snipe (Australian subspecies)	E1	V, Mar, M CAMBA	The Australian Painted Snipe has been recorded at wetlands in all states of Australia. It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia. It has been recorded less frequently at a smaller number of more scattered locations farther west in South Australia, the Northern Territory and Western Australia.	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (OEH 2013b). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (*ibid.*). Breeding is often in response to local conditions; generally occurs from September to December (OEH 2013b). Roosts during the day in dense vegetation (OEH 2013b). Forages nocturnally on mud-flats and in shallow water (OEH 2013b). Feeds on worms, molluscs, insects and some plant-matter (*ibid.*).	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	~	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.	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies (SFNSW 1995). It roosts in tree hollows and may also use caves. The species has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). It is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).	High	Known
Sminthopsis macroura	Stripe-faced Dunnart	V	~	Throughout much of inland central and northern Australia, extending into central and northern NSW, western Queensland, Northern Territory, South Australia and Western Australia. They are rare on the NSW Central West Slopes and North West Slopes with the most easterly records of recent times located around Dubbo, Coonabarabran, Warialda and Ashford. (OEH 2013b)	Native dry grasslands and low dry shrublands, often along drainage lines. During periods of hot weather they shelter in cracks in the soil, in grass tussocks or under rocks and logs (OEH 2013b)	Low	Unlikely
Stagonopleura guttata	Diamond Firetail	V	~	The Diamond Firetail is endemic to south-eastern Australia, extending from central QLD to the Eyre Peninsula in SA. It is widely distributed in NSW, with a number of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species has a scattered distribution over the rest of NSW, and is rare west of the Darling River	Typically found in grassy eucalypt woodlands, but also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities (OEH 2013b). It is often found in riparian areas and sometimes in lightly wooded farmland (OEH 2013b). Appears to be sedentary, though some populations move locally, especially those in the south (OEH 2013b).	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Stictonetta naevosa	Freckled Duck	V	~	The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. It breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina (OEH 2013b)	This species prefers permanent freshwater swamps and creeks with heavy growth of Typha, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. They generally rest in dense cover during the day in deep water. They feed at dawn and dusk and at night on algae, seeds and aquatic grasses and sedges and small invertebrates. Nesting usually occurs between October and December but can take place at other times when conditions are favourable (OEH 2013b).	Low	Unlikely
Tyto longimembris	Eastern Grass Owl	V	~	Eastern Grass Owls have been recorded occasionally in all mainland states of Australia but are most common in northern and north-eastern Australia. In NSW they are more likely to be resident in the north-east. Eastern Grass Owl numbers can fluctuate greatly, increasing especially during rodent plagues (OEH 2013b).	This species is found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. They rest by day in a 'form' - a trampled platform in a large tussock or other heavy vegetative growth. They breeds on the ground and nests are found in trodden grass, and often accessed by tunnels through vegetation OEH 2013b.	Low	Unlikely
Tyto novaehollandiae	Masked Owl	V	~	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution. (OEH 2013b)	The species is associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (OEH 2013b) and especially the ecotone between wet and dry forest, and non forest habitat (Environment Australia 2000). The species is known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).	High	Likely
Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	V	V	The Border Thick-tailed Gecko is found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree (OEH 2013b). Most common in the granite country of the New England Tablelands (OEH 2013b).	The Border Thick-tailed Gecko is found in rocky hills with dry open eucalypt forest or woodland (OEH 2013b). Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter (OEH 2013b).	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Vespadelus troughtoni	Eastern Cave Bat	V	~	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT.	The species inhabits tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western slopes and inland areas (Churchill 1998). It has been found roosting in sandstone overhand caves, boulder piles, mine tunnels and occasionally in buildings (Churchill 1998).	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
FLORA							
Acacia jucunda	Yetman Wattle	E1	-	The Yetman Wattle is found in the Yetman district near the Queensland border on the North West Slopes of NSW. It also occurs in Queensland where it is reasonably common (OEH 2013b).	The Yetman Wattle is mainly restricted to the dry eucalypt forests or woodlands on sandy to sandy-loam soils. It is associated with other species in NSW including, Western Silver Wattle (*Acacia polybotrya*) and Black Cypress Pine (*Callitris endlicheri*). The species is known to occur within the Border Rivers – Gwydir CMA area but mostly restricted to the Yetman area.	Low	Unlikely
Bertya opponens	Coolabah Bertya	V	V	Known from scattered sites in NSW including Coolabah, south of Narrabri on the North West Slopes (including Jacks Creek State Forest), Cobar and the North Coast.	Ranges from stony mallee ridges and cypress pine forest on red soils.	Moderate	Potential
Boronia granitica	Granite Boronia	V	E	Granite Boronia is known from scattered localities on the New England Tablelands and North West Slopes north from the Armidale area to the Stanthorpe district in southern Queensland	Granite Boronia grows amongst granite outcrops, often in rock crevices, north from Inverell district.	No habitat	No
Cadellia pentastylis	Ooline	V	V	This species occurs along the western edge of the North West Slopes from north of Gunnedah to west of Tenterfield with some records from in Queensland. The natural range of Ooline is from 24ºS to 30ºS in the 500 to 750 mm per annum rainfall belt.	Ooline occurs in low- to medium-nutrient soils of sandy clay or clayey consistencies, with a typical soil profile having a sandy loam surface layer, grading from a light clay to a medium clay with depth.	Low	Unlikely
Cyperus conicus	A sedge	E1		This species occurs rarely in the Pilliga area of NSW and is also found in Victoria, Qld, the NT and WA	The species grows in open woodland on sandy soil. In central Australia, it grows near waterholes and on the banks of streams in sandy soils. In Qld the species is usually found on heavy soils. It has been recorded from *Callitris* forest in the Pilliga area, growing in sandy soil with *Cyperus gracilis, C. squarrosus* and *C. fulvus*.	Moderate	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Desmodium campylocaulon	Creeping Tick-Trefoil	E1		Occurs chiefly in the Collarenebri and Moree districts in the north-western plains of NSW. Also occurs in the NT and Darling Downs district of south-eastern Queensland (OEH 2013b)	In NSW the species grows on cracking black soils in the Narrabri, Moree and Walgett local government areas. It is associated with other species including *Acacia harpophylla, Astrebla pectinata* and *Sorghum, Dichanthium* and *Panicum* species. It flowers summer and autumn (OEH 2013b)		Unlikely
Dichanthium setosum	Bluegrass	V	V	New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia.	Associated with heavy basaltic black soils. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture.	Low	Unlikely
Digitaria porrecta	Finger Panic Grass	E1	E	Occurs in NSW and Queensland. In NSW it is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran.	Habitat includes native grassland, woodlands or open forest with a grassy understorey, on richer soils.	Low	Unlikely
Diuris tricolor	Painted Diuris	V	V	Sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the far north of NSW.	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. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats.	Low	Likely
Haloragis exalata	-	V	V	Disjunctly distributed in the central coast, south coast and north-western slopes botanical subdivisions of NSW	Protected and shaded damp situations in riparian habitats.	Low	Unlikely
Homopholis belsonii	Belson's Panic	E1	V	North from the Warialda district and into Queensland	Habitat and ecology poorly known. Grows in dry woodland (e.g. Belah) on poor soils.	Low	Unlikely
Lepidium aschersonii	Spiny Peppercress	V	V	Not widespread, occurring in the marginal central-western slopes and north-western plains regions of NSW (and potentially the south western plains). A several populations recorded at Narrabri. Also known from the West Wyalong, Barmedman and Temora areas.	Found on ridges of gilgai clays dominated by *Acacia harpophylla* (Brigalow), with *Austrodanthonia* and/or *Austrostipa* species in the understorey. The species grows as a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense Brigalow, with sparse grassy understorey and occasional heavy litter.	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Lepidium monoplocoides	Winged Peppercress	E1	E	Widespread in the semi-arid western plains region of NSW. Recorded in previous ELA survey in Western Pilliga.	Known to occur on seasonally moist to waterlogged sites, on heavy fertile soils. In W Pilliga, it was found in White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion vegetation and associated with gilgais.	Moderate	Potential
Monotaxis macrophylla	Large-leafed Monotaxis	E1	~	Large-leaf Monotaxis is recorded from several highly disjunct populations in NSW: eastern edge of Deua NP (west of Moruya), Bemboka portion of South East Forests National Park, Cobar area (Hermitage Plains), the Tenterfield area, and Woodenbong (near the Queensland border). It is also in Queensland.	Grows on rocky ridges and hillsides. There is a great diversity in the associated vegetation within NSW (less though in Queensland), encompassing coastal heath, arid shrubland, forests and montane heath from almost sea level to 1300 m altitude.	Moderate	Unlikely
Myriophyllum implicatum		CE	~	This species was previously thought to be extinct in NSW; however the plant was recently discovered in the Pilliga National Park, south of Narrabri. It is known from QLD and is listed as 'Least Concern' under that States Nature Conservation Act (1992) (OEH 2013b).	The species occurs in moist situations, extending away from fresh water. A recent population was found in NSW in a large open partly inundated gilgai depression on cracking clay soil (OEH 2013b).	Low	Unlikely
Platyzoma microphyllum	Braid Fern	E1	~	Species records exist in NSW only in the Yetman district. However, the species is widespread across northern Australia, from WA to the NT, eastern Qld and just into central-northern NSW (OEH 2013b).	It grows in sandy or swampy soils, or in clay soils adjacent to streams and lagoons and subject to periodic flooding. It has been recorded in NSW at Bruxner Highway growing as one localised patch in deep sandy soil, with *Leptospermum* species, *Brachyloma daphnoides* and *Lomandra* species (OEH 2013b).	Low	Unlikely
Polygala linariifolia	Native Milkwort	E1	~	Found north from Copeton Dam and the Warialda area to southern QLD; also found on the NSW north coast near Casino and Kyogle, and there is an isolated population in far western NSW near Weebah Gate, west of Hungerford. This species also occurs in Western Australia.	Occurs in sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of *Eucalyptus caleyi, Eucalyptus dealbata* and *Callitris*, and in yellow podsolic soil on granite in layered open forest.	High	Known

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Pomaderris queenslandica	Scant Pomaderris	E1	~	Records are 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.	The species is found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Low	Potential
Pterostylis cobarensis	Greenhood Orchid	V	V	It is known chiefly from the Nyngan-Cobar-Bourke district in the far western plains of New South Wales. Recorded districts include Narrabri, Nyngan, Cobar, Nymagee, Mt Gundabooka, Mt Grenfell and Mutawintji National Park. There are also records from the Darling Downs district of Queensland.	The Greenhood Orchid is found in Eucalypt woodlands, open mallee or *Callitris* shrublands on low stony ridges and slopes in skeletal sandy-loam soils.	Moderate	Known
Rulingia procumbens	-	V	V	The species is endemic to NSW and mainly confined to the Dubbo-Mendooran-Gilgandra region, but also in the Pilliga and Nymagee areas.	It grows in sandy sites, often along roadsides. Recorded in *Eucalyptus dealbata* and *E. sideroxylon* communities, *Melaleuca uncinata* scrub, under mallee eucalypts with a *Calytrix tetragona* understorey, and in a recently burnt Ironbark and *Callitris* area. It also occurs in *E. fibrosa* subsp. *nubila, E. dealbata, E. albens* and *Callitris glaucophylla* woodlands north of Dubbo.	High	Potential
Sida rohlenae	Shrub Sida	E1	~	It has a limited distribution in QLD, the NT, SA and WA. In NSW it has been recorded south of Enngonia, south of Bourke and north-west of Coonamble	It occurs in flood-out areas, creek banks and at the base of rocky hills. NSW specimens have been found along roadsides in hard red loam to sandy-loam soils.	Low	Unlikely
Swainsona murrayana	Slender Darling Pea	V	V	The species is found throughout NSW. It has been recorded in the Jerilderie and Deniliquin areas of the southern Riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree.	The species has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams. It grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with Maireana species.	Low	Unlikely

SCIENTIFIC NAME	COMMON NAME	TSC ACT	EPBC ACT	DISTRIBUTION	HABITAT	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
Thesium australe	Austral Toadflax	V	V	Small populations are scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia.	Austral Toadflax occurs in grassland or grassy woodland and often found in damp sites in association with *Themeda australis* (Kangaroo Grass).	Low	Unlikely
Tylophora linearis	-	V	E	The species is found in the Barraba, Mendooran, Temora and West Wyalong districts in the northern and central western slopes of NSW.	It grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *E. sideroxylon*, *E. albens*, *Callitris endlicheri*, *C. glaucophylla* and *Allocasuarina luehmannii*.	High	Known

TSC LISTED ECOLOGICAL COMMUNITY	TSC ACT	EPBC ACT	DESCRIPTION	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
ENDANGERED ECOLOGICAL COMMUNITIES					
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	EEC	E	The ecological community is a low woodland or forest community dominated by *Acacia harpophylla* (Brigalow), with pockets of *Casuarina cristata* (Belah) and *Eucalyptus populnea* subsp. *bimbil* (Poplar Box). The canopy tends to be quite dense and the understorey and ground cover are only sparse. It is found in the Brigalow Belt South Bioregion in NSW and as isolated occurrences in the Darling Riverine Plains and Nandewar Bioregions.	Low	Known
Cadellia pentastylis (Ooline) community in the Nandewar and Brigalow Belt South Bioregions	EEC	~	The Ooline community is an unusual and distinctive forest community with the canopy dominated by the tree *Cadellia pentastylis* (Ooline). Other canopy species include *Eucalyptus albens* (White Box), *E. beyeriana* and *E. melanophloia*, *E. chloroclada* (Dirty Gum), *E. pilligaensis* (Narrow-leaved Grey Box), *E. viridis* (Green Mallee) and *Callitris glaucophylla* (White Cypress Pine). The understorey is made up of a range of shrubs such as Wattles and grasses. It is now known from only seven main locations on the North West Slopes in NSW, between Narrabri and the Queensland border, and also in Queensland.	Not observed within study area	Unlikely
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	EEC	E	Represents occurrences of one type of semi-arid to humid subtropical woodland where *Eucalyptus coolabah* subsp. *coolabah* (Coolibah) and/or *Eucalyptus largiflorens* (Black Box) are the dominant canopy species and where the understorey tends to be grassy. The structure of the community may vary from tall riparian woodlands to very open 'savanna like' grassy woodlands with a sparse midstorey of shrubs and saplings. The ecological community is associated with the floodplains and drainage areas of the Darling Riverine Plains and the Brigalow Belt South bioregions.	Not observed within study area	Unlikely
Myall Woodlands in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW south western slopes bioregions	E	E	Occurs on red-brown earths and heavy textured grey and brown alluvial soils where annual rainfall is in the range 375 and 500 mm. The structure can varies from low woodland and low open woodland to low sparse woodland or open shrubland. The tree layer grows up to a height of about 10 metres and invariably includes *Acacia pendula* (Weeping Myall or Boree) as one of the dominant species or the only tree species present. The understorey includes an open layer of chenopod shrubs and other woody plant species and an open to continuous groundcover of grasses and herbs. The shrub stratum may have been reduced by clearing or heavy grazing. It is scattered across the eastern parts of alluvial plains of the Murray-Darling river system.	Not observed within study area	Unlikely

TSC LISTED ECOLOGICAL COMMUNITY	TSC ACT	EPBC ACT	DESCRIPTION	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	E	CE	The community has an overstorey dominated, or was once dominated by *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box) or *E. blakelyi* (Blakely's Red Gum) trees. It is characterised by a species-rich understorey of native tussock grasses, herbs and forbs. In the Nandewar Bioregion, *E. microcarpa* or *E. moluccana* may also be dominant or co-dominant. The tree-cover is generally discontinuous and consists of widely-spaced trees of medium height in which the canopies are clearly separated. The shrub layer can be non-existent. In NSW the community is found from the Queensland border in the north, to the Victorian border in the south along the tablelands and western slopes areas.	Low	Potential
Fuzzy Box Woodland on alluvial soils of the south western slopes, Darling Riverine Plains and Brigalow Belt South bioregions	E	~	The community is a tall woodland or open forest usually dominated by *Eucalyptus conica* (Fuzzy Box), which often grows with *E. microcarpa* (Inland Grey Box), *E. melliodora* (Yellow Box) or *Brachychiton populneus* (Kurrajong). *Allocasuarina luehmannii* (Buloke) is common in places. Shrubs are generally sparse and the ground cover moderately dense, but this can change with the season. It is found on the alluvial soils of the South West Slopes, Brigalow Belt South and Darling Riverine Plains Bioregions (mainly in the Dubbo-Narromine-Parkes-Forbes area).	Moderate	Known
TSC: Inland Grey Box Woodland in the Riverina, NSW south western slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions EPBC: Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of south-eastern Australia	E	E	The community is a woodland dominated by *Eucalyptus microcarpa* (Inland Grey Box). It is often found in association with *E. populnea* subsp. *bimbil*, *Callitris glaucophylla* (White Cypress Pine), *Brachychiton populneus* (Kurrajong), *Allocasuarina luehmannii* (Bulloak) or *E. melliodora* (Yellow Box), and sometimes with *E. albens* (White Box). It occurs in landscapes of low-relief such as flat to undulating plains, low slopes and rises and, to a lesser extent, drainage depressions and flats. The ecological community may extend to more elevated hillslopes on the fringes of its range where it intergrades with other woodland or dry sclerophyll forest communities. In NSW the community principally occurs within the Riverina and South West Slopes Bioregions and is also found in portions of the Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions.	Not observed within study area	Unlikely

TSC LISTED ECOLOGICAL COMMUNITY	TSC ACT	EPBC ACT	DESCRIPTION	AVAILABILITY OF HABITAT IN STUDY AREA	LIKELIHOOD OF OCCURRENCE IN STUDY AREA
TSC: Native Vegetation on Cracking Clay Soils of the Liverpool Plains EPBC: Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	E	CE	The ecological community is mainly a native grassland community containing a range of small forb and herb species, but can be found with scattered / patchy shrubs and trees. The main grass species include *Austrostipa aristiglumis* (Plains Grass), *Dichanthium sericeum* (Queensland Bluegrass) and *Panicum queenslandicum* (Coolibah Grass). It occurs on flat to low slopes, of no more than 5 percent (or less than 1 degree) inclination. As slope increases, grassy woodlands dominated by trees such as *Acacia pendula* (Weeping Myall), *Eucalyptus coolabah* (Coolabah), *E. populnea* (Poplar Box) or *E. melliodora* (Yellow Box) occur. The ground layer component of these woodlands may be similar to the grassland but the soils will not be the same cracking clays as on the plains.	Not observed within study area	Unlikely
Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	E	E	The community is a low, dense form of dry rainforest generally less than 10 m high, made up of vines and rainforest trees as well as some shrubs. The main canopy is dominated by rainforest species such as *Cassine australis* var. *angustifolia* (Red Olive Plum), *Geijera parvifolia* (Wilga), *Notelaea microcarpa* var. *microcarpa* (Native Olive) and *Ehretia membranifolia* (Peach Bush), with taller eucalypts and cypress pines from surrounding woodland vegetation emerging above the main canopy. *Carissa ovata* (Currant Bush) is often present and typical vines include *Parsonsia eucalyptophylla* (Gargaloo) and *Pandorea pandorana* (Wonga Vine). It has a scattered distribution near Gunnedah, Barraba, Bingara and north of Warialda on the NSW North West Slopes and Plains, and also in Queensland.	Not observed within study area	Unlikely
Marsh Club-rush sedgeland in the Darling Riverine Plains Bioregion	CE	~	The community is dominated by *Bolboschoenus fluviatilis* (Marsh Club-rush), which forms dense stands up to 2 m tall. The community is further characterised by an understorey including *Carex appressa* (Tussock Sedge), *Eleocharis plana* (Ribbed Spike Rush), *Lachnagrostis filiformis* (Blown Grass), *Paspalum distichum* (Water Couch) and *Ranunculus undosus* (Swamp Buttercup). It is distinguished from other surrounding communities by a lack of trees and the dominance of *Bolboschoenus fluviatilis* (generally over 40% of the vegetation cover) although the structure may vary depending on past disturbance. The community is associated with grey clay soils usually with a surface layer of organic matter several centimetres thick. The community has a very fragmented distribution and is mainly restricted to the Gwydir wetlands but may occur elsewhere in the Darling Riverine Plains Bioregion.	Not observed within study area	Unlikely

HEAD OFFICE
Suite 4, Level 1
2-4 Merton Street
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

SYDNEY
Level 6
299 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9264 0717

ST GEORGES BASIN
8/128 Island Point Road
St Georges Basin NSW 2540
T 02 4443 5555
F 02 4443 6655

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 0145
F 02 6103 0148

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 0125
F 02 4910 0126

NAROOMA
5/20 Canty Street
Narooma NSW 2546
T 02 4476 1151
F 02 4476 1161

COFFS HARBOUR
35 Orlando Street
Coffs Harbour Jetty NSW 2450
T 02 6651 5484
F 02 6651 6890

ARMIDALE
92 Taylor Street
Armidale NSW 2350
T 02 8081 2681
F 02 6772 1279

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1230
F 02 6372 9230

PERTH
Suite 1 & 2
49 Ord Street
West Perth WA 6005
T 08 9227 1070
F 08 9322 1358

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 4268 4361

GOSFORD
Suite 5, Baker One
1-5 Baker Street
Gosford NSW 2250
T 02 4302 1220
F 02 4322 2897

DARWIN
16/56 Marina Boulevard
Cullen Bay NT 0820
T 08 8989 5601

BRISBANE
PO Box 1422
Fortitude Valley QLD 4006
T 0400 494 366

1300 646 131
www.ecoaus.com.au

Appendix 2

Additional assessments of significance – Dewhurst 26-29 Pilot

.

A2.1 Assessment of significance - Bertya opponens

A2.1.1 Overview

Bertya opponens is a shrub that grows to 4 m tall. It can be multi or single stemmed and has smooth, thick leaves that are dark green above and covered in velvety hairs below. Its branches and stems are also densely covered with hairs. The leaves of *Bertya opponens* measure 10-80 mm long by 5-25 mm wide; have curved margins and are mostly arranged in pairs.

The flowering time of *Bertya opponens* is between July and August. It is found in a range of habitats including cypress pine forest on red soils and stony mallee ridges, but has not been found within the wetter areas of the Pilliga Scrub (NSW NPWS 2002). Fire and mechanical disturbance appear to trigger germination and/or suckering, although the most appropriate time interval between these disturbance events are not known.

Associated species include: *Eucalypts chloroclada, Callitris glaucophylla* and *Eucalyptus fibrosa* (OEH, 2013).

A2.1.2 7-Part test criteria

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

This species was not recorded throughout the surveys, which were undertaken just after the optimal flowering time. While the surveys were undertaken outside of the optimal flowering time, it is a distinct species, given that it reaches a height of up to four metres, with distinct features for identification. It is therefore considered unlikely that this species occurs in the disturbance area.

The proposed activities may lead to the clearing of approximately 5.598 hectares of Narrow-leaved Ironbark habitat.

Due to the small amount of potential habitat to be removed, in comparison to the contiguous habitat within the Pilliga Forest, it is unlikely that an adverse effect on the life cycle of Bertya opponens would occur. If it were present, a viable local population of this species is unlikely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

There is no endangered population for these species currently listed on the TSC Act within the survey area, however it is known to occur within Jacks Creek State Forest (approximately 20 kilometres north of Dewhurst 26-29).

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

This factor does not apply to threatened species.

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

(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

The proposed activity may lead to the clearing of approximately 5.598 hectares of Narrow-leaved Ironbark habitat for this species. This is considered to be minimal when compared to available habitat within the Pilliga Scrub (Narrow-leaved Ironbark communities account for approximately 198,219 hectares of the Pilliga Scrub).

(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

This existing habitat is well connected to similar surrounding habitats in the immediate surrounds and the proposed activities are unlikely to fragment or isolate the species from such areas.

(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.

The proposed activities may lead to the clearing of approximately 5.598 hectares of habitat for this species. Large tracts of similar habitat are to be left undisturbed within the immediate vicinity of the proposed activity. Given that this species was not recorded on site, and large tracts of habitat will be left undisturbed, the habitat to be removed is not considered to be critical to the survival of this species.

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

There is no critical habitat listed for these species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The recovery plan for this species outlines five specific objectives, including: 1) limit grazing impacts at the Coolabah population; 2) survey potential habitat for further populations; 3) ensure there is recruitment at senescent populations; and 4) raise awareness of the conservation significance of *Bertya* sp. Cobar-Coolabah and involve the community in the recovery program. The survey area is located within a state forest and is therefore not grazed by cattle. Although the action is not consistent with the recovery plan, it is unlikely to have a significant impact on the species.

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

The action will result in land clearance, which is a key threatening process that has the potential to impact upon this species. However, the minimal clearing proposed in the context of the broader Pilliga Scrub is not considered to be a significant impact.

A2.1.3 Conclusion

Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species *Bertya opponens* or its habitats.

A2.2 Assessment of Significance - Native Milkwort (*Polygala linariafolia*)

A2.2.1 Overview

Native Milkwort is an annual or perennial herb that grows to approximately 20 centimetres high. Its leaves are up to 3.5 centimetres long and are variable in shape, with a short point at the tip, a dull texture and sparse covering of hairs. Native Milkwort flowers from spring to summer.

Native Milkwort is found within sandy soils in Dry Eucalypt communities with a sparse understorey. In the Pilliga area, this species has been recorded in Rough-barked Apple riparian forb-grass open forest; Fuzzy Box woodland, Ironbark-Brown Bloodwood shrubby woodland and White Cypress Pine-Bulloak-Ironbark woodland.

Other associated species include *Angophora floribunda, Angophora leiocarpa*, *Corymbia Eucalyptus trachyphloia, Eucalyptus sphaerocarpa, Allocasuarina torulosa; Tristania suaveolens* and *Wahlenbergia* species in the understorey (OEH, 2013).

A2.2.2 7-Part test criteria

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Native Milkwort was not identified throughout the surveys undertaken by RPS, but records do occur within and adjacent to Dewhurst 28, recorded by EcoLogical in 2011. A review of EcoLogical GIS data indicates that 29 individuals have been recorded within the Dewhurst 28 lease area, with a further 49 individuals recorded immediately adjacent to the lease area.

Previous correspondence between EcoLogical and OEH has indicated that populations previously observed were not present following a period of low rainfall. This is consistent with the survey conditions as targeted searches failed to identify this species.

The proposed activities will result in the clearing of 5.598 hectares of suitable habitat within Dewhurst 26 – 29. While no species were recorded throughout the recent surveys, the lease area was known to support 29 individuals previously recorded that will be removed, thus 67% of the population occurring will remain.

The clearing of 5.598 hectares of suitable habitat to support this species is not considered to be significant, given the large tracts of habitat available that are also likely to support this species. Furthermore, viable populations of this species are known to occur outside of the study area, based on EcoLogical threatened species records. Therefore, it is unlikely that the proposed activities would have an adverse effect on the life cycle of Native Milkwort such that a viable local population of this species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

There is no endangered population for these species currently listed on the TSC Act within the survey area.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

This factor does not apply to threatened species.

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

(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

The proposed activity may lead to the clearing of approximately 5.598 hectares of suitable habitat to support this species. This is considered to be minimal when compared to available habitat within the Pilliga Scrub, particularly given that this species is associated with numerous habitat types. Clearing will not result in the removal of unique or niche habitat for this species.

(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

Areas of contiguous habitat will be retained in the immediate surrounds of each of the wells.

(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.

The habitat to be removed is not considered critical to the long-term survival of the species within the Pilliga Scrub, given that no unique or niche habitats are to be removed.

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

There is no critical habitat listed for these species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

A recovery plan does not exist for this species, however six priority actions have been identified by OEH. Relevant actions include managing livestock grazing, and monitoring the effect of weed control on this species.

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

The action will result in land clearance, which is a key threatening process that has the potential to impact upon this species. However, the minimal clearing proposed in the context of the broader Pilliga Scrub is not considered to be a significant impact.

A2.2.3 Conclusion

Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species or its habitats.

A2.3 Assessment of Significance - Cobar Greenhood Orchid (*Pterostylis cobarensis*)

A2.3.1 Overview

Cobar Greenhood Orchid is a terrestrial orchid that inhabits Eucalypt woodland, open mallee or *Callitris* shrubland on low stony ridges and slopes with skeletal sandy-loam soils. The Cobar Greenhood Orchid is distinguished by 7-10 narrow elliptic leaves which form a basal rosette, each 1.5 – 2.5 centimetres long, and 5 – 8 millimetres wide. Three to 8 transparent flowers with green and brown markings occur on stems up to 40 centimetres high, between September to November. Plants are deciduous and die back to large underground tubers after seed release. New rosettes are produced following autumn / winter rains (DECC 2008).

Other associated species include *Eucalyptus morrisii, E. Viridis, E. Inertexta, E. Vicina, Callitros glaocuophylla, Geijera parviflora, Casuarina cristata, Acacia doratoxylon, Senna* spp., and *Eremophila* spp (DECC 2008).

A2.3.2 7-Part test criteria

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Cobar Greenhood Orchid was not identified within the survey areas. Targeted surveys were conducted in the optimal flowering period, however it is possible that due to the dry autumn / winter, the species may not have been prevalent. This species is known to occur within the Pilliga Scrub, with the closest record located over 1.5 kilometres from the site.

The proposed activity may lead to the clearing of approximately 5.598 hectares of Narrow-leaved Ironbark habitat. This is not considered to be significant, given the large tracts of habitat available that are also likely to support this species. Furthermore, viable populations of this species are known to occur throughout the Pilliga Scrub. Therefore, it is unlikely that the proposed activities would have an adverse effect on the life cycle of Cobar Greenhood Orchid such that a viable local population of this species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

There is no endangered population for these species currently listed on the TSC Act within the survey areas.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

This factor does not apply to threatened species.

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

(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

The proposed activity may lead to the clearing of approximately 5.598 hectares of Narrow-leaved Ironbark habitat. This is considered to be minimal when compared to available habitat within the Pilliga Scrub. Narrow-leaved Ironbark communities account for approximately 198 219 hectares of the Pilliga Scrub. The clearing results in a reduction of approximately 0.002 % of available habitat within the forest.

(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The clearing required is not likely to fragment or isolate habitat in a way that will impact upon the long-term survival of the species.

(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.

Given the large tracts of available habitat within the Pilliga Scrub, habitat to be removed is not considered to be significant for the long-term survival of this species in the locality.

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

There is no critical habitat listed for these species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

No recovery plan exists for this species, however OEH has identified 11 priority actions for this species. Relevant actions include eliminating rabbits, feral goats and stock from sites where this species is known to occur.

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

The action will result in land clearance, which is a key threatening process that has the potential to impact upon this species. However, the minimal clearing proposed in the context of the broader Pilliga Scrub is not considered to be a significant impact.

A2.3.3 Conclusion

Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species or its habitats.

A2.4 Assessment of Significance - Rulingia procumbens

A2.4.1 Overview

Rulingia procumbens is a prostrate shrub with slender trailing stems to 30 centimetres. The leaves are 2 – 5 cm long, and 1.5 – 2.5 cm wide, with a rounded shape and lobed margins (Harden 2000). The upper surface of the leaves are green with star-shaped hairs, and the under surface are white and densely covered with hairs.

The shrub flowers from August to December, displaying pinkish petals about 2 millimetres long. It fruits in summer and autumn, with fruit capsules reaching 6 -8mm, covered in bristles and hairs.

Rulingia procumbens is known to occur in sandy soils, within *Melaleuca uncinata* shrubland and Mallee Eucalypt with a *Calytrix tetragona* understorey.

Associated species include *Acacia triptera, Callitris endlicheri, Eucalyptus melliodora, Allocasuarina diminuta, Philotheca salsolifolia, Xanthorrhoea* spp., *Exocarpos cupressiformis*, *Leptospermum parvifolium,* and *Kunzea parvifolia* (DECC 2005).

A2.4.2 7-Part test criteria

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Rulingia procumbens was not identified within the survey area. Targeted surveys were conducted in the optimal flowering period, however it is possible the species may not have been prevalent due to the dry winter, or lack of recent bushfire. Additionally, portions of the disturbance area are considered to be marginal habitat due to the lack of heath understorey, where associated species such *Melaleuca uncinata*, *Calytrix tetragona* or *Leptospermum parvifolium* do not occur.

This species has not previously been recorded within the well leases, but is known to occur within the Pilliga Scrub.

The proposed activities will result in the clearing of 5.598 hectares of suitable habitat to support this species. Areas with a denser heath understorey are considered to provide more suitable habitat which is present within the proposed lease areas and access tracks.

The clearing of suitable habitat to support this species is not considered to be significant, given the large tracts of habitat available that is also likely to support this species. Furthermore, viable populations are known to occur throughout the Pilliga Scrub, with the closest population occurring five kilometres from the site. It is unlikely that the proposed activities would have an adverse effect on the life cycle of *Rulingia procumbens* such that a viable local population of this species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

There is no endangered population for these species currently listed on the TSC Act within the survey areas.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

This factor does not apply to threatened species.

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

(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

The proposed activities will result in the clearing of 5.598 hectares of suitable habitat which is considered to be minimal when compared to available habitat within the Pilliga Scrub.

(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The clearing required is not likely to fragment or isolate habitat in a way that will impact upon the long-term survival of this species.

(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.

Given the large tracts of available habitat within the Pilliga Scrub, habitat to be removed is not considered to be significant for the long-term survival of this species in the locality.

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

There is no critical habitat listed for these species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

No recovery plan exists for this species, however OEH has identified 12 priority actions for this species. Although the action is not consistent with many of the priority actions, it is unlikely to have a significant impact on the species.

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

The action will result in land clearance, which is a key threatening process that has the potential to impact upon this species. However, the minimal clearing proposed in the context of the broader Pilliga Scrub is not considered to be a significant impact.

A2.4.3 Conclusion

Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species *Rulingia procumbens* or its habitats.

A2.5 Assessment of Significance - Tylophora linearis

A2.5.1 Overview

Tylophora linearis is a herbaceous climber that reaches two metres in length. It is distinguishable by cylindrical stems that have a diameter of three millimetres, with internodes up to 100 millimetres long. The leaves are dark green, up to 100 millimetres long and four millimetres wide.

Tylophora linearis has been recorded flowering in November and May. Flowers are 6 – 22 millimetres in diameter, with olive-green external colouring, and purple internal colouring. Short hairs are internally concentrated towards the tip (Forster et al. 2004).

This species is known to occur within dry scrub, open forest and woodlands associated with *Melaleuca uncinata, Eucalyptus fibrosa, E. Sideroxylon, E. Albens, Callitris endlicheri, C. Glaucophylla, Allocasuarina luehmannii, Acacia hakeoides, A. Lineate, Myoporum* spp. and *Casuarina* spp (DECC 2005).

A2.5.2 7-Part test criteria

a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Tylophora linearis was not recorded within the survey area. Targeted surveys were conducted prior the optimal flowering period, and therefore it is possible that this species may not have been distinguishable. This species has not previously been recorded in close proximity to the proposed lease areas, access tracks or gathering system corridor, but has been recorded in the Pilliga Scrub, with the closest record occurring approximately 2.8 kilometres from the proposed activity (based on EcoLogical GIS data).

The proposed activity will result in the clearing of 5.598 hectares of Narrow-leaved Ironbark habitat. This is considered to be minimal when compared to available habitat within the Pilliga Scrub. Furthermore, viable populations of this species are known to occur throughout the Pilliga Scrub. Therefore, it is unlikely that the proposed activities would have an adverse effect on the life cycle of *Tylophora linearis* such that a viable local population of this species is likely to be placed at risk of extinction.

b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

There is no endangered population for these species currently listed on the TSC Act within the survey areas.

c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

This factor does not apply to threatened species.

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

(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

The proposed activity may lead to the clearing of approximately 5.598 hectares of Narrow-leaved Ironbark habitat. This is considered to be minimal when compared to available habitat within the Pilliga Scrub. Narrow-leaved Ironbark communities account for approximately 98 219 hectares of the Pilliga Scrub, which results in a reduction of approximately 0.002 % of available habitat.

(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The clearing required for the proposed activity is not likely to fragment or isolate habitat in a way that will impact upon the long-term survival of this species.

(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.

Given the large tracts of available habitat within the Pilliga Scrub, habitat to be removed is not considered to be significant for the long-term survival of this species in the locality.

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

There is no critical habitat listed for these species on the register of critical habitat.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

No recovery plan exists for this species, however OEH has identified 12 priority actions for this species.

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

A2.5.3 Conclusion

Based on the consideration of the above factors, the proposed activities are not likely to significantly affect the listed threatened species *Tylophora linearis* or its habitats. Although the action is not consistent with many of the priority actions, it is unlikely to have a significant impact on the species.