APPENDIX 11

Ecological Assessment

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ECOLOGICAL ASSESSMENT

Mount Owen Continued
Operations Project

FINAL

October 2014

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ECOLOGICAL ASSESSMENT

Mount Owen Continued Operations Project

FINAL

October 2014

Prepared by
Umwelt (Australia) Pty Limited

on behalf of
Glencore

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Report:	**3109/R03/FINAL**
Date:	**October 2014**

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Executive Summary

The Mount Owen Complex is located within the Hunter Coalfields in the Upper Hunter Valley of New South Wales (NSW), approximately 20 kilometres north-west of Singleton, 24 kilometres south-east of Muswellbrook and to the north of Camberwell village. Mount Owen Pty Limited (Mount Owen), a subsidiary of Glencore Coal Pty Limited (formerly Xstrata Coal Pty Limited) currently owns the three open cut operations in the Mount Owen Complex, Mount Owen (North Pit), Ravensworth East (West Pit) and Glendell (Barrett Pit). The Mount Owen Continued Operations Project aims to maintain the utilisation of the existing Mount Owen and Ravensworth East infrastructure and to maximise the recovery of mineable coal tonnes from within Mount Owen Mine (North Pit Continuation, Bayswater North Pit and RERR Mining Area), which in turn reduces potential additional disturbance associated with coal extraction.

The Proposed Disturbance Area for the Project represents the total area that would be disturbed, outside of the areas that were previously approved for disturbance. The Proposed Disturbance Area is 485 hectares, of which 381 hectares is associated with the North Pit Continuation and 104 hectares is associated with the infrastructure upgrades.

Mount Owen undertook a detailed ecological constraints study to guide the development and detailed design of the Project. Through this process, alternative mining options were considered and Mount Owen has sought to minimise the environmental and community impacts associated with the Project whilst maximising the economic resource recovery.

Key factors in Project design have been to ameliorate the impacts on significant ecological features, such as threatened species, Endangered Populations, Threatened Ecological Communities and/or their habitats. The approach to this has been to avoid ecological impact and maximise use of existing disturbed areas as much as possible. In addition to actions undertaken by Mount Owen to avoid and minimise impacts on ecological values, significant impact mitigation measures and a Biodiversity Offset Strategy are proposed to ameliorate the residual significant impacts of the Project on ecological values.

The Project will result in the clearing of approximately 485 hectares of land which includes 451.5 hectares of native vegetation, of which 223.1 hectares is native grassland; and 33.5 hectares comprises disturbed land. A total of 2766 hectares of native vegetation occurs in the Project Area providing known habitat for 29 threatened fauna species, two threatened flora species and approximately 830.6 hectares of EEC as listed under the TSC Act.

The clearing associated with the Project and assessed as part of this Ecological Assessment includes 217.7 hectares of native woodland and forest; 6.0 hectares of riparian vegetation and 4.7 hectares of shrubland. In addition to the loss of native vegetation communities, the Project will result in the loss of approximately 223.1 hectares of Derived Native Grassland

A comprehensive assessment of potential ecological impacts of the Project has been prepared in accordance with the DGRs and relevant guidelines and legislation.

Ecological Survey Methodology

A detailed survey methodology was designed and executed in order to gain a thorough understanding of the ecological features of the Project Area. The methods included a detailed review of relevant literature, reports and vegetation mapping, as well as searches of relevant ecological databases. A large amount of ecological data had already been collected in the Project Area during past ecological surveys and assessment, and annual flora and fauna monitoring surveys between 1996 and 2014.

The Project specific flora field surveys were carried out in late spring 2011, spring 2012 and in multiple seasons in 2014. Field survey allowed sampling of vegetation and field reconnaissance to identify spatial vegetation patterns. Survey methods included vegetation survey quadrats, BioBanking plots/quadrats, meandering transects, rapid assessment points and field reconnaissance to identify spatial arrangement of vegetation across the Proposed Disturbance Area.

Fauna surveys were carried out to identify the fauna species and their habitats occurring, or considered to have the potential to occur in the Proposed Disturbance Area, including threatened species, migratory species, EPs, and species of local or regional significance. Fauna surveys were undertaken by Umwelt within the Proposed Disturbance Area (and surrounds) in August 2011, February and June 2012, January 2013 and March, April and July 2014. During each of the fauna survey periods, a variety of survey techniques were employed including mammal trapping, hair funnel sampling, bird searches, reptile searches, amphibian searches, spotlighting, call playback, Anabat echolocation call detection and harp trapping. Targeted fauna surveys were also undertaken for green and golden bell frog (*Litoria aurea*), swift parrot (*Lathamus discolor*) and regent honeyeater (*Anthochaera phrygia*).

Aquatic fauna survey, including detailed habitat assessments and aquatic vertebrate sampling, was undertaken in October 2012. Habitat assessment and aquatic vertebrate sampling were conducted in Bowmans Creek, with two replicate surveys undertaken at upstream and downstream locations near the proposed Bowmans Creek Bridge on Hebden Road.

Existing Flora and Vegetation Communities

A total of 355 flora species were recorded during flora surveys, of which approximately 26 per cent were not native to the area. One threatened flora species has been recorded within the Project Area: *Ozothamnus tesselatus*. *Ozothamnus tesselatus* is known to occur in Ravensworth State Forest however, has not been recorded in the Proposed Disturbance Area. No threatened flora species are known to occur within the Proposed Disturbance Area.

Surveys of the Proposed Disturbance Area identified eight vegetation communities (excluding variants), with the dominant communities identified in the Proposed Disturbance Area comprising Derived Native Grassland, Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC and Central Hunter Bulloak Forest Regeneration.

Two vegetation communities recorded in the Proposed Disturbance Area and one within the wider Project Area conform to descriptions provided by the NSW Scientific Committee of a listed EEC, being Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions and Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions.

Existing Fauna

A total of 271 fauna species have been recorded in the Project Area, comprising 174 bird species, 27 reptiles, 17 frog species and 53 mammals. Fifteen (5.5 per cent) of these species were introduced species (birds and mammals).

A total of 29 threatened fauna species (as listed under the TSC Act and/or the EPBC Act) were recorded within the Proposed Disturbance Area or wider Project Area either as part of the current survey, or from other sources such as annual monitoring surveys, databases searches or literature reviews.

The Darling River hardyhead Endangered Population in the Hunter River catchment was listed under the *Fisheries Management Act 1994* in June 2014. Bowmans Creek provides potential habitat for the species, although it was not recorded in the vicinity of the Hebden Road bridge during aquatic surveys undertaken for the Project. .

Ecological Impact Assessment Outcomes

The Project will result in the removal of a total of 451.5 hectares of native vegetation, including (approximately):

- 223.1 hectares of Derived Native Grassland;
- 131.9 hectares of Central Hunter Ironbark – Spotted Gum - Grey Box Forest EEC;
- 54.0 hectares of Central Hunter Bulloak Forest Regeneration;
- 27.4 hectares of Planted Ironbark – Spotted Gum – Grey Box Forest EEC;
- 5.8 hectares of Central Hunter Swamp Oak Forest;
- 4.4 hectares of Central Hunter Grey Box – Ironbark Woodland EEC;
- 4.7 hectares of Kunzea Closed Shrubland; and
- 0.2 hectares of Hunter Valley River Oak Forest.

No EPBC Act-listed EECs have been recorded in the Project Area or Proposed Disturbance Area.

The Project is considered likely to result in a significant impact on the spotted-tailed quoll (*Dasyurus maculatus*) and squirrel glider (*Petaurus norfolcensis*). It is noted that the impact of the Project on the spotted-tailed quoll is not considered to be significant at the Commonwealth level.

The Project is predicted to potentially result in a significant impact on the following additional threatened fauna species:

- masked owl (*Tyto novaehollandiae*);
- brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- speckled warbler (*Chthonicola sagittata*);
- grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- varied sittella (*Daphoenositta chrysoptera*);
- hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- diamond firetail (*Stagonopleura guttata*);
- brush-tailed phascogale (*Phascogale tapoatafa*);
- yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*);
- east coast freetail-bat (*Mormopterus norfolkensis*);
- southern myotis (*Myotis macropus*); and

- greater broad-nosed bat (*Scoteanax rueppellii*).

These species and Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC have been categorised as 'potentially significantly impacted' as there are a range of factors that reduce the certainty as to whether the Project will result in a significant impact. These factors include (but are not limited to) certainty regarding the importance of habitat utilisation in the Proposed Disturbance Area; the cryptic nature of many of these species; and the uncertainty regarding the local populations of these species occurring within and beyond the Proposed Disturbance Area.

Flora and Fauna Management Commitments

One of the key goals of the impact mitigation strategy is to maintain or improve ecological features within the Project Area and proposed Biodiversity Offset Areas, in order to compensate for unavoidable impacts on the ecological values of the Proposed Disturbance Area.

Key impact mitigation strategies will be detailed in a comprehensive Management Plan and will include strategies to guide mine rehabilitation with the aim of creating self sustaining communities characteristic of extant vegetation communities, fauna habitat augmentation, targeted passive and active regeneration of currently degraded vegetation communities, specific strategies to protect the spotted-tailed quoll (*Dasyurus maculatus*), strategies to protect threatened woodland dependent species, and general impact mitigation strategies such as sediment and erosion control, weed and feral animal control and bushfire management.

Biodiversity Offset Strategy

The key components of the Biodiversity Offset Strategy include the following land-based components:

- long-term conservation of a 367 hectare property located adjacent to existing Mount Owen Biodiversity Offset Areas, known as the Cross Creek Offset Site. The Cross Creek Offset Site provides targeted 'like for like' vegetation and threatened fauna habitats and opportunities for environmental improvement. It is strategically located in the vicinity of a number of existing and proposed Glencore biodiversity offset areas and immediately adjoins the existing Mount Owen offset area;

- long-term conservation of a 303 hectares property located in the Manobalai region, known as the Esparanga Offset Site. The Esparanga site is located in a priority conservation area located in the Great Eastern Ranges and the Upper Hunter Strategic Assessment priority areas and provides high conservation value vegetation communities and 'like for like' threatened fauna habitat;

- Stringybark Creek Habitat Corridor regeneration strategy that will provide an approximately 97.5 hectare corridor that links existing high quality habitat associated with the Mount Owen Biodiversity Offset areas and Ravensworth State Forest with adjacent corridors and proposed conservation areas at Liddell Coal Operations to the west of the Project Area. The corridor includes key commitments relating to the establishment of spotted-tailed quoll habitat; and

- on-site mine rehabilitation that comprises key commitments to vegetation community re-establishment and fauna habitat augmentation.

The Biodiversity Offset Strategy includes long-term protection of the proposed offset sites. The mechanism to achieve the long-term protection objective will be determined in consultation with Department of Planning and Environment (DPE) and the Office of Environment and Heritage (OEH).

The Biodiversity Offset Strategy is considered to provide an adequate and appropriate offset to counterbalance the loss of regionally and state significant vegetation communities, fauna habitats and threatened species.

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1.0 Introduction

The Mount Owen Complex is located within the Hunter Coalfields in the Upper Hunter Valley of New South Wales (NSW), approximately 20 kilometres north-west of Singleton, 24 kilometres south-east of Muswellbrook and to the north of Camberwell village (refer to **Figure 1.1**).

Mount Owen Pty Limited (Mount Owen), a subsidiary of Glencore Coal Pty Limited (formerly Xstrata Coal Pty Limited (Xstrata)), currently owns and operates the three existing open cut operations in the Mount Owen Complex; Mount Owen (North Pit), Ravensworth East (West Pit and Glendell (Barrett Pit). Mount Owen anticipate that mining will commence in the northern portion of the Ravensworth East in an area known as the Bayswater North Pit (BNP) in 2015. The mining operations at the Mount Owen Complex include the integrated use of the Mount Owen coal handling and preparation plant (CHPP), coal stockpiles and the rail load out facility (refer to **Figure 1.2**).

Mount Owen (North Pit) has an approved production rate of 10 million tonnes per annum (Mtpa) of run of mine (ROM) coal, and blended with Ravensworth East (approved 4 Mtpa) and Glendell (approved 4.5 Mtpa) ROM coal, feed the Mount Owen CHPP and associated infrastructure, which has a total approved processing capacity of 17 Mtpa of ROM coal. Processed coal, both semi soft and thermal, are transported via the Main Northern Rail Line to the Port of Newcastle for export, or by conveyor for domestic use as required.

Mount Owen expects, subject to market conditions, that mining will be completed within the currently approved area of the North Pit and the West Pit by 2018 and late 2014 respectively; and Glendell by 2022. Mount Owen has undertaken extensive exploration of its mining tenements and identified substantial additional mineable coal tonnes to the south of the currently approved North Pit. Further exploration verified economically viable reserves within an area located in the northern portion of the existing approved Ravensworth East Mine, referred to as the BNP. The proposed Ravensworth East Resource Recovery (RERR) Mining Area, is located immediately east of the West Pit and is proposed to be mined sequentially after mining has been completed in the BNP.

Mount Owen is seeking development consent for the Mount Owen Continued Operations Project (the Project) to extract these additional mineable coal tonnes through continued open cut mining methods. The Project proposes to continue the existing mining operations within the North Pit to the south beyond the current approved North Pit mining limit (the North Pit Continuation) in addition to undertaking mining operations within the BNP area, sequentially followed by the RERR Mining Area.

The Project design has taken account of issues raised during extensive stakeholder consultation and was the subject of rigorous iterative studies to refine the Project to minimise environment and community impacts. The Project avoids disturbance of Ravensworth State Forest and existing Offset Areas, whilst maximising the use of previously disturbed areas and infrastructure.

The Project seeks to maintain the current approved North Pit extraction rate of 10 Mtpa of ROM coal, extracting approximately 74 million tonnes (Mt) of ROM coal from the North Pit Continuation. The extraction of these additional mineable coal tonnes would continue the North Pit life to approximately 2030 (an additional 12 years). Additionally, the Project seeks to maintain the current approved Ravensworth East extraction rate of 4 Mtpa of ROM coal, and to extract approximately 12 Mt of ROM coal from the BNP. Subject to market conditions, mining within the BNP area would be undertaken from approximately 2015 to 2022, with the mining in the RERR Mining Area to follow sequentially from approximately 2022 to 2027 and extract approximately 6 Mt of ROM coal.

FIGURE 1.1

Locality Plan

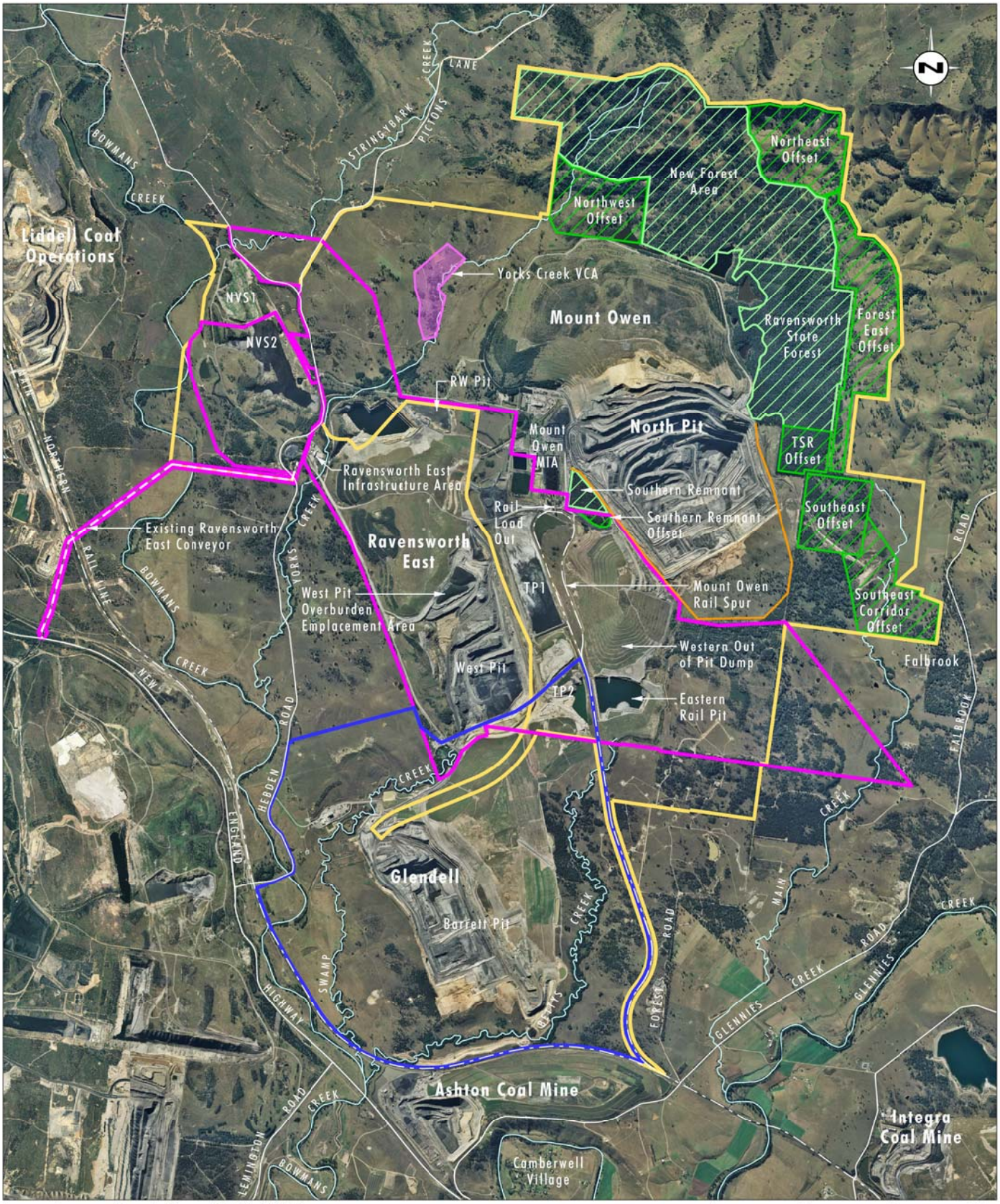

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2013), Department of Lands (2006)

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Legend

- Ravensworth East Mine DA Boundary (DA 52-03-99)
- Glendell Mine DA Boundary (DA 80/952)
- Mount Owen Mine DA Boundary (DA 14-1-2004)
- Existing Biodiversity Offset Area
- Ravensworth State Forest
- Yorks Creek VCA
- Approved North Pit Mining Extent

FIGURE 1.2

Mount Owen Complex Current Operations

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The Project will enable the consolidation of the Mount Owen and Ravensworth East Operations to provide for further operational efficiency by providing a single development consent for continued operations. The Project does not include any aspect of the ongoing operations at Glendell Mine and it will continue to operate in accordance with its current development consent.

The Project is State Significant Development as defined by the provisions of the State Environmental Planning Policy (State and Regional Development) 2011 and requires development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Minister for Planning is the consent authority for the Project.

An Environmental Impact Statement (EIS) has been prepared for the Project to accompany a Project Application following Department of Planning and Environment (DP&E) issuing Director-General's Requirements (DGRs) for the Project in March 2013. The following Ecological Assessment was prepared to meet the Director-General's Environmental Impact Statement (EIS) requirements in relation to ecological issues for the Project.

1.1 Report Structure

This report provides an assessment of the potential ecological impacts of the Project. It begins with an introduction to the Project, including an overview of the Project and the assessment approach undertaken.

Section 2.0 explains the regional context of the Project, discussing regional considerations such as the history of land use, surrounding land uses and regional connectivity of habitats within the Project Area.

Section 3.0 provides a detailed methodology of the surveys undertaken for the Project including detailed flora, fauna and aquatic survey methods.

Section 4.0 provides the results of the surveys described in **Section 3.0** and lists the threatened species, threatened ecological communities (TECs), endangered populations (EPs) and migratory species identified during surveys or during the literature review.

Section 5.0 details the assessment of the level of impact the Project may have on the threatened species, TECs, EPs and migratory species that were identified in **Section 4.0**.

Section 6.0 discusses the impact mitigation measures to reduce the likely level of impact on threatened species, TECs, EPs and migratory species.

Section 7.0 details the biodiversity offset strategy that has been developed to offset residual significant impacts of the Project that could not be avoided or fully mitigated.

Section 8.0 provides an overview of the proposed monitoring requirements that have been formulated to assess the success of proposed impact mitigation and biodiversity offset strategy in reducing the impacts of the Project on ecological values.

Section 9.0 provides references.

1.2 Project Overview

As noted in **Section 1.0**, the Project aims to maintain the utilisation of the existing Mount Owen and Ravensworth East infrastructure and to maximise the recovery of mineable coal tonnes from within the existing Glencore mining tenements.

A key Project design consideration has been to maximise the efficient use of the existing infrastructure and areas previously approved for disturbance and as a result, minimise the overall surface disturbance area required for the Project as far as practicable.

The key features of the Project are outlined in **Table 1.1**. **Figure 1.3** shows the general layout of the Project. For a detailed description of the existing approved operations and the Project refer to Section 2 of the Environmental Impact Statement.

Table 1.1 – Key Proposed Features of the Project

Key Feature	Proposed Operations
Mine Life	• Consent will be sought for 21 years (from date of Project Approval) to provide for mining until approximately 2030 and contingency for other activities such as rehabilitation and capping of tailings emplacement areas.
Limits on Extraction	No change in approved extraction rates. • North Pit – up to 10 Mtpa ROM. • Ravensworth East – up to 4 Mtpa ROM.
Mine Extent	• Continuation of the North Pit footprint to the south of current approved North Pit mining limit. • Mining within the approved BNP, followed sequentially by mining within the RERR Mining Area within the Ravensworth East Mine. • Mining depths to approximately 300 m (North Pit). • Total additional mineable coal tonnes of approximately 92 Mt ROM (comprising 74 Mt ROM (North Pit Continuation), 12 Mt ROM (BNP) and 6 Mt ROM (RERR) Mining Area). • Changes to mine water management system.
Operating Hours	• No change proposed - 24 hours per day, 7 days per week.
Workforce Numbers	• No significant change to workforce numbers is required. Current workforce required to operate North Pit and CHPP fluctuates and peaks at about 660 and the Ravensworth East development consent allows for a workforce of up to 260 to operate Ravensworth East operations. • Addition of approximately 330 personnel for construction phase for proposed infrastructure works (approximately 18 months).
Mining Methods	• No change to mining methods proposed.
Mount Owen CHPP and MIA	• No change to existing approved CHPP capacity of 17 Mtpa ROM. • product stockpile extension; • CHPP improvements (including operational efficiencies) to increase processing capacity and tailings management; • MIA extensions and improvements;
Existing Mine Infrastructure	• Continued utilisation of all existing mining infrastructure, including the existing crushing plant for the crushing of overburden.

Table 1.1 – Key Proposed Features of the Project (cont.)

Key Feature	Proposed Operations
Infrastructure Construction Activities	• Infrastructure upgrades including: ▪ provision for a northern rail line turn-out and additional Mount Owen rail line;Hebden Road overpass over Main Northern Rail Line; and ▪ New Hebden Road bridge crossing over Bowmans Creek.
Tailings and Coarse Reject Emplacement	• Continued use of the Ravensworth East voids for tailings emplacement and co-disposal of coarse reject and overburden within the North Pit Continuation, the West Pit / BNP and the RERR Mining Area as mining progresses. • Tailings cells may be constructed and filled within the North Pit Continuation area as required to allow time for consolidation and drying of tailings in the West Pit and the RERR Mining Area. • Allowance for the receipt of tailings from other mines.
Coal Transportation	• No change to current export coal transportation with the exception of the use of the proposed additional rail line. • No change to capacity of 17 Mtpa ROM coal. • Use of existing rail line for Glencore train park up. • Transportation of up to 2 Mtpa ROM coal and crushed gravel on an as required basis via the existing overland conveyor to Liddell Coal Operations and the RCT in addition to maintaining the current approval to transport ROM coal to Bayswater and Liddell power stations.

1.3 The Project Area and Proposed Disturbance Area

The Project Area (refer to **Figure 1.3**), including the North Pit Continuation (including in pit dumping and out of pit dumping), the Hebden Road upgrade works and the proposed rail line and mining related infrastructure is approximately 4940 hectares in area, of which approximately 2119 hectares (approximately 43 per cent) is either disturbed land (largely by mining activities), or land in the process of being rehabilitated from approved mining activity or planted areas. Approximately 1433 hectares (approximately 29 per cent) is Derived Native Grassland. Approximately 27 per cent (approximately 1355 hectares) of the Project Area comprises woodland, forest or riparian vegetation (either remnant or regenerating).

The Proposed Disturbance Area for the Project represents the total area that would be disturbed, outside of the areas that were previously approved for disturbance. The total area of the Proposed Disturbance Area is 485 hectares, of which 381 hectares is associated with the North Pit Continuation and 104 hectares is associated with the infrastructure upgrades. Ecological surveys for this report focused on the Proposed Disturbance Area (as shown in **Figure 1.3**) however, additional field surveys were undertaken within the broader Project Area and adjacent areas to inform this assessment and to describe areas that have subsequently been removed from the Proposed Disturbance Area due to changes in project design.

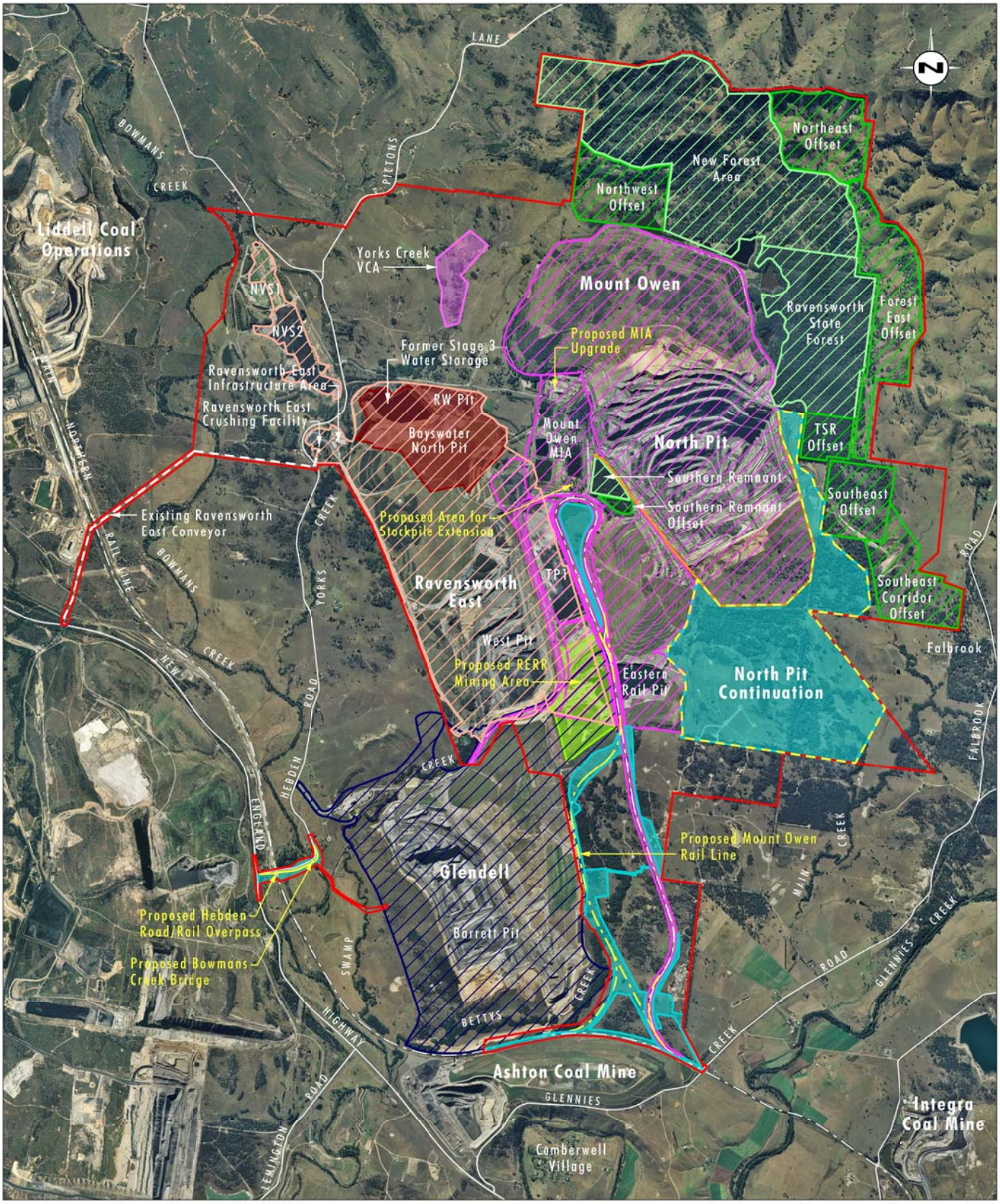

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014)

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Legend

- Project Area
- Approved North Pit Mining Extent
- Proposed North Pit Continuation
- Proposed Rail Upgrade Works
- Proposed Hebden Road Upgrade Works
- Proposed Disturbance Area
- Proposed RERR Mining Area
- Yorks Creek VCA
- Bayswater North Pit
- Mount Owen Operational Area
- Glendell Operational Area
- Ravensworth East Operational Area
- Existing Biodiversity Offset Area
- Ravensworth State Forest

FIGURE 1.3

Proposed Mount Owen Continued Operations Project

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20141008 16.13

1.4 Objectives of Ecological Assessment

This Ecological Assessment has been prepared to assess the potential impact of the Project on native flora and fauna species, threatened and migratory species, EPs, TECs and their habitats occurring in the Project Area and on adjoining lands. As described in **Section 1.5**, this assessment has been prepared in accordance with the DGRs for the EIS.

The objectives of the Ecological Assessment were to:

- identify the flora and fauna species recorded within the Project Area from previous studies in the Project Area, local studies and/or ecological databases;
- undertake targeted surveys to further identify any threatened flora or fauna species, migratory fauna species, EPs, TECs, or their habitats within the Project Area, particularly those listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act), NSW *Fisheries Management Act 1994* (FM Act), and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- assess the potential impact of the Project on any threatened flora and fauna species, migratory fauna species, EPs, TECs, or their habitats recorded (or with potential to occur) in the Project Area;
- assess the potential impact of the Project on any threatened flora and fauna species, migratory fauna species, EPs, TECs, or their habitats recorded (or with potential to occur) on lands adjoining the Project Area or with potential to be affected by the Project;
- develop appropriate impact mitigation and management options to minimise ecological impacts associated with the Project;
- prepare a comprehensive biodiversity offset strategy to compensate for the residual impacts of the Project that cannot otherwise be satisfactorily avoided, minimised or mitigated; and
- prepare a detailed monitoring program to assess the success of the impact mitigation and biodiversity offset strategies in reducing and compensating for the residual impacts of the Project.

1.5 Relevant Legislation and Guidelines

The ecological assessment completed as part of this Project was prepared in accordance with the relevant DPE DGRs for the Project, dated 13 March 2013 as detailed in **Table 1.2**, with the OEH submission to the DGRs dated 4 March 2013. In addition, on 24 October 2013 the Commonwealth Department of the Environment determined that the Project constitutes a 'controlled action' under the EPBC Act and approval from the Commonwealth minister for the Department of Environment is required through accreditation of the NSW Government process. Supplementary DGRs were issued by the Department of the Environment on 8 November 2013 and a detailed response to each of the matters raised is addressed in the MNES report included as Appendix 4 of the EIS. In August 2014, Mount Owen sought a variation to the controlled action to allow for the optimisation of the North Pit Continuation. This application for variation was approved on 25 August 2014.

The supplementary DGRs require that while the EIS may assess all relevant MNES in an integrated manner in the main EIS, it must be accompanied by a separate appendix that deals with all relevant matters in one discrete location. On 19 September 2014 DoE confirmed that the supplementary DGRs would remain applicable to the varied action.

Table 1.2 – Matters Specified in the Director-General's Requirements and Where They Are Addressed in this Report

DGRs for Ecological Studies	Where addressed in report
The ecological assessment must include:	
Measures taken to avoid, reduce or mitigate impacts on biodiversity.	**Section 5.1** – Project Changes to Avoid and Minimise Impacts.
Identification of existing vegetation within disturbance areas, and the ecological values of this habitat.	**Section 4.1.3** – Vegetation Communities in the Proposed Disturbance Area.
Accurate estimates of proposed vegetation clearing.	**Section 5.4** – Impact of the Project on Vegetation Communities.
A detailed assessment of potential impacts of the development on any: • terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems; and • remnant vegetation, habitat corridors, and existing biodiversity offset areas.	**Section 5.4 –** Impact of the Project on Vegetation Communities **Section 5.6** – Impact of the Project on Threatened Species, Populations and Ecological Communities. **Section 5.7** - Impact of the Project on Existing Biodiversity Offset Areas and Habitat Corridors. **Section 5.8** – Impact of the Project on Groundwater Dependent Ecosystems.
A comprehensive offset strategy for the development including a justification of how the strategy would maintain or improve the terrestrial and aquatic biodiversity values of the region in the medium to long term, and how the strategy would be integrated with the Upper Hunter Strategic Assessment process.	**Section 7.0** – Biodiversity Offset Strategy

In addition to the DGRs, submissions from other relevant government agencies, including OEH and NSW Fisheries, have been received. The OEH submission outlined the requirements of the Ecological Assessment with particular reference to conducting new field surveys (refer to **Section 3.0**) and assessing the Project using either the BioBanking Assessment Methodology (Scenario 1) or a detailed biodiversity assessment (Scenario 2) (refer to **Section 7.0**). The NSW Fisheries submission required the assessment of potentially occurring threatened aquatic species (refer to **Section 5.0**) and descriptions of the aquatic habitat within the Proposed Disturbance Area (refer to **Section 4.0**).

The ecological survey and assessment completed as part of the Project was undertaken in accordance with Part 4 of the EP&A Act and the following legislation and licences, where relevant:

- TSC Act;
- FM Act;
- EPBC Act;
- Forestry Corporation Special Purpose Permit for Research;
- National Parks and Wildlife Service (NPWS) Scientific Research Licence;

- Animal Research Authority as provided by the NSW Department of Primary Industries; and

- NSW Department of Primary Industries Fishing Licence for Aquatic Surveys.

1.5.1 Relevant Guidelines, Frameworks and Policies

The ecological survey and assessment completed as part of the Project took into account the following guidelines, frameworks and policies.

Table 1.3 - Relevant Guidelines, Frameworks and Policies Considered in the Ecological Assessment

Specified in the Project DGRs
• Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna - Amphibians (DECCW 2009). • Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft (DEC 2004). • Threatened Species Assessment Guidelines: the Assessment of Significance (DECC 2007). • Guidelines for Threatened Species Assessment (DoP 2005). • Department of Environment, Climate Change (DECC) (2009) BioBanking Assessment Methodology and Credit Calculator Operational Manual. • NSW State Groundwater Dependent Ecosystem Policy (DLWC 2002). • Policy & Guidelines - Aquatic Habitat Management and Fish Conservation (DPI NSW Fisheries 1999 (update 2013)). • Policy & Guidelines – Fish Friendly Waterway Crossings (NSW Fisheries). • Principles for the Use of Biodiversity Offsets in NSW (OEH). • Environmental Offsets Policy (DSEWPC 2012). • Upper Hunter Strategic Assessment – Interim Policy (DP&I 2012).
Other Relevant Guidelines
• Department of Environment and Climate Change (DECC) and Department of Primary Industries (DPI) (2005). Draft Guidelines for Threatened Species Assessment (Part 3A), July 2005. • DECC (2008). Hygiene Protocol for the Control of Disease in Frogs. • NSW Office of Environment and Heritage (OEH) Interim Policy on Assessing and offsetting Biodiversity Impacts of Part 3A, State Significant Development (SSD) and State Significant Infrastructure (SSI) Projects, June 2011. • Department of the Environment (2013). Significant Impact Guidelines 1.1 – Matters of National Environmental Significance. • DPI (2008). Threatened Species Assessment Guidelines – The Assessment of Significance. February 2008. • OEH (2012). Assessors' Guide to Using the BioBanking Credit Calculator v2.0. • NSW Office of Environment and Heritage (OEH) Interim Policy on Assessing and offsetting Biodiversity Impacts of Part 3A, State Significant Development (SSD) and State Significant Infrastructure (SSI) Projects, June 2011.

1.6 Assessment Approach

This Ecological Assessment has been prepared to assess the potential impact of the Project on native flora and fauna species, threatened and migratory species, EPs, TECs and their habitats occurring in the Project Area and on adjoining lands. The process of undertaking an ecological assessment requires particular steps to identify the ecological features that require specific assessment, and to determine the level at which they are likely to be impacted. This is initially undertaken without consideration of any mitigation or offsetting measures, however the preliminary impact assessment informs project design and, in this case, has led to the development of project avoidance measures undertaken specifically to protect, or reduce impact on, ecological matters (refer to **Section 5.1**). Through the use of impact assessments under the EP&A Act and the EPBC Act, a decision is made as to whether or not species, populations or communities will be significantly impacted by the Project. For those species and communities that were determined to be significantly impacted, or potentially significantly impacted and for which avoidance measures are not feasible, detailed mitigation and offsetting measures were developed. **Figure 1.4** provides a visual representation of this process.

During all steps the precautionary principle was applied to ensure that wherever there was uncertainty resulting from lack of data or knowledge, or uncertainty in the level or extent of impact, the worst case was assumed. The application of the precautionary principle in the project assessment is detailed in **Section 5.6**.

In 2012, Mount Owen identified a conceptual design for the Project which included continuation of mining in the North Pit and proposed infrastructure as identified above. The conceptual design and associated disturbance area were subject to ecological survey in 2011 and 2012, with additional targeted surveys undertaken in early 2013.

Throughout late 2013, Glencore refined the mine plan for the proposed North Pit Continuation in order to further optimise the benefits of the Project. The optimisation of the North Pit Continuation plan has yielded approximately 4 million additional minable coal tonnes for the Project and resulted in an additional area of approximately 21 hectares that was not included in the proposed disturbance area previously surveyed (refer to **Section 2** of the EIS for further detail). Accordingly, further survey focussing on this additional area of proposed disturbance was undertaken in March, April and July 2014 (refer to **Section 3.0**) with the results of this survey, combined with the previous assessment completed, detailed in this report.

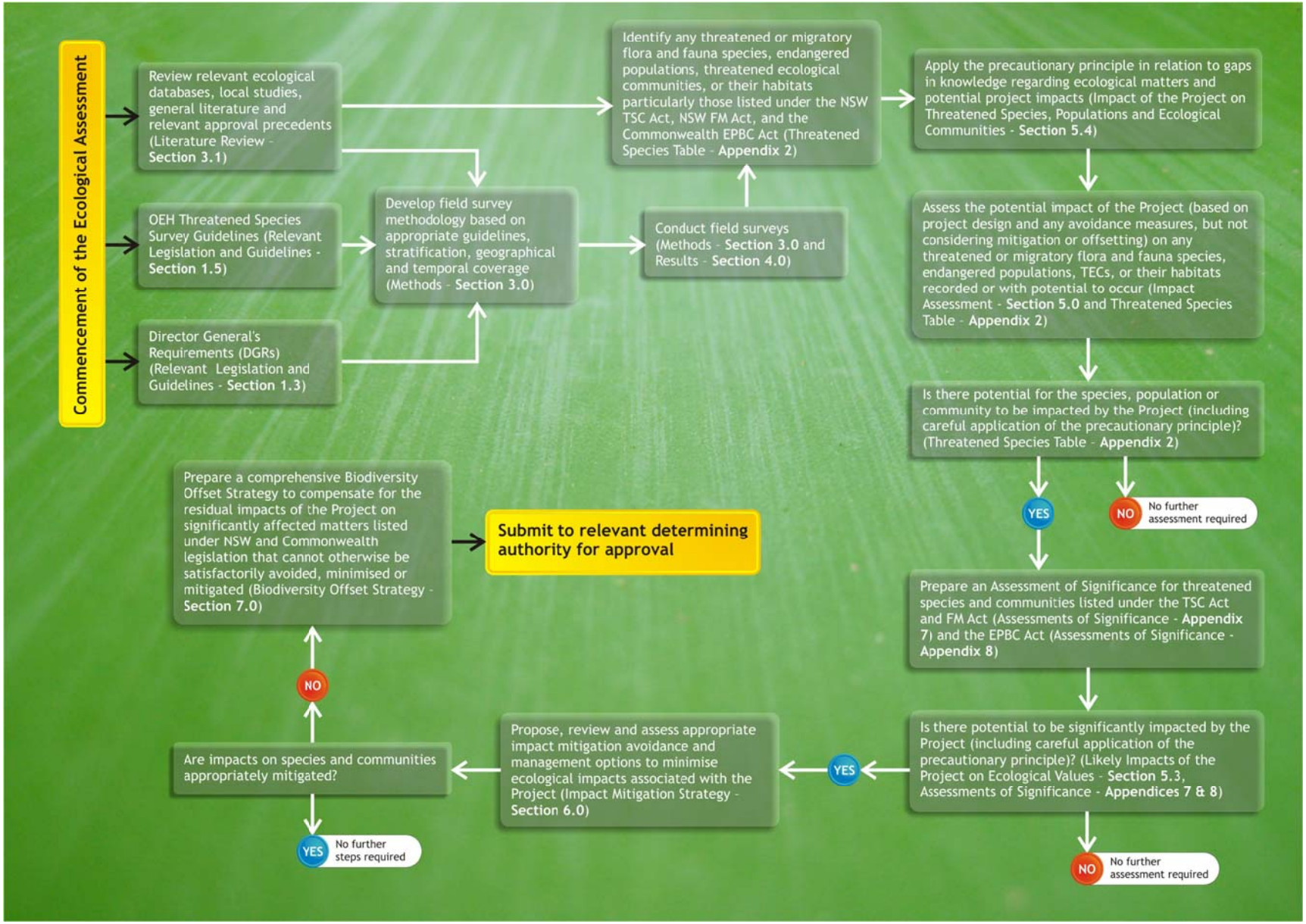

FIGURE 1.4

Ecological Assessment, Mitigation and Offsetting Pathway

2.0 Regional Setting

2.1 Physiography, Geology and Soils

The Project Area is situated centrally on the main floor of the Hunter Valley. It lies within the 22,000 km^2 Hunter River catchment which is drained by the Hunter and Goulburn Rivers and their tributaries. The Project Area is situated approximately 87 kilometres from the coast and 150 kilometres from the western extremity of the Hunter catchment at the Great Dividing Range.

The Project Area is typical of the Central Lowlands of the Hunter Valley, which are characterised by undulating to low rolling hills formed on weak sedimentary rocks with low local relief (Kovac and Lawrie 1991). The topography of the Project Area is characterised by an undulating and hilly landscape extending to lower areas associated with the waterways that traverse the Project Area. Elevations range between 80 metres AHD in the south and 400 metres AHD in the northern extent of the Project Area.

To the south of the Project Area are the dissected sandstone plateaux of Wollemi and Yengo National Parks, while to the north the foothills of the Barrington Tops and Mount Royal Range adjoin the Hunter Valley floor, which is bounded by the Hunter Thrust System (Peake 2006). To the east and west of the Project Area extend the highly eroded Permian lowlands of the floor of the Hunter Valley (refer to **Figure 2.1**).

Geology

The central Hunter Valley lies at the intersection (defined by the presence of the Hunter Overthrust (McClung 1980)) of the north-eastern margin of the Sydney Basin and the south-eastern margin of the New England Fold Belt. The Hunter Overthrust is a succession of faults where the layers of Carboniferous rock have been thrust south-west and in some areas moved over areas of Permian rock (Branagan and Packham 2000). The Sydney Basin extends from the south coast of NSW well into the central Queensland Coast (Hawley and Brunton 1995), and it mostly consists of a thick Permian-Triassic rock succession formed during early Permian rifting and contains large reserves of coal.

The central Hunter Valley is primarily underlain by four major geological strata: Carboniferous; Permian; Triassic and Quaternary. To a lesser extent it is also underlain by Jurassic and Tertiary strata. Carboniferous rocks mostly underlie the areas in the north-east of the region and are a combination of erosion resistant marine, volcanic, conglomerate, and limestone sediments; these typically form steep-sided hills and valleys. Permian rocks make up the majority of the region and mostly consist of the moderately erosion resistant Singleton Coal Measures, conglomerate, sandstone, shale, tuff, and some lava beds; these typically form low, undulating hills. The Triassic rocks are mostly located in areas in the north-west, west, and south of the upper Hunter Valley and consist of highly erosion resistant sandstone which tends to form infertile, rugged country. Quaternary sediments are mostly identified along and in proximity to the major rivers and creeks of the central and lower Hunter Valley.

Soil Landscapes

The Soil Landscapes occurring within the Proposed Disturbance Area are mapped on the Singleton 1:250,000 Soil Landscapes Map Sheet (Kovac and Lawrie 1991). There are three soil landscapes that occur within the Proposed Disturbance Area with the Bayswater Soil Landscape the dominant soil type, while small areas of Hunter and Lambs Valley also occur.

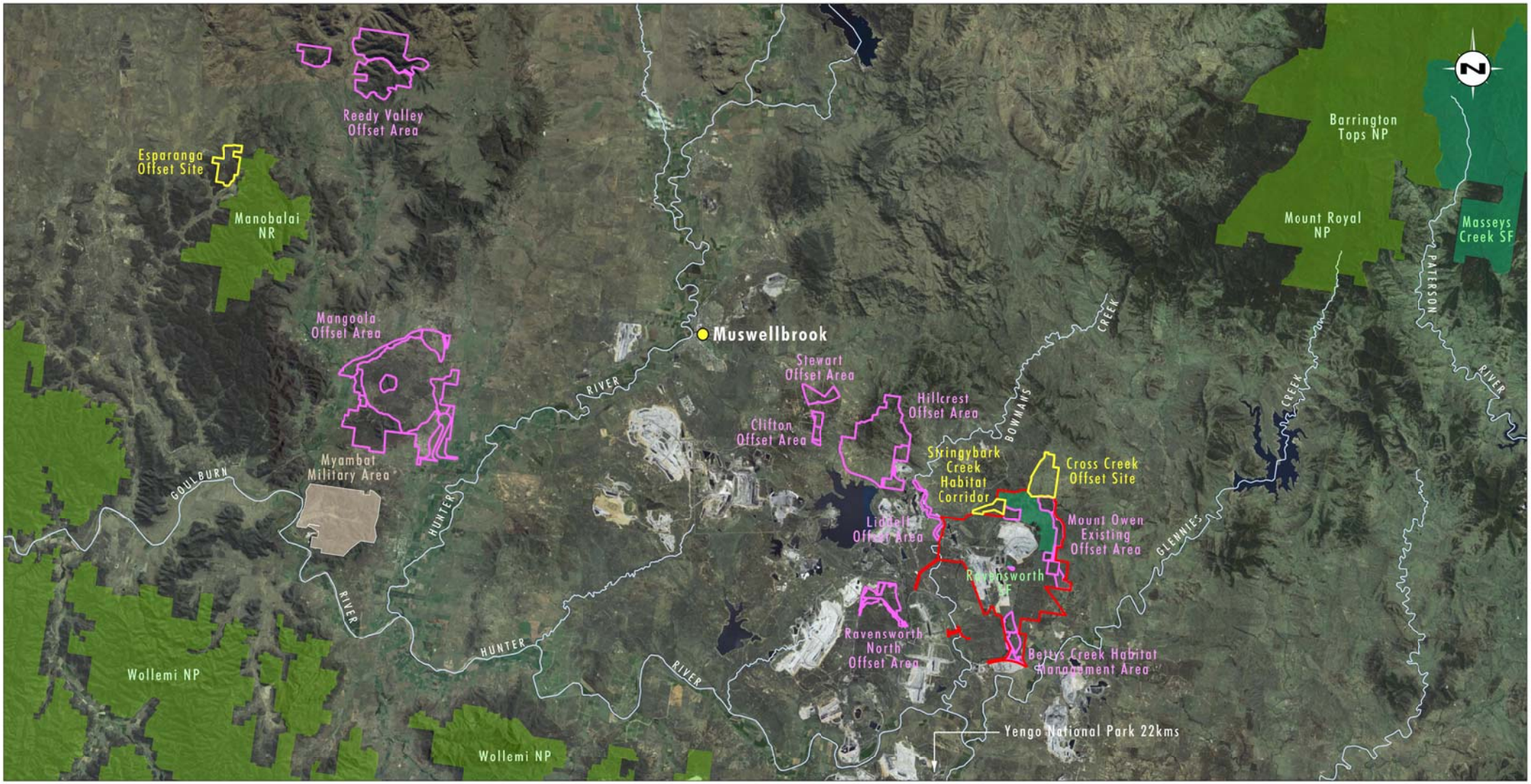

Image Source: Google Earth (2009)
Data Source: Department of Lands (2003), LPI (2012), OEH (2013), State of NSW (2013), Mount Owen (2014)

0 5.0 10.0 15.0km
1:350 000

FIGURE 2.1

Glencore Biodiversity Offset Areas
Regional Setting

Legend

- Project Area
- Existing Glencore Offset Areas
- Proposed Mount Owen Offset Sites
- National Park/Nature Reserve (NP/NR)
- State Forest (SF)
- Crown Reserve

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20140822 13.14

The main soils of the Bayswater Soil Landscape are yellow solodic and yellow and brown podzolic soils occurring on slopes, and alluvial soils in drainage lines. The soils of this landscape are susceptible to moderate sheet and gully erosion on slopes. Salt scalds and associated erosion are also common in some areas. The soils within this soil landscape have a low fertility, are typically moderately well drained and have a moderate water-holding capacity. Soil pH varies between 5.5 and 7.0 and mass movement hazard is low.

The Hunter Soil Landscape occurs throughout the floodplains of the Hunter River and its tributaries (Matthei 1995). The main soils of this landscape are all formed in alluvium. The soils of the Hunter Soil Landscape are susceptible to erosion along stream banks with minor sheet erosion on the adjacent terraces. The soil types within this soil landscape vary between moderately and rapidly draining, with moderate to low fertility levels. The available water-holding capacity is high throughout the landscape with the exception of sands and loams which have a low capacity. Typically soil pH varies between 5.5 and 7.5.

The Lambs Valley Soil Landscape covers the lower slopes and foothills and is present in small patches within the Project Area. The main soils are yellow and brown soloths on the slopes and brown earths on some upper parts of the foothills. The soils are susceptible to moderate topsoil erosion and are a high to very high erosion hazard. The soil types are imperfectly drained, with low fertility levels. Typically soil pH is 6.0 and mass movement level is low.

2.2 Catchment Characteristics

The Project Area is located within both the Bowmans Creek and Main Creek catchments. Bowmans Creek is a tributary of the Hunter River. Mining in the Proposed Disturbance Area is primarily within three sub-catchments of Bowmans Creek, namely Yorks Creek, Swamp Creek and Bettys Creek. Areas associated with the alluvial plains of Bettys Creek, Main Creek and the Hunter River, are generally flat to gently sloping.

Bettys Creek, Yorks Creek and Swamp Creek flow through the Project Area before flowing into Bowmans Creek. Main Creek flows for a short section through the east of Project Area and then into Glennies Creek south-east of the Project Area. Bowmans Creek is located to the west of the existing Mount Owen Complex and flows in a southerly direction to join the Hunter River approximately 4 kilometres downstream of the Project Area.

The Project Area occurs within the wider Hunter River catchment which covers approximately 22,000 km^2 of land bordered by the Liverpool Ranges, the Great Dividing Range, the Mount Royal Range and the Barrington Tops. The Hunter River originates in the Mount Royal Range and Barrington Tops Plateau, flowing for some 250 kilometres to the sea at Newcastle. River regulation has lead to the disruption of natural flow regimes and stream geomorphological impacts. In addition, land clearing over the past 200 years has lead to the degradation of riparian corridors, broad scale hydrological changes, biodiversity losses, stream bank erosion and sedimentation.

The Hunter River Inquiry (Healthy Rivers Commission 2002) provided evidence that ecological sustainability was not being achieved in the Hunter catchment. Across the catchment, only one third of streams are in good condition, with stable banks and a natural pool/riffle structure, and approximately 10 per cent of streams are unstable. Water quality is extremely variable and the extraction of water has placed most streams under stress. Studies of macroinvertebrates show that between 40 per cent and 70 per cent of sites or subcatchments surveyed are in poor condition and approximately 30 per cent of native fish species have been lost from the catchment.

2.3 History of Land Use in the Project Area and Region

A review of historical aerial photographs was undertaken to ascertain the historical land use within the Project Area and particularly the historical extent of native vegetation. Three sets of aerial photographs were obtained from the Crown Lands Division of the Department of Primary Industries (DPI), with sets covering the Project Area in 1958, 1967, and 1983. Additionally, a 2002 aerial was also reviewed and these photograph sets were compared to the extent of native vegetation cover shown on the 2013 aerial photograph of the Project Area.

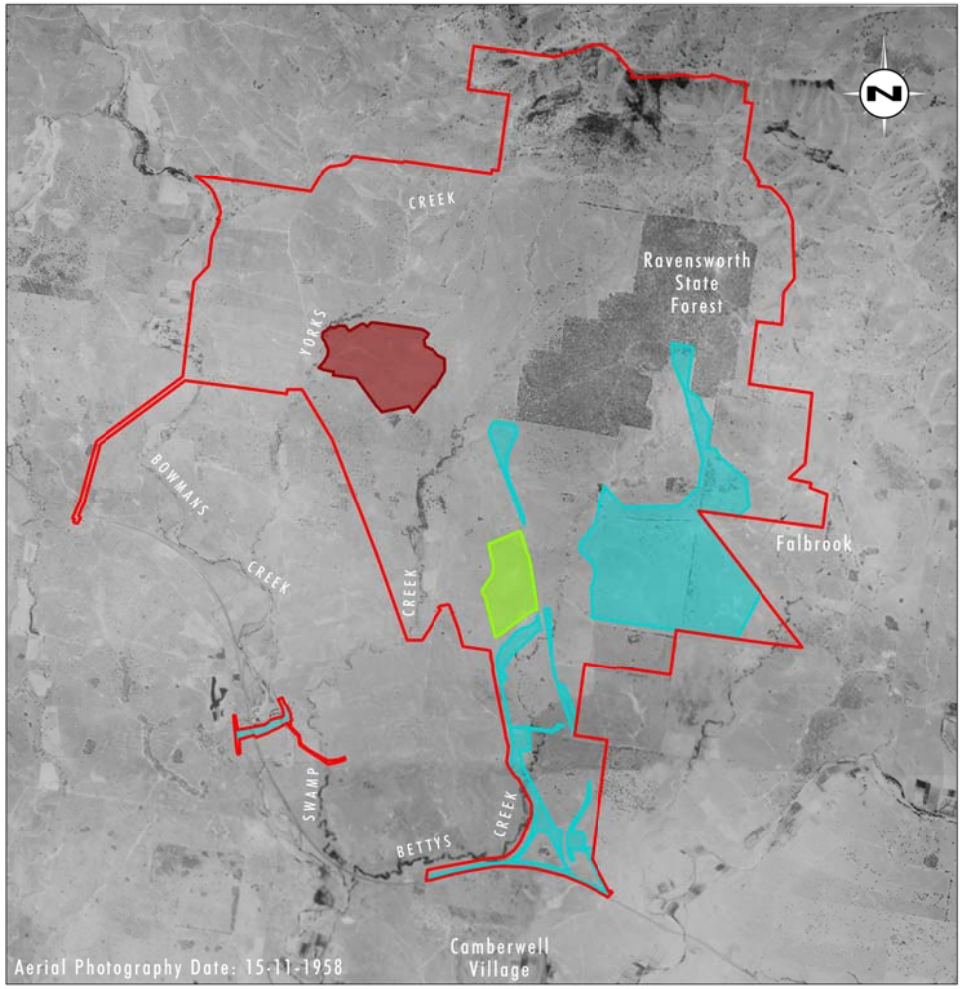
Examination of the 1958 set of photographs shows that substantial clearing in the Project Area had been undertaken prior to that time, likely as a result of agricultural expansion (refer to **Figure 2.2a**). The majority of the woodland within the Project Area is located in Ravensworth State Forest. Some riparian vegetation is visible along Bettys Creek, Swamp Creek, Bowmans Creek and Yorks Creek and forested habitats occur along the ridgeline on the northern boundary of the Project Area. At this time however, the Project Area generally comprises cleared grazing land with scattered trees and the Proposed Disturbance Area included less than 10 hectares of open woodland vegetation.

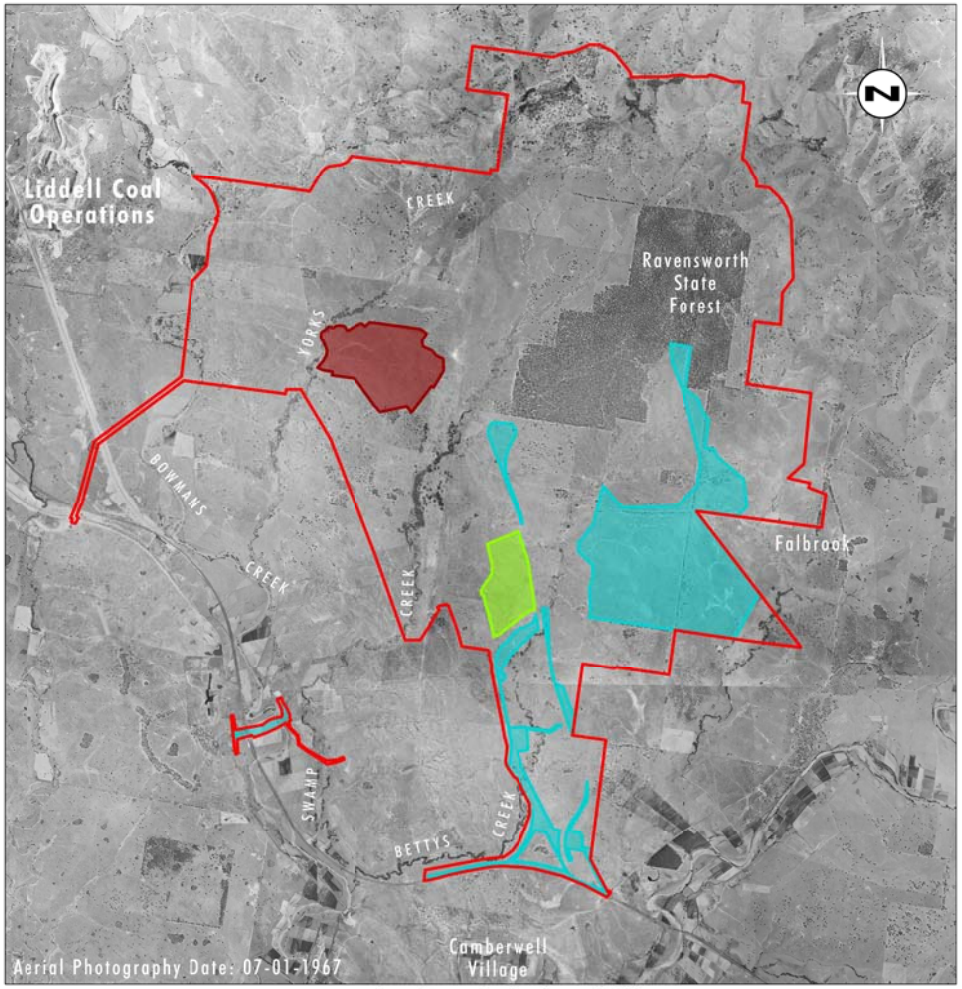
Examination of the 1967 set of photographs (refer to **Figure 2.2a**) shows a small increase in woodland and scattered tree vegetation in the Project Area. Regeneration is visible around Ravensworth State Forest and riparian vegetation around Bettys Creek, Swamp Creek and Glennies Creek has increased. Selective logging is known to have occurred in Ravensworth State Forest; however the extent of the woodland in this area has not substantially changed during the period 1958 to 1967. By this time, mining had commenced at Liddell Colliery and in the Project Area in the now Ravensworth East mining area (former Swamp Creek Mine). The Proposed Disturbance Area remains predominantly grassland vegetation.

Examination of the 1983 set of photographs (refer to **Figure 2.2b**) shows substantial change across the Project Area landscape with mining progressed in the Ravensworth area. Ravensworth State Forest shows signs of increased regeneration surrounding the area in the north and south likely due to the removal of grazing practices in the area. Forested vegetation to the north of the Project Area is shown to be increasing. Riparian vegetation along Yorks Creek and Swamp Creek has been severed by mining activities. The Proposed Disturbance Area remained in a generally cleared state, with small patches of vegetation totalling approximately 5 hectares.

Examination of the 2002 set of photographs (refer to **Figure 2.2b**) shows further change in the extent of vegetation across the Project Area, with the Mount Owen North Pit removing a substantial portion of Ravensworth State Forest. Additionally, significant regeneration of vegetation occurred between 1983 and 2002, particularly in the northern portion of the Project Area (in what is now referred to as the New Forest area) with approximately 1,050 hectares occurring in the Project Area in 2002.

Table 2.1 presents an analysis of the age structure of the vegetation within the Project Area. The analysis is based on this review of historical aerial photographs and provides the area of vegetation that is currently present (2013) in the Project Area that was also present in 1958, 1967, 1983 and 2002.





Note: Mining commenced in the Project Area in the late 1960s

Legend

- Project Area
- Proposed Disturbance Area
- Bayswater North Pit
- Proposed RERR Mining Area

0 1.0 2.5 5.0km

1:100 000

Image Source: Land and Property Information (received 2013)
Data Source: Mount Owen (2014)

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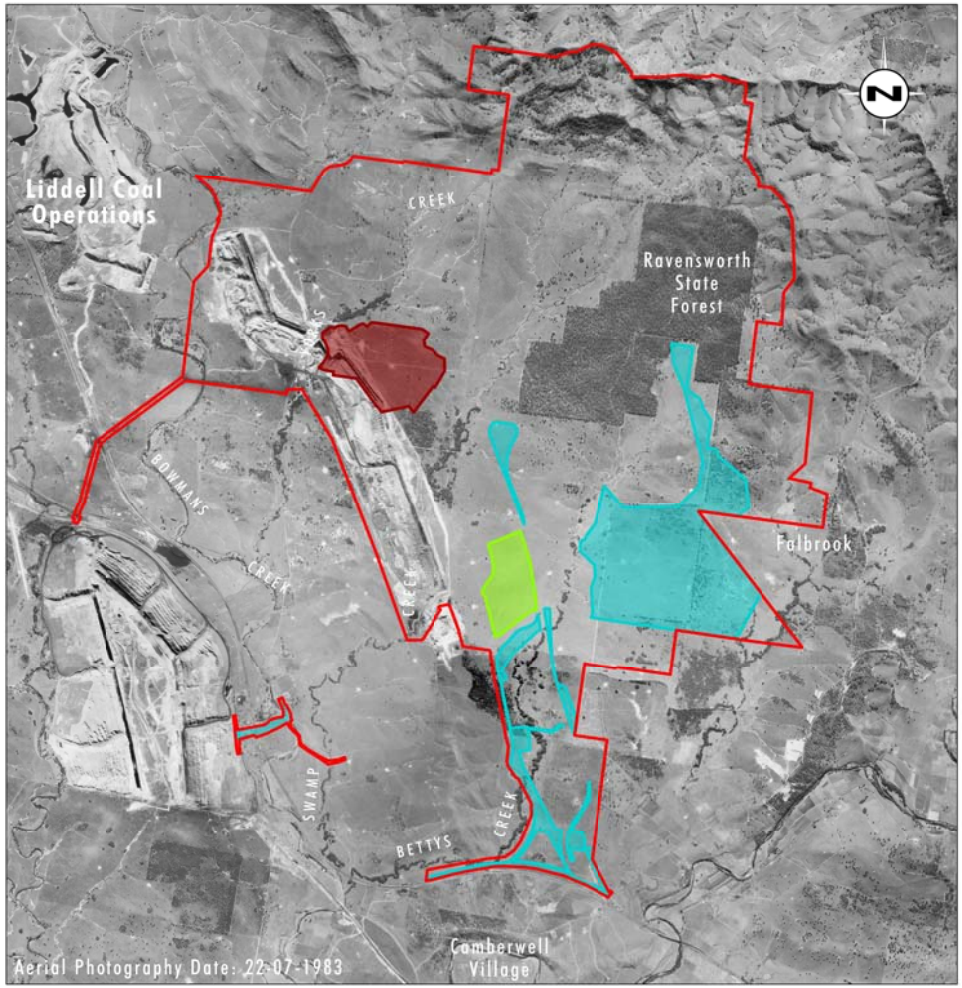
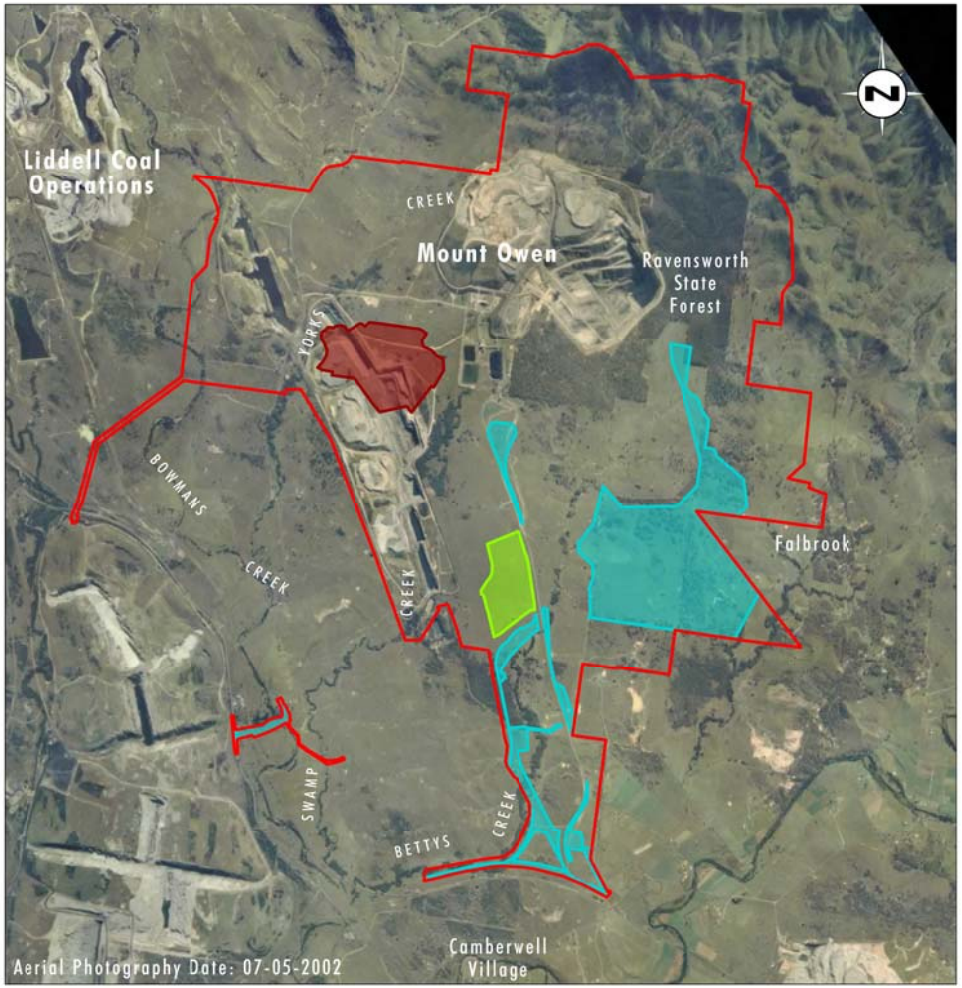
20140926 8.37

FIGURE 2.2a

Mount Owen Aerial Photographs 1958 and 1967





Legend

- Project Area
- Proposed Disturbance Area
- Bayswater North Pit
- Proposed RERR Mining Area

0 1.0 2.5 5.0km
1:100 000

Image Source: Land and Property Information (received 2013)
Data Source: Mount Owen (2014)

File Name (A4): R03/3109_809.dgn
20140926 8.39

FIGURE 2.2b

Mount Owen Aerial Photographs
1983 and 2002

Table 2.1 – Approximate Age Classes of Woodland Vegetation Occurring in the Project Area and Proposed Disturbance Area

Age Class	Area of Vegetation in Project Area (hectares)	Proportion of Project Area (%)	Area of Vegetation in Proposed Disturbance Area (hectares)	Proportion of Woodland in the Proposed Disturbance Area (%)
Pre 1958	542	11	38	17
47-55 years	45	1	3	1.3
21-46 years	269	5	56	25
11-20 years	190	4	57	25
<11 years	343	7	70	31

As outlined in **Table 2.1**, the majority of the existing vegetation within the Proposed Disturbance Area exists as a result of the extensive re-growth over the past 30 years. A relatively small proportion of the existing native vegetation (approximately 38 hectares) that will be cleared in the Proposed Disturbance Area is at least 55 years old. Approximately 800 hectares of the existing native vegetation in the Project Area has regenerated since 1967, of which 533 hectares (38 per cent) comprises regrowth that has regenerated since 1983.

None of the vegetation communities recorded in the Project Area can be currently considered 'old growth' vegetation. Old growth vegetation refers to any vegetation that was present at the time of European arrival in Australia that still remains in essentially similar condition. The extant woodland in the Project Area is entirely 'regrowth' or logged vegetation, that is, it has been previously cleared and its present extent is based entirely on natural regeneration or on targeted planting of canopy species. Regrowth is, ecologically, any native vegetation that has been cleared and has regrown since that time.

2.4 Existing Mount Owen Biodiversity Offset Areas

The original approval for development of the Mount Owen Mine was granted in November 1991. A modification to the original approval was granted in July 1994, which involved an extension to the south-east of the approved mining area. This area included Ravensworth State Forest, which was identified as a local and regionally significant remnant of natural vegetation and habitat for native flora and fauna. The Mount Owen Mine extension approved in 1994 permitted clearing of approximately 240 hectares (or about 55 per cent) of Ravensworth State Forest. Fauna investigations of Ravensworth State Forest and surrounding areas during the EIS prepared in 1994 identified the presence of five threatened species, the squirrel glider (*Petaurus norfolcensis*), spotted-tailed quoll (*Dasyurus maculatus*), green and golden bell frog (*Litoria aurea*), east coast freetail-bat (*Mormopterus norfolkensis*) and common bentwing-bat (*Miniopterus schreibersii*) (Resource Planning 1994).

A number of development consent conditions applied to the 1994 Mount Owen Mine extension, including the formulation of a Revegetation and Wildlife Plan of Management and the creation of an area of 'New Forest' as compensation for the area of Ravensworth State Forest that was to be mined. The Plan of Management included issues relating to management of flora and fauna in the re-afforestation and rehabilitation areas of the then Project Area. The strategies adopted to achieve the objectives of the Plan of Management include the monitoring of fauna populations within the forest and adjoining areas. The fauna monitoring program commenced in August 1995, and is required to be undertaken to the

satisfaction of the Director-General until cessation of mining activities. The fauna monitoring program is conducted on a quarterly basis and targets birds, mammals (including bats), reptiles and amphibians.

Mount Owen Mine gained approval in 2004 for the expansion of mining operations (DA 14-1-2004) that included the disturbance of an additional 35 hectares of Ravensworth State Forest and 59 hectares of additional woodland that occurred outside Ravensworth State Forest. The Project was referred under the EPBC Act at this time and was determined to not constitute a 'controlled action' and Commonwealth approval was therefore not required. Key project components included extension of mining areas, out-of-pit dumps and the diversion of Bettys Creek. The project identified a likely significant impact on the squirrel glider, brown treecreeper, eastern bentwing-bat, east coast freetail bat and the southern myotis. To offset the significant impact of the project on threatened fauna species, Mount Owen developed a comprehensive Biodiversity Offset Strategy (BOS) in consultation with regulatory authorities and other key stakeholders. The BOS covers an area of 415 hectares adjoining the northern remnant of Ravensworth State Forest and New Forest Area, including approximately 100 hectares of established woodland. Since that time the Southern Remnant Offset, totalling 4 hectares, has also been established. The BOS areas are managed to promote natural revegetation of native vegetation communities and to protect threatened species habitat in the long term. The BOS incorporates seven individual offset areas (refer to **Figure 1.2**):

- Northwest Offset;
- Northeast Offset;
- Forest East Offset;
- Travelling Stock Reserve (TSR) Offset;
- Southeast Offset;
- Southeast Corridor Offset; and
- Southern Remnant Offset.

The BOS was developed with specific focus on threatened species habitat, in particular that of hollow-dependent fauna species such as the masked owl (*Tyto novaehollandiae*), brown treecreeper (*Climacterispicumnus victoriae*), spotted-tailed quoll (*Dasyurus maculatus*), squirrel glider (*Petaurus norfolcensis*), east coast freetail bat (*Mormopterus norfolkensis*), greater broad-nosed bat (*Scoteanax rueppellii*) and southern myotis (*Myotis macropus*). These species are all hollow dependent and are considered at particular risk on a local level due to the potential loss of a significant portion of their habitat (Mount Owen and Thiess 2006).

The ongoing fauna utilisation of the BOS areas is monitored as part of the annual fauna monitoring program, conducted in accordance with the site Flora and Fauna Management Plan (Mount Owen and Thiess 2006). Woodland/forest rehabilitation, particularly in the context of threatened fauna habitat reconstruction was a key commitment of the 2004 BOS and the success of the habitat reconstruction initiatives in the context of the currently proposed Biodiversity Offset Strategy is provided in **Section 7.0**.

2.5 Vegetation Types and Plant Species

The areas surrounding and within the Project Area are predominantly composed of valley floor woodlands, forests and native and exotic pastures derived from the clearing of woodlands.

The vegetation communities mapped in the Project Area are consistent with the vegetation community descriptions described by Peake (2006) who mapped Hunter Valley floor vegetation on behalf of the former Hunter-Central Rivers Catchment Management Authority (HCRCMA) (now Hunter Local Land Services). The vegetation community classification and mapping is referred to as the Hunter Remnant Vegetation Project (HRVP) (refer to **Figure 2.3**). That study area covered approximately 315,000 hectares stretching from Scone in the north to Denman in the south-west and Branxton in the south-east. The Project Area is almost wholly included in the HRVP study area. This work included the botanical survey of 327 sites and mapping of approximately 60,000 hectares of forest or woodland remnants. Peake (2006) found that the native forests and woodlands of the central Hunter Valley have probably been reduced by approximately 76 per cent (238,000 hectares) since European settlement.

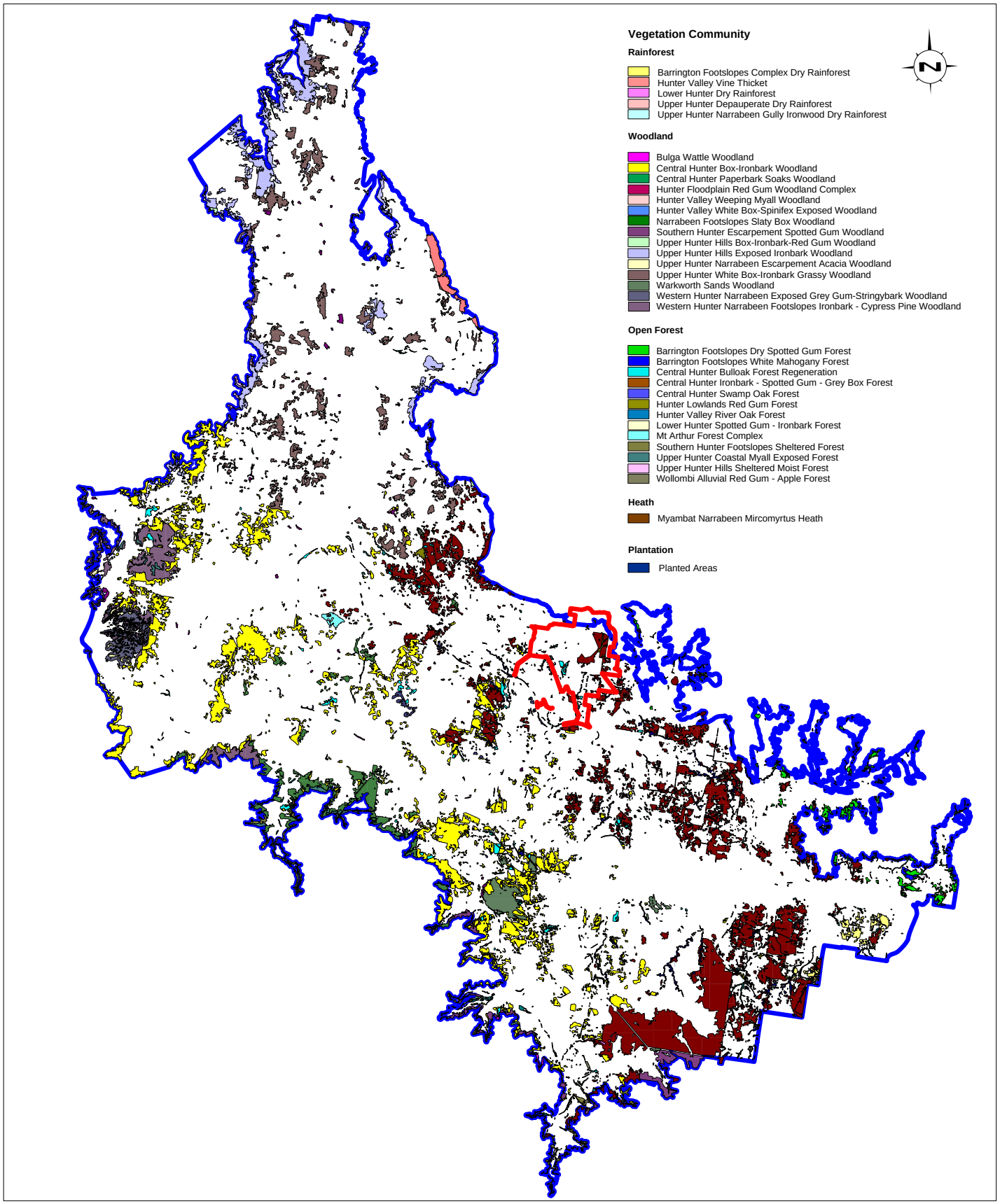
Most remaining forest and woodland remnants on the Hunter Valley floor are small, with 87 per cent being less than 10 hectares in size, and the median remnant size being 1.6 hectares (Peake 2006). Approximately 65 per cent of all remnant vegetation on the Hunter Valley floor occurs within the relatively few remnants that are over 100 hectares in area, with the largest remnant, which is mostly within Myambat Military Area near Denman, being approximately 2250 hectares.

Thirty-six vegetation communities were delineated by Peake (2006) in the central Hunter Valley, comprising five rainforest communities, 16 woodlands, 13 open forest communities, one heath and one (unnatural) plantation community. Six are listed as TECs under the TSC Act, while a further five communities have been nominated for listing since the Report was published. Twenty-two of the 36 identified communities meet the criteria for listing as EECs under the TSC Act or the Commonwealth EPBC Act and the remaining 13 naturally-occurring vegetation communities are either restricted or limited in extent (Peake 2006). Only a small number of vegetation communities described by Peake (2006) are well-represented in the NSW conservation reserve system. Most have relatively poor representation and a few communities, that are generally restricted to the valley floor, have little or no representation in existing reserves (Peake 2006).

Peake (2006) recorded 1127 plant species in the remnant vegetation of the central Hunter Valley, 22 per cent of which were not native to the area. Twenty-five plant species are of significance (either Rare or Threatened Australian Plants (ROTAP) or listed under the TSC Act or EPBC Act). Peake (2006) also recorded two previously undescribed species, 31 range extensions and seven species endemic to the Hunter Valley. Thirty-seven plant species occurring on the Hunter Valley floor are regionally rare and 12 plant populations are regionally endangered (Peake 2006). Of these populations, three are listed under the TSC Act. Peake (2006) also recorded twenty noxious or nationally significant weed species, and 49 important environmental weeds.

2.6 Fauna Habitats and Species

The broad fauna habitat types of grassland, riparian, woodland/forest and aquatic habitat found within the Project Area are representative of the broad habitat types within the surrounding region. All habitats in the region have been extensively cleared or modified for agriculture, largely for cattle grazing.



Source: Peake (2006), Mount Owen (2014)

0 12.5 25km

1:500 000

Legend

Project Area

Hunter Remnant Vegetation Project Study Area

FIGURE 2.3

Hunter Remnant Vegetation Project Study Area

Communities occurring on floodplains and more fertile soils in the Hunter Valley floor have been most extensively cleared (Peake 2006). Because of the widespread clearing of habitats in the region, those remaining contain important refuges for a number of fauna species, many of which are now threatened due to habitat loss and fragmentation.

Woodland and forests of the central Hunter Valley floor support a range of fauna species. These habitats are characterised by a dry environment with little or no standing water. Habitat is provided by a moderately open canopy and a sclerophyllous understorey that ranges from very dense to sparse, while the ground cover is generally sparse and dominated by grasses and forbs.

Alluvial forests generally provide a more dense vegetation cover than woodland and forest habitats. The relatively larger sizes of trees supported by the alluvial soils often also provide larger-sized hollows than those found on surrounding, drier slopes and ridges. The alluvial sites also provide ephemeral standing and moving water, with small wetlands and farm dams occurring in some areas. Aquatic habitat provided by farm dams and ephemeral creek lines and drainage lines are common across the undulating landscape surrounding the Project Area.

Grassland habitats are dominated by a range of native and naturalised perennial grasses and forbs. The health and integrity of the vegetation largely corresponds with the grazing history, particularly grazing intensity with many grassland habitats formed as a result of the clearing of woodland well over 100 years ago. The grass and forb dominated groundcover includes log and stump cover that provides habitat for grassland mammals (small and large), birds and terrestrial reptile species. The highly scattered trees throughout the grassland provided nesting, roosting and perching habitat for bird species, roosting habitat for some micro-bat species and shade for larger grazing mammal species.

2.7 Conservation Areas

Two large national parks are situated approximately 18 kilometres to the south-west of the Project Area (Wollemi and Yengo National Parks) (refer to **Figure 2.1**). These National Parks contain large areas of native vegetation and offer a wide range of good quality fauna habitats. Smaller, yet significant areas of National Park also exist approximately 30 kilometres to the north-east of the Project Area (Mount Royal and Barrington Tops National Parks) (refer to **Figure 2.1**). These national parks also contain significant areas of remnant vegetation and important fauna habitats. These conservation areas are located on the edges of the Hunter Valley, and are not representative of the central Hunter Valley floor. These conservation areas will not be adversely affected by the Project.

Ravensworth State Forest and adjoining Mount Owen Biodiversity Offset Areas (refer to **Figure 2.1**) represent an important link and refuge area between remnant patches of vegetation in the central Hunter Valley. Ravensworth State Forest (including the New Forest area) is located in the north-eastern portion of the Project Area and is zoned for environmental protection and conservation. This forest forms an important and integral component of the preservation of the flora and fauna of the upper Hunter Valley (Umwelt 2003). Approximately 415 hectares of vegetation contiguous with Ravensworth State Forest has been set aside for in perpetuity conservation as part of the Mount Owen Biodiversity Offset Strategy (Umwelt 2003), representing a significant area of conserved habitats in the central Hunter Valley.

2.8 Connectivity

The Project Area comprises a relatively large area of disturbed land (1253 hectares) and native vegetation of approximately 2794 hectares, with the Proposed Disturbance Area for the Project containing approximately 451.5 hectares of native vegetation. The remnant vegetation occurring in the Project Area occurs in the central portion of the Hunter Valley floor, approximately 87 kilometres from the coast and 150 kilometres from the western extremity of the Hunter catchment. In the central Hunter Valley, remnant vegetation occurring in the Project Area comprises approximately 1355 hectares of woodland, forest and riparian vegetation (the remnant), making it one of the largest remnants of native vegetation in the Hunter Valley, with Myambat Military area (2251 hectares), Wybong Uplands (2067 hectares) (which includes the approved Mangoola mining area), Singleton Military Area south and east (2020 and 1681 hectares respectively) the only remnants greater in area (Peake 2006).

The central location of the vegetation in this locality (including the Proposed Disturbance Area and the adjacent Ravensworth State Forest and Mount Owen Biodiversity Offset areas) increases its importance due to its functionality as a fauna refuge and 'stepping stone' in a highly fragmented landscape. The remnant includes Ravensworth State Forest, including the New Forest Area; existing Mount Owen Biodiversity Offset Areas; and other native woodland and forest vegetation that are connected to these conservation areas. The remnant provides an important link in the generally north/south movement of highly mobile species, from other sizeable remnants in the north-west such as those of Antiene, to large remnants to the south-east and south-west of the Project Area, including remnants at Jerrys Plains. Further from these valley floor remnants, the vegetation in the Mount Owen Complex provides a central stepping stone between the conserved habitats of Mount Royal and Barrington Tops National Parks to the north and Wollemi National Park to the south. Connectivity to the east and west of the Project Area is limited due to extensive areas of cleared land and adjoining open cut mining operations.

The large size of the remnant means that it provides an important area of habitat for a wide range of flora and fauna species. Of particular importance is the ability of the remnant to support a range of species whose occurrence is limited by the need for a large area of contiguous habitat, such as woodland dependent bird species. Due to the widespread historic clearing and fragmentation of valley floor vegetation there are few large remnants greater than 100 hectares remaining in the central Hunter Valley (Peake 2006) increasing the significance of those remaining large remnants. These remnants are threatened by ongoing disturbance and isolation due to the expansion of the mining industry, agriculture, rural residential development and other developments.

2.9 Upper Hunter Strategic Regional Land Use Plan and Upper Hunter Strategic Assessment

One of the key strategic policies guiding the assessment of mining development is the NSW Government's Upper Hunter Strategic Regional Land Use Plan. The Upper Hunter Strategic Regional Land Use Plan (Upper Hunter SRLUP), which was approved in September 2012 and covers the Project Area, contains the detailed direction for assessing and managing strategic land use decisions in the Upper Hunter Valley. The stated objective of the Upper Hunter SRLUP is to balance the strong economic growth in Regional NSW with the protection of valuable agricultural land and the sustainable management of natural resources. In particular, the Upper Hunter SRLUP identifies the importance of minimising the land use conflicts arising from the rapid growth of coal mining activities and the recent emergence of the coal seam gas industry.

The Upper Hunter SRLUP recognises the substantial natural heritage values of the Upper Hunter region and aims to ensure that ongoing development in the region does not compromise high value terrestrial and aquatic biodiversity. The Upper Hunter SRLUP supports the development of a Strategic Assessment under Part 10 of the EPBC Act for proposed new coal mines and mine expansions in the Upper Hunter Valley. The Strategic Assessment is being undertaken by OEH, DPE and Department of the Environment. The aims of the Strategic Assessment are to:

- resolve Commonwealth and State threatened species/biodiversity issues in one/upfront process;
- consider the impacts of all mines together and in a regional context;
- consider how rehabilitation can contribute to biodiversity conservation in a regional context;
- improve the process of finding and securing offsets; and
- target offsetting to deliver regional conservation gains.

The development of the Strategic Assessment, to be completed in 2014, is an identified action of the Upper Hunter SRLUP.

The Upper Hunter SRLUP identifies that land set aside for biodiversity offsets should not result in the significant loss or destruction of agricultural resources or industries, and that offsets can support continued agricultural production on biodiversity offset land in many instances.

The Upper Hunter SRLUP supports the development of a state-wide offsets database (to be undertaken by DPE) to identify terrestrial biodiversity offsets associated with major project approvals. The offsets database will be used to inform future assessments so that offset areas are not compromised by further development.

3.0 Methods

3.1 Literature Review

A review of previous documents and reports relevant to the Project Area was undertaken to inform the field survey methodology, results and impact assessment component of this report. This included regional and sub-regional vegetation mapping reports, site-specific monitoring surveys, ecological surveys undertaken in the vicinity of the Project Area and also relevant ecological database searches. The information obtained was used to inform survey design, and was also used to assist in the assessment of potentially occurring threatened and migratory species, EPs and TECs. Relevant documents are discussed below; focusing on the key findings of each assessment.

3.1.1 Hunter Remnant Vegetation Project (Peake 2006)

The Hunter Remnant Vegetation Project (HRVP) (Peake 2006) documents the distribution, composition and conservation status of vegetation communities occurring in the central Hunter Valley of NSW. Four vegetation communities were mapped within the Project Area, comprising:

- Central Hunter Box – Ironbark Woodland;
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest;
- Central Hunter Bulloak Forest Regeneration; and
- Central Hunter Swamp Oak Forest.

Small pockets of Hunter Valley River Oak Forest were identified along Bowmans Creek.

Peake (2006) regarded all of these identified vegetation communities to be of conservation significance and under threat. Central Hunter Box – Ironbark Woodland and Central Hunter Ironbark – Spotted Gum – Grey Box Forest are listed as Endangered Ecological Communities (EECs).

The HRVP (Peake 2006) has been used as a basis for the regional assessment of vegetation communities and as a comparison in an impact assessment context against which the loss of vegetation communities as a result of the Project was assessed. While the HRVP utilised imagery from 2000, the report provides a thorough analysis and mapping of remnant vegetation in the central Hunter Valley.

Since the HRVP was published in 2006, additional areas of native forests and woodlands have been cleared as part of mining and other approvals within the study area. Other areas are likely to have regenerated during this time. The precise locations and extent of clearing and regeneration since 2006 are unknown.

3.1.2 Greater Hunter Native Vegetation Mapping

As part of the Upper Hunter Strategic Assessment (UHSA), OEH released the Draft Greater Hunter Vegetation Map (Sivertsen *et al*. 2012) (GIS format) and associated Vegetation Classification Dataset (Excel spreadsheet), covering the entire UHSA area which includes the central Hunter Valley. The vegetation types of the Draft Greater Hunter Vegetation Map will replace the Hunter Central Rivers vegetation types currently used in the BioBanking credit calculator. While the Draft Greater Hunter Vegetation Map was produced using a number of on-ground data collection points, many parts of the map are based on modelling

results and may contain errors and therefore does not replace the need for on-ground vegetation community survey and mapping.

All of the vegetation communities recorded in the Proposed Disturbance Area have been aligned with the vegetation community nomenclature of the Greater Hunter Native Vegetation Mapping, where appropriate, to inform an indicative BioCertification Assessment of the Project outlined in **Section 7.10**.

3.1.3 Annual Fauna Monitoring Surveys, Mount Owen Complex 1996 – 2013

The 1994 development consent for Mount Owen Mine permitted disturbance of 240 hectares of Ravensworth State Forest, which was considered to be a highly significant remnant on a local and regional scale. As part of the this development approval, Mount Owen committed to the establishment of an area of forest vegetation to the north of Ravensworth State Forest, known as the New Forest area, that aimed to compensate for the loss of State Forest resources. A Plan of Management for Revegetation and Wildlife Management (POM) was developed following the granting of development consent for the Project which included a requirement to implement ecological monitoring to assist the management of threatened species, populations and communities, their habitats, and ecosystems across the Mount Owen Complex.

An annual fauna monitoring program was devised to monitor the distribution and abundance of native fauna in the remaining area of Ravensworth State Forest and the New Forest area, mine rehabilitation areas and subsequently approved Biodiversity Offset Areas. A Flora and Fauna Interagency Advisory Group, consisting of representatives from the (former) National Parks and Wildlife Service (NPWS), Department of Mineral Resources (DMR), State Forests, Department of Land and Water Conservation (DLWC), Hunter Environment Lobby and Mount Owen, oversees the implementation of the Plan of Management. In recent years, these meetings have not been well attended, particularly by state government agency representatives.

Annual fauna monitoring has been designed to monitor the distribution and abundance of protected and threatened species of fauna over time in different habitats to provide detailed information regarding habitat use for management of the area and also the usefulness of habitat establishment programs for conservation of native fauna. Modifications to the fauna monitoring program have been made over the years as required since its inception in accordance with new listings of threatened species and or detection of new threatened species in the Mount Owen Complex area.

A spotted-tailed quoll radio tracking program has been undertaken in addition to the standard fauna monitoring requirements in order to gain an understanding of the species' utilisation of the Mount Owen mining area. One male spotted-tailed quoll was fitted with a radio tracking collar and monitored between October 2012 and March 2013. A second male was collared and tracked between April and July 2013. The results of the radio-tracking are presented in **Section 4.2.4.1** and have been considered in the impact assessment in **Section 5.0**.

3.1.3.1 Plan of Management for Revegetation and Wildlife Management

The original POM specified 11 fauna monitoring sites to be sampled annually. However, during the period 1997 to 2005, three fauna monitoring sites were removed from the program as they were located in the mine operation area. In addition, three additional fauna monitoring sites were removed from the monitoring program following a review of the Plan in 2000. To offset the loss of monitoring sites from mining operations, four replacement sites were selected and included in the monitoring program in the years 2004 and 2005. The new sites were located in rehabilitation and biodiversity offset areas.

3.1.3.2 Flora and Fauna Management Plan

The current Mount Owen Complex Flora and Fauna Management Plan (FFMP) (Xstrata Coal and Thiess 2006) specifies nine fauna monitoring sites for general fauna, 10 monitoring sites for microchiropteran bats and 13 frog monitoring sites. The monitoring of these sites employs a range of survey methods such as bird census surveys, Elliot trapping, cage trapping, pitfall, spotlight searches and call playback surveys that target specific species.

Since the initial flora and fauna surveys in 1994, annual fauna monitoring surveys have recorded 28 threatened species listed under the TSC Act and EPBC Act that occur within the Mount Owen Complex.

3.1.4 Upper Hunter Strategic Assessment (UHSA) Greater Ravensworth Biodiversity Assessment

In accordance with an agreement between the Australian and New South Wales governments to undertake a strategic assessment for a Biodiversity Plan for Coal Mining in the Upper Hunter Valley, a Biodiversity Certification assessment was undertaken across the Glencore-operated coal mines in the Upper Hunter. Umwelt was engaged to prepare an ecological assessment of the Greater Ravensworth UHSA project area, which included areas within the Mount Owen, Glendell, Liddell and Ravensworth operations.

Flora and fauna surveys for the UHSA assessment were undertaken in March and April 2014 and included systematic plot and transect flora surveys, quantitative and semi-quantitative rapid flora assessments and targeted fauna surveys for Species Credit species including targeted bird surveys for the red goshawk and black-breasted buzzard; Anabat echolocation detection surveys for threatened micro-bats; Spot Assessment Technique (SAT) surveys and spotlight searches for the koala; remote camera surveys for the brush-tailed phascogale; and call playback and wetland searches for the green and golden bell frog.

As part of the UHSA, a number of targeted flora and threatened fauna species surveys were undertaken within and surrounding the Project Area as part of this UHSA. The relevant methods and results have been incorporated within this report and are outlined in **Sections 3.0** and **4.0**.

3.1.5 Ravensworth State Forest Vegetation Complex Research Program, Mount Owen Complex 1996 – 2013

Since 1996, 12 Honours Degree and three PhD Degree candidates have been linked to flora and vegetation research at the Mount Owen Complex. The main outcomes of these studies include research training, monitoring diversity of Ravensworth State Forest and Mount Owen Rehabilitation Sites and the use of manipulative experiments to improve rehabilitation outcomes. The research developed with these degree candidates and research staff was developed into the Ravensworth State Forest Vegetation Complex Research Program. This program comprises two sub-programs being the:

- Forest-Woodland Reconstruction Research Program; and
- Biodiversity Offsets Research Program.

The objectives of the Forest-Woodland Reconstruction Research Program include developing an understanding of plant diversity and function as part of the ecological process in Ravensworth State Forest and understanding barriers in the reconstruction of forest and woodland on rehabilitated spoil. Since studies of plant diversity in the Mount Owen Complex began in 1996, the number of species present has increased due to the further investigation of the site including the seed bank. Overall, 552 species (406 native, 146 exotic) have been

identified in Ravensworth State Forest Vegetation Complex (includes mine rehabilitation, Ravensworth State Forest and biodiversity offset areas). Multiple PhD studies have investigated the limiting factors and importance of soil structure and composition to effectively rehabilitate land previously impacted by mining including the contribution of nitrogen, bacteria and mycorrhizae.

The Biodiversity Offsets Research Program commenced in 2005 and focuses on establishing forest and woodland communities in the Mount Owen offset areas developed as part of the 2003 mine approval and includes 415 hectares of land protected for conservation outcomes. Active planting rehabilitation was undertaken in 99 hectares of grassland. The remaining areas of the offsets were left for natural regeneration of woodland and forest habitats. Research into soil microbes and plant root associations has been undertaken to understand their role in reconstructing treed communities in previously cleared areas. Experiments have also been undertaken that involve transferring fresh topsoil from Ravensworth State Forest with supplementary seeding that favour canopy species to the rehabilitation sites.

3.1.6 Mount Owen Flora Assessment (Umwelt 2003)

A flora assessment was undertaken by Umwelt in 2003 as part of an assessment of the impact of extending mining operations at the Mount Owen Complex. The Project included new mining areas, development of overburden dumps, haul roads and stock piles, resulting in the disturbance of Ravensworth State Forest and rehabilitated land and the diversion of Bettys Creek.

Targeted flora surveys of the Project Area were conducted in varying seasons over four survey periods in 2001, 2002 and 2003. This included walking transects and vegetation survey plots. Additionally, aquatic surveys were conducted over three survey periods in 2002 and 2003 of Bettys Creek and artificial aquatic habitats in the Mount Owen Complex.

At the time of this assessment, one EEC was recorded within the then Project Area being Hunter Lowland Redgum Forest EEC (TSC Act). It is noted that the dominant woodland and forest communities occurring in the Mount Owen Complex were not listed as EECs at the time of the assessment. No threatened flora species or EPs were recorded during the field surveys.

The impact assessment found that the Project would result in the removal of approximately 425 hectares of vegetation from within the Project Area, including the 94 hectares of Central Hunter Spotted Gum/Grey Box/Ironbark Woodland; 29 hectares of regenerating woodland; 8 hectares of riparian vegetation; one hectare of Bull Oak Woodland; and approximately 293 hectares of pastoral grassland habitat.

3.1.7 Mount Owen Fauna Assessment and Species Impact Statement (Forest Fauna Surveys, Fly by Night and TUNRA, Umwelt 2003)

A fauna assessment was undertaken by Forest Fauna Surveys, Fly by Night Bat Surveys, TUNRA and Umwelt in 2003 for the proposed extension of mining operations at the Mount Owen Complex in 2003.

Targeted fauna surveys of the then Project Area were conducted by Forest Fauna Surveys, Fly By Night Bat Surveys, TUNRA as part of the annual monitoring requirements of the POM for the 1994 development consent for the Mount Owen mine (refer to **Section 3.1.3**). Additional fauna and aquatic surveys were conducted within the then Project Area, including the Glendell Haul Road area by Umwelt in 2003.

At the time of this assessment, 145 bird species, 24 non-flying mammals and 18 bat species, 20 reptile and 15 amphibian species had been recorded within the Mount Owen Complex

since the annual monitoring surveys commenced in October 1995. Of these 18 threatened species had been recorded within the Mount Owen Complex and an additional two species (swift parrot and regent honeyeater) were considered to have the potential to occur.

The impact assessment found that the Project may result in a significant impact on the brown treecreeper (*Climacteris picumnus victoriae*), squirrel glider (*Petaurus norfolcensis*), east coast freetail-bat (*Mormopterus norfolkensis*), eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) and southern myotis (*Myotis macropus*). Additionally, non-significant impacts were considered likely to occur on a range of other threatened species across the site. As a result, a range of mitigation and offsetting strategies (refer to **Section 3.1.7**) were recommended.

3.1.8 Mount Owen Biodiversity Offset Strategy (Umwelt 2003)

As a result of the ecological impacts of the extension of mining operations within the Mount Owen Complex, the proponent committed to mitigate the impacts through the adoption of a BOS, which was prepared by Umwelt in 2003. The BOS outlined a range of offset sites located to the north and east of the Project Area which comprised a total of 415 hectares including 100 hectares of woodland vegetation and habitat. These offsets are known as the TSR Offset, Southeast Offset, Southeast Corridor Offset, Forest East Offset, Northeast Offset, Northwest Offset (refer to **Figure 1.2**).

The offsets were considered to comprise a 'like for like' offset terms of woodland and riparian vegetation and fauna habitat. The Project disturbed 94 hectares of woodland and 8 hectares of riparian vegetation. The offset areas contained 100 hectares of woodland and 4 hectares of riparian vegetation. This provided a ratio of greater than 1:1 immediately in terms of the woodland protected in offset areas compared with that disturbed by the Project. Additional to this, it was proposed to actively plant native woodland species in pasture areas to increase and improve the area of habitat available in these areas. These offset areas have been established and now form part of a habitat movement corridor for terrestrial fauna around Ravensworth State Forest.

3.1.9 Xstrata Biodiversity and Land Management Strategy Stage 2b (Umwelt 2009)

The ecological assessment of the Xstrata Biodiversity and Land Management Strategy (BLMS) (Umwelt 2009) aimed to document the vegetation communities, threatened species, populations and ecological communities on non-operational land managed by Glencore.

A gap analysis was conducted initially to determine the information available for each XCN operation. For areas where there was limited existing ecological information, field surveys were conducted to delineate and describe vegetation communities, and to document the occurrence of threatened species, populations and ecological communities. For areas where there was existing and reliable information available, surveys were conducted to ground-truth existing vegetation mapping and to record any additional threatened species, EP or TECs. Field surveys at Mount Owen Complex were undertaken to delineate and describe the vegetation communities in the northern part of the study area and to ground-truth existing vegetation mapping in the eastern part of the study area by Peake (2006), which has not been subject to extensive ground-truthing field surveys.

This BLMS provided vegetation mapping and information on threatened species, populations or ecological communities within the Project Area.

3.1.10 Environmental Assessment for the Modification of Glendell Mine Operations (Umwelt 2007)

Xstrata Mount Owen Pty Limited (now Mount Owen Pty Limited) sought approval to modify the Glendell Mine development consent to enable the integration of Glendell Mine operations with the approved Mount Owen Complex operations. A comprehensive ecological assessment was undertaken by Umwelt to assess the impacts of the proposed modifications (Umwelt 2007).

Ecological surveys identified a range of ecological values including the following:

- five vegetation communities, which included:
  - Derived Grassland;
  - Central Hunter Bulloak Forest Regeneration;
  - Central Hunter Swamp Oak Forest;
  - Central Hunter Box - Ironbark Woodland; and
  - Hunter Valley River Oak Forest.
- two EPs *Eucalyptus camaldulensis* and *Acacia pendula* that were recorded within the south-western extent of the Glendell Mine, associated with Swamp Creek;
- a total of 88 fauna species that included 56 bird species, five reptile species, five amphibian species and 22 mammal species; and
- a total of five fauna species listed as threatened under the TSC Act, including the grey-crowned babbler (*Pomatostomus temporalis temporalis*), eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), speckled warbler (*Chthonicola sagittata*), brown treecreeper (*Climacteris picumnus victoriae*) and the yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*).

The Project was not expected to result in a significant impact on threatened species, populations and EECs listed under the TSC Act and EPBC Act.

3.1.11 Liddell Coal Mine Extension Aquatic Ecology and Groundwater Dependent Ecosystem Assessment (Eco Logical 2012)

An Aquatic Ecology and Groundwater Dependent Ecosystem Assessment of Bayswater and Bowmans Creeks was undertaken in 2012 to inform the Liddell Coal Mine Extension Project (Eco Logical 2012). The proposed Liddell Coal Mine Extension is located to the west of Mount Owen Complex and included assessment of Bowmans Creek. The assessment included:

- a desktop review of databases and existing reports to determine whether any threatened aquatic species occur on-site, and the likelihood of there being groundwater dependent ecosystems (GDEs) present;
- field surveys of macroinvertebrates, fish, creek habitat, riparian zone, and aquifer fauna (stygofauna) communities to establish baseline condition;
- an indication of whether the proposed Project is likely to impact on key aquatic or groundwater dependent ecosystems or processes; and
- recommendations for monitoring aquatic and groundwater dependent communities.

The results of this assessment were considered in the assessment of the Project on aquatic values and are discussed further in **Section 4.3**.

3.1.12 Liddell Coal Mine Extension Ecological Assessment (Umwelt 2013a)

The Liddell Coal Mine ecological assessment was undertaken as part of the Environmental Assessment for the proposed extension of mining operations. The Project includes minor additional mining infrastructure and additional tailings emplacement areas.

Flora surveys identified one EEC, being Central Hunter Grey Box – Ironbark Woodland (TSC Act) and one EP, being the tiger orchid (*Cymbidium canaliculatum*) population in the Hunter catchment (TSC). No threatened flora species were recorded in the Project Area.

Fauna surveys identified the following threatened or migratory species: spotted harrier (*Circus assimilis*), grass owl (*Tyto longimembris*); brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*); speckled warbler (*Chthonicola sagittata*); grey-crowned babbler (*Pomatostomus temporalis*); Southern myotis (*Myotis macropus*); eastern cave bat (*Falsistrellus tasmaniensis*); east coast freetail-bat (*Mormopterus norfolkensis*); eastern bentwing bat (*Miniopterus schreibersii oceanensis*); and rainbow bee-eater (*Merops ornatus*).

Although the spotted-tailed quoll (*Dasyurus maculatus maculatus*) was not recorded within the Project Area, it was considered likely to occur based upon nearby records.

Key ecological issues identified for the project were potential impacts to the spotted-tailed quoll (*Dasyurus maculatus maculatus*), removal of 125 hectares of native woodland, forest and riparian vegetation habitat and 58 hectares of TEC.

Mitigation strategies included the development of an offset strategy with the aim of maintaining or improving biodiversity values in the Hunter Valley; and a rehabilitation strategy focused on habitat enhancement and corridor linkages within the final landscape.

3.1.13 Assessment of the Ecological Outcomes of Mine Rehabilitation, Regeneration and Revegetation at Mount Owen Mine (Umwelt 2013b)

An assessment of the ecological value of mine rehabilitation and offset restoration at the Mount Owen Mine was undertaken to determine how previously rehabilitated landforms and restored forests have been created and whether they are trending towards performance/completion criteria. In addition, the degree to which these areas contribute ecologically to surrounding landscapes was evaluated. The knowledge derived from this review was used to enable Glencore to strive for best-practice ecological rehabilitation at Mount Owen and other sites in the Hunter Valley and elsewhere.

To ensure that restoration efforts were appropriately sampled, assessed and described, 14 systematic 20 x 20 metre plots were surveyed across the Mount Owen rehabilitation area as well as assessments of fauna habitat and fauna monitoring results. This included the sampling of:

- mine rehabilitation areas of different age classes;
- active revegetation in the New Forest Area and Biodiversity Offset Areas;
- passive regeneration in Biodiversity Offset Areas; and
- reference sites within the Ravensworth State Forest for comparative purposes.

This review concluded that regeneration, revegetation and mine rehabilitation areas are developing into complex vegetation types and ultimately meet endangered ecological community status. These areas have also shown to provide suitable habitat for a range of threatened fauna species. The outcomes of this review demonstrate, through practical and recent examples, that rehabilitation objectives and completion criteria can be met at Mount Owen and reinforce the need to appropriately value mine rehabilitation and the regeneration and revegetation of offset areas in mining approvals.

3.1.14 Ashton Coal Goaf Gas Drainage Project Stage 2 – Riparian and Terrestrial Ecology (Pacific Environmental Associates Pty Ltd 2012)

A riparian and terrestrial ecological assessment was prepared to support an application by Ashton Coal Operations to construct a Central Gas Drainage Plant and associated infrastructure over a total area of 13.3 hectares. The ecological assessment study area is located less than 1 kilometre from the southern extent of the Proposed Disturbance Area.

The majority of the vegetation identified was disturbed vegetation/dry pasture with less than 1 hectare of the vegetation identified consisting of Central Hunter Grey Box Ironbark EEC. Two endangered populations were also identified being river red gum (*Eucalyptus camaldulensis*) in the Hunter Catchment (TSC) and weeping myall (*Acacia pendula*) in the Hunter catchment (TSC Act). No threatened flora species were identified.

Six threatened fauna species were identified including the grey-crowned babbler, turquoise parrot, speckled warbler, scarlet robin, hooded robin and flame robin, with habitat identified for a further seven threatened fauna species.

Outcomes of the project determined that there would be no significant ecological impacts as a result of proposed works. Mitigation works to reduce ecological impacts of the project included minimising the areas required for disturbance, pre-clearance inspections to be undertaken by a qualified ecologist, employment of appropriate erosion measures, and an appropriate rehabilitation program following works.

3.1.15 Ashton Coal Pty Limited Aquatic Ecology Assessment, Upper Liddell Seam LW 1-8 (Anink 2011)

Aquatic ecology and water quality sampling has been conducted in Bowmans Creek, between the New England Highway and the confluence of Bowmans Creek and the Hunter River from 2007 onwards. The monitoring area occurs approximately 2.5 kilometres downstream from the proposed Bowmans Creek Bridge on Hebden Road.

Since a major flood event in 2007 when only resilient taxa remained in the lower section of Bowmans Creek between New England Highway and the Hunter River confluence, monitoring results show a stabilisation of habitats and an increase in habitat complexity over time. As a result, there has been an increase in diversity for macroinvertebrate assemblages, with a shift to include more pollution/instability intolerant taxa.

To assess the impacts of mining on the aquatic ecology of Bowmans Creek resulting from the revised subsidence predications, no additional field surveys were conducted as existing monitoring data of the affected section of Bowmans Creek provided sufficient information. This included 17 Stream Health Sample Sites and 15 ACOL Water Quality sites.

The riparian zone of this section of Bowmans Creek supports a narrow strip of river oak (*Casuarina cunninghamiana*) and the introduced willow (*Salix babylonica*). The aquatic vegetation includes true aquatic species as well as emergent species. A total of 14 flora species have been recorded, two of which are introduced species, namely watercress

(*Nasturtium officinale*) and elodea (*Elodea canadensis*). The most commonly recorded aquatic flora species was cumbungi (*Typha* sp.).

A total of 22 vertebrate fauna species have been recorded in the lower section of Bowmans Creek. Field surveys have recorded eight species of frogs, all of which are native, and 14 fish species, two of which comprise the introduced species carp (*Cyprinus carpio*) and plague minnow (*Gambusia holbrooki*). The plague minnow was the most commonly recorded fish, generally occurring at every monitoring site.

An additional 70 aquatic macroinvertebrate species have been recorded from the lower section of Bowmans Creek. Of these, 67 per cent of species were insects, 12 per cent were molluscs and 9 per cent were crustaceans. The remaining 12 per cent of species were species comprised arachnids, flatworms, annelid worms, leeches, roundworms and springtails. The more common species included midge fly larvae (sub-family Chironominae), freshwater shrimp (family Atyidae), damselflies (family Coenagrionidae), mayflies (family Caenidae), water boatmen (family Corixidae) and caddis flies (family Leptoceridae).

The impacts of proposed mining on aquatic biota and habitats in Bowmans Creek was expected to be negligible based on the assessment of predicted subsidence induced changes to stream morphology, water quantity and quality. The availability of drought refuge pools and condition of fish passages within the creek were not expected to be significantly impacted.

3.1.16 Flora and Fauna Assessment – Ashton Coal South East Open Cut Project & Modification to the Existing ACP Consent (ERM 2009)

ERM was engaged by Ashton Coal Operations Pty Ltd to assess potential flora and fauna impacts of the proposed South East Open Cut coal mine. The South East Open Cut area is located approximately 2.5 kilometres from the southern extent of the Proposed Disturbance Area.

Vegetation communities recorded were open grassland (262.22) and Central Hunter Ironbark – Spotted Gum-Grey Box Forest (24.74 hectares). At the time of the surveys the Central Hunter Ironbark – Spotted Gum – Grey Box Forest was only preliminarily listed as an EEC under the TSC Act. No threatened species were identified, however one endangered population was identified being river red gum (*Eucalyptus camaldulensis*) in the Hunter Catchment (TSC Act) it was considered that this pocket of river red gum may have also comprised the Hunter Floodplain Red Gum Woodland EEC, which at the time of the Assessment was preliminarily listed as an EEC.

Eight threatened fauna species were recorded in the Project Area being the grey-crowned babbler (*Pomatostomus temporalis temporalis*), speckled warbler (*Chthonicola sagittata*), scarlet robin (*Petroica boodang*), flame robin (*Petroica phoenicea*), turquoise parrot (*Neophema pulchella*), eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), large-eared pied bat (*Chalinolobus dwyeri*) and yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*).

It was considered unlikely that the project would have a significant impact on the ecology of the Project Area; however mitigation measures to reduce impacts included pre-clearance inspections, a detailed plan for the clearing of vegetation (including habitat features), rehabilitation works, nest box installation and relocation of habitat features from cleared areas. An offset strategy that comprised a 62 hectare offset area was also included.

3.1.17 Preliminary Assessment of Assemblages of Fish Associated With Upgrading the Bowmans Creek Rail Bridge Crossing

Roberts and Murray (2005) undertook a before and after quantitative assessment of the fish assemblages in Bowmans Creek and two reference creeks at appropriate spatial scales to determine the impact of upgrading the Bowmans Creek rail bridge crossing. Reference sites were located in Rouchel and Glennies Creeks.

The assessment was undertaken using an Electrofisher backpack unit. The Electrofisher was used to stun the fish in open water and in submerged and emergent aquatic vegetation. Ten fish and three crustacean species were identified in the study area during the survey. Surveys within Bowmans Creek identified six fish and three crustacean species, with the introduced mosquito fish (*Gambusia holbrooki*) the most abundant species recorded in the creek, followed by long-finned eels (*Anguilla reinhardtii*).

3.2 Database Searches

In order to identify threatened species, migratory species, EPs and TECs with the potential to occur in the Project Area relevant ecological databases were searched.

The databases searched were:

- a 10 kilometre radius search from the centre of the Project Area of the OEH Atlas of NSW Wildlife (May 2014);
- a 10 kilometre radius search from the centre of the Project Area of the Department of Environment Protected Matters Database (May 2014);
- PlantNET (Royal Botanic Gardens Sydney) database search for Rare or Threatened Australian Plants (ROTAP) species within the Singleton Local Government Area (LGA) (May 2014); and
- DPI Threatened and Protected Species Records Viewer search within the Hunter/Central Rivers Catchment (May 2014).

Records from these database searches were combined with records derived through literature reviews and professional opinion to identify the range of potentially occurring threatened and migratory species. The identification of potentially occurring threatened and migratory species was then used to assist in the development of appropriate survey methods.

Current lists of threatened species and key threatening processes listed under the FM Act were sourced from the Department of Primary Industries (NSW Fisheries) and Department of Environment websites.

3.3 Flora Survey Methods

Vegetation survey and mapping was carried out to sample and describe flora and vegetation communities present in the Proposed Disturbance Area. In particular, literature review and vegetation survey aimed to identify threatened species, EPs, TECs and species of local or regional significance present or potentially occurring within the Project Area. Key steps involved in the vegetation survey included:

- aerial photograph interpretation (API);
- field survey site selection using stratification;
- field survey and associated plant identification; and
- vegetation community description and delineation.

3.3.1 Aerial Photograph Interpretation

Aerial photographs of the Project Area were viewed prior to and after vegetation survey to identify spatial patterns in vegetation, land use and landscape features. These informed field survey design and implementation, ecological assessment and vegetation community mapping in the Project Area.

The Manifold System 8.0 Enterprise Edition geographical information system (GIS) was used to view these aerial photos on-screen, using a 32 bit mode. Use of GIS allowed zooming to a relatively large scale. Using this method, mapping was carried out at a scale of up to approximately 1:700, since at higher magnification than this the gain in scale was outweighed by the loss in resolution.

In addition to contemporary aerial photography of the Project Area, historical photos were also viewed in hard copy to inform the assessment, particularly in relation to the changes in vegetation patterns and land use over time. Those historical aerial photographs utilised are listed below in **Table 3.1**.

Table 3.1 – Historical Aerial Photography of Project Area used in Ecological Assessment

Area Covered	Details of Photo	Source
Entire Project Area	Black and white 1:25,000 flown 1958	Department of Lands
Entire Project Area	Black and white 1:25,000 flown 1967	Department of Lands
Entire Project Area	Colour 1:25,000 flown in 1983	Department of Lands
Entire Project Area	Colour 1:25,000 flown in 2002	Department of Lands

3.3.2 Field Survey Site Selection and Stratification of the Proposed Disturbance Area

Designing an appropriate flora survey requires consideration of both survey methods and effort. In other words, surveys should be undertaken during periods of optimal climatic and seasonal conditions and the use of stratification should be employed to ensure that the full range of potential habitats present are assessed and adequately surveyed. Reference was made to the relevant OEH flora survey guidelines (DEC 2004 and DECC 2008) when designing the field survey, with appropriate survey methods selected that maximised the opportunities of identifying the full suite of flora species (and vegetation communities) that occur within the Project Area.

Survey sites were selected by considering a range of attributes that were thought to influence or determine the type of vegetation communities present. The vegetation survey of the Project Area was stratified using the biophysical attributes shown in **Table 3.2**. This stratification was done intuitively, but based on existing topographic, soil, vegetation and geological mapping. Other factors considered included the spreading the survey sites across the Proposed Disturbance Area, as well as topographic position and aspect.

Table 3.2 – Biophysical Attributes Used for Stratification of the Proposed Disturbance Area

Attribute	Attribute in Project Area	Definition
Landform[1]	Ephemeral and permanent creeks	Bettys Creek flowing south through the Proposed Disturbance Area. Bowmans Creek in the far south of the Project Area.
Vegetation Structure	Closed forest	Trees dominant strata with crowns touching to overlapping.
	Open forest	Trees dominant strata with crowns touching or slightly separated.
	Woodlands	Trees dominant strata with crowns rarely touching or overlapping. Wide gaps in the canopy are common. Grasses and forbs dominate the understorey.
	Grassland	Open grasslands dominated by grasses and forbs. Trees and shrubs may be present, but at very low frequency.
	Shrublands	Shrubs dominant strata (range of densities).
	Revegetation	Northern parts of the Proposed Disturbance Area that has been revegetated with Central Hunter Ironbark – Spotted Gum – Grey Box Forest canopy species.

Notes: 1. Landform from Speight (2009)

3.3.3 Flora Field Survey

The flora field survey was carried out in late spring 2011, spring 2012, and summer and autumn 2014. Additional flora surveys were also undertaken within the Project Area as part of the UHSA surveys in autumn 2014. Field survey allowed sampling of vegetation and field reconnaissance to identify spatial vegetation patterns. Survey methods included:

- quadrat vegetation sampling: semi-quantitative sampling of 400 m^2 quadrats placed within distinctive vegetation units;
- BioBanking plots/transects: additional biometric data was collected at each standard flora quadrat, which also necessitated the establishment of 20 x 50 m^2 plots and 50 metre transects;
- meandering transects: non-quantitative sampling along transects through vegetation units;
- rapid vegetation assessments: non-quantitative point sampling within distinct vegetation units; and
- field reconnaissance: identifying spatial arrangement of vegetation across the Proposed Disturbance Area.

These survey methods are described in the following sections. A number of survey techniques were employed outside the Proposed Disturbance Area as a result of refinement in the mine plan over time and as part of broader constraints analysis on Mount Owen owned land. The results of the flora sampling conducted for the Project has been included in discussions below, including those locations that now fall outside the Proposed Disturbance Area. All of the information collected has informed the definition and delineation of vegetation on communities and all sampling techniques targeted potentially occurring threatened species.

3.3.3.1 Quadrat Survey

Quadrat survey of flora was undertaken using methods that are relatively standard in most NSW government vegetation management agencies and elsewhere. This ensured that data collected by other relevant surveys could be compared to the current survey results, and that the data from the Project could be analysed in an equivalent way to that collected by other recognised studies.

Quadrat survey involved semi-quantitative sampling flora in systematic 400 m^2 areas. The typical dimensions of the quadrats were 20 metres by 20 metres, although in some places this was altered to 10 metres by 40 metres to allow sampling of linear vegetation communities, particularly along watercourses.

When undertaking systematic sampling to facilitate vegetation community mapping and description, quadrat surveys have several distinct advantages over non-quantitative transects, including:

- providing a quantitative examination of species distribution and abundance;
- being likely to detect inconspicuous or rare species (especially forbs and grasses) within the given sampling area, as a smaller area is surveyed in a concentrated search; and
- providing a basis for any subsequent monitoring required.

Quadrat sampling was carried out systematically to provide representative sampling of a range of attributes that occur in the Project Area, that influence or determine the presence of different flora species and vegetation associations. Data collected in vegetation quadrats sampled during early studies for the Project, that now fall outside the Project Area, has been included to inform vegetation community delineation and to provide context when determining the spatial patterns of vegetation communities in the Project Area. The location of these quadrats has been included on **Figure 3.1**.

The location of each quadrat was recorded using aerial photography and/or a hand-held GPS with accuracy of ± 5 metres. The Map Grid of Australia (MGA) coordinate system was used. The location of the 46 vegetation quadrats (including those undertaken as part of the UHSA surveys) completed within the Project Area is provided on **Figure 3.1**.

At each quadrat, about 45 to 60 minutes were spent searching for all vascular flora species present within the 400 m^2 area. These were recorded on a proforma with a cover-abundance value to reflect their percentage cover in the quadrat. A modified Braun-Blanquet 6-point scale was used to estimate cover-abundances of all plant species within each quadrat (Braun-Blanquet 1927), with selected modifications sourced from Poore (1955) and Austin *et al*. (2000). **Table 3.3** shows the cover-abundance categories used. Additional searches were carried out for extra species located outside of the quadrat and within the vegetation unit being sampled. These were recorded without a cover-abundance value. Voucher specimens were collected of cryptic and significant species as well as any species that could not be identified in the field for later identification.

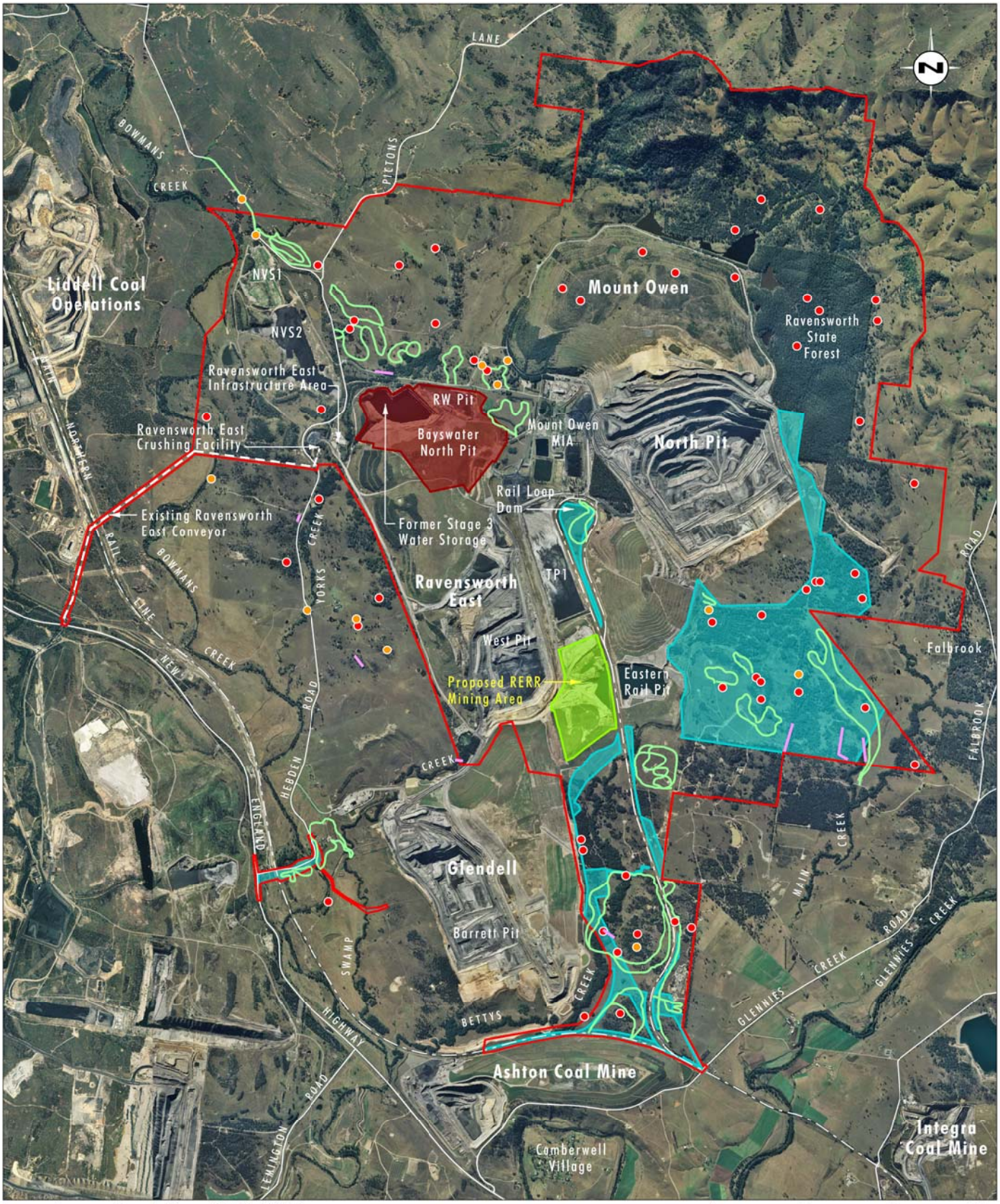


Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014)

0 1 2 3 km
1:60 000

Legend

- Project Area
- Proposed Disturbance Area
- Bayswater North Pit
- Proposed RERR Mining Area
- Meandering Transect
- Targeted Flora Survey Transect
- Quadrat Location
- Rapid Vegetation Assessment

FIGURE 3.1

Flora Survey Effort

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Table 3.3 – Modified Braun-Blanquet Crown Cover-abundance Scale

Class	Cover-abundance*	Notes
1	Few individuals (less than 5 per cent cover)	Herbs, sedges and grasses: <5 individuals Shrubs and small trees: <5 individuals
2	Many individuals (less than 5 per cent cover)	Herbs, sedges and grasses: 5 or more individuals Shrubs and small trees: 5 or more individuals Medium-large overhanging tree
3	5 – less than 20 per cent cover	-
4	20 – less than 50 per cent cover	-
5	50 – less than 75 per cent cover	-
6	75 – 100 per cent cover	-

Note: * Modified Braun-Blanquet scale (Poore 1955; Austin *et al*. 2000)

Additional details were also recorded in each quadrat, including soil texture, drainage and depth; site disturbances; physiography (position in the landscape); and vegetation structure (strata percentage covers, heights and dominant species). Photographic records were also taken at each site.

3.3.3.2 Biometric Data Collection

In addition to the data collected at each standard flora quadrat, biometric site attribute data was also collected for BioCertification assessment purposes according to Appendix 2 of the BioBanking Assessment Methodology and Credit Calculator Operational Manual (DECC 2009). Biometric data was collected at each of the quadrat locations identified on **Figure 3.1**.

At each standard flora quadrat, 10 points along a 50 metre transect were assessed for:

- percentage native overstorey cover; and
- percentage native mid-storey cover.

In addition, 50 points along a 50 metre transect were assessed for:

- percentage native groundcover (grass);
- percentage native groundcover (shrubs);
- percentage native ground cover (other); and
- percentage exotic plant cover.

The native plant species richness in a 20 metre x 20 metre quadrat was recorded as part of the standard flora quadrat surveys and was incorporated into the data collected for BioBanking purposes. The standard flora quadrat was also increased to a 20 metre x 50 metre plot in order to count the number of trees with hollows and total length of logs. Notes were also made on the regeneration of canopy species within each vegetation community.

3.3.3.3 Meandering Transects

Meandering transects were walked through vegetation units across much of the Proposed Disturbance Area (refer to **Figure 3.1**), particularly searching for threatened and otherwise

significant species, EPs and TECs. Meandering transects enable floristic sampling across a much larger area than systematic quadrats. Records along transects supplemented floristic sampling carried out in quadrats, however, the data collected was in the form of presence records, rather than semi-quantitative cover abundance scores.

Meandering transects targeted specific vegetation units and provided invaluable information on spatial patterns of vegetation that informed vegetation community mapping of the Proposed Disturbance Area.

3.3.3.4 Rapid Vegetation Assessments

Rapid vegetation assessments were completed across much of the Project Area and wider contextual survey area (refer to **Figure 3.1**) during the spring 2011 and summer and autumn 2014 surveys. Two rapid vegetation assessments are located within the Proposed Disturbance Area and a further ten are located within the broader Project Area and immediate surrounds. They were used in combination with meandering transects primarily to assist in the delineation and refinement of vegetation mapping. Rapid vegetation assessment points were located within distinct vegetation community units, rather than within ecotones, to allow data collection for each community without confounding effects from adjacent communities. Dominant, common and some uncommon (but notable) plant taxa were recorded within each vegetation community, but cover abundance scores were not. However, the vegetation structure at each rapid vegetation assessment point was documented, including the dominant species in each stratum.

3.3.3.5 Field Reconnaissance

Field reconnaissance was carried out during all field surveys and while travelling throughout the Project Area. Field reconnaissance contributed to the ground-truthing of vegetation community boundaries, refinement of community descriptions, and providing a more comprehensive understanding of the floristic features across the Proposed Disturbance Area.

3.3.3.6 Field Survey Timing

Field survey was carried out over many years and seasons throughout the Project Area. **Table 3.4** provides details of these surveys and the survey locations are shown in **Figure 3.1**.

Table 3.4 – Flora Field Survey Timing and Locations

Date of Surveys	Description and Names of Survey Locations	Survey Type
10 – 13 October 2011	In suitable habitat throughout the Project Area	Targeted field orchid surveys
17 – 18 October 2011	Throughout the Project Area	Quadrat sampling Meandering transects Rapid vegetation assessments
8 – 12 October 2012	Throughout the Proposed Disturbance Area	Quadrat sampling
3 – 5 June 2013	Mine rehabilitation, regeneration and rehabilitation areas in the north of the Project Area	Quadrat sampling
31 January 2014	Northern portion of Project Area	Quadrat sampling Meandering transects Rapid vegetation assessments.

Table 3.4 – Flora Field Survey Timing and Locations (cont.)

Date of Surveys	Description and Names of Survey Locations	Survey Type
31 March – 17 April 2014	Throughout the Project Area and surrounds (as part of the UHSA surveys)	Quadrat sampling
30 April 2014	Northern portion of Project Area Additional disturbance footprint	Quadrat sampling

3.3.4 Targeted Threatened Flora Surveys

Throughout flora surveys of the Proposed Disturbance Area, targeted searches were carried out for threatened flora species that are known to occur in or near to the Project Area or were considered likely to occur in the Project Area based on the species' known distribution and the presence of suitable habitat. Searches for these species were undertaken in suitable habitat along numerous walking meandering transects and quadrats (refer to **Figure 3.1**). The list of species that were specifically targeted during targeted threatened flora surveys was compiled through database searches and literature reviews (refer to **Section 3.1**) and is included in **Table 3.5.**

Table 3.5 – Threatened Flora Species Survey Effort Table

Species	Optimal Survey Period*	Project Survey Timing
Austral toadflax (*Thesium australe*)	September – February	October 2011 and October 2012
Euphrasia arguta	October – January	October 2011 and October 2012
Illawarra greenhood (*Pterostylis gibbosa*)	August – November	October 2011 and October 2012
leek orchid (*Prasophyllum* sp. Wybong)	September – November	October 2011 and October 2012
Ozothamnus tesselatus	September – November	October 2011 and October 2012
slaty red gum (*Eucalyptus glaucina*)	August – December	October 2011 and October 2012
painted diuris (*Diuris tricolor*)	September – November	October 2011 and October 2012

*Optimal survey periods were determined from the Flora of NSW (Harden: 1992; 1993; 2000; and 2002).

Of these species, *Ozothamnus tesselatus* was known to occur in the Project Area based on survey of the Ravensworth State Forest by the University of Newcastle (Cole *et al.* 2004) and Slaty red gum (*Eucalyptus glaucina*) was known to occur in one location within remnant forest that has since been removed as part of approved mining operations. All threatened species known to occur in the local area were specifically targeted during flora surveys. Surveys for lobed blue-grass (*Bothriochloa biloba*) was undertaken in spring 2011 and 2012 when the species was listed as vulnerable under the EPBC Act. This species has since been de-listed and is not considered further in this report.

3.3.5 Threatened Ecological Community Delineation Techniques

Vegetation communities identified in the Project Area were compared to TECs listed under the NSW TSC Act and the Commonwealth EPBC Act and an assessment of similarity with TECs, including White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC and *Swamp Oak Floodplain Forest of the North Coast*, *Sydney Basin* and *South East Corner Bioregions EEC.* White Box-Yellow Box-Blakely's Red Gum

Grassy Woodland and Derived Native Grassland CEEC were assessed using the following approach:

- comparison with published species lists, including lists of 'important species' as identified on the listing advice provided by the OEH and Department of Environment scientific committees;
- comparison with habitat descriptions and distributions for listed TECs;
- assessment using guidelines published by the Commonwealth Department of Environment and the NSW OEH;
- collection of 'box' and 'red gum' eucalypt specimens to determine if white box (*Eucalyptus albens*) and Blakely's red gum (*Eucalyptus blakelyi*) or their hybrids white box/grey box intergrade (*Eucalyptus albens-moluccana*) or Blakely's red gum/forest red gum intergrade (*Eucalyptus blakelyi-tereticornis*) are present in the Project Area;
- formal identification of potential 'box' and 'red gum' eucalypt specimens by the Royal Botanic Gardens Sydney; and
- comparison with other assessments of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the region.

Assessment of Swamp Oak Floodplain Forest EEC

The Proposed Disturbance Area supports 5.7 hectares of Central Hunter Swamp Oak Forest. A comprehensive analysis of this vegetation community was undertaken to determine if it conformed to the *Swamp Oak Floodplain Forest of the North Coast*, *Sydney Basin* and *South East Corner Bioregions EEC*, listed under the TSC Act.

The TSC Act (section 4(1)) defines an ecological community as 'an assemblage of species occupying a particular area'. This definition embodies three requirements (Preston and Adam 2004a):

- the constituents of a community must be species;
- the species need to be brought together into an assemblage; and
- the assemblage of species must occupy a particular area.

The following text provides an analysis of Central Hunter Swamp Oak forest in the Project Area in relation to these three requirements, together with additional matters that pertain to the identification of the Swamp Oak Floodplain Forest EEC.

Constituent Species

Section 4(1) of the Act adopts a pragmatic and inclusive definition of a species as including 'any defined sub-species and taxon below subspecies and any recognisable variant of a sub-species or taxon' (NSW Scientific Committee 2012).

The species recorded within Central Hunter Swamp Oak Forest in the Project Area comprise species, and/or taxa below species, as required by the Act.

Assemblage of Species

An assemblage of species involves the bringing together or gathering into a location or locations the identified species (Preston and Adam 2004a). Species co-occurrence is central to the existence of an assemblage of species, with an important aspect of co-occurrence being the notion that a common, albeit variable, group of species occur within the distribution of a community (NSW Scientific Committee 2012). It is common to use structurally dominant species, those most abundant or with greatest height or biomass, to form abbreviated descriptions of assemblages, however, the occurrence of one or two dominant species, of itself, is not evidence of the existence of an ecological community (NSW Scientific Committee 2012). The emphasis of description and diagnosis of ecological communities should address overall species composition of the assemblage, rather than occurrence of selected species (dominant or otherwise) (NSW Scientific Committee 2012). Unlike species, there is no currently accepted typology of ecological communities (Preston and Adam 2004a).

The NSW Scientific Committee (2012) states that descriptions of the assemblage of species:

> ...would usually aim to include frequently occurring species, those that may be locally abundant, though not necessarily present throughout the distribution of the community, and species whose occurrence may help to distinguish the community from other similar communities.

The NSW Scientific Committee (2004) lists 45 species as characterising the assemblage of species for Swamp Oak Floodplain Forest EEC. As part of ecological investigations for the Project, three systematic 20 metre x 20 metre quadrats were sampled in Central Hunter Swamp Oak Forest. Of these, swamp oak (*Casuarina glauca*) was recorded in all three plots. Indian pennywort (*Centella asiatica*) was recorded in one plot. No other species listed in the Final Determination were recorded from plots. Thus, in total two species (5 per cent) of the species listed in the Final Determination, were present. In many cases the plot data showed that many *genera* listed in the Final Determination are present, however the species present in the Project Area are typically inland species, while the Final Determination lists coastal species of those genera.

Particular Area

The particular area defines the location(s) at which species of the assemblage co-occur. According to Preston and Adam (2004a), this represents the 'natural habitat in which the assemblage of species occurs or has historically occurred and is capable of recurring if measures are taken to restore or allow the habitat to recover.' It therefore excludes captive or cultivated occurrences because they are not within the 'natural habitat' of the community (NSW Scientific Committee 2012). In the Final Determination, the particular area of an ecological community is described by identifying the bioregions in which it occurs and the local government areas in which it has been recorded.

In relation to the particular area of the Swamp Oak Floodplain Forest EEC, the NSW Scientific Committee (2004) states that the community occurs within the NSW North Coast, Sydney Basin and South East Corner Bioregions. The Project Area is situated within the Sydney Basin Bioregion and the NSW North Coast Bioregion.

Supplementary Descriptors

The NSW Scientific Committee (2012) states that:

> Although not legally required, information about 'supplementary descriptors' (section 4.2.3) may also assist in the interpretation of the particular area occupied by an ecological community. For example, environmental conditions such as typical climate,

> terrain, substrates and other abiotic, biotic or ecological factors that influence the community can assist in drawing inferences about its likely occurrence at particular locations (Preston and Adam 2004b).

In relation to supplementary descriptors the NSW Scientific Committee (2004) includes the following key information pertaining to the Swamp Oak Floodplain Forest EEC:

- occurs on grey-black clay-loams and sandy loams;
- occurs where the groundwater is saline or sub-saline;
- occurs on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains;
- generally occurs below 20 metres (rarely above 10 metres) elevation; and
- the structure may vary from open forests to low woodlands, scrubs or reedlands with scattered trees.

Of the above supplementary descriptors, the Central Hunter Swamp Oak Forest present in the Project Area is nowhere less than 80 metres above sea level. Although the Final Determination does not rule out the presence of the EEC at this elevation (through the use of the word 'generally' in relation to occurring below 20 metres), the use of the term 'rarely above 10 metres' suggests occurrences at 80 metres elevation would be highly unlikely or remarkable, and therefore improbable or impossible.

The Central Hunter Swamp Oak Forest occurring in the Project Area generally occurs within very small closed flats (e.g. up to several metres in width) within incised creek channels, as well as along the top of incised creek channels. These creeks ultimately drain in to the Hunter River, which itself enters the Tasman Sea 87 kilometres to the south-east. The Final Determination does not define what a 'coastal floodplain' is. The NSW *Coastal Protection Act 1979* refers to maps of the 'coastal zone' which, among other things, limit the landward extent of the coastal zone to 1 kilometre landward of the open coast high water mark; and a distance of 1 kilometre around all bays, estuaries, coastal lakes, lagoons and islands.

Notwithstanding the lack of definition around the term 'coastal' in relation to floodplains, OEH has produced a series of predictive maps that model the likely distribution of coastal floodplains. This includes creek flats within the Project Area. Despite this, the models are merely informative and not definitive, and thus there remains no definitive interpretation of the term 'coastal floodplain'.

3.3.6 Plant Identification and Nomenclature Standards

All vascular plants recorded or collected within quadrats and on meandering transects were identified using keys and nomenclature in Harden (1992, 1993, 2000 and 2002) and Wheeler *et al.* (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2014), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 and 2002) where available, and draw on other sources such as local names where these references do not provide a common name. Where the identity of a specimen was unknown or uncertain, it was lodged with the National Herbarium of New South Wales at the Royal Botanic Gardens Sydney for expert identification.

3.3.7 Summary and Adequacy of Flora Field Survey Effort

Table 3.6 summarises the suggested minimum effort required to undertake adequate surveys of flora species in accordance with DEC (2004), including threatened species and mapping and describing vegetation communities.

Table 3.6 – Recommended Flora Survey Effort with Respect to OEH Draft Guidelines*

Survey Technique	Suggested Minimum Effort
Transects	• 1 x 100 m traverse per stratification unit <2 hectares • 2 x 100 m traverses per 2-50 hectares of stratification unit • 3 x 100 m traverses per 51-250 hectares of stratification unit • 5 x 100 m traverses per 251-500 hectares of stratification unit • 10 x 100 m traverses per 501-1,000 hectares of stratification unit, plus one additional 100 m traverse for each extra 100 hectares thereof
Quadrat	At least: • 1 quadrat per stratification unit <2 hectares • 2 quadrats per 2-50 hectares of stratification unit • 3 quadrats per 51-250 hectares of stratification unit • 5 quadrats per 251-500 hectares of stratification unit • 10 quadrats per 501-1,000 hectares of stratification unit, plus one additional quadrat for each extra 100 hectares thereof.

* Number of quadrats recommended in accordance with Draft Threatened Species Survey and Assessment: Guidelines for Developments and Activities (DEC 2004)

Table 3.7 identifies the adequacy of the flora survey with respect to OEH draft guidelines and indicates that the level of field survey undertaken for the Project exceeds or greatly exceeds the suggested minimum sampling frequency for quadrats. Generally, the survey effort meets or exceeds the suggested minimum sampling frequency for all stratification units, except for the number of transects required for Central Hunter Ironbark – Spotted Gum – Grey Box Forest (Planted) and Kunzea Shrubland. Central Hunter Ironbark – Spotted Gum – Grey Box Forest (Planted) is a variant of Central Hunter Ironbark – Spotted Gum – Grey Box Forest and therefore when considering the number of quadrats sampled in both stratification units for the area of vegetation, the effort is considered to be sufficient. Similarly, Kunzea Shrubland is a structurally and floristically simple community and the sampling effort undertaken is considered to have been adequate to describe the extent, composition and condition of the community. It is also noted that the majority of transects were far in excess of the 100 metres prescribed by the DEC (2004) guidelines. The results of the flora assessment and vegetation mapping can be viewed with a high degree of certainty.

Table 3.7 – Adequacy of Vegetation Survey

Stratification Unit[1]	Area (ha) in Disturbance Area	No. of Quadrats and Transects Sampled and No. of each required (x)[2]
Central Hunter Grey Box – Ironbark Woodland	4.4	Quadrats: 6 (**2**) Transects: 2 (**2**)
Derived Native Grassland	223.1	Quadrats: 9 (**3**) Transects: 9 (**3**)
Central Hunter Bulloak Forest Regeneration	54.0	Quadrats: 4 (**3**) Transects: 4 (**3**)

Table 3.7 – Adequacy of Vegetation Survey (cont.)

Stratification Unit[1]	Area (ha) in Disturbance Area	No. of Quadrats and Transects Sampled and No. of each required (x)[2]
Central Hunter Ironbark – Spotted Gum – Grey Box Forest	131.9	Quadrats: 13 (**3**) Transects: 2 (**3**)
Central Hunter Ironbark – Spotted Gum – Grey Box Forest (Planted)	27.4	Quadrats: 5 (**2**) Transects: 0 (**2**)
Hunter Valley River Oak Forest	0.2	Quadrats: 1 (**1**) Transects: 1 (**1**)
Central Hunter Swamp Oak Forest	5.8	Quadrats: 3 (**2**) Transects: 2 (**2**)
Kunzea Shrubland	4.7	Quadrats: 2 (**2**) Transects: 1 (**2**)

Notes:
1. See **Table 3.2** for details about biophysical attributes used in stratification units
2. Number of quadrats and transects (100 m traverses) recommended in accordance with Draft Threatened Species Survey and Assessment: Guidelines for Developments and Activities (DEC 2004) – see **Table 3.6**

3.4 Vegetation Mapping

Vegetation mapping was undertaken using best-practice techniques to delineate vegetation communities across the Proposed Disturbance Area.

Vegetation mapping involved the following key steps:

- import of licensed regional vegetation community mapping for the Hunter Remnant Vegetation Project (HRVP) (Peake 2006) from the Hunter – Central Rivers Catchment Management Authority;
- review of mapping undertaken by Umwelt (2003) and Umwelt (2009);
- preparation of draft vegetation community map based on aerial photograph interpretation and preliminary delineation of vegetation community floristics;
- ground-truthing of vegetation map based on survey effort documented in **Section 3.3**;
- revision of vegetation community floristic delineations based on plot data; and
- revision of vegetation map based on ground-truthing.

Vegetation communities were delineated through the identification of repeating patterns of plant species assemblages in each of the identified strata. Communities were then compared to those vegetation communities identified in the HRVP (Peake 2006). The dendrogram and vegetation community profiles provided in the HRVP report were interrogated to identify those communities that contained similar species and structural compositions to ensure that, where possible, the communities identified in the disturbance area were aligned with similar communities known to occur elsewhere in the Hunter Valley. Communities were then named in accordance with those communities described by Peake (2006) and the corresponding Greater Hunter Native Vegetation community types.

Vegetation communities were grouped into five vegetation formations, which were based solely on structural characteristics rather than floristic components. These comprised:

- forest (dominated by trees of 20 to 40 per cent cover and typically 16 to 18 metres height, with or without a mid-understorey or understorey);
- woodland (dominated by trees of 10 to 30 per cent cover and typically 8 to 20 metres height, with or without a mid-understorey or understorey);
- shrubland (dominated by shrubs of 10 to 80 per cent cover and typically 2 to 6 metres height with the occasional young scattered tree, with or without an understorey);
- riparian forests (dominated by trees of 10 to 80 per cent cover and typically 6 to 20 metres height, in a linear strip along waterways, with or without a mid-understorey or understorey); and
- grassland (dominated by grasses, sedges and forbs, with trees and shrubs very sparse or absent).

3.5 Terrestrial Fauna Survey

Fauna surveys were carried out to identify the fauna species and their habitats occurring, or considered to have the potential to occur in the Proposed Disturbance Area and the BNP area, including threatened species, migratory species, EPs, and species of local or regional significance.

Fauna surveys were undertaken by Umwelt within the Proposed Disturbance Area (and surrounds) in August 2011, February and June 2012, January 2013, March, April and July 2014 and are outlined in **Sections 3.5.1** to **3.5.5**. **Figure 3.2** shows the location of all fauna survey methods undertaken for the Project. A number of survey techniques were employed outside the Proposed Disturbance Area as a result of refinement in the mine plan over time. The results of the all fauna sampling conducted for the Project has been included in discussions below, including those locations that now fall outside the Proposed Disturbance Area. All of the information collected as part of the Project has informed the definition and delineation of fauna habitat characteristics and all sampling techniques targeted potentially occurring threatened species.

In addition to Project-specific survey undertaken by Umwelt, annual monitoring surveys have also been undertaken annually since 1996 in the Proposed Disturbance Area (Forest Fauna Surveys *et al.* 2012). A description of the fauna survey methods employed at the annual ecological monitoring locations is described in **Section 3.5.3**.

During each of the fauna survey periods, a variety of survey techniques were employed. Each technique is described in detail in the following sections. Reference was made to the relevant OEH fauna survey guidelines (DEC 2004) when designing the field survey, with appropriate survey methods selected that maximised the opportunities of identifying the full suite of fauna species that occur within the Project Area.

The DEC (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft*, defines stratification as necessary to ensure that all potential habitats and vegetation types will be systematically sampled.

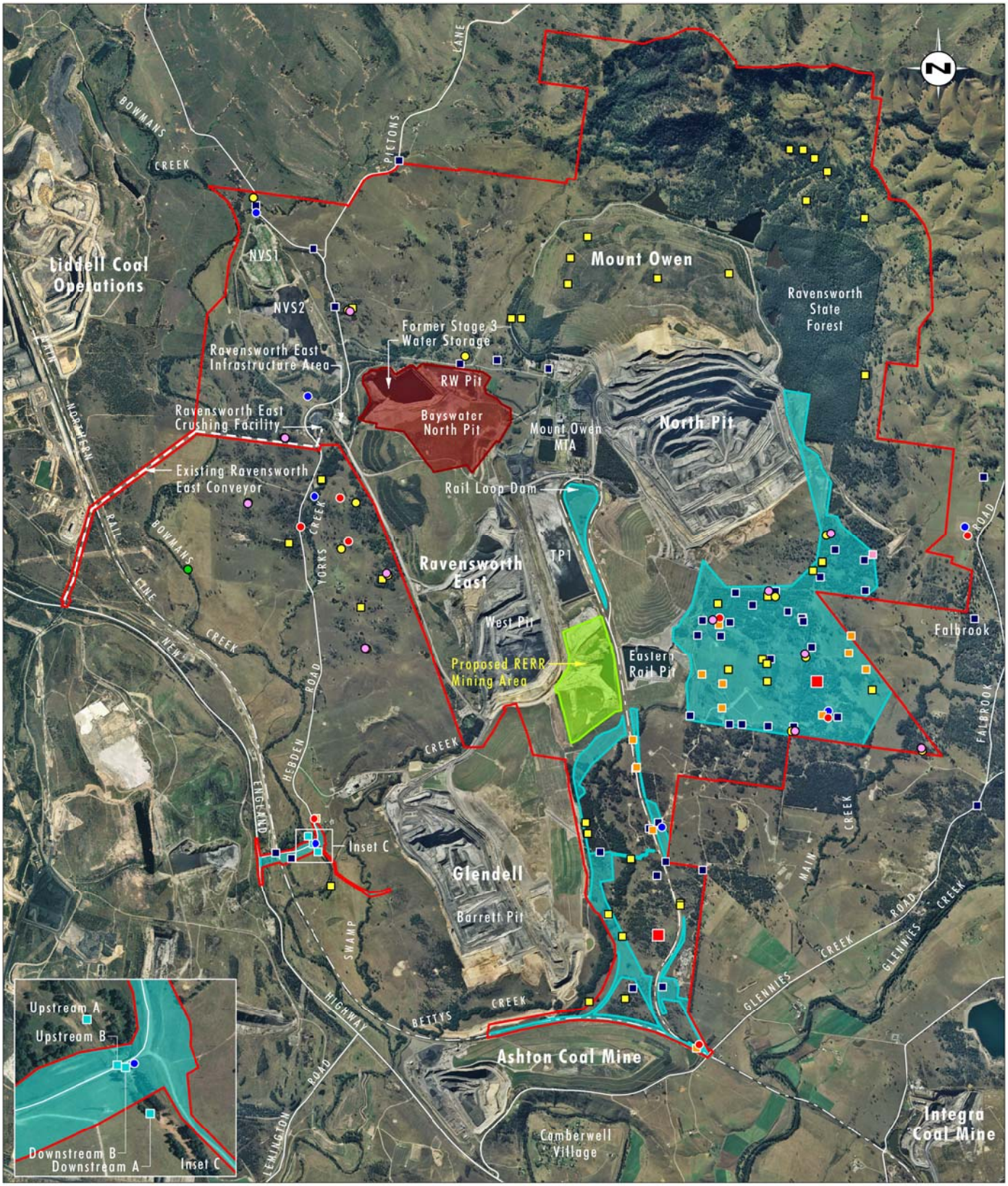

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014)

0 1 2 3km
Main Scale 1:60 000
0 150 300 450m
Inset Scale 1:10 000

Legend

- Project Area
- Proposed Disturbance Area
- Bayswater North Pit
- Proposed RERR Mining Area

Targeted Fauna Survey:

- Green and Golden Bell Frog Survey
- Habitat and Condition Assessment
- Aquatic Survey Site
- Diurnal Bird Survey
- Swift Parrot and Regent Honeyeater Survey

General Fauna Survey Site:

- Terrestrial and Arboreal Elliot Trapping
- Terrestrial Cage Trapping
- Harp Trapping
- Terrestrial and Arboreal Hair Funnel
- Diurnal Bird Survey
- Diurnal Herpetological Survey
- Spotlight Survey
- Nocturnal Call Playback Survey
- Micro-bat Echolocation Recording

UHSA Targeted Fauna Survey:

- Green and Golden Bell Frog Survey
- Koala SAT Survey
- Micro-bat Echolocation Recording
- Red Goshawk Black-breasted Buzzard Survey
- Remote Camera Survey

FIGURE 3.2

Fauna and Aquatic Survey Effort

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A study area should be initially stratified on:

- biophysical attributes (e.g. landform, geology, elevation, slope, soil type, aspect); then
- vegetation structure (e.g. forest, woodland, shrubland etc); and
- floristics (e.g. species).

Stratification of the Project Area included an initial analysis of aerial photographs to delineate potential fauna habitats. The stratification units were revised and defined following initial flora surveys and habitat assessments. The floristic attributes of the vegetation communities were considered to be similar in a fauna habitat context and five stratification units were delineated in the Project Area: Woodland/Forest Habitat; Shrubland Habitat, Riparian Habitat; and Derived Native Grassland Habitat. Aquatic habitats were also identified and were targeted as 'special habitats' as identified in Section 5.3.1 of the *Draft Threatened Species Survey and Assessment: Guidelines for Developments and Activities* (DEC 2004).

3.5.1 General Fauna Surveys

A variety of fauna survey methods, targeting the full suite of vertebrate fauna species, were employed at each of the general fauna survey sites (covering approximately 2 hectares) identified on **Figure 3.2**, as detailed below.

3.5.1.1 Terrestrial Elliott Trapping

Terrestrial Elliott A and Elliott B traps were set in pairs approximately 20 metres apart on the ground and baited with a mixture of rolled oats and peanut butter. All traps were positioned where possible amongst habitat features such as logs, fallen bark, rocks and ground cover. All Elliott traps were covered with a plastic bag to prevent rain entering and were lined with woollen wadding to provide insulation for captured animals. All terrestrial Elliott traps were positioned to avoid overheating in early morning sunlight, and were tilted towards the front to prevent rain from entering the plastic bag covering the trap. Terrestrial Elliot trapping was undertaken during February 2012 (refer to **Figure 3.2**).

Trapping sites contained 25 terrestrial Elliott A and 25 terrestrial Elliott B traps. A total of 400 terrestrial Elliott trap nights were completed across the Proposed Disturbance Area by Umwelt in 2012, comprising 200 terrestrial Elliott A trap nights and 200 terrestrial Elliott B trap nights.

3.5.1.2 Arboreal Elliot B Trapping

Arboreal Elliott B traps were set approximately 30 metres apart on tree trunks, and were baited with a mixture of rolled oats, peanut butter and honey. Traps were positioned on platforms attached to the trunks of large trees, 3 to 4 metres above the ground. Where possible, large trees with hollows were selected as trap sites. The trunk of the tree and entrance to the trap were sprayed with a honey and water mixture to attract arboreal mammals. All Elliott traps were covered with a plastic bag to prevent rain entering and were lined with woollen wadding to provide insulation for captured animals. All traps were positioned to avoid exposure to morning sunlight, and were tilted towards the tree to prevent rain from entering the plastic bag covering the trap.

A total of six arboreal Elliott B traps were set at two trap sites (refer to **Figure 3.2**). A total of 48 arboreal Elliott B trap nights were completed by Umwelt during the survey period.

3.5.1.3 Terrestrial Cage Trapping

Single ended cage traps (600 millimetres (L) × 300 millimetres (H) × 300 millimetres (W)) were baited with raw chicken necks and half of the length of each trap was covered with a plastic bag and shade cloth to provide shelter for captured animals from the elements (rain, wind and sun). All cage traps were positioned to avoid exposure to early morning sunlight. Traps were positioned on level ground or amongst vegetation where the trap was unable to roll away if a captured animal struggled within the trap.

A total of six cage traps were set at each general fauna site for four nights (refer to location of general fauna site on **Figure 3.2**). A total of 48 terrestrial cage trap nights were completed within the Project Area by Umwelt during the survey period.

3.5.1.4 Terrestrial Hair Funnels

A total of 20 terrestrial hair funnels were set each general fauna survey site (refer to **Figure 3.2**). A total of 1000 terrestrial hair funnel nights were completed across the Project Area by Umwelt.

Terrestrial Faunatech hair funnels were baited with either meat (raw chicken necks) or a rolled oats and peanut butter mixture. All terrestrial hair funnels were positioned amongst habitat features such as logs, fallen bark, rocks and ground cover. All hair funnels were left in position for 25 nights and all hair samples collected were identified by Barbara Triggs, (a recognised expert in the field of hair and scat identification) of 'Dead Finish', Victoria.

3.5.1.5 Arboreal Hair Funnels

A total of 10 arboreal hair tubes were set at the general fauna survey sites (refer to **Figure 3.2**). A total of 500 arboreal hair funnel sampling nights were completed across the Project Area by Umwelt in 2012.

Hair funnels were baited with a rolled oats, peanut butter and honey mixture. Arboreal hair funnels were positioned 1.5 to 2.0 metres above the ground on tree trucks or branches. The entrance to the hair funnel and the tree trunk were sprayed with a honey and water emulsion as an attractant. All collected hair samples were identified by Barbara Triggs of Dead Finish.

3.5.1.6 Diurnal Bird Surveys

Three diurnal bird surveys, each of one person-hour, were undertaken at each general fauna survey site identified in **Figure 3.2**. Bird surveys were undertaken at various times of the day, primarily in early to mid morning and mid to late afternoon. Each survey consisted of a slow walking transect within a 2 hectare area of the survey site. Bird species were identified from characteristic calls and by observation using binoculars with magnification up to 10 x. Opportunistic observations were recorded during all other aspects of the field survey.

3.5.1.7 Diurnal Herpetological Surveys

Two targeted diurnal herpetological (reptile and amphibian) surveys, each of one person-hour on two separate days, were undertaken at each general fauna survey site. The location of the diurnal herpetological survey is shown in **Figure 3.2**. Herpetological surveys were generally undertaken during the warmest parts of the day. Surveys targeted areas of likely habitat in proximity to each fauna survey site. During the search likely micro-habitats were examined including around waterbodies, beneath rocks and logs, in tree bark and in ground litter.

Amphibians not identifiable from their calls and non-venomous reptiles were captured for visual identification. All amphibians were handled according to the hygiene protocol for the control of disease in frogs (DECC 2008).

3.5.1.8 Spotlighting Surveys

Two nocturnal spotlighting surveys, each of one person-hour on two separate nights, were undertaken at each general fauna survey site. The location of the nocturnal spotlighting survey is shown in **Figure 3.2**. Spotlighting surveys targeted nocturnal birds, mammals and herpetofauna. Spotlighting was conducted on foot within a 2 hectare area of the survey site using 30 watt Lightforce hand-held spotlights and head torch. Spotlighting was undertaken generally between 8.00 pm and 12.00 am, commencing one hour after dusk. In addition, opportunistic spotlighting was undertaken from a slow-moving vehicle while travelling between fauna survey sites at night.

3.5.1.9 Nocturnal Call-playback

Two nocturnal call-playback sessions were undertaken at each general fauna survey site over consecutive nights using a 15 watt directional loud hailer. The location of nocturnal call-playback sessions is shown in **Figure 3.2**. Call-playback sessions commenced with a quiet listening period of approximately five minutes. Each species' call was played for a minimum of 4 minutes followed by a listening period of 2 minutes before the beginning of the next species' call. Call-playback sessions included the calls of:

- bush stone-curlew (*Burhinus grallarius*);
- squirrel glider (*Petaurus norfolcensis*);
- koala (*Phascolarctos cinereus*);
- powerful owl (*Ninox strenua*);
- masked owl (*Tyto novaehollandiae*);
- barking owl (*Ninox connivens*); and
- sooty owl (*Tyto tenebricosa*).

3.5.1.10 Micro-bat Echolocation Recording

Recordings of micro-bat echolocation calls were conducted over four nights at each fauna survey site identified in **Figure 3.2.** Calls were recorded using an Anabat SD1 device (hereafter referred to as an Anabat). At each site, the Anabat was positioned at an approximate 30 degree angle 1 metre above the ground in waterproof housing. Each detector was positioned towards potential micro-bat flight paths or over waterbodies to increase the likelihood of detecting micro-bat species. The Anabat detector was programmed to start recording from one hour before sunset to one hour after sunrise.

Recordings of bat calls were analysed by Glenn Hoye of Fly By Night Bat Surveys Pty Ltd (a recognised expert in the identification of micro-bat calls). The echolocation calls of species were identified to one of three levels of confidence:

- confident;
- probable; and
- possible.

All three levels of identification confidence were treated as positive identifications for the purposes of the ecological assessment.

3.5.1.11 Harp Trapping

A total of two harp traps were set at each general fauna survey site (refer to **Figure 3.2**). A total of 16 harp trap nights were completed across the Proposed Disturbance Area by Umwelt.

Faunatech harp traps were positioned in potential micro-bat flyways such as open tracks in surrounding woodland. All harp traps were left in position for four nights and checked daily for any captures.

3.5.2 Targeted On-site Threatened Fauna Surveys

Throughout the fauna surveys of the Proposed Disturbance Area, targeted searches were carried out for threatened fauna species that are known to occur in or near to the Project Area or were considered likely to occur based on the species' known distribution and the presence of suitable habitat. These species are listed in Table 2 of **Appendix A**.

Of these species, the following are known to occur in the Project Area and were considered to require targeted surveys in addition to the general fauna surveys described in **Section 5.3.1** above. Species included:

- green and golden bell frog (*Litoria aurea*) (refer to **Section 3.5.2.1**); and
- swift parrot (*Lathamus discolor*) (refer to **Section 3.5.2.2**).

Additionally, the regent honeyeater (*Anthochaera phrygia*) was considered to potentially occur and was included in targeted surveys (refer to **Section 3.5.2.2**).

Additional targeted threatened fauna surveys were undertaken within the Project Area for the red goshawk (*Erythrotriorchis radiatus*), black-breasted buzzard (*Hamirostra melanosternon*), green and golden bell frog (*Litoria aurea*), koala (*Phascolarctos cinereus*), brush-tailed phascogale (*Phascogale tapoatafa*), and threatened micro-bats as part of the UHSA surveys (refer **Section 3.5.2.3**).

3.5.2.1 Green and Golden Bell Frog

Researchers from The University of Newcastle have been conducting extensive surveys of the green and golden bell frog in the Project Area since 1996.

Umwelt's survey effort for the green and golden bell frog (*Litoria aurea*) was undertaken at 15 locations within the Project Area during the known breeding season of the species, that is, between October and March. Surveys were conducted in February 2012, January 2013 and February 2013 and each location was surveyed each night over two consecutive nights during each survey period. Additional survey of high quality potential habitat locations was also undertaken to supplement the survey effort and results. All surveys were conducted during appropriate weather conditions that maximised the chance of identifying the species if it was present.

Each survey commenced with five minutes of call playback of the species, followed by 5 minutes of listening for vocalising males. Directly following the call playback, 30 minutes of spotlighting was undertaken by two ecologists (a total of one person hour) at each site. These surveys involved searching through the edge of open water and fringing vegetation for individuals and listening for vocalisation by males.

The survey effort relating to the targeted surveys for the green and golden bell frog is summarised in **Table 3.8** with the location of the surveys shown on **Figure 3.2**.

3.5.2.2 Swift Parrot and Regent Honeyeater Surveys

Targeted swift parrot and regent honeyeater surveys were undertaken during August 2011, July 2012 and July 2014. Bird surveys were undertaken across eight days and targeted areas of flowering eucalypt species, predominantly spotted gum (*Corymbia maculata*), and other areas of eucalypt vegetation containing other nectarivorous species such as lorikeets and honeyeaters. The location of the surveys is shown in **Figure 3.2**.

A total of 42 targeted surveys were undertaken within the Project Area with each survey consisting of a 5 minute period of call playback for both species followed by 30 minutes of searching which consisted of a slow walking transect within a 2 hectare area. Bird species were identified from characteristic calls and by observation using binoculars with magnification up to 10 x. Opportunistic observations were recorded during all other aspects of the field survey.

3.5.2.3 UHSA Targeted Fauna Species Credit Species Surveys

Green and Golden Bell Frog Surveys

Green and golden bell frog surveys were undertaken in eight targeted dam locations within and around the Project Area in March 2014 as part of the UHSA Project. These surveys generally followed the methodology described in **Section 3.5.2.1.** The locations of the UHSA green and golden bell frog surveys searches are shown on **Figure 3.2**.

Remote Camera Surveys

The brush-tailed phascogale was targeted using remote camera surveys in 13 locations in and around the Project Area in March and April 2014 as part of the UHSA Project. Bushnell Trophy Cam HDs were used for the remote camera surveys. At each site, the remote camera was mounted approximately 1 metre above the ground on a tree trunk and positioned towards a bait station containing chicken meat, oats and honey to increase the likelihood of detecting target species. They were set to take three photos in quick succession when movement was detected. The remote cameras were programmed to record movement on an ongoing basis until removed from the site. Each site was monitored between 3 and 33 days across the Project Area. The locations of the remote camera surveys are shown on **Figure 3.2**.

Koala SAT Surveys

Searches for signs of the presence of koalas were undertaken at 16 locations in and around the Project Area in March 2014 using the Spot Assessment Technique (SAT). Searches were undertaken on and around the base of 30 trees per location. These searches focused on signs of occupancy including scats left at the base of trees or characteristic scratches on the trunk. The locations of the SAT searches are shown on **Figure 3.2**.

Micro-bat Echolocation Recording

Threatened micro-bat surveys were undertaken in six locations within and around the Project Area in March 2014 as part of the UHSA Project. These surveys used Anabat Echolocation Detectors as described in **Section 3.5.1.10**. The locations of the UHSA micro-bat echolocation surveys are shown on **Figure 3.2**.

Red Goshawk and Black-breasted Buzzard Surveys

Bird surveys, targeting the potential presence of the red goshawk and black-breasted buzzard involved area searches of woodland edges within the Project Area in March 2014. Bird species were identified from characteristic calls and by observation using 10 x 42 binoculars.

A total of two targeted surveys were undertaken in the vicinity of the Project Area with each survey consisting of 30 minutes of searching which consisted of a slow walking transect within a 2 hectare area. While the bird surveys focused on the presence of the black-breasted buzzard, all bird species encountered were recorded. The locations of the UHSA red goshawk and black-breasted buzzard surveys are shown on **Figure 3.2**.

3.5.3 Mount Owen Complex Annual Fauna Monitoring Program Methodology

Extensive fauna monitoring surveys have been undertaken at Mount Owen Complex, including in the Proposed Disturbance Area, for 18 years, since 1996. Surveys have focused on each of the four vertebrate fauna groups with particular focus on threatened species known, or considered to potentially occur. Monitoring has taken into account seasonal requirements and utilised a wide range of sampling techniques, resulting in the development of a substantial data set from which a detailed assessment of the range of fauna species that occur in the Mount Owen Complex can be made, including threatened, cryptic and rare species. The extensive monitoring has allowed many species that are uncommon and are likely to utilise the habitats of the Mount Owen Complex during favourable conditions such as prolific eucalypt flowering; or when rehabilitating or regenerating habitats are optimal for initial colonising species such as the New Holland mouse (*Pseudomys novaehollandiea*) to occur. Many of these species are difficult to detect during project specific surveys due to limitations in survey timing, seasonality and duration. The results of these monitoring surveys have been included in following discussions relating to survey results and have directly informed the impact assessment in **Section 5.0**.

Nine general fauna survey sites are sampled annually within Mount Owen Complex with one general fauna survey site located within the Proposed Disturbance Area (refer to **Figure 3.3**). Each of the fauna survey methodologies employed at the monitoring location is outlined below and the results of fauna monitoring from within the Proposed Disturbance Area has have been used to supplement the survey results and inform the impact assessment for the Project (refer to **Sections 4.2** and **5.0**).

Each survey is undertaken in accordance with the methodologies described in the DEC (2004) survey guidelines and is consistent with the methodologies described in the **Sections 3.5.1** and **3.5.2** above. The following survey methodologies are implemented annually in the Proposed Disturbance Area as part of the annual fauna monitoring program:

- diurnal and opportunistic bird census;
- diurnal and opportunistic herpetological census;
- Elliott A trapping (7 x 7 grid pattern);
- Elliott B arboreal trapping;
- pitfall trapping (two parallel lines with 11 pits per trap line);
- cage trapping in northern Ravensworth State Forest targeting the spotted-tailed quoll;
- nocturnal spotlighting survey transects; and

- call playback sessions for the powerful owl, masked owl and barking owl.

In addition to the general fauna monitoring, targeted amphibian and microbat surveys are also undertaken at the locations identified on **Figure 3.3**. These surveys include:

- Anabat echolocation surveys;
- harp trapping;
- targeted spotlighting surveys;
- targeted waterbody searches;
- call playback surveys for green and golden bell frog; and
- dip netting for tadpoles.

3.5.3.1 Annual Monitoring Roost Box and Nest Box Inspections

Annual fauna monitoring (Forest Fauna Surveys and Newcastle Innovation 2014) also includes the installation and annual inspection of roost and nest boxes targeting micro-bat and arboreal mammal species. In accordance with the monitoring schedule, roost boxes were inspected in May and June and nest boxes were inspected in October in the 2012 survey year.

3.5.4 Terrestrial Fauna Survey Timing and Effort

Fauna surveys have been conducted over several months and seasons in order to optimise the likelihood of identifying the full range of species that could occur in the Proposed Disturbance Area. Fauna surveys were conducted in summer and winter to account for the known seasonal requirements and detectability period for most of the targeted species. Surveys across the Proposed Disturbance Area also focused on providing high levels of survey effort for a number of key species which were considered to be difficult to detect and this was carried out within predicted seasonal times of highest detectability. This effort was also matched to habitat areas considered likely to be of importance for target species.

3.5.4.1 Summary and Adequacy of Terrestrial Fauna Survey Effort

Table 3.8 outlines the fauna survey effort completed within the Proposed Disturbance Area. The locations of these survey methods are provided in **Figure 3.2**. It is noted that extensive annual fauna monitoring is undertaken both within and outside the Proposed Disturbance Area, as shown on **Figure 3.3**.

An extensive amount of fauna survey has been undertaken in the Project Area as a result of annual fauna monitoring (refer to **Section 3.5.3**) and therefore the fauna surveys undertaken as part of the Project aimed to describe the types and specific features of the Proposed Disturbance Area. For woodland habitats, survey effort met or in many cases exceeded guideline requirements, In some areas, such as Derived Native Grassland and riparian habitat, survey effort was slightly less than guideline requirements, however when considered in the context of the habitat requirements of particular fauna groups and/or targeted threatened species, the combined survey effort was appropriate and met guideline expectations.

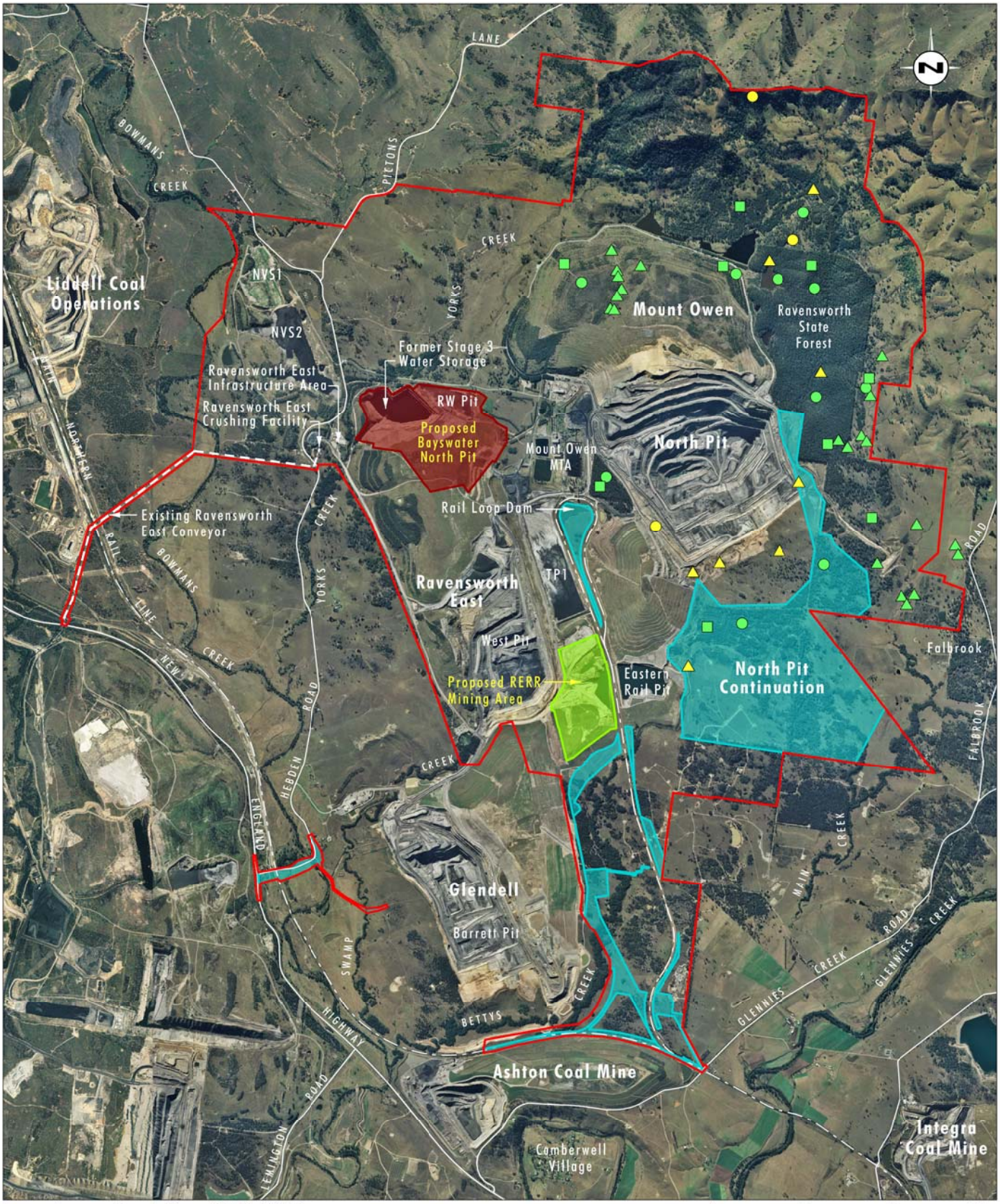

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014)

0 1 2 3 km
1:60 000

Legend

- Project Area
- Proposed Disturbance Area
- Bayswater North Pit
- Proposed RERR Mining Area

Previous Monitoring Locations:
- Targeted Frog Survey Location
- Targeted Microbat Survey Location

Current Monitoring Locations:
- Targeted Frog Survey Location
- Targeted Microbat Survey Location
- General Fauna Survey Location

FIGURE 3.3

Mount Owen Annual Fauna Monitoring Locations

File Name (A4): R03/3109_813.dgn
20140926 8.48

Table 3.8 – Adequacy of Terrestrial Fauna Survey Effort with Respect to OEH Guidelines (DEC 2004)

Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
Amphibians (including targeted green and golden bell frog (*Litoria aurea*) surveys)	Nocturnal Call playback	At least one playback on each of two separate nights	56 sessions of call playback were undertaken across 15 targeted green and golden bell frog sites during three survey periods. Targeted green and golden bell frog surveys were undertaken in March 2014 as part of the UHSA surveys, in eight locations across the Project Area and surrounds. Annual fauna monitoring is undertaken across Mount Owen Complex at 21 locations.	All dams located within the Proposed Disturbance Area. Additional annual monitoring surveys within wider Project Area.	Adequate
	Diurnal herpetological searches	One hour per stratification unit	Four person hours. Annual fauna monitoring undertaken across Mount Owen Complex at 21 locations.	Woodland/Forest	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys.	Proposed Disturbance Area	Adequate
Reptiles	Diurnal herpetological searches	30 minute search on two separate days targeting specific habitat per stratification unit	Two diurnal herpetological habitat searches, each of one person-hour on two separate days, were undertaken at the two general fauna survey sites and one annual fauna monitoring survey site. Opportunistic observations were made throughout all surveys.	Woodland/Forest	Adequate
	Spotlighting surveys	30 minute search on two separate nights targeting specific habitat	Two nocturnal spotlighting surveys, each of one person-hour on two separate nights, were undertaken at the two fauna survey sites and one annual fauna monitoring survey site.	Woodland/Forest	Adequate

Table 3.8 – Adequacy of Terrestrial Fauna Survey Effort with Respect to OEH Guidelines (DEC 2004) (cont.)

Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys.	Proposed Disturbance Area	Adequate
Diurnal Birds (including threatened raptors, threatened wetland-dependent birds and threatened woodland birds)	Area search	Per stratification unit	Three diurnal bird surveys, each of one person-hour, were undertaken at the two fauna survey sites and one annual fauna monitoring survey site. In addition to this, targeted winter bird surveys, each of one person hour in duration, were undertaken at 42 locations in and around the Project Area over three survey seasons. Targeted raptor surveys were undertaken in March 2014 as part of the UHSA surveys, in two locations across the Project Area and surrounds.	Woodland/Forest	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys	Proposed Disturbance Area	Adequate

Table 3.8 – Adequacy of Terrestrial Fauna Survey Effort with Respect to OEH Guidelines (DEC 2004) (cont.)

Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
Nocturnal Birds (including threatened owls, bitterns and bush stone-curlew (*Burhinus grallarius*))	Call playback surveys	Sites should be separated by 800 metres – 1 km, and each site must have the playback session repeated as follows: • at least 5 visits per site, on different nights are required for the Powerful Owl, Barking Owl and the Grass Owl; • at least 6 visits per site for the Sooty Owl, and 8 visits per site for the Masked Owl are required. Sites for bush stone-curlew surveys should be 2 to 4 km apart and conducted during the breeding season.	4 sessions of call playback were undertaken across two fauna survey sites for all threatened forest owls and the bush stone-curlew. Call playback targeting the masked owl, powerful owl and barking owl was undertaken over two nights at one fauna monitoring location.	Woodland/Forest Derived Native Grassland	Adequate
	Spotlighting surveys	Spotlighting for plains wanderer and bush stone-curlew by foot or from a vehicle driven in first gear.	Two nocturnal spotlighting surveys, each of one person-hour on two separate nights, were undertaken at the two fauna survey sites and one fauna monitoring location.	Woodland/Forest Derived Native Grassland Riparian Habitat	Adequate
Nocturnal Birds (including threatened owls, bitterns and bush stone-curlew (*Burhinus grallarius*)) (cont.)	Day habitat searches	Search habitat for pellets, and likely hollows. Flushing of bush stone-curlews by walking through potential habitat.	Targeted pellet searches were undertaken and inspection of potential roost trees within the Proposed Disturbance Area.	Woodland/Forest Derived Native Grassland Riparian Habitat	Adequate

Table 3.8 – Adequacy of Terrestrial Fauna Survey Effort with Respect to OEH Guidelines (DEC 2004) (cont.)

Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys.	Woodland/Forest Derived Native Grassland Riparian Habitat	Adequate
Mammals (excluding bats)	Hair tubes	10 large and 10 small tubes in pairs for at least 4 days and 4 nights.	Hair funnel transects were placed along a 200 metre transect at the two general fauna survey sites. Each transect comprised 20 terrestrial hair funnels and 10 arboreal hair funnels. Hair funnels remained on-site for 25 days thereby resulting in 1,500 trap nights.	Woodland/Forest Riparian Habitat	Adequate
	Spotlighting surveys	2 x one hour and 1 km up to 200 hectares of stratification unit, walking at approximately 1 km per hour on 2 separate nights.	Two nocturnal spotlighting surveys, each of one person-hour on two separate nights, were undertaken at the two general fauna survey sites and one annual fauna monitoring site. Targeted koala spotlighting surveys were undertaken in March 2014 as part of the UHSA surveys across the Project Area and surrounds. Driving spotlighting was undertaken across the Project Area during all nocturnal surveys.	Woodland/Forest Derived Native Grassland Riparian Habitat	Adequate

Table 3.8 – Adequacy of Terrestrial Fauna Survey Effort with Respect to OEH Guidelines (DEC 2004) (cont.)

Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
Mammals (excluding bats) (cont.)	Search for scats and signs	30 minutes searching each relevant habitat, including trees for scratch marks	29 general habitat searches, each of one person-hour, were undertaken within the Proposed Disturbance Area. Targeted koala SAT surveys were undertaken in March 2014 as part of the UHSA surveys, in 16 locations across the Project Area and surrounds.	Woodland/Forest Derived Native Grassland Riparian Habitat	Adequate
	Remote camera surveys	-	Remote camera surveys were undertaken in 13 locations across the Project Area as part of the UHSA surveys. Each site was monitored between 3 and 33 days across the Project Area and surrounds.	Woodland/Forest Riparian Habitat	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys.	Woodland/Forest Derived Native Grassland Riparian Habitat	Adequate
Bats (including threatened micro-bats and the grey-headed flying-fox (*Pteropus poliocephalus*))	Ultrasonic call recording (Anabat)	Two sound activated recording devices utilised for the entire night (a minimum of four hours), starting at dusk for two nights.	A total of four full nights of ultrasonic call recording was undertaken at the two general fauna survey sites. Nine full nights of ultrasonic call recording at one annual fauna monitoring site within the Proposed Disturbance Area. A total of six full nights of ultrasonic call recording was undertaken in March 2014 across the Project Area and surrounds as part of the UHSA surveys.	Woodland/Forest Derived Native Grassland Riparian Habitat	Adequate

Table 3.8 – Adequacy of Terrestrial Fauna Survey Effort with Respect to OEH Guidelines (DEC 2004) (cont.)

Survey Target	Survey Method	Survey Requirement (DEC 2004)	Survey Effort Employed for Ecology Assessment	Habitat Stratification Units Surveyed	Adequacy of Survey Effort With Respect to OEH Guidelines
	Harp trapping	Four trap nights over two consecutive nights.	Two nights of harp trapping was undertaken at the two general fauna survey sites. Nine full nights of harp trapping at one annual fauna monitoring site within the Proposed Disturbance Area.	Woodland/Forest	Adequate
	Spotlighting surveys	2 x one hour spotlighting on two separate nights	Two nocturnal spotlighting surveys, each of one person-hour on two separate nights, were undertaken at the two general fauna survey sites, over two seasons.	Woodland/Forest Derived Native Grassland Riparian Habitat	Adequate
	Opportunistic observations	-	Opportunistic observations were made throughout all surveys.	Proposed Disturbance Area	Adequate

Notes: Dams have been stratified as a special habitat as per **Section 5.3.1** of the Draft Threatened Species Survey: Guidelines for Developments and Activities (DEC 2004).

3.6 Habitat and Condition Assessment Methodology

The field sampling for the condition assessment was based on stratification using native vegetation communities as the base unit and the sampling of a 20 metre by 20 metre quadrat. Ten vegetation communities were delineated in the Proposed Disturbance Area of which two are non-native communities.

Thirty-seven habitat assessment surveys were undertaken across the Project Area and wider contextual area (refer to **Figure 3.2**). The number of survey sites per vegetation community was determined by an intuitive process that allocated a given number of sites based on the size of the vegetation formation (refer to **Table 3.9**).

Table 3.9 - Number of Survey Sites per Vegetation Formation

Vegetation Formation	Number of Quadrats
Woodland/Forest	25
Riparian	3
Shrubland	2
Derived Native Grassland	7

Figure 3.2 shows the location of each of the habitat and condition assessments sites within and outside the Project Area.

3.6.1.1 Collection of Habitat and Condition Assessment Data

At each quadrat the following habitat data was collected.

Physical Site Characteristics:

- aspect; and
- slope.

Disturbance Level:

- evidence of fire;
- cut stump density;
- grazing pressure level;
- erosion severity and type;
- weed infestation level and dominant species;
- level of rubbish dumping; and
- signs of feral animals.

Foliage Health:

- number and size of stags;
- dieback level;

- mistletoe infestation level; and
- level of foliage insect attack.

Ground Cover:

- number and types of ground logs;
- number and types of stumps;
- per cent rock cover;
- per cent boulder and solid rock cover;
- per cent soil and lichen cover;
- ground vegetation cover percentage, dominant growth form, number of species and dominant species; and
- understorey layer cover percentage, dominant growth form, number of species and dominant species.

Tree Cover:

- mid-understorey layer cover percentage, dominant growth form, number of species and dominant species;
- canopy cover percentage, dominant growth form, number of species and dominant species;
- diameter of up to 15 trees greater than 100 millimetres diameter at breast height (DBH); and
- number and age of eucalypt trees.

Target Species Habitat Features:

- amount of horizontal perch sites;
- number of trees with loose bark; and
- number of trees with bark/litter mound at base.

Many of the habitat parameters measured at each quadrat were scored into categories or ranges, while the remainder were derived from direct measurements.

3.6.1.2 Measurement of average Diameter at Breast Height (DBH) per quadrat

The average DBH (millimetres) of trees (greater than 100 millimetres DBH) was one of the key measurements made at each sampling site. The minimum number of trees required to determine a representative average was considered to be 15 trees. Not all plots sampled contained 15 trees greater than 100 millimetres DBH however, and in such cases all trees present were measured and the average was calculated from less than 15 trees. Where more than 15 trees greater than 100 millimetres DBH were present within the quadrat, the 15 closest to the north-eastern corner of the quadrat were measured, to reduce bias that could result from individual selection.

3.6.2 Hollow-bearing Tree Density

All trees present within each condition assessment quadrat were searched for the presence of hollows. When hollows were present, the size, orientation and location of each hollow was recorded. Tree hollows were recorded with consideration of the individual classes of hollow size, orientation and location. The DBH, height, percentage dead timber and species of each hollow-bearing tree were also recorded.

The mean number of hollows per hectare for each vegetation formation was calculated based on condition assessment data, using the following formula:

$$\text{Mean number of hollows per hectare, per vegetation formation} = \frac{\left(\left(\sum H\,x\right)\times 25\right)}{\sum S}$$

Where:

H_x = total hollows for each site in the vegetation formation (H_1, H_2, H_3, H_n)

S = sites surveyed

3.6.3 SEPP 44 (Koala Habitat) Assessment

An application for a proposed development approval which relates to a site occurring within an LGA specified under State Environmental Planning Policy 44 (SEPP 44) – Koala Habitat Protection, must be assessed under SEPP 44. Assessment under SEPP 44 is based on an initial determination of whether the land constitutes potential koala (*Phascolarctos cinereus*) habitat. This is determined by assessing whether the eucalypt species present in Schedule 2 of the policy (refer to **Table 3.10**) constitute 15 per cent or more of the total number of trees in the upper or lower strata of the tree component. If potential koala habitat is present, the area must be further assessed to determine if the land is core koala habitat.

Table 3.10 – Eucalypt Species Listed Under Schedule 2 of SEPP 44

Scientific Name	Common Name
Eucalyptus tereticornis	forest red gum
Eucalyptus microcorys	tallowwood
Eucalyptus punctata	grey gum
Eucalyptus viminalis	ribbon or manna gum
Eucalyptus camaldulensis	river red gum
Eucalyptus haemastoma	broad-leaved scribbly gum
Eucalyptus signata	scribbly gum
Eucalyptus albens	white box
Eucalyptus populnea	bimble box or poplar box
Eucalyptus robusta	swamp mahogany

An assessment of the presence of trees listed on Schedule 2 of SEPP 44 was undertaken throughout the Proposed Disturbance Area. All SEPP 44 listed canopy species were recorded if present, along with an estimate of the percentage of the total trees that comprise SEPP 44 species within the Proposed Disturbance Area.

3.7 Aquatic Survey

An aquatic assessment was undertaken in order to record the aquatic biodiversity of the Proposed Disturbance Area, and to identify any aquatic threatened species, populations or communities under the EPBC Act, FM Act or the TSC Act, that occur or have potential to occur within the Proposed Disturbance Area.

A survey of aquatic flora and fauna species, including detailed habitat assessments and aquatic vertebrate sampling, was undertaken in October 2012. Habitat assessment and aquatic vertebrate sampling were conducted in Bowmans Creek, with two replicate surveys undertaken at each of the upstream and downstream locations near the proposed Bowmans Creek Bridge on Hebden Road. A qualitative assessment of riparian and aquatic habitat, in accordance with the Australian Rivers Assessment Scheme (AUSRIVAS) was undertaken at both locations along Bowmans Creek. The riparian and aquatic habitat of Bettys Creek was also described.

AUSRIVAS sampling is a national, standardised sampling and prediction system used for the assessment of the ecological condition of Australia's rivers. It was developed in 1994 as part of the National River Health Program, which has been adopted by the major environmental federal, state and territory agencies in Australia. AUSRIVAS includes a habitat assessment component for recording the river substratum, flow conditions, water quality and aquatic riparian attributes.

3.7.1 Aquatic Habitat Assessment

Preliminary mapping of the broad scale aquatic habitats within the Proposed Disturbance Area was undertaken using recent aerial photography in conjunction with topographic maps prior to field surveys. Topographic maps were used to gain a broad understanding of catchment characteristics including adjacent land use, elevation, access routes, distance from source and location of barriers to fish passage, such as dams and weirs.

An assessment of the aquatic habitat characteristics within each of the sampling sites was undertaken, and indicators of stream condition were also noted. The aquatic habitat characteristics were recorded using standard recording sheets (adapted from those developed for the AUSRIVAS sampling protocol available as a web resource (AUSRIVAS 2007)).

Some of the habitat features and stream condition indicators assessed included:

- characteristics of bed substrate;
- presence of in-stream woody debris;
- presence of gravel beds;
- presence of drought and flood refuge areas;
- depth of water;
- width of channel;
- presence of pool, riffle and edge habitats;
- height of bank and evidence of erosion;
- channel geomorphology;

- evidence of sediment deposition;
- degree of bank erosion;
- the presence of natural or artificial barriers to fish passage upstream and downstream;
- colour and clarity of water, and any visual evidence of water quality; and
- characteristics of in-stream, riparian and floodplain vegetation.

3.7.2 Aquatic Vertebrate Fauna Sampling

Aquatic vertebrate sampling was undertaken along Bowmans Creek, with two replicate surveys undertaken in both the upstream and downstream locations of the proposed Bowmans Creek Bridge on Hebden Road. Box trapping occurred on 1 November 2012 at two locations along Bowmans Creek. Four large box traps (44 centimetres x 57 centimetres x 21 centimetres with 1 centimetre mesh) and four small box traps (25 centimetres x 25 centimetres x 45 centimetres, with 1 millimetre mesh) were deployed at each of the locations (refer to **Figure 3.2**). One additional small box trap, was deployed downstream of the proposed Bowmans Creek Bridge on Hebden Road.

Traps were baited with fresh chicken necks and deployed for three hours. The large box traps were semi-immersed at all times to ensure that any turtles or platypus caught were not adversely affected. Alternatively, the small traps were immersed at all times to ensure that trapped fish would not be adversely affected.

The likelihood of aquatic mammals occurring within the study area was also considered during the habitat assessment, in particular the water rat (*Hydromys chrysogaster*) and the platypus (*Ornithorhynchus anatinus*). The potential presence of these species was assessed by searching for suitable bank habitat, burrows and also through search for characteristic scats.

3.7.3 Aquatic Flora

A walking transect was undertaken at each sampling site to assess the presence and types of aquatic flora. These walking transects were conducted to determine species composition and community structure. Walking transects were also used to determine species composition and community structure of fringing riparian vegetation.

Samples of all unknown plant species were collected in the field, pressed and dried for later identification, and forwarded to the National Herbarium of New South Wales if necessary.

3.7.4 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are described in the NSW GDE Policy (DLWC 2002) and can include terrestrial vegetation, base flow in streams, aquifer and cave ecosystems and wetlands.

A review of the Groundwater Assessment (Jacobs 2014) was undertaken to determine the extent and potential location of groundwater resources in the Project Area to inform the identification of GDEs.

4.0 Survey Results

4.1 Flora Survey Results

The results of the flora survey, including field survey, vegetation description and mapping and desktop components are detailed in the following sections. The results in this section include specific flora survey effort for the Project as well as surveys undertaken as part of the Upper Hunter Strategic Assessment surveys (Umwelt 2014, in prep) and the Mount Owen Mine Rehabilitation, Regeneration and Revegetation Assessment surveys (Umwelt 2013b) within the Project Area.

4.1.1 Database Searches

The threatened flora species recorded on the OEH Atlas of NSW Wildlife and Department of Environment Protected Matters Database are included in **Appendix A**.

4.1.2 Flora Species

A total of 355 plant species were identified during the flora surveys undertaken in 2011, 2012 and 2014. Plants were recorded from two major vascular plant classes, being: ferns and flowering plants (**Table 4.1**) and included trees, shrubs, forbs, grasses, sedges, rushes, reeds, ferns, lithophytes, epiphytes, mistletoes, vines and twiners. The full list of flora species recorded during flora surveys is provided in **Appendix B**.

Table 4.1 – Composition of Plant Classes and Families Recorded

Plant Classes	Sub-class	Number of Families	Number of Species
Filicopsida (ferns)	-	3	4
Magnoliopsida (flowering plants)	Magnoliidae (dicots)	56	233
Magnoliopsida (flowering plants)	Liliidae (monocots)	12	118
Totals (all plants)	**-**	**71**	**355**

A total of 71 plant families were recorded (refer to **Table 4.1**). Poaceae (grasses) was the most speciose family with 79 species recorded, followed by Asteraceae (daisies) with 44 species, Fabaceae (Faboideae) (pea flowers) with 44 species and Myrtaceae (eucalypts) with 13 species recorded.

Of the 355 species recorded, 92 (26 per cent) were introduced species. Introduced species recorded include paspalum (*Paspalum dilatatum*), pepper tree (*Schinus areira*), kikuyu (*Pennisetum dilatatum*), galenia (*Galenia pubescens*), African olive (*Olea europaea* subsp. *cuspidata*) and sharp rush (*Juncus acutus* subsp. *acutus*). Six species recorded (representing 1.7 per cent of species recorded) are declared noxious in the Singleton control area. Declared noxious weeds are listed in **Table 4.2**.

Table 4.2 – Noxious Weeds Recorded During Flora Surveys

Family	*Scientific name*	Common name
Asparagaceae	**Asparagus asparagoides*	bridal creeper
Cactaceae	**Opuntia aurantiaca*	tiger pear
Cactaceae	**Opuntia humifusa*	creeping pear
Cactaceae	**Opuntia stricta* var. *stricta*	common prickly pear
Crassulaceae	**Bryophyllum delagoense*	mother of millions
Solanaceae	**Lycium ferocissium*	African boxthorn

Notes: *Denotes introduced – not native to Australia.

No threatened flora species were recorded within the Proposed Disturbance Area during the flora surveys.

4.1.3 Vegetation Communities in the Proposed Disturbance Area

Surveys of the Proposed Disturbance Area identified eight native vegetation communities (excluding variants) (refer to **Figure 4.1**). These vegetation communities were aligned with vegetation map units as described in the Hunter Remnant Vegetation Project (Peake 2006), where possible and were aligned with vegetation community classifications from the recently released Greater Hunter Native Vegetation Mapping (Sivertsen *et al*. 2011).

The eight native vegetation communities include two EECs listed under the TSC Act being Central Hunter Grey Box – Ironbark Woodland EEC and Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC. . One non-native vegetation community, mine rehabilitation, was recorded within the BNP and Proposed RERR Mining Area disturbance areas. The extent of each of these vegetation communities is shown in **Table 4.3**. The dominant communities identified in the Proposed Disturbance Area are Derived Native Grassland, Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC and Central Hunter Bulloak Forest Regeneration (refer to **Figure 4.1**).

Table 4.3 – Vegetation Communities of the Proposed Disturbance Area

Vegetation Community Name	Area in the Disturbance Area (ha)
Central Hunter Bulloak Forest Regeneration	54.0
Central Hunter Grey Box – Ironbark Woodland (EEC – TSC Act)	4.4
Central Hunter Ironbark – Spotted Gum – Grey Box Forest (EEC – TSC Act)	131.9
Planted Ironbark – Spotted Gum – Grey Box Forest (EEC – TSC Act)	27.4
Central Hunter Swamp Oak Forest	5.8
Derived Native Grassland	223.1
Hunter Valley River Oak Forest	0.2
Kunzea Closed Shrubland	4.7
Total Native Vegetation	**451.5**
Mine Rehabiliation	86.9
Total Mine Rehabiliation	**86.9**

Descriptions of each of the vegetation communities recorded in the Proposed Disturbance Area are provided below. These descriptions draw upon data obtained during field surveys and also from information contained within Peake (2006).

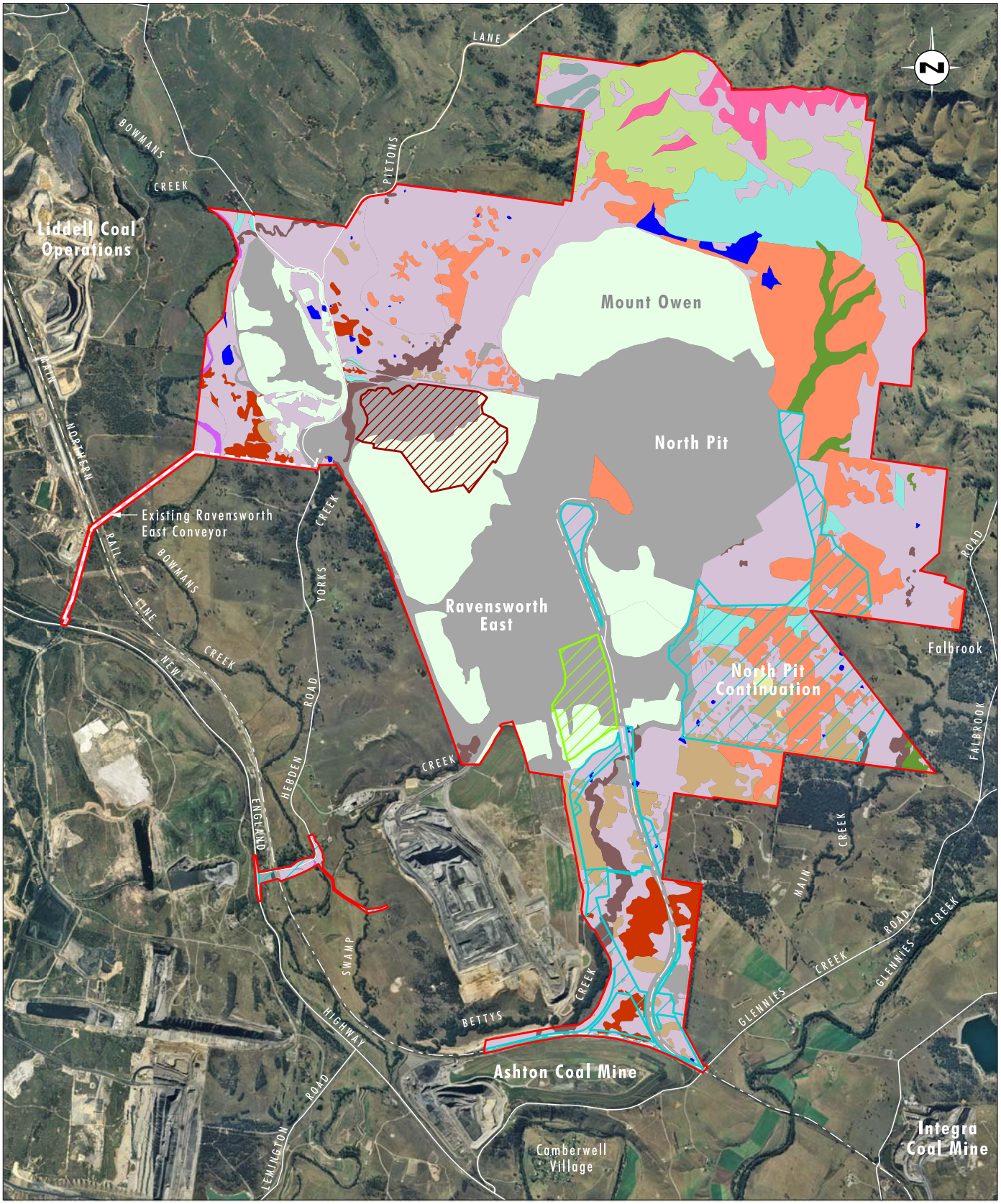

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014)

0 1 2 3 km
1:60 000

Legend

- Project Area
- Proposed Disturbance Area
- Bayswater North Pit
- Proposed RERR Mining Area

Vegetation Communities:

- Disturbed Land
- Barrington Footslopes Dry Spotted Gum Forest
- Central Hunter Bulloak Forest Regeneration
- Central Hunter Swamp Oak Forest
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest
- Central Hunter Grey Box - Ironbark Woodland
- Derived Native Grassland
- Dry Rainforest
- Hunter Lowland Red Gum Forest
- Hunter Footslopes Sheltered Forest
- Hunter Valley River Oak Forest
- Planted Ironbark - Spotted Gum - Grey Box Forest
- Kunzea Closed Shrubland
- Water Body
- Mine Rehabilitation

FIGURE 4.1

Vegetation Communities within the Project Area

File Name (A4): R03/3109_091.dgn
20141008 16.17

4.1.3.1 Central Hunter Ironbark – Spotted Gum – Grey Box Forest

A tall (14 to 24 metres tall) woodland co-dominated by more than one of the following canopy species, narrow leaved ironbark (*Eucalyptus crebra*), broad-leaved ironbark (*E. fibrosa*), spotted gum (*Corymbia maculata*) and grey box (*E. moluccana*). Bulloak (*Allocasuarina luehmannii*) was also common in the canopy and sub-canopy.

A very sparse shrub layer to a height of 3 metres was present and dominated by gorse bitter pea (*Daviesia ulicifolia*), broom bitter pea (*Daviesia genistifolia*), peach heath (*Lissanthe strigosa*) and fan wattle (*Acacia amblygona*).

The understorey is generally sparse and dominated by grasses, forbs and ferns. Commonly occurring species include threeawn speargrass (*Aristida vagans*), *Austrostipa scabra* subsp. *falcata*, bogan flea (*Calotis hispidula*), yellow burr-daisy (*Calotis lappulacea*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), *Cleistochloa rigida*, barbed wire grass (*Cymbopogon refractus*), *Dianella revoluta* subsp. *revoluta*, kidney weed (*Dichondra repens*), winter apple (*Eremophila debilis*), *Glycine tabacina,* many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), *Juncus* sp., *Sida corrugata*, whiteroot (*Pratia purpurascens*), Narrawa burr (*Solanum cinereum*) and *Vernonia cinerea*.

Weed species occurring in this community were generally low in abundance and diversity. Some common species included scarlet pimpernel (*Anagallis arvensis*), annual trampweed (*Facelis retusa*), prickly pear (*Opuntia stricta* var. *stricta*) and fireweed (*Senecio madagascariensis*).

Central Hunter Ironbark – Spotted Gum – Grey Box-Forest is the dominant woodland community in the Proposed Disturbance Area, being present on gentle slopes in the north (refer to **Figure 4.1**) and conforms to the Central Hunter Ironbark – Spotted Gum – Grey Box Forest described by Peake (2006). Based on historical aerial photography, this area has regenerated following extensive clearing prior to 1958.

Central Hunter Ironbark – Spotted Gum – Grey Box-Forest corresponds to MU086 Narrow-leaved Ironbark/Grey Box/Spotted Gum shrub/grass open forest of the central and lower Hunter as described by the Greater Hunter Native Vegetation Mapping (Sivertsen *et al*. 2011).

The NSW Scientific Committee has made a final determination to list Central Hunter Ironbark – Spotted Gum – Grey Box Forest as an EEC (NSW Scientific Committee 2010). The Central Hunter Ironbark – Spotted Gum – Grey Box Forest mapped within the Proposed Disturbance Area conforms to the description of the final determination and has been considered as an EEC for the purposes of this ecological assessment.

Planted Ironbark – Spotted Gum – Grey Box Forest

A variation of Central Hunter Ironbark – Spotted Gum – Grey Box-Forest occurred in the north of the Proposed Disturbance Area. An area of Derived Native Grassland situated adjacent to intact woodland vegetation was revegetated with the canopy species grey box (*Eucalyptus moluccana*), broad-leaved ironbark (*Eucalyptus fibrosa*), spotted gum (*Corymbia maculata*) and narrow-leaved ironbark (*Eucalyptus crebra*) approximately 15 years ago. Some of the common species recorded in the community variant included, *Acacia crassa* subsp. *crassa*, blackthorn (*Bursaria spinosa*), gorse bitter pea (*Daviesia ulicifolia*), Narrawa burr (*Solanum cinereum*), kidney weed (*Dichondra repens*), barbed wire grass (*Cymbopogon refractus*), threeawn speargrass (*Aristida vagans*), *Bothriochloa* sp., bulloak (*Allocasuarina luehmannii*), broom bitter pea (*Daviesia genistifolia*), blue trumpet (*Brunoniella australis*), winter apple (*Eremophila debilis*), *Glycine tabacina* and small-leaf glycine (*Glycine microphylla*).

The Planted Ironbark – Spotted Gum – Grey Box Forest was noticeably different (in structure) to Central Hunter Ironbark – Spotted Gum – Grey Box Forest in that canopy species were planted in rows. Additionally the number of introduced flora species and their cover was also slightly higher than the surrounding remnant woodland. Introduced flora species were consistent with the remnant community. Although this community was planted, natural recruitment of canopy species was evident with eucalypt saplings occurring on the edges of the community and into adjacent grasslands.

Central Hunter Ironbark – Spotted Gum – Grey Box-Forest corresponds to MU086 Narrow-leaved Ironbark/Grey Box/Spotted Gum shrub/grass open forest of the central and lower Hunter as described by the Greater Hunter Native Vegetation Mapping (Sivertsen *et al*. 2011).The Planted Ironbark – Spotted Gum – Grey Box Forest mapped within the Proposed Disturbance Area also conforms to the description of the final determination to list Central Hunter Ironbark – Spotted Gum – Grey Box Forest as an EEC and has been considered as an EEC for the purposes of this ecological assessment.

4.1.3.2 Central Hunter Grey Box – Ironbark Woodland

A mid-high (14 to 18 metres tall) woodland dominated by narrow-leaved ironbark (*Eucalyptus crebra*) and grey box (*Eucalyptus moluccana*). A sub-canopy dominated by bulloak (*Allocasuarina luehmannii*) is usually present. Low trees are generally absent from this community. A variant of this community is present to the east of Bettys Creek, where forest red gum (*Eucalyptus tereticornis*) is also present with narrow-leaved ironbark and grey box.

The majority of this community is regenerating from historical clearing for agriculture with regeneration occurring since approximately 30 years ago (refer to **Section 2.3**). Scattered narrow-leaved ironbark which survived this clearing are present within the community. Small areas of this community are sometimes dominated by bulloak (*Allocasuarina luehmannii*). These areas have been mapped as Central Hunter Box – Ironbark Woodland when there are scattered mature canopy trees nearby.

A low and very sparse shrub layer was generally present within this community, with gorse bitter-pea (*Daviesia ulicifolia*) as the sole shrub species. The introduced shrub African boxthorn (*Lycium ferocissimum*) was present in moderately high cover.

The understorey is usually mid-dense and dominated by a variety of native grasses and forbs. Common species include threeawn speargrass (*Aristida vagans*), *Aristida* sp., *Austrodanthonia* sp., slender bamboo grass (*Austrostipa verticillata*), windmill grass (*Chloris truncata*), barbed wire grass (*Cymbopogon refractus*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), kidney weed (*Dichondra repens*), berry saltbush (*Einadia hastata*), *Einadia nutans* subsp. *linifolia,* climbing saltbush (*Einadia nutans* subsp. *nutans*), ruby saltbush (*Enchylaena tomentosa*), winter apple (*Eremophila debilis*) and many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*).

Introduced species were relatively common within the understorey of this community. Scarlet pimpernel (*Anagallis arvensis*), spear thistle (*Cirsium vulgare*), galenia (*Galenia pubescens*), Coolatai grass (*Hyparrhenia hirta*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), flatweed (*Hypochaeris radicata*), *Lolium* sp., common prickly pear (*Opuntia stricta* var. *stricta*), fireweed (*Senecio madagascariensis*), common sowthistle (*Sonchus oleraceus*), dandelion (*Taraxacum officinale*) and purpletop (*Verbena incompta*) were the dominant species.

This is a common woodland community in the Project Area, but is restricted within the Proposed Disturbance Area being present only in a small portion in the south of the Proposed Disturbance Area (refer to **Figure 4.1**). It is, however, the dominant woodland vegetation community surrounding the Proposed Disturbance Area to the south and is the likely parent community of the southern Derived Native Grassland variant. The intact stands

of this community conform to Central Hunter Box – Ironbark Woodland described by Peake (2006) and MU173 Narrow-leaved Ironbark/Bull Oak/Grey Box shrub/grass open forest of the central and lower Hunter as described by the Greater Hunter Native Vegetation Mapping (Sivertsen *et al*. 2011).

The Central Hunter Grey Box – Ironbark Woodland mapped within the Proposed Disturbance Area conforms to the description of the Central Hunter Grey Box – Ironbark Woodland EEC listed under the TSC Act.

4.1.3.3 Central Hunter Bulloak Forest

A low to mid-high (10 to 18 metres in height) open forest dominated by bulloak (*Allocasuarina luehmannii*). Narrow-leaved ironbark (*Eucalyptus crebra*) occurs occasionally as an emergent.

Shrubs are generally absent from this community; however the low shrub peach heath (*Lissanthe strigosa*) was recorded in low abundance.

The groundcover vegetation is generally sparse and is comprised of native grasses and forbs. Commonly recorded species include *Aristida* sp., blue trumpet (*Brunoniella australis*), lemon beauty-heads (*Calocephalus citreus*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), barbed wire grass (*Cymbopogon refractus*), *Dianella revoluta* var*. revoluta,* Browns lovegrass (*Eragrostis brownii*), many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), silvertop wallaby grass (*Rytidosperma pallidum*) and smallflower wallaby grass (*Rytidosperma setaceum*).

Introduced species such as common prickly pear (*Opuntia stricta* var. *stricta*) and fireweed (*Senecio madagascariensis*) were recorded in low abundance.

This community was mainly present in the northern part of the Proposed Disturbance Area adjacent to Central Hunter Box – Ironbark Woodland (refer to **Figure 4.1**). It conforms to the Central Hunter Bulloak Forest Regeneration community described by Peake (2006), is not considered to be regionally significant (Peake 2006) or consistent with any listed TECs. Central Hunter Bulloak Forest corresponds to MU174 Bull Oak grassy woodland of the central Hunter Valley, as described by the Greater Hunter Native Vegetation Mapping (Sivertsen *et al*. 2011).

4.1.3.4 Central Hunter Swamp Oak Forest

A low to mid-high (10 to 16 metres in height) closed forest with a canopy dominated by swamp oak (*Casuarina glauca*). Rough-barked apple (*Angophora floribunda*) canopy trees were also scattered throughout the community. Shrubs were usually absent from this community.

The groundcover is sparse to dense and is dominated by native grasses, forbs and ferns. The most abundant species recorded include slender bamboo grass (*Austrostipa verticillata*), weeping grass (*Microlaena stipoides* var. *stipoides*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), kidney weed (*Dichondra repens*), berry saltbush (*Einadia hastata*), *Glycine clandestina, Glycine tabacina*, blue trumpet (*Brunoniella australis*), winter apple (*Eremophila debilis*), *Oxalis perennans* and whiteroot (*Pratia purpurascens*).

Introduced species were common throughout the understorey of this community. Dominant species included scarlet pimpernel (*Anagallis arvensis*), spear thistle (*Cirsium vulgare*), (*Conyza bonariensis*), slender celery (*Cyclospermum leptophyllum*), galenia (*Galenia pubescens*), box-thorn (*Lycium ferocissum*), fireweed (*Senecio madagascariensis*), common prickly pear (*Opuntia stricta* var. *stricta*) and black-berry nightshade (*Solanum nigrum*), occasionally in high abundance.

This community conforms to the Central Hunter Swamp Oak Forest described by Peake (2006) and MU213 Swamp Oak grassy riparian forest of the Central Hunter, as described by the Greater Hunter Native Vegetation Mapping (Sivertsen *et al*. 2011). It occurs along Bettys Creek in the south of the Proposed Disturbance Area (refer to **Figure 4.1**) and does not conform to any listed TECs. The community is considered to be regionally significant as it has been extensively cleared and covers an area of less than 10,000 hectares, and it suffers from serious threats that include land clearing, dieback, lack of recruitment and invasion by weeds (Peake 2006).

4.1.3.5 Hunter Valley River Oak Forest

A mid-high to tall (10 to 17 metres in height) forest dominated by river oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*). The community is heavily disturbed and introduced trees weeping willow (*Salix babylonica*) and pepper tree (*Schinus areira*) occur as co-dominant species. Rough-barked apple (*Angophora floribunda*) can occur less frequently.

The introduced shrubs African boxthorn (*Lycium ferocissum*) and lady-of-the-night (*Cestrum nocturnum*) are generally the only shrub species identified in the understorey.

The mid-stratum of this community is generally sparse or absent and dominated by weed species. Commonly recorded mid-stratum species (all introduced) include Paddys lucerne (*Sida rhombifolia*), peppercorn tree (*Schinus areira*) and sharp rush (*Juncus acutus* subsp. *acutus*).

The Hunter Valley River Oak Forest ground stratum is typically dense (90 per cent) and characterised by introduced grasses and forbs. The following native species were commonly recorded: *Austrostipa* sp., common couch (*Cynodon dactylon*), and slender bamboo grass (*Austrostipa verticillata*). Common introduced species were panic veldtgrass (*Ehrharta erecta*), perennial ryegrass (*Lolium perenne*), scarlet pimpernel (*Anagallis arvensis*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), spear thistle (*Cirsium vulgare*), lambs tongue (*Plantago lanceolata*), blue heliotrope (*Heliotropium amplexicaule*) and Mediterranean turnip (*Brassica tournefortii*).

This community is consistent with Hunter Valley River Oak Forest described by Peake (2006) and MU215 River Red Gum/River Oak grassy riparian woodland of the Hunter Valley, as described by the Greater Hunter Native Vegetation Mapping (Sivertsen *et a*l. 2011). It is the dominant riparian community along Bowmans Creek (refer to **Figure 4.1**) and it generally occurs as a narrow band of vegetation restricted to the generally steep river bank.

4.1.3.6 Kunzea Closed Shrubland

This area of dense shrubland occurred on a south-west facing slope in the north of the Proposed Disturbance Area (refer to **Figure 4.1**). The community was lower in species diversity compared to surrounding woodland communities due to the thick cover of burgan (*Kunzea ericoides*). It is assumed that the community has developed as a result of land disturbance.

Ranging from 2 metres to 8 metres in height, burgan (*Kunzea ericoides*) was the sole canopy species within this community and comprised a projected foliage cover between 60 and 80 per cent. Emergent bulloak (*Allocasuarina luehmannii*) trees were thinly scattered throughout this community but generally had no more than 5 per cent cover.

The ground layer cover was dominated by a small diversity of native grass, rush and forb species. The percentage cover however was noticeably lower than surrounding vegetation communities as a result of the thick burgan (*Kunzea ericoides*) canopy. Dominant species in the ground layer included peach heath (*Lissanthe strigosa*), gorse bitter pea (*Daviesia*

ulicifolia), fan wattle (*Acacia amblygona*), *Aristida echinata*, many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), Browns lovegrass (*Eragrostis brownii*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*) and *Dianella* sp.

This community is considered to be a variant of Central Hunter Ironbark – Spotted Gum – Grey Box-Forest that has developed due to ground disturbance. They community therefore corresponds to MU086 Narrow-leaved Ironbark/Grey Box/Spotted Gum shrub/grass open forest of the central and lower Hunter as described by the Greater Hunter Native Vegetation Mapping (Sivertsen *et al*. 2011).

4.1.3.7 Derived Native Grassland

Two variants of Derived Native Grassland are present in the Proposed Disturbance Area. The two variants are not mapped as separate units (refer to **Figure 4.1**) as the boundary between the two is not evident.

The first variant occurs in the north of the Proposed Disturbance Area and is derived from Central Hunter Ironbark – Spotted Gum – Grey Box Forest. The second occurs east of Bettys Creek in the south of the Proposed Disturbance Areas and is likely to have once comprised Central Hunter Box – Ironbark Woodland. Both Derived Grassland variants are of similar quality and have only been separated due to the distribution of intact woodland and forest vegetation communities and are described below.

Variant 1 - Central Hunter Ironbark – Spotted Gum – Grey Box Derived Native Grassland

Occurring on the elevated, rolling hills in the north of the Proposed Disturbance Area near Ravensworth State Forest, this moderate to low quality native grassland located between remnants of Central Hunter Ironbark – Spotted Gum – Grey Box Forest and is likely to have once comprised this community. Scattered red ironbark (*Eucalyptus fibrosa*) and bulloak (*Allocasuarina luehmannii*) are present within the grassland areas.

Small shrubs occurred in low abundances, including gorse bitter pea (*Daviesia ulicifolia*) and peach heath (*Lissanthe strigosa*).

Commonly recorded native species within the ground stratum were dominated by grasses and forbs. Dominants included *Aristida* sp., *Austrostipa* sp., red grass (*Bothriochloa decipiens*), barbed wire grass (*Cymbopogon refractus*), *Dichelachne micrantha*, windmill grass (*Chloris truncata*), *Lomandra* sp., poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), *Wahlenbergia* sp. and *Glycine tabacina*.

Commonly recorded introduced species include saffron thistle (*Carthamnus lanatus*), fireweed (*Senecio madagascariensis*), spike centaury (*Centaurium spicatum*), French flax (*Linum trigynum*), Paddys lucerne (*Sida rhombifolia*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), lambs tongue (*Plantago lanceolata*) and scarlet pimpernel (*Anagallis arvensis*).

This community is not considered to be regionally significant (Peake 2006). While this native grassland is derived from the Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC, grasslands are not covered by the final determination for this EEC (NSW Scientific Committee 2010). Therefore this Derived Native Grassland variant community is not considered part of the EEC.

Variant 2 - Central Hunter Grey Box – Ironbark Derived Native Grassland

The second Derived Native Grassland variant was of moderate to low quality occurring on the floodplains of Bettys Creek, which is likely to have once been dominated by Central Hunter Grey Box – Ironbark Woodland. Scattered trees that remain in the community

included grey box (*Eucalyptus moluccana*). Native shrubs occurred in very low abundance throughout this community, species included bulloak (*Allocasuarina luehmannii*) and sifton bush (*Cassinia arcuata*).

The ground stratum of this community was relatively disturbed, but native grasses and forbs remained dominant over other introduced flora species. Common species included barbed wire grass (*Cymbopogon refractus*), threeawn speargrass (*Aristida vagans*), *Aristida* sp., *Austrostipa* sp., couch (*Cynodon dactylon*), kidney weed (*Dichondra repens*), ruby saltbush (*Enchylaena tomentosa*), Browns lovegrass (*Eragrostis brownii*) and common woodruff (*Asperula conferta*).

The cover of introduced flora species was relatively high in this variant. Common species included purpletop (*Verbena incompta*), fireweed (*Senecio madagascariensis*), scarlet pimpernel (*Anagallis arvensis*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), flatweed (*Hypochaeris radicata*), lambs tongue (*Plantago lanceolata*) and slender celery (*Cyclospermum leptophyllum*).

This community is not considered to be regionally significant (Peake 2006). While this native grassland is derived from the Central Hunter Grey Box – Ironbark Woodland EEC, grasslands are not covered by the final determination for this EEC (NSW Scientific Committee 2010). Therefore this Derived Native Grassland variant community is not considered part of the EEC.

4.1.3.8 Mine Rehabilitation

Mine rehabilitation occurs across the Project Area in areas of previous mining disturbance that have been actively rehabilitated with groundcover and/or canopy species. The quality of mine rehabilitation across the Project Area ranges from exotic-dominated grassland to immature forest complexes.

The mine rehabilitation within the BNP and Proposed RERR Mining Area disturbance areas primarily contains a low diversity of grass and shrub species and no canopy species. The shrub cover is sparse and dominated by scattered juvenile sickle wattle (*Acacia falcata*) and other planted *Acacia* sp. The dense ground cover is largely dominated by exotic grasses including Rhodes grass (*Chloris gayana*) kikuyu (*Pennisetum clandestinum*) and other weeds including purpletop (*Verbena bonariensis*) and cobblers pegs (*Bidens pilosa*).

4.1.4 Additional Vegetation Communities in the Project Area

An additional four vegetation communities have been mapped within the Project Area, but do not occur in the Proposed Disturbance Area. These communities have been mapped through referencing regional scale mapping, with limited ground truthing that has aimed to identify community dominants rather than to provide sufficient plot-based data to accurately describe and delineate vegetation communities. Sources include the Mount Owen Environmental Impact Statement (Umwelt 2003), Xstrata Biodiversity and Land Management Strategy Stage 2 (Umwelt 2009), Glencore Upper Hunter Strategic Assessment (Umwelt 2014, in prep) and Peake (2006) (refer to **Figure 4.1**). These communities include:

- Barrington Footslopes Dry Spotted Gum Forest;
- Dry Rainforest;
- Hunter Lowland Red Gum Forest EEC; and
- Hunter Footslopes Sheltered Forest.

Barrington Footslopes Dry Spotted Gum Forest, Hunter Footslopes Sheltered Forest and Dry Rainforest communities occur on the northern slopes of the Project Area in the northern Biodiversity Offset Areas and New Forest Area. Hunter Lowland Red Gum Forest EEC occurs within Ravensworth State Forest and on a drainage flat associated with Main Creek, in the south-east of the Project Area.

Only those communities that occur within the Proposed Disturbance Area are susceptible to direct impacts as a result of the Project. These communities have been described above in **Section 4.1.3**. The remaining vegetation communities listed above as occurring in the Project Area will not be directly impacted by the Project.

4.1.5 Threatened Flora Species, Endangered Flora Populations and Threatened Ecological Communities

A detailed table of all recorded and potentially occurring threatened flora species, EP and TECs is provided in **Appendix A**. The extent of each of the occurring threatened flora species, EP and TECs described in **Section 4.1.3** is shown on **Figures 4.1** and **4.2**.

Those threatened flora species, EPs and TECs that have been recorded or have the potential to occur in the Proposed Disturbance Area are listed in **Table 4.4**.

Table 4.4 – Threatened Flora Species, Endangered Populations and Threatened Ecological Communities Recorded in the Project Area and Proposed Disturbance Area

Species/Population/Community Name **Common name** ***Scientific name***	Recorded in Project Area?	Recorded in Proposed Disturbance Area?	Status	
			TSC Act 1995	EPBC Act 1999
slaty red gum *Eucalyptus glaucina*	✓	×	V	V
Ozothamnus tesselatus	✓	×	V	V
Cymbidium canaliculatum population in the Hunter Catchment	✓	×	EP	
Acacia pendula population in the Hunter Catchment	✓	×	EP	-
Eucalyptus camaldulensis in the Hunter Catchment	✓	×	EP	
Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	✓	✓	EEC	-
Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	✓	✓	EEC	-
Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	✓	×	EEC	-

Notes: EEC = endangered ecological community
EP = endangered population
V = vulnerable

The following threatened flora species, EPs and EECs (as listed under the TSC Act and EPBC Act) were recorded within the Project Area either as part of the current survey, or from other sources such as previous surveys, databases searches or literature reviews. A summary of ecological requirements for each species, EP and EEC is provided, sourced from the OEH Threatened Species website:

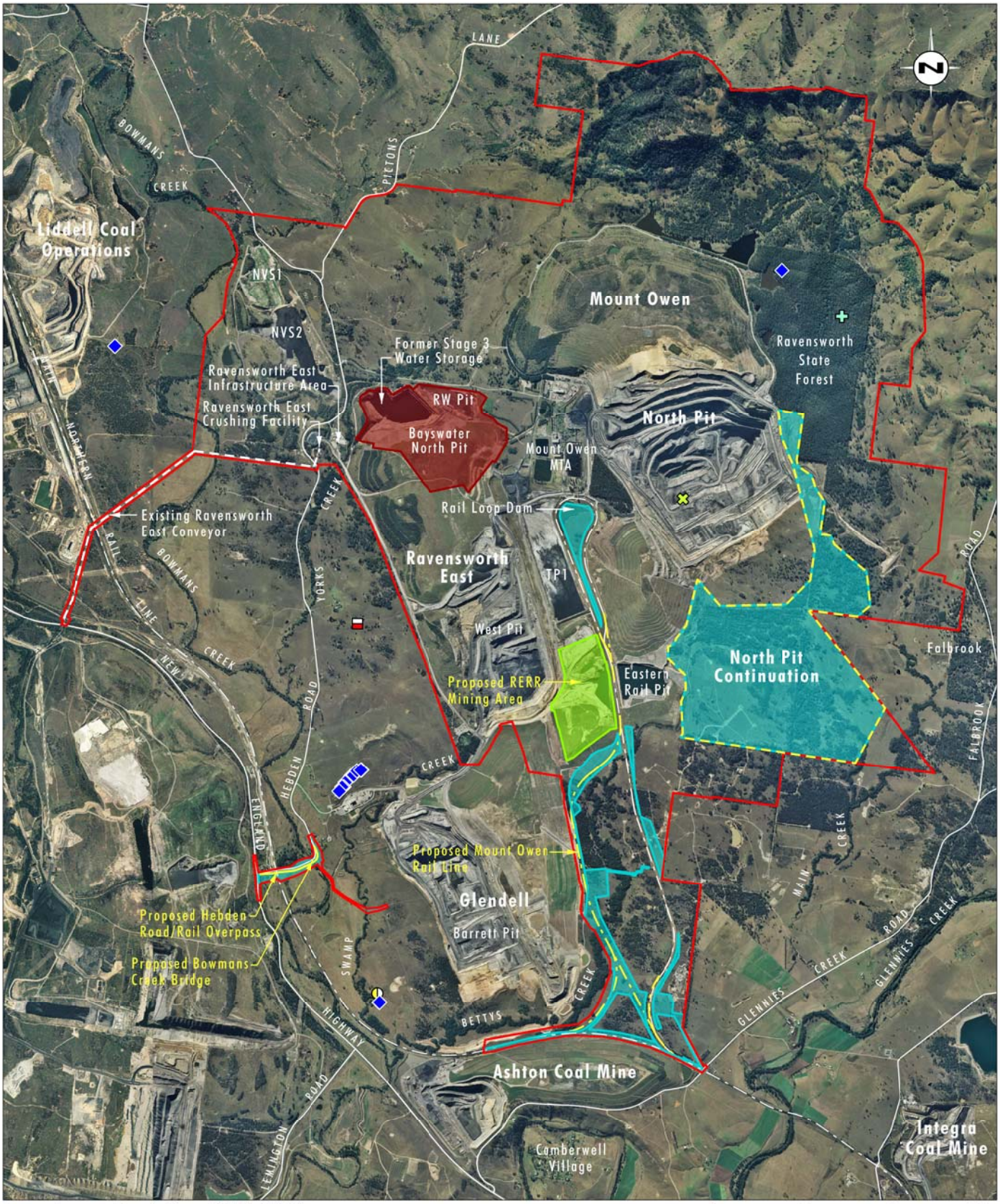

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014), Atlas (2012), Umwelt (2012)

0 1 2 3 km
1:60 000

Legend

- Project Area
- Proposed Disturbance Area
- Proposed North Pit Continuation
- Proposed Rail Upgrade Works
- Proposed Hebden Road Upgrade Works
- Proposed RERR Mining Area
- Bayswater North Pit
- *Acacia pendula* population in the Hunter Catchment
- *Cymbidium canaliculatum* population in the Hunter Catchment
- *Eucalyptus camaldulensis* population in the Hunter Catchment
- *Eucalyptus glaucina*
- *Ozothamnus tesselatus*

FIGURE 4.2

Threatened Flora Species and Endangered Populations within the Project Area and Surrounds

File Name (A4): R03/3109_814.dgn
20141008 16.18

- http://www.environment.nsw.gov.au/threatenedspecies.

Unless indicated otherwise.

4.1.5.1 Threatened Flora Species

Slaty Red Gum – *Eucalyptus glaucina*

Slaty red gum is listed as vulnerable under the TSC and EPBC Acts. The species is found only on the north coast of NSW and in separate districts including from Taree to Broke, west of Maitland. It grows in grassy woodland and dry eucalypt forest.

Despite the substantial amount of field sampling that has been conducted across the Proposed Disturbance Area and Project Area generally, only one specimen has been recorded which has subsequently been removed by approved mining operations in the current north pit. It is therefore unlikely that this species occurs in the Proposed Disturbance Area.

Ozothamnus tesselatus

Ozothamnus tesselatus is listed as vulnerable under the TSC and EPBC Acts. The species is restricted to a few locations in an east-west zone south of Bunnan and between west Bylong and Ravensworth and grows in eucalypt woodland.

The species has been previously recorded during surveys undertaken within Ravensworth State Forest in the north-east of the Proposed Disturbance Area (Cole 2004). The species was not recorded during Umwelt surveys in the Proposed Disturbance Area, despite target surveys. The species may occur in the habitats around Ravensworth State Forest.

4.1.5.2 Endangered Flora Populations

Three endangered flora populations listed under the TSC Act have been recorded in proximity to the Project Area. The locations of the endangered flora populations are shown on **Figure 4.1**.

***Cymbidium canaliculatum* Population in the Hunter Catchment**

Cymbidium canaliculatum in the Hunter Catchment is listed as an EP under the TSC Act. The Hunter population of tiger orchid (*Cymbidium canaliculatum*) is known to occur naturally as far south as Weston and Pokolbin in the lower Hunter, which represents its south-eastern geographic limit, but appears to be more centred in the upper Hunter, predominantly north of Singleton.

A tiger orchid was recorded in a eucalypt east of Hebden Road, however does not occur in the Project Area or Proposed Disturbance Area.

Acacia pendula Population in the Hunter Catchment

Acacia pendula in the Hunter Catchment is listed as an EP under the TSC Act. The Hunter population is known to occur naturally as far east as Warkworth, and extends north-west to Muswellbrook and to the west of Muswellbrook at Wybong.

Weeping myall (*Acacia pendula*) has been previously recorded along Swamp Creek near the Project Area and in the north of Ravensworth State Forest. The species is also present and naturally recruiting within a planted rehabilitation area to the west of the Glendell site office outside the Project Area. The naturally recruiting *Acacia pendula* conforms to the Weeping Myall in the Hunter Catchment endangered population; however, *Acacia pendula* or the endangered population does not occur in the Proposed Disturbance Area.

Eucalyptus camaldulensis Population in the Hunter Catchment

Eucalyptus camaldulensis in the Hunter Catchment is listed as an endangered population under the TSC Act. The Hunter population is known to occur from the west at Bylong, south of Merriwa, to the east at Hinton, on the bank of the Hunter River, in the Port Stephens LGA.

River red gum (*Eucalyptus camaldulensis*) has been previously recorded along Swamp Creek near the Project Area. River Red gum has not been recorded in the Proposed Disturbance Area and is not expected to occur.

4.1.5.3 Endangered Ecological Communities Recorded in the Project Area

Two vegetation communities (including a community variant), recorded in the Proposed Disturbance Area, and one recorded in the Project Area conform to descriptions provided by the NSW Scientific Committee of a listed EEC and are described below.

Central Hunter Grey Box – Ironbark Woodland EEC

Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions is listed as an EEC under the TSC Act. The community occurs in the central Hunter Valley between Singleton and Muswellbrook. It is known to occur in the Cessnock, Singleton and Muswellbrook LGAs. Central Hunter Grey Box – Ironbark Woodland recorded in the Proposed Disturbance Area conforms to this EEC.

This community has been recorded south-west of Glendell Mine within the Proposed Disturbance Area and in the north-west of the Project Area near Hebden Road. The Project Area contains approximately 82.6 hectares of the community, of which approximately 4.4 hectares occurs within the Proposed Disturbance Area.

Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC

Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions is listed as an EEC under the TSC Act. The community occurs in the central Hunter Valley mainly between Maitland and Muswellbrook. It has been recorded from Singleton, Cessnock and Muswellbrook LGAs.

This community has been recorded throughout the Proposed Disturbance Area, particularly on the eastern portion of the Project Area within and around Ravensworth State Forest. The Project Area contains approximately 699.3 hectares of the community, of which 131.9 hectares (including 27.4 hectares of planted forest) occur within the Proposed Disturbance Area.

Hunter Lowland Redgum Forest EEC

Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is listed as an EEC under the TSC Act. The community occurs between Muswellbrook, Beresfield, Mulbring and Cessnock Sydney Basin and North Coast bioregions.

This community has been recorded within the Project Area, concentrated in the Bettys Creek drainage depressions in Ravensworth State Forest and in the south-east corner of the Project Area near Main Creek. A total of 48.7 hectares has been mapped in the Project Area. The community does not occur within the Proposed Disturbance Area.

4.1.5.4 Other Potential Endangered Ecological Communities

A discussion relating to the potential presence of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC and Swamp Oak Floodplain Forest EEC is provided below.

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC

Vegetation communities recorded within the Project Area are not considered to be consistent with White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC. None of the vegetation communities are dominated by Blakely's red gum, and no white box or yellow box or their hybrids are present in the Project Area. None of these species is likely to have previously occurred in any higher level of frequency than it does today, as a result of clearing since European settlement. As there is no white box, yellow box, Blakely's red gum, or their hybrids, present in the Project Area, there is no potential for the CEEC to be present within the Project Area.

Central Hunter Swamp Oak Forest EEC

The Central Hunter Swamp Oak Forest present in the Project Area does not conform to the Swamp Oak Floodplain Forest EEC. Although the particular area of the EEC, and some of the supplementary descriptors, presented in the Final Determination are inclusive of the EEC's presence, the EEC can be ruled out on the following points: a) partly based on the clear intent of the Scientific Committee in limiting the EEC's occurrence to 'rarely above 10 metres elevation'; and b) firmly based on the very restricted number of species listed in the Final Determination that are present at the site (being about 5 per cent).

4.2 Fauna Survey Results

The results of the fauna field surveys are detailed in the following sections. The results in this section include specific fauna survey effort for the Project as well as surveys undertaken as part of the UHSA surveys (Umwelt 2014, in prep) within the Project Area.

4.2.1 Database Searches

The threatened fauna species recorded on the OEH Atlas of NSW Wildlife and Department of Environment Protected Matters Database, based on searches within 10 kilometres of the Project Area, are included in **Appendix A**.

4.2.2 Fauna Habitat of the Proposed Disturbance Area

The assessment of terrestrial fauna habitat identified a range of habitat characteristics which contribute to the distribution, abundance and diversity of terrestrial fauna within the Proposed Disturbance Area.

Several general fauna habitat types were identified during surveys within the Project Area. Each of these broad habitat types has a range of characteristics which influence the habitat value, and the range of fauna species that are likely to be identified within each type. The broad habitat types recorded within the Proposed Disturbance Area consist of woodland and forest, grassland, riparian and aquatic habitat.

4.2.2.1 Woodland and Forest Habitat

Woodland and forest communities occur across most of the Proposed Disturbance Area with trees in a range of age classes dominating the landscape. This habitat type is the most extensive in the Proposed Disturbance Area, comprising approximately 217.7 hectares. Scattered mature trees were identified in a generally even spaced pattern across the site, as expected due to the long history of agriculture prior to the commencement of mining at Ravensworth East (formerly Swamp Creek Mine) in the 1960s. The eucalypt species present within the woodland habitat provide seasonal foraging resources for a number of nectarivorous bird species and mammals, as well as insectivorous bats. The eucalypt species present also provide a nesting resource for small birds (such as the grey fantail, (*Rhipidura fuliginosa*)) and larger birds of prey (such as the black-shouldered kite (*Elanus notatus*)) and also for hollow dependent mammal species such as the squirrel glider (*Petaurus norfolcensis*). Mistletoe is present throughout the woodland habitat, providing a foraging and nesting resource for small birds.

Hollow-bearing trees were present throughout the woodland and tree hollows were recorded in high densities due to the dominance of mature spotted gum in the canopy. Hollows range in size from small (26 to 50 millimetres diameter) to large (100 to 300 millimetres diameter) and occur at a density of approximately 75 per hectare. These hollows could provide nesting habitat for a number of bird species, arboreal mammals and micro-bats, including a range of threatened species. The shrub layer within this habitat type ranges from scarce to medium density, providing shelter for a number of small woodland birds. Scattered logs and rocks within the woodland habitat type provide refuge and foraging habitat for reptiles and amphibians. The grassy understorey provides foraging habitat for macropods and for omnivorous birds such as the Australian magpie (*Gymnorhina tibicen*).

Approximately 1269 hectares of woodland/forest habitat occurs within the Project Area of which 217.7 hectares occurs within the Proposed Disturbance Area.

Table 4.5 provides a summary of the habitat and condition assessment results for woodland and forest communities in the Proposed Disturbance Area. The results for each of the woodland and forest communities have been combined as Woodland/Forest formation as they are considered to provide comparable habitat features across the Proposed Disturbance Area.

Table 4.5 – Summary of Habitat and Condition Assessment Results for Woodland/Forest Formation in the Proposed Disturbance Area

Woodland/Forest Formation		
Total area	217.7 ha	
Vegetation Structure and Health		
Canopy dominants	*C. maculata, E. moluccana*, *E. fibrosa, E. crebra*, *A. luehmannii*	
	Height	**Cover**
Canopy	8 - 20 m	Wide ranging usually between 26 and 50 per cent cover
Mid-storey 1	2 - 10 m	Variable, usually less than 50 per cent cover
Mid-storey 2	0.5 – 7.5 m	Usually less than 25 per cent cover
Ground	<0.8 m	Usually less than 50 per cent cover
Age/maturity	Due to a history of clearing for agriculture, the majority of trees in this formation are of younger age classes, with the DBH range being 12-45 cm. Occasional old (pre 1958), mature trees are present. A wide range of age and size classes were recorded in this formation suggesting uneven aged stands and progressive recruitment.	
Vegetation health	27.4 ha of this formation comprise actively regenerated woodland with a planted overstorey that is considered to be in good condition with active canopy recruitment observed. Despite past impacts from agriculture and mining, the vegetation of the woodland/forest formation is regenerating well and is in good condition. Weed invasion is primarily a concern on disturbed edges, while deeper in the remnants weed density is generally low. Limited dieback, mistletoe or insect attack was observed.	
Disturbances		
Fire	No evidence of fire was observed in this formation.	
Weeds	All sites had only a slight level of weed infestation. Key weed species recorded included fireweed (*Senecio madagascariensis*) prickly pear (*Opuntia stricta* var. *stricta*), and African box thorn (*Lycium ferocissimum*).	
Dieback	The majority of the sites showed only mild signs of dieback, with a small proportion showing evidence of more severe dieback. Dieback is likely to be attributed to the poor seasonal conditions at the time of survey.	
Erosion	Nil to slight evidence of sheet erosion was observed in this formation	
Mistletoe	All sites had a nil to mild density of mistletoe.	
Grazing	Evidence of mild grazing was recorded at most sites. This grazing was attributed to both feral animals and native herbivores.	
Feral animals	Evidence of feral animals was observed including European rabbit (*Oryctolagus cuniculus*) and foxes (*Vulpes vulpes*); it is likely that they would occur reasonably widely throughout this formation.	
Insect attack	No signs of insect attack were recorded in this formation.	
Ground habitats		
Log cover	<25 per cent	
Leaf litter	Variable, usually around 50 per cent cover	
Bare soil	Variable, usually less than 50 per cent	
Specific Habitats and Foraging Resources		
Hollow density	75 per hectare	
Foraging resources	Some canopy trees are winter flowering, providing potential foraging resources for winter migrants such as the swift parrot (*Lathamus discolor*). The diversity of flowering canopy trees in this formation would provide a good resource for a range of nectarivorous species. Small mammals utilising these foraging resources may also be prey for the masked owl (*Ninox novaehollandiae*).	

Table 4.5 – Summary of Habitat and Condition Assessment Results for Woodland/Forest Formation in the Proposed Disturbance Area (cont.)

Woodland/Forest Formation	
Dominant winter-flowering tree species	*C. maculata, E. moluccana*, *E. crebra, E. fibrosa*
Perch sites	Generally moderate density.
Water resources	There are several small farm dams which occur in the vicinity of this formation across the Project Area.

4.2.2.2 Riparian Habitat

The riparian habitat recorded within the Project Area occurs along Bettys Creek and a small area of Bowmans Creek. This habitat type is dominated by swamp oak (*Casuarina glauca*) and river oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*). Riparian vegetation provides a foraging resource for insectivorous birds, and foraging and roosting resources for micro-bats. The shrub layer, although scarce in density, and the grassy groundlayer provides a foraging and refuge resource for small birds, reptiles and amphibians. Some water was present within the generally ephemeral Bettys Creek and Bowmans Creek provides a permanent water source, providing a drinking resource for native fauna as well as a foraging, refuge and breeding resource for amphibians.

Approximately 85.5 hectares of riparian habitat occurs within the Project Area of which 6.0 hectares occurs within the Proposed Disturbance Area. **Table 4.6** provides a summary of the habitat and condition assessment results for woodland and forest communities in the Proposed Disturbance Area.

Table 4.6 – Summary of Habitat and Condition Assessment Results for Riparian Formation in the Proposed Disturbance Area

Riparian Formation		
Total area	6.0 ha	
Vegetation Structure and Health		
Canopy dominants	*Casuarina glauca*	
	Height	**Cover**
Canopy	5 -15 m	<25 per cent
Mid-storey 1	2-5 m	<25 per cent
Mid-storey 2	1-2 m	<25 per cent
Ground	<1 m	51-75 per cent
Age/maturity	No old growth trees were recorded in this formation. Trees recorded were mature or middle aged, or regenerating. The DBH of regenerating trees formed a large range suggesting that progressive regeneration has occurred in this formation.	
Vegetation health	Despite past impacts from agriculture and mining, the vegetation of the riparian formation is regenerating well and is in good condition. Weed invasion is primarily a concern on disturbed edges. Limited dieback, mistletoe or insect attack was observed.	
Disturbances		
Fire	No evidence of fire was observed in this formation.	
Weeds	All sites had slight to medium levels of weed infestation. Key weed species recorded included galenia (*Galenia pubescens*), spear thistle (*Cirsium vulgare*) and African boxthorn (*Lycium ferocissimum*).	

Table 4.6 – Summary of Habitat and Condition Assessment Results for Riparian Formation in the Proposed Disturbance Area (cont.)

Riparian Formation	
Dieback	The majority of the sites showed evidence of mild dieback. This is likely to be as a result of overtopping and or dry conditions,
Erosion	No evidence of erosion was recorded in this formation.
Mistletoe	No evidence of mistletoe was recorded in this formation.
Grazing	Low levels of grazing were recorded in this formation, likely caused by rabbits and hares and native grazers.
Feral animals	Evidence of feral animals was observed; European rabbit (*Oryctolagus cuniculus*) and red fox (*Vulpes vulpes*).
Insect attack	No sites showed any sign of insect attack
Ground Habitats	
Log cover	Very few logs were recorded in this formation.
Vegetation Structure and Health	
Leaf litter	Generally less than 25 per cent
Bare soil	<25 per cent
Specific Habitats and Foraging Resources	
Hollow density	No hollows were recorded in this formation.
Foraging resources	Specific glossy black-cockatoo (*Calyptorhynchus lathami*) foraging trees were recorded in the riparian formation. No canopy trees are winter flowering, thus not providing potential foraging resources for winter migrants such as the swift parrot (*Lathamus discolor*). The lack of diversity of flowering canopy trees in this formation would fail to provide resource for a range of nectarivorous species. Small mammals utilising these foraging resources may also be prey for the masked owl (*Ninox strenua*).
Dominant winter-flowering tree species	No winter flowering trees present.
Perch sites	Generally low density.
Water resources	This riparian formation is situated along creeklines, which provided water resources.

4.2.2.3 Shrubland Habitat

Shrubland habitat occurs in one small area in the Proposed Disturbance Area, providing habitat for a variety of native fauna species. This habitat is considered to be derived from surrounding woodland/forest habitats, with expansion of the community likely a result of ground disturbance in this area that facilitated the development of the habitat. Small mammals such as antechinus (*Antechinus* spp.) and small woodland birds such as the speckled warbler (*Chthonicola saggitatus*) are provided foraging habitat as well as refuge habitat within the dense shrub layers. This habitat type also provides foraging and refuge habitat for a number of reptile species and amphibians.

Approximately 4.7 hectares of shrubland habitat occurs within the Project Area which occurs entirely within the Proposed Disturbance Area. **Table 4.7** provides a summary of the habitat and condition assessment results for shrubland habitat.

Table 4.7 – Summary of Habitat and Condition Assessment Results for Shrubland Formation in the Proposed Disturbance Area

Shrubland Formation		
Total area	4.7 ha	
Vegetation Structure and Health		
Canopy dominants	Generally, a tree canopy is absent from the shrubland formation, however scattered remnant trees do occur.	
	Height	**Cover**
Canopy	Generally absent	Generally absent
Mid-understorey 1	0.5- 5 m	70-90 per cent
Mid-understorey 2	-	-
Ground	<0.5 m	Up to 25 per cent
Age/maturity	There are very few canopy trees scattered through the shrubland formation. Where present, these are generally regenerating young to middle-aged trees. There are very few large mature trees present.	
Vegetation health	Good	
Disturbances		
Fire	No evidence of fire was observed in the shrubland formation.	
Weeds	Minor infestation of fireweed (*Senecio madagascariensis*) was recorded in this formation.	
Dieback	Moderate die-back was recorded across this formation and is expected to be as a result of the growth habit of the species present.	
Erosion	No erosion was recorded in this formation.	
Mistletoe	Minor evidence of mistletoe was recorded in this area.	
Grazing	Minor evidence of grazing in this formation was recorded and attributed to brown hare (*Lepus capensis*) and European rabbit (*Oryctolagus cuniculus*).	
Feral animals	Evidence of brown hare (*Lepus capensis*) was recorded and it is likely that a moderate population of European rabbit (*Oryctolagus cuniculus*) and red fox (*Vulpes vulpes*) also occurs.	
Insect attack	Mild insect attack was recorded in some areas of this formation while others showed no signs of attack.	
Ground Habitats		
Log cover	Overall, log cover in the shrubland formation was low; however occasional old rotting logs were recorded.	
Leaf litter	Leaf litter cover was low, in the 1 – 25 per cent cover range.	
Bare soil	Low levels of bare soil were recorded across this formation.	
Specific Habitats and Foraging Resources		
Hollow density	The hollow density is very low in this formation given the general lack of a canopy stratum.	
Foraging resources	Foraging resources in this formation may be high during the flowering period of the dominant species but low during the remainder of the year.	
Dominant winter-flowering tree species	Only tree species present was *Allocasuarina luehmannii*	
Perch sites	Given the lack of a tree stratum, there is a very low abundance of perch sites in the shrubland formation.	
Water resources	This area is low-lying and subject to inundation in times of high rainfall.	

4.2.2.4 Native Grassland Habitat

Native grassland habitat occurs widely across the Project Area and Proposed Disturbance Area, providing habitat for a variety of native fauna species, albeit for most fauna species it represents marginal habitat. The large areas of open grassland provide a foraging resource for macropods and a hunting resource for owls and micro-bats. Small mammals such as antechinus (*Antechinus* spp.) are provided foraging habitat as well as refuge habitat within the dense grass layers. This habitat type also provides foraging and refuge habitat for a number of reptile species and amphibians.

Approximately 1434 hectares of native grassland habitat occurs within the Project Area of which 223.1 hectares occurs within the Proposed Disturbance Area. **Table 4.8** provides a summary of the habitat and condition assessment for the grassland formation.

Table 4.8 – Summary of Habitat and Condition Assessment Results for Grassland Formation in the Proposed Disturbance Area

Grassland Formation		
Total area	223.1 ha	
Vegetation Structure and Health		
Canopy dominants	Generally, a tree canopy is absent from the grassland formation, however scattered remnant trees do occur.	
	Height	**Cover**
Canopy	Generally absent	Generally absent
Mid-understorey 1	-	-
Mid-understorey 2	-	-
Ground	<0.7 m	70-90 per cent
Age/maturity	There are very few canopy trees scattered through the grassland formation. Where present, these are generally mixed in ages ranging from regenerating young to large mature trees.	
Vegetation health	Good	
Disturbances		
Fire	No evidence of fire was observed in the grassland formation.	
Weeds	Weed abundance is variable across this formation, ranging from 15 per cent to 50 per cent cover. Commonly recorded weed species include fireweed (*Senecio madagascariensis*), flat weed (*Hypochaeris radicata*) and plantain (*Plantago lanceolata*).	
Dieback	No dieback was observed within any sites assessed within the grassland formation. It is likely that slight to mild dieback occurs in the few scattered canopy trees that occur in this formation.	
Erosion	Due to the history of mining and formerly grazing in the Project Area, there is evidence of sheet erosion where the ground has been heavily impacted. Furthermore, due to the widespread removal of woody vegetation, there is mild to moderate gully erosion in areas of water flow across the landscape. Evidence of erosion was recorded across this formation; it is expected that due to the nature of the grassland that the potential for erosion to occur is higher than other formations.	
Mistletoe	No evidence of mistletoe in the grassland formation was observed at any of the sites assessed. There is potential for occurrence of mistletoe in the few scattered canopy trees that occur in this formation.	
Grazing	Evidence of grazing was present across the formation. This grazing was attributed to feral animals such as European rabbit (*Oryctolagus cuniculus*) and brown hare (*Lepus capensis*). Grazing pressure ranged from moderate to mild.	

Table 4.8 – Summary of Habitat and Condition Assessment Results for Grassland Formation in the Proposed Disturbance Area (cont.)

Disturbances	
Feral animals	Evidence of feral animals was observed in the grassland formation, specifically evidence of as European rabbit (*Oryctolagus cuniculus*) and brown hare (*Lepus capensis*). It is likely that the red fox (*Vulpes vulpes*) also occurs in this formation in moderate numbers.
Insect attack	Little evidence of insect attack in the remnant canopy trees was observed.
Ground Habitats	
Log cover	Very few logs were recorded in this formation, occasional logs were recorded. These were usually seasoned timber with no bark remaining, some contained hollows while others appeared to be solid.
Leaf litter	Leaf litter cover was generally low throughout this formation.
Bare soil	The extent of bare soil across this formation was generally low, comprising less than 25 per cent cover.
Specific Habitats and Foraging Resources	
Hollow density	The hollow density is very low in this formation given the general lack of a tree stratum.
Foraging resources	The foraging resources in this formation would be limited due to the highly modified structure of the vegetation. The flowering canopy trees provide limited foraging resources for nectarivorous and insectivorous species, and there are a range of small birds which would benefit from foraging in the grassland, particularly in taller areas of grassland which have been left free of grazing long enough to develop seed heads on the grasses.
Dominant winter-flowering tree species	None.

4.2.2.5 Aquatic Habitat

Aquatic habitat is limited in the Proposed Disturbance Area and wider Project Area. A small area of Bowmans Creek occurs within the Proposed Disturbance Area which represents the only perennial aquatic habitat while ephemeral drainage lines, farm dams, mine water dams and water fill points also occur in other parts of the Proposed Disturbance Area. Fifteen farm dams are located within the Proposed Disturbance Area, and these provide a water source for native fauna. The dams also provide a foraging and refuge resource for a diverse and abundant number of amphibian species, particularly in those dams where fringing vegetation is present.

A full description of aquatic habitat is provided in **Section 4.3**.

4.2.3 Fauna Species Recorded

A total of 271 fauna species have been recorded in the Project Area. An outline and discussion of the species recorded within each of the four major fauna groups is presented in the following sections.

A list of all fauna species recorded within the Project Area is presented in **Appendix C** of this report. This species list was compiled from data from the OEH Atlas of NSW Wildlife, species recorded during field surveys undertaken by Umwelt from 2011 to 2014, as well as records from the 18 years of biodiversity monitoring of the Mount Owen Complex by the University of Newcastle (TUNRA and Newcastle Innovation), Forest Fauna Surveys Pty Ltd and Fly By Night Pty Ltd) (refer to **Section 3.1** and **Figure 3.1** for details of survey locations).

Records of fauna species should be interpreted carefully, since a record of a species within a particular area does not suggest it only occurs within that specific part of the Project Area, and not within other parts. The high levels of mobility of many fauna species (particularly many birds and mammals) mean that those species could readily occur in areas other than where they were recorded.

The discussions below include the total numbers of each of the fauna groups, based on project specific surveys and annual fauna monitoring results. Descriptions of commonly recorded or notable species relates to observations within the Proposed Disturbance Area, unless otherwise specified.

4.2.3.1 Birds

A total of 174 bird species have been recorded in the Project Area. Fifty-four families are represented with Meliphagidae (honeyeaters) recording 18 species, the Acanthizidae (warblers) recording 12 species, the Accipitridae (eagle, hawks and kites) and Columbidae (pigeons and doves) recording 9 species each.

Some of the more frequently observed bird species recorded in woodland communities included the noisy miner (*Manorina melanocephala*), rufous whistler (*Pachycephala rufiventris*), grey fantail (*Rhipidura fuliginosa*) eastern rosella (*Platycercus eximius*), willie wagtail (*Rhipidura leucophrys*), yellow thornbill (*Acanthiza chrysorrhoa*), noisy friarbird (*Philemon corniculatus*), black-faced cuckoo-shrike (*Coracina novaehollandiae*), Australian magpie (*Gymnorhina tibicen*), pied butcherbird (*Cracticus nigrogularis*), Australian raven (*Corvus coronoides*) and white-winged chough (*Corcorax melanorhamphos*).

Nocturnal birds are well represented in the Project Area with a total of seven species recorded. The masked owl (*Tyto novaehollandiae*), southern boobook (*Ninox novaeseelandiae*) and Australian owlet nightjar (*Aegotheles cristatus*) are known to occur in the Proposed Disturbance Area.

The galah (*Cacatua roseicapilla*) and Australian pipit (*Anthus novaeseelandiae*) were commonly recorded in grassland habitats.

Farm dams and mine water storage facilities provided a permanent area of aquatic habitat for 26 species. Commonly recorded species included the Australian wood duck (*Chenonetta jubata*), Pacific black duck (*Anas superciliosa*) and Australasian grebe (*Tachybaptus novaehollandiae*).

Three introduced species were recorded: the common starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*) and Indian myna (*Acridotheres tristis*). These species are generally recorded around the existing mine offices and workshop.

Fifteen threatened bird species are known to occur in the Project Area and each of these species have been recorded or are expected to occur in the Proposed Disturbance Area. The speckled warbler (*Chthonicola saggitatus*), brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*), scarlet robin (*Petroica boodang*), hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*), varied sittella (*Daphoenositta chrysoptera*) and little lorikeet (*Glossopsitta pusilla*) are the most commonly recorded threatened species. The endangered swift parrot (*Lathamus discolor*) was recorded in Ravensworth State Forest during annual fauna monitoring surveys, foraging in prolifically flowering canopy species in 2005 and 2007. The location of threatened bird species are shown on **Figure 4.3**

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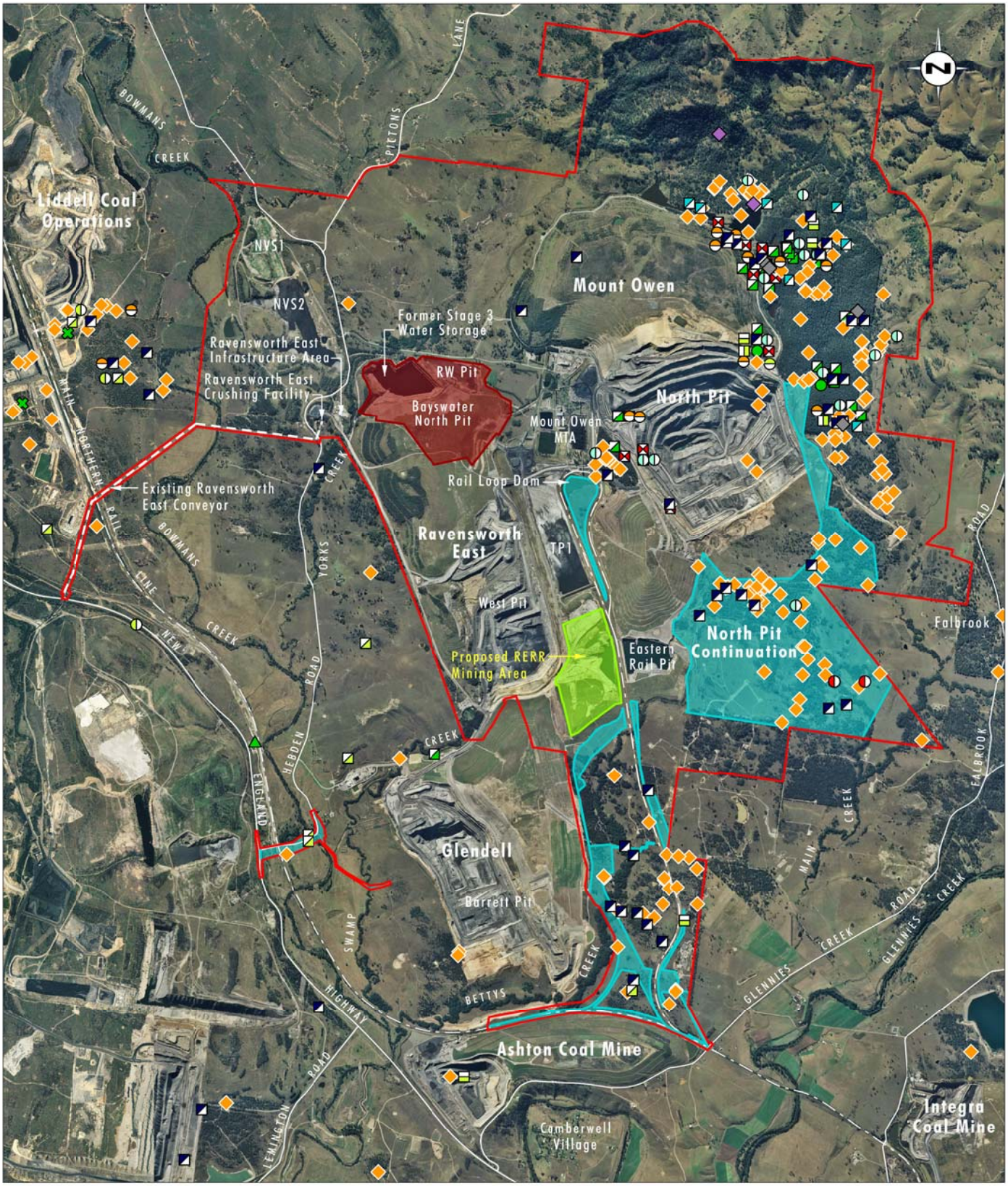

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014), Atlas (2013), Umwelt (2008, 2012)

0 1 2 3km
1:60 000

Legend

- Project Area
- Proposed Disturbance Area
- Proposed RERR Mining Area
- Bayswater North Pit
- Black-chinned Honeyeater (eastern subspecies)
- Black-necked Stork
- Blue-billed Duck
- Brown Treecreeper (eastern subspecies)
- Diamond Firetail
- Flame Robin
- Grey-crowned Babbler (eastern subspecies)
- Hooded Robin (south-eastern form)
- Little Eagle
- Little Lorikeet
- Masked Owl Pellet Location
- Masked Owl
- Powerful Owl
- Scarlet Robin
- Speckled Warbler
- Spotted Harrier
- Swift Parrot
- Varied Sittella

FIGURE 4.3

Threatened Avifauna Species within the Project Area and Surrounds

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20140905 9.53

Of the species recorded, seven species listed on international migratory species conventions have been recorded, including the cattle egret (*Ardea ibis*). These species are protected under the schedules of the EPBC Act which have been formulated to protect migratory and marine species listed under international conventions. These species are addressed further in **Section 5.6.4** and **Appendix F**.

4.2.3.2 Reptiles

Twenty-seven species have been recorded within the Project Area comprising a total of eight reptile families, with the skink family (Scincidae) being the most well represented.

The most commonly encountered reptile species in the Proposed Disturbance Area were the lace monitor (*Varanus varius*), bearded dragon (*Pogona barbata*), tree-base litter skink (*Lygisaurus foliorum*) and the southern rainbow skink (*Carlia tetradactyla*). The snake-necked turtle (*Chelodonia longicollis*) was commonly recorded in dams and two snakes, the red-bellied black snake (*Pseudechis porphyriacus*) and eastern brown snake (*Pseudonaja textilis*) were also recorded.

No threatened reptile species have been recorded or are expected to occur in the Proposed Disturbance Area or wider Project Area.

4.2.3.3 Amphibians

Seventeen species of frog have been recorded in the Project Area comprising eight species of Myobatrachidae (southern frogs) and nine tree frogs from the family Hylidae. Frog species diversity is considered to be relatively high for the central Hunter Valley area.

Farm dams were found to comprise the most important breeding habitat within the Proposed Disturbance Area. The green and golden bell frog has been recorded within the Project Area in the early years of monitoring (1994, 1996, 1997 and 1999) however no additional green and golden bell frog records have been confirmed since the 1999 record in Bettys Creek. The location of historic green and golden bell frog records is shown on **Figure 4.4**.

The most commonly recorded frogs were the common eastern froglet (*Crinia signifera*), smooth toadlet (*Uperoleia fusca*), broad-palmed frog (*Litoria latopalmata*), dwarf tree frog (*Litoria fallax*) and Perons tree frog (*Litoria peronii*).

4.2.3.4 Mammals

Fifty-three mammal species have been recorded within the Project Area with the most common family (Vespertilionidae) recording 15 species.

Four arboreal mammal species has been recorded in the Project Area, including the common brush-tailed possum (*Trichosurus vulpecula*) and the common ringtail possum (*Pseudocheirus peregrinus*) are commonly recorded and the squirrel glider (*Petaurus norfolcensis*) is also commonly recorded during monitoring surveys and during inspections of nest boxes. The brush-tailed phascogale (*Phascogale tapoatafa*) is known to occur in regenerating habitats in the New Forest Area in the north of the Project Area. This species is difficult to detect using standard fauna survey techniques (Forest Fauna Surveys and Newcastle Innovation 2014) and was identified using nest boxes during spotlighting. Ground-dwelling mammals are represented by nine species with the most commonly recorded being the yellow-footed antechinus (*Antechinus flavipes*) and common dunnart (*Sminthopsis murina*). The introduced house mouse (*Mus musculus*) and black rat (*Rattus rattus*) were also recorded.

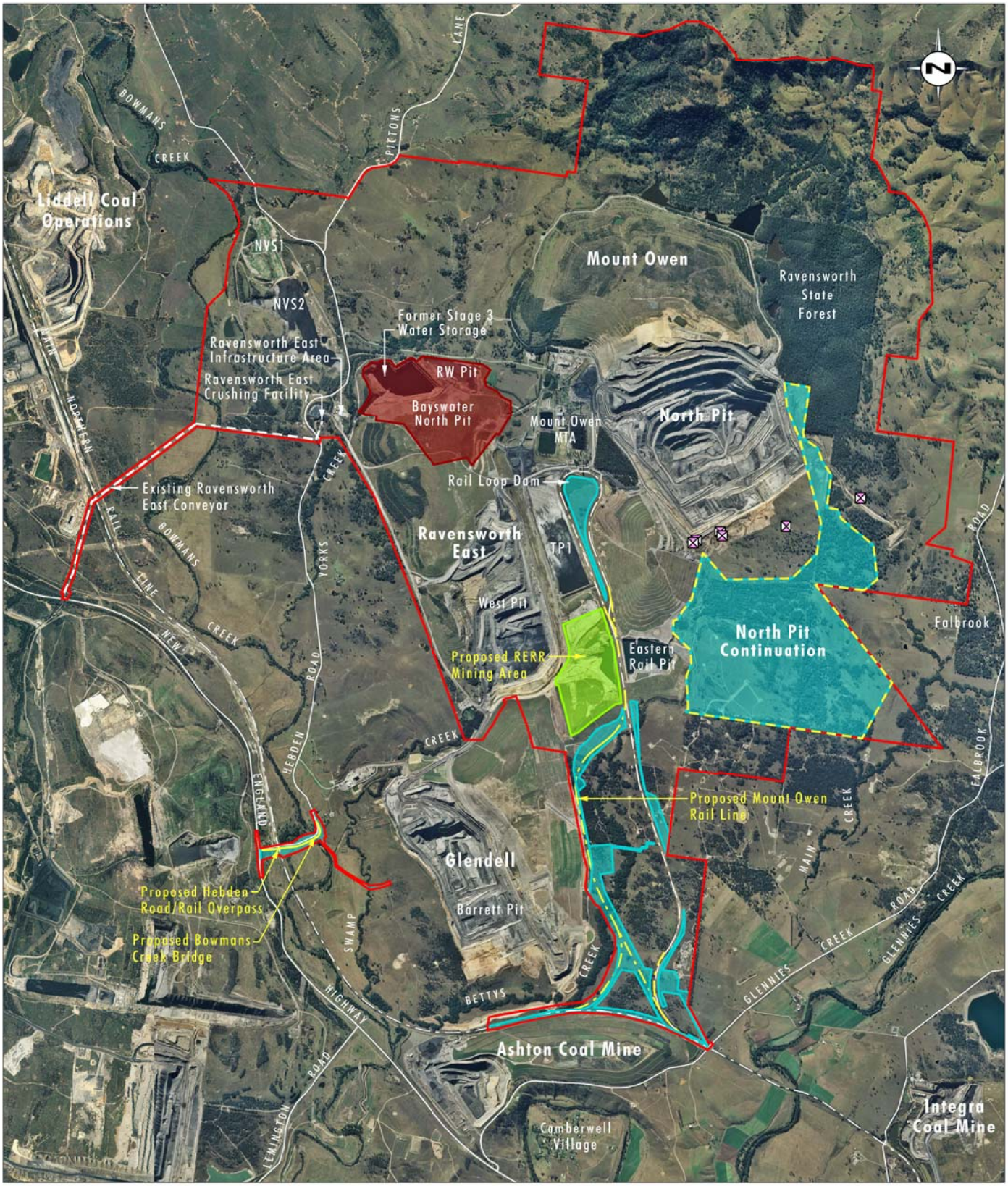

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014), Atlas (2012), Umwelt (2012)

0 1 2 3km
1:60 000

Legend

- Project Area
- Proposed Disturbance Area
- Proposed RERR Mining Area
- Bayswater North Pit
- Proposed North Pit Continuation
- Proposed Rail Upgrade Works
- Proposed Hebden Road Upgrade Works
- Green and Golden Bell Frog

FIGURE 4.4

Threatened Amphibian Species within the Project Area and Surrounds

File Name (A4): R03/3109_816.dgn
20140902 10.45

Four species of macropod are known to occur in the Project Area comprising the eastern grey kangaroo (*Macropus giganteus*), common wallaroo (*Macropus robustus*), swamp wallaby (*Wallabia bicolor*) and red-necked wallaby (*Macropus rufogriseus*). Each of these species was principally observed in the open grassland areas and were also less frequently recorded in the woodland communities.

Twelve threatened mammal species are known to occur within the Project Area, including the spotted-tailed quoll (*Dasyurus maculatus*), brush-tailed phascogale (*Phascogale tapoatafa*), New Holland mouse (*Pseudomys novaehollandiae*), squirrel glider (*Petaurus norfolcensis*), yellow-bellied sheathtail bat (*Saccolaimus flaviventris*) eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), little bentwing-bat (*Miniopterus australis*), southern myotis (*Myotis macropus*), east coast freetail-bat (*Mormopterus norfolkensis*), large-eared pied bat (*Chalinolobus dwyeri*), greater broad-nosed bat (*Scoteanax ruppellii*) and grey-headed flying-fox (*Pteropus poliocephalus*). The koala (*Phascolarctos cinereus*) was identified adjacent to the corner of Hebden Road and the New England Highway, within the Project Area in 2012 and historic records of the species are known in the local area. The New Holland mouse has only been recorded in mine rehabilitation areas and regenerating habitats. The location of the threatened mammal species recorded in the Project Area is shown on **Figure 4.5**.

Ten introduced mammal species are known to occur within the Project Area including feral dogs (*Canis familiaris*), fox (*Vulpes vulpes*) and the European rabbit (*Oryctolagus cuniculus*).

4.2.4 Threatened Fauna Records

A table of all threatened fauna species and EPs known to occur in the local area is provided in **Appendix A**. **Table 4.9** below lists the threatened fauna species recorded within the Project Area and/or the Proposed Disturbance Area. The Proposed Disturbance Area and wider Project Area is not considered to provide habitat for any listed endangered fauna populations.

Table 4.9 – Threatened Fauna Species Recorded in the Project Area and Proposed Disturbance Area

Species Name	Status		Recorded in Project Area?	Recorded in Proposed Disturbance Area?
Common name ***Scientific name***	**TSC Act 1995**	**EPBC Act 1999**		
swift parrot *Lathamus discolor*	E	E	✓	×
spotted-tailed quoll *Dasyurus maculatus*	V	E	✓	✓
green and golden bell frog *Litoria aurea*	E	V	✓	×
koala *Phascolarctos cinereus*	V	V	✓	✓
New Holland mouse *Pseudomys novaehollandiae*	-	V	✓	×
grey-headed flying-fox *Pteropus poliocephalus*	V	V	✓	×
large-eared pied bat *Chalinolobus dwyeri*	V	V	✓	×
little eagle *Heiraaetus morphnoides*	V	-	✓	×
spotted harrier *Circus assimilis*	V	-	✓	✓

Table 4.9 – Threatened Fauna Species Recorded in the Project Area and Proposed Disturbance Area (cont.)

Species Name	Status		Recorded in Project Area?	Recorded in Proposed Disturbance Area?
Common name ***Scientific name***	**TSC Act 1995**	**EPBC Act 1999**		
little lorikeet *Glossopsitta pusilla*	V	-	✓	✓
powerful owl *Ninox strenua*	V	-	✓	×
masked owl *Tyto novaehollandiae*	V	-	✓	✓
brown treecreeper *Climacteris picumnus victoriae*	V	-	✓	×
speckled warbler *Chthonicola saggitata*	V	-	✓	✓
black-chinned honeyeater *Melithreptus gularis gularis*	V	-	✓	×
grey-crowned babbler *Pomatostomus temporalis temporalis*	V	-	✓	✓
varied sittella *Daphoenositta chrysoptera*	V	-	✓	×
hooded robin *Melanodryas cucullata cucullata*	V	-	✓	×
scarlet robin *Petroica boodang*	V	-	✓	×
flame robin *Petroica phoenicea*	V	-	✓	×
diamond firetail *Stagonopleura guttata*	V	-	✓	✓
brush-tailed phascogale *Phascogale tapoatafa tapoatafa*	V	-	✓	×
squirrel glider *Petaurus norfolcensis*	V	-	✓	✓
yellow-bellied sheathtail bat *Saccolaimus flaviventris*	V	-	✓	×
east coast freetail-bat *Mormopterus norfolkensis*	V	-	✓	✓
little bentwing-bat *Miniopterus australis*	V	-	✓	×
eastern bentwing-bat *Miniopterus schreibersii oceanensis*	V	-	✓	✓
southern myotis *Myotis macropus*	V	-	✓	✓
greater broad-nosed bat *Scoteanax rueppellii*	V	-	✓	✓

Notes: E = endangered
V = vulnerable

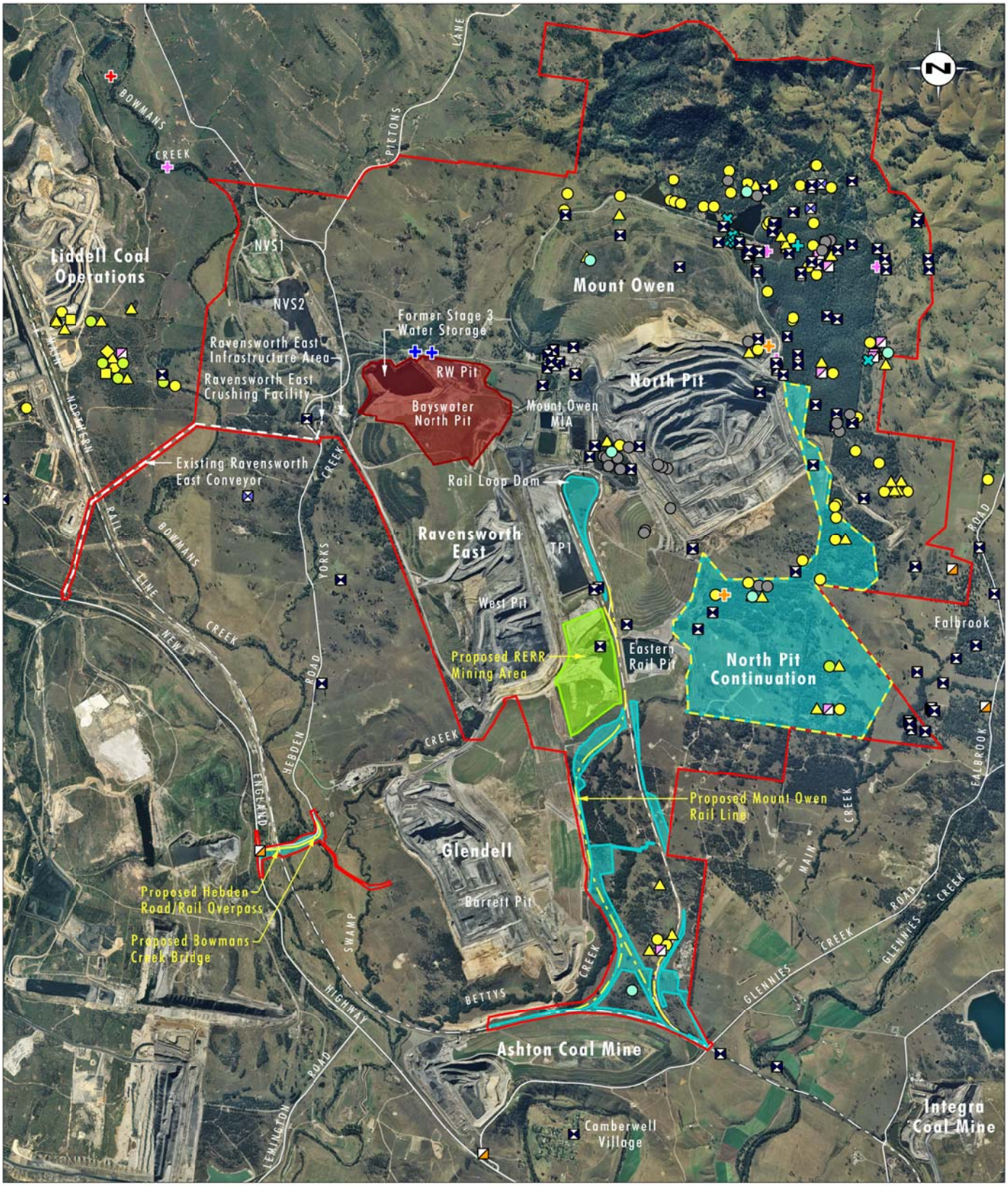

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014), Atlas (2013), Umwelt (2012)

0 1 2 3km
1:60 000

Legend

- Project Area
- Proposed Disturbance Area
- Proposed RERR Mining Area
- Bayswater North Pit
- Proposed North Pit Continuation
- Proposed Rail Upgrade Works
- Proposed Hebden Road Upgrade Works
- Brush-tailed Phascogale
- East-coast Freetail Bat
- Eastern Bentwing-bat
- Eastern Cave Bat
- Eastern False Pipistrelle
- Greater Broad-nosed Bat
- Grey-headed Flying-fox
- Koala
- Little Bentwing-bat
- New Holland Mouse
- Southern Myotis
- Spotted-tailed Quoll
- Squirrel Glider
- Yellow-bellied Sheathtail-bat

Other Features:
- Spotted-tailed Quoll Den Site
- Spotted-tailed Quoll Latrine Site
- Juvenile Spotted-tailed Quoll Road Kill - indicative

FIGURE 4.5

Threatened Mammal Species within the Project Area and Surrounds

File Name (A4): R03/3109_817.dgn
20140902 10.48

4.2.4.1 Threatened Fauna Species Recorded in the Project Area

The following threatened species (as listed under the TSC Act and EPBC Act) were recorded within the Proposed Disturbance Area or wider Project Area either as part of the current survey, or from other sources such as annual monitoring surveys, databases searches or literature reviews. The location of each of the threatened species is shown on **Figures 4.3**, **4.4** and **4.5**.

A précis of ecological requirements for each species is provided, sourced from the OEH Threatened Species website:

- http://www.environment.nsw.gov.au/threatenedspecies

and site specific information from annual fauna monitoring results unless indicated otherwise. Details of the number and location of records for each species are provided also, as well as any other relevant ecological information relating to these records.

Green and Golden Bell Frog – *Litoria aurea*

The green and golden bell frog is listed as endangered under the TSC Act and vulnerable under the EPBC Act. A small population of the species is known from the central Hunter Valley, known as the Upper Hunter Green and Golden Bell Frog Key Population (DECC 2007).

The species was formerly distributed from the NSW North Coast near Brunswick Heads southwards along the NSW coast to Victoria, where it extends into East Gippsland and west to Bathurst, Tumut and the ACT. In the 1960s, the species was considered widespread, abundant and commonly encountered (DECC 2007). In the Hunter, the species is now only known from three key populations: occurring in the lower Hunter on Kooragang and Ash Island; the mid Hunter in the Gilleston Heights area and in the upper Hunter located between Singleton and Muswellbrook.

The Proposed Disturbance Area forms part of the Upper Hunter Green and Golden Bell Frog Key Population consisting of one main diffuse population at, or in the vicinity of, the Ravensworth and Liddell area and bordering areas of the Singleton and Muswellbrook LGA (DECC 2007). The Upper Hunter Key Population is one of two inland populations of the species and is known from eight verified locations. The population is assumed to have a diffuse distribution across lands encompassed by these locations and has been recorded sporadically, probably caused by climatic circumstances and/or seasonal life cycle changes of the species (DECC 2007). It is considered highly likely that the precipitous state of the Upper Hunter population is directly due to the impact of disease rather than habitat or other ecological factors (Forest Fauna Surveys and Newcastle Innovation 2014).

The green and golden bell frog was 'rediscovered' in the upper Hunter in 1994 at Mount Owen mine where it was subsequently recorded 1996, 1997 and 1999 (Forest Fauna Surveys and Newcastle Innovation 2014). An unconfirmed record of the species exists from 2005 at this location from constructed habitats (Forest Fauna Surveys and Newcastle Innovation 2014). No more than three individuals were recorded at any one time at Mount Owen. All confirmed records in recent times for the Upper Hunter population detail only low numbers of adult individuals (DECC 2007, Umwelt 2010).

An additional unconfirmed record of the species exists from the north-west shore of Lake Liddell in 2006 (DECC 2007) and the species was recently recorded during surveys for the Ravensworth North Project in 2009 and previously in that locality in 1998 and 2000 (Umwelt 2010). The Ravensworth North Offset Area was established to conserve the known habitat of the species in the Ravensworth North Project Area (Umwelt 2010) (refer to **Figure 2.1**).

The green and golden bell frog population within the Project Area has been monitored annually since its discovery in Bettys Creek in 1994, conducted by frog researchers from the University of Newcastle. Despite extensive surveys, the species has not been recorded in the Project Area since 1999, although an unconfirmed report of a single calling male during August 2005 was made (J Rennie, Earthtech, pers. comm.) at a small pond on a drainage line that enters Main Creek. However, intensive monitoring of this pond over the summer of 2005/2006 did not produce further evidence of the species; that is, no tadpoles, juveniles or adults were located, or calls heard in response to call playback surveys. The record has remained unconfirmed by physical identification. Nevertheless, it is possible that a transient male was present at this pond, but there is no evidence of the pond being utilised for breeding (Fly by Night Surveys *et al*. 2006).

The absence of individuals at historical sites, or the intermittent observation of single individuals, or very small numbers of green and golden bell frogs, fits with the pattern of observation of bell frogs in the Upper Hunter over a period of more than a decade. Records of the species in the Project Area indicate an area of historic habitat for the green and golden bell frog as the species has not been confidently recorded since 1999. The Upper Hunter, which is at the inland edge of the current, contracted distribution of the bell frog, appears to support only a precarious regional population that cannot be regarded as secure (DECC 2007). The disturbance area is considered to comprise potential habitat for this species.

A detailed assessment of significance for the green and golden bell frog is provided in **Section 5.6**.

Swift Parrot – *Lathamus discolor*

The swift parrot is listed as endangered on the TSC and EPBC Acts. The central Hunter Valley is considered to form part of a regional dispersal route close to important winter foraging areas in the lower Hunter Valley.

The species is known to occur from Victoria and the eastern parts of South Australia to south-east Queensland in the winter months. The swift parrot occurs as a single population, although it migrates annually from breeding grounds in Tasmania to the winter foraging grounds on the coastal plains and slope woodlands of mainland eastern Australia (Saunders 2002). Approximately 200 mature birds (10 per cent of the total estimated population) are known to over-winter in the Lower Hunter Region of New South Wales (Saunders 2002).

The species has been recorded in 2005, 2007 and 2014 (Forest Fauna Surveys and Newcastle Innovation 2014) in the Project Area and near the Proposed Disturbance Area within Ravensworth State Forest during annual monitoring surveys. The species was recorded foraging during a mass eucalypt flowering event, with approximately 20 individuals recorded in 2005 and approximately five in 2007. Two birds were recorded in June 2014 in the Southeast Offset Area feeding on a flowering *E. tereticornis* (M. Murray pers comm.). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area, however prolific flowering of eucalypts were not recorded during winter 2011 and 2012 or 2014 surveys. There have been few records of the species within the central Hunter Valley in the past few years; however recent sightings have been recorded in the winter 2012 season in the Muswellbrook and Bulga (Birdline 2013) areas.

This species has potential to make use of the box-gum forest and woodland habitats of the Proposed Disturbance Area, particularly where there are prolific flowering eucalypts and this migratory species is likely to move throughout the area in response to mass flowering events. This species does not breed on mainland Australia, and as such the disturbance area only

represents potential foraging habitat for this species. The disturbance area contains approximately 163.7 hectares of box-ironbark foraging habitat for the species.

A detailed assessment of significance for the swift parrot is provided in **Section 5.6**.

Spotted-tailed Quoll – *Dasyurus maculatus*

The spotted-tailed quoll is listed as vulnerable under the TSC Act and endangered under the EPBC Act. A small population of the species is known to occur in the central Hunter Valley around the Mount Owen, Ravensworth and Liddell areas.

Spotted-tailed quoll records are generally confined to within 200 kilometres of the NSW coast and range from the Queensland border to Kosciuszko National Park. The species is known to occur in the Hunter Valley. It is considered likely that the total number of mature adult spotted-tailed quolls is probably greater than 2000 but fewer than 10,000 individuals in Australia (Long and Nelson 2004). Extant populations are highly fragmented and declining. The geographic distribution of the species is contracting and its subpopulations are becoming increasingly fragmented.

The species has been recorded regularly at Mount Owen during fauna monitoring, with the species recorded annually between 1994 and 2013 (except 1998, 1999 and 2005) in Ravensworth State Forest and surrounding woodland and forest communities, including mine rehabilitation. There have also been a number of unconfirmed sightings within the Mount Owen active mine area and the species has also been recorded at Bowmans Creek during fauna monitoring undertaken at the nearby Liddell Mine (Umwelt 2008) and in 2010 in the Ravensworth North Project Hillcrest Offset Area approximately 6 kilometres to the north-west of the Project Area (Umwelt 2010).

Recent surveys reported in Umwelt (2013) and Eco Logical (2012) undertaken on lands to the west of the Project Area along Bowmans Creek have identified a den site, latrines and have verified, through the deployment of infra-red cameras, a recent breeding event. Following these surveys, potential den sites in the northern portion of the Project Area have also been identified through the analysis of radio tracking that has been undertaken on behalf of Mount Owen (refer to **Figure 4.5**). One male spotted-tailed quoll was fitted with a radio tracking collar and monitored between October and November 2012. The results indicated that the individual was not recorded in the Proposed Disturbance Area, rather that the core habitat for the individual was centred on Ravensworth State Forest, with ancillary habitat in pastures and woodland remnants to the south and east and mine rehabilitation to the west. A second male was collared and tracked between April and July 2013. Radio-tracking data indicated that habitat for this individual was centred on Ravensworth State Forest along with riparian and woodland habitats associated with Main Creek, to the east of the Project Area. This individual was recorded using woodland habitats at five locations within the Proposed Disturbance Area during the period April to July 2013. The locations of the known dens site, latrines and the den site where a female and two joeys were recorded are shown on **Figure 4.5**. The results of the detailed surveys indicate that the Project Area and surrounding habitat areas, including Bowmans Creek, contain at least one female, two joeys and two males that form part of a breeding population that has persisted in the Project Area since before 1994 when the species was first identified on site.

All natural and derived vegetation communities in the disturbance area are likely to provide known habitat for the spotted-tailed quoll and the disturbance area is comprises a portion of the home range of at least one individual. While the species will forage and move through native grassland habitat, dense woodland and forest communities provide the most important foraging habitat for the species due to the greater habitat complexity and increased prey opportunities. The loss of approximately 217.7 hectares of woodland/forest habitat represents a loss of approximately 17 per cent of the remnant vegetation located within the Project Area.

The records of the species indicate a small local population of the species occurs in the locality. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares and usually traverse their ranges along densely vegetated creek lines. Woodland and forest communities provide higher quality habitat than native grassland habitats due to increased habitat complexity and the presence of increased prey resources. Grassland habitats are expected to provide dispersal habitat and connectivity between disjunct woodland remnants, as well as poorer quality hunting areas. Intact woodland and rehabilitation/regeneration communities in the north of the Project Area provide likely core habitat for the species while the Proposed Disturbance Area provides potential foraging habitat, dispersal habitat and connectivity to potential habitats to the south of the Project Area. Bettys Creek is likely to provide a movement/dispersal habitat within the Proposed Disturbance Area.

A detailed assessment of significance for the spotted-tailed quoll is provided in **Section 5.6**.

Little Eagle – *Heiraaetus morphnoides*

The little eagle is listed as vulnerable under the TSC Act. The species is known to occur throughout the Australian mainland and occurs as a single population in NSW.

The species has been recorded in Project Area during the annual monitoring surveys in the years 1996, 1997, 1999 and 2001 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. It is likely that Project Area, and the Proposed Disturbance Area for the Project provides suitable foraging habitat for the species. Potential nesting habitat occurs within the Proposed Disturbance Area with some appropriately tall trees in the area; however nesting has not been previously recorded. The disturbance area is considered to comprise likely foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the little eagle is provided in **Section 5.6**.

Spotted Harrier – *Circus assimilis*

The spotted harrier is listed as vulnerable under the TSC Act. The species is known to occur throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania.

The spotted harrier has been recorded in the Project Area on one occasion by Umwelt during surveys of the Proposed Disturbance Area near the Bowmans Creek rail crossing. The species has not been recorded during annual monitoring surveys of the Project Area; however record of the species from 2000 occurs near Liddell approximately 1 kilometre from the Project Area. The species was recorded flying over open native grassland habitat within the Project Area during the Umwelt UHSA surveys in 2014 (Umwelt 2014, in prep). The Proposed Disturbance Area is considered to comprise likely foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the spotted harrier is provided in **Section 5.6**.

Little Lorikeet – *Glossopsitta pusilla*

The little lorikeet is listed as vulnerable under the TSC Act. The species is known to occur across the coastal and Great Dividing Range regions of eastern Australia from Cape York to South Australia.

The little lorikeet has been regularly recorded in the Project Area during annual monitoring surveys from 1996 to 2009 (Forest Fauna Surveys and Newcastle Innovation 2014). They are typically observed foraging in flowering eucalypt trees across the Project Area. The

species absence from the Project Area in 2010 and 2013 suggest that the species utilised other foraging habitat in the region as no significant flowering event occurred in the Project Area in that year. The species was recorded during annual monitoring in 2011 (Forest Fauna Surveys and Newcastle Innovation 2014) and during Umwelt surveys of the Proposed Disturbance Area in 2012. The disturbance area is considered to comprise potential foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the little lorikeet is provided in **Section 5.6.**

Powerful Owl – *Ninox strenua*

The powerful owl is listed as vulnerable under the TSC Act. The species is known to occur in NSW throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the western slopes and plains.

The species has been recorded in the Project Area during annual monitoring surveys in 2004, and was subsequently recorded in 2005, 2006 and 2007 (Forest Fauna Surveys and Newcastle Innovation 2014). On all occasions the species was recorded in the north of the Project Area, near Ravensworth State Forest. The species was not recorded during Umwelt surveys of the Proposed Disturbance Area and habitat within woodland and Derived Native Grassland habitats in this area are considered to be marginal for this species. The species is likely to utilise the habitats around Ravensworth State Forest and north of the Project Area for foraging, roosting and breeding and potentially the habitats of the disturbance area for foraging.

A detailed assessment of significance for the powerful owl is provided in **Appendix E**.

Masked Owl – *Tyto novaehollandiae*

The masked owl is listed as vulnerable under the TSC Act. This species occurs sparsely throughout the continent and nearby islands, including Tasmania and New Guinea (Kavanagh 2002) and is generally recorded from open forest habitat with a sparse mid-storey and patches of dense, low ground cover.

The species has been recorded in the Project Area during annual monitoring surveys and in the Proposed Disturbance Area through regurgitated pellet analysis by Umwelt in 2012. The species was initially recorded in 1997, and was subsequently recorded in 1999, 2002, 2005, 2006, 2009, 2011 and 2013 (Forest Fauna Surveys and Newcastle Innovation 2014). The species is mainly recorded in the north of the Project Area, within Ravensworth State Forest. Two potential roost sites for the species were investigated during fauna surveys following the identification of regurgitated pellets that were attributed to the species however potential roost sites have not been identified in the Proposed Disturbance Area. The disturbance area is considered to comprise likely foraging habitat for this species as part of a wider foraging range in surrounding habitats and potential roosting/nesting habitat in mature eucalypts.

A detailed assessment of significance for the masked owl is provided in **Section 5.6**.

Brown Treecreeper (eastern subspecies) – *Climacteris picumnus victoriae*

The brown treecreeper (eastern subspecies) is listed as vulnerable under the TSC Act. It is endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range

The species has been regularly recorded in the Project Area during annual monitoring surveys from 1994 to 2013 (Forest Fauna Surveys and Newcastle Innovation 2014) and nests of the species have been recorded in nest boxes and relocated tree hollows indicating that the species is a breeding resident in the Project Area. They are typically observed in the

northern portion of Ravensworth State Forest which supports large mature ironbark trees (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area; however the species is expected to occur there. The Proposed Disturbance Area is considered to comprise likely foraging and potential nesting habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the brown treecreeper (eastern subspecies) is provided in **Section 5.6**.

Speckled Warbler – *Chthonicola sagittata*

The speckled warbler is listed as vulnerable under the TSC Act. In NSW, this species occupies eucalypt and cypress woodlands, generally on the western slopes of the Great Dividing Range.

The species has been regularly recorded in the Project Area during annual monitoring surveys from 1994 to 2013, with the exception of 2009 and 2012 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded commonly during Umwelt surveys of the Proposed Disturbance Area. The species has been observed in many different habitat types including remnant forest, regeneration and planted areas and within rehabilitation sites (Forest Fauna Surveys and Newcastle Innovation 2014). Additionally, they inhabit woodlands with grassy understoreys often on ridges and gullies (Forest Fauna Surveys and Newcastle Innovation 2014). The disturbance area is considered to comprise likely foraging and breeding habitat for this species.

A detailed assessment of significance for the speckled warbler is provided in **Section 5.6**.

Black-chinned Honeyeater (eastern subspecies) – ***Melithreptus gularis gularis***

The black-chinned honeyeater (eastern subspecies) is listed as vulnerable under the TSC Act. The eastern subspecies occurs in the eastern states of Australia and in NSW is known from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina.

The species has been infrequently recorded in the Project Area during annual monitoring surveys in 1994, 1995, 1996 and 2004 (Forest Fauna Surveys and Newcastle Innovation 2014). They are typically observed foraging in flowering eucalypt trees within Ravensworth State Forest. The species was not recorded during Umwelt surveys of the Proposed Disturbance Area and is considered to be nomadic and non-resident in the Project Area, visiting the area when foraging conditions are favourable for the species. The disturbance area is considered to comprise likely foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the black-chinned honeyeater (eastern subspecies) is provided in **Section 5.6**.

Grey-crowned Babbler (eastern subspecies) – *Pomatostomus temporalis temporalis*

The grey-crowned babbler (eastern subspecies) is listed as vulnerable under the TSC Act. In NSW, the eastern subspecies occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Hay. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW.

The species has been regularly recorded in the Project Area during annual monitoring surveys from 1994 to 2013 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded on many occasions during Umwelt surveys of the Proposed

Disturbance Area. They have been observed in most woodland habitats; and habitats including foraging, breeding and nest sites. The Proposed Disturbance Area is considered to comprise known foraging and nesting habitat for this species.

A detailed assessment of significance for the grey-crowned babbler is provided in **Section 5.6**.

Varied sittella – ***Daphoenositta chrysoptera***

The varied sittella is listed as vulnerable under the TSC Act. The species distribution in NSW is nearly continuous from the coast to the far west.

This sedentary species has been regularly recorded in the Project Area during annual monitoring surveys in 1994, 1997 to 2000 and 2002 to 2009 (Forest Fauna Surveys and Newcastle Innovation 2014). They are typically observed in eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The disturbance area is considered to comprise likely foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the varied sittella is provided in **Section 5.6**.

Hooded Robin (south-eastern form) – *Melanodryas cucullata cucullata*

The hooded robin (south-eastern form) is listed as vulnerable under the TSC Act. The south-eastern form of the species is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west.

The species has been regularly recorded during annual monitoring surveys in 1994 to 2013, with the exception of 2006 and 2010 (Forest Fauna Surveys and Newcastle Innovation 2014). The species is typically recorded in the northern part of Ravensworth State Forest, and has also been observed foraging in the rehabilitation area immediately adjacent to remnant forest, although it is generally recorded in low abundance, being limited to one or two pairs of birds (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area and this area is considered to comprise likely foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the hooded robin (south-eastern form) is provided in **Section 5.6**.

Scarlet Robin – *Petroica boodang*

The scarlet robin is listed as vulnerable under the TSC Act. The species is found from south-east Queensland to south-east South Australia and also in Tasmania and south-west Western Australia. In NSW, it occurs from the coast to the inland slopes.

The species has been infrequently recorded in the Project Area during annual monitoring surveys, only being recorded in 1994, 1997 and 2011 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The Proposed Disturbance Area is considered to comprise potential foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the scarlet robin is provided in **Section 5.6**.

Flame Robin – *Petroica phoenicea*

The flame robin is listed as vulnerable under the TSC Act. The species is endemic to south-eastern Australia, and ranges from near the Queensland border to south-east 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.

The species has been infrequently recorded in the Project Area during annual monitoring surveys, only being recorded in 1994, 1999 and 2000 (Forest Fauna Surveys and Newcastle Innovation 2014). In NSW the flame robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains (Higgins and Peter 2002). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area although the Proposed Disturbance Area is considered to comprise potential foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the flame robin is provided in **Section 5.6**.

Diamond Firetail – *Stagonopleura guttata*

The diamond firetail is listed as vulnerable under the TSC Act. The species is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina.

The diamond firetail has been regularly recorded in the Project Area during annual monitoring surveys, being recorded in every year between 1994 and 2012, with the exception of 1999 (Forest Fauna Surveys and Newcastle Innovation 2014). The species is often recorded in the northern portion of Ravensworth State Forest, but has also been observed in woodland habitat in the Proposed Disturbance Area. The species appears to frequent the edges of remnant forested areas and forages in the open grassland areas, particularly when abundant grass seeds are present (Forest Fauna Surveys and Newcastle Innovation 2014). The disturbance area is considered to comprise potential foraging habitat and potential nesting habitat as the species has been recorded nesting in the Project Area (Forest Fauna Surveys and Newcastle Innovation 2014).

A detailed assessment of significance for the diamond firetail is provided in **Section 5.6**.

Brush-tailed phascogale – *Phascogale tapoatafa*

The brush-tailed phascogale is listed as vulnerable under the TSC Act. The species was not recorded during Umwelt surveys of the Proposed Disturbance Area, however was recorded for the first time during annual fauna monitoring surveys in 2011 (Forest Fauna Surveys and Newcastle Innovation 2014). This species has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are occasional records west of the divide.

Two adult phascogales were observed utilising glider nest boxes in the regeneration area north of Ravensworth State Forest in May 2011. This is the first documented record of the species occurring within the Project Area, despite a number of records of the species in the locality including near Glennies Creek to the south-west of the Project Area (Forest Fauna Surveys and Newcastle Innovation 2014). A brush-tailed phascogale was recorded via remote camera in scattered woodland habitat to the west of Hebden Road, outside the Project Area, in March 2014 (Umwelt 2014, in prep). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area, however the species is notoriously trap

shy and very difficult to detect and so may occur there. The Proposed Disturbance Area is considered to comprise potential foraging and nesting habitat for this species.

A detailed assessment of significance for the brush-tailed phascogale is provided in **Section 5.6**.

Koala – *Phascolarctos cinereus*

The koala is listed as vulnerable under the TSC and EPBC Acts. In NSW this species mainly occurs on the central and north coast with some populations in the west of the Great Dividing Range.

The species was tentatively recorded during the Mount Owen Complex monitoring in 1995 through the collection of scats resembling those of the koala (Forest Fauna Surveys and Newcastle Innovation 2014). A historic database record of the species (1980) is located in the south east of the Project Area. Although no evidence of this species has been recorded within the Project Area since (Forest Fauna Surveys and Newcastle Innovation 2014, Umwelt 2014, in prep) a recent (2012) database record occurs near the intersection of the New England Highway and Hebden Road near Bowmans Creek (OEH 2014) within the Proposed Disturbance Area. The species was not recorded during Umwelt surveys and few preferred feed trees were recorded within the Proposed Disturbance Area. The koala has been recorded approximately 6 kilometres to the north-west of the Project Area in the Hillcrest Offset Area that was established as part of the Ravensworth Continued Operations Project (Umwelt 2010). The Proposed Disturbance Area is considered to comprise potential foraging and dispersal habitat for this species although it has not been confirmed in the area.

A detailed assessment of significance for the koala is provided in **Section 5.6**.

Squirrel Glider – *Petaurus norfolcensis*

The squirrel glider is listed as vulnerable under the TSC Act. The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria.

The species has been regularly recorded within the Project Area during fauna monitoring from 1994 to 2013 (Forest Fauna Surveys and Newcastle Innovation 2014). The species is often recorded in Ravensworth State Forest, but has also been observed in woodland habitat in the Proposed Disturbance Area. The squirrel glider is also frequently recorded occupying nest box and relocated hollow resources. The Proposed Disturbance Area is considered to comprise known foraging and nesting habitat for this species.

Assessment of the average estimated density of squirrel gliders in the Project Area was determined by home range calculations derived from radio-tracking results. The mean home range of the squirrel glider is 33 hectares, with an average density of 0.09 gliders per hectare (Xstrata Coal and Thiess (2006). This compares to an average home range in coastal Lake Macquarie and Wyong of 6.0 hectares, and 0.39 gliders per hectare (Smith and Murray 2003). The lower density of gliders occurring in the Project Area and almost a fivefold increase in home range of the population, compared to the coastal populations, is considered due to absence of understorey foraging resources (e.g. *Acacia* species) (Xstrata Coal and Thiess (2006)).

The population of the squirrel glider in the Project Area prior to approval of existing mining was estimated to be 40 to 50 individuals. The extent of woodland/forest remaining following clearing of approved mining is expected to have reduced the population to around 20 to 25 individuals. Previous approvals are likely to have resulted in the removal of at least two known sub-populations, one occurring in the Southern Remnant and one population in the approved Western out of Pit Dump location. (Forest Fauna Surveys *et al*. 2004). The squirrel

glider continues to be recorded during annual fauna monitoring within Ravensworth State Forest and existing Biodiversity Offset Areas.

A detailed assessment of significance for the squirrel glider is provided in **Section 5.6**.

New Holland Mouse – *Pseudomys novaehollandiae*

The New Holland mouse is listed as vulnerable under the EPBC Act. The species has a fragmented distribution across Tasmania, Victoria, NSW and Queensland.

This species has been recorded during five of the last 18 years of fauna monitoring, with all captures of the species occurring between 2003 and 2007 (Forest Fauna Surveys and Newcastle Innovation 2014). The species has been recorded in areas of rehabilitation in the North Pit and to the east of Ravensworth State Forest in regenerating habitats. The species selectively prefers habitats which have been disturbed by events in which it rapidly colonises following the event (Fly By Night *et al.* 2007). The New Holland mouse has not been recorded in the Project Area since 2007, despite annual targeted surveys.

Habitat requirements for the species includes open heathland, open woodland with a heathland understorey and is usually found to peak in abundance during the early to mid stages of vegetation succession, three to five years after fire or other disturbances. It is considered likely that this successional species will utilise rehabilitated and disturbed habitats within the disturbance area when conditions are optimal, followed by the decline of the species once rehabilitated habitats improve in habitat complexity, thereby reducing the area of habitat that can be successfully occupied by the species. The Proposed Disturbance Area is considered to comprise potential foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the New Holland mouse is provided in **Section 5.6.**

Grey-headed Flying fox – *Pteropus poliocephalus*

The grey-headed flying-fox is listed as vulnerable under the TSC and EPBC Acts. This species has generally been recorded within 200 kilometres of the eastern coast, from Bundaberg in Queensland, through NSW and south to eastern Victoria.

The species has been occasionally recorded in the Project Area during annual monitoring surveys in 1994, 1996, 1997, 2000, 2004, 2006, 2007 and 2010 when eucalypt species are flowering (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. All woodland vegetation within the Project Area is expected to provide potential foraging habitat for this species. Camp sites (breeding habitat) have not been identified and are not expected to occur due to a lack of preferred habitat.

The two nearest substantial roost camp sites of the grey-headed flying-fox to the Project Area are at Burdekin Park, Singleton (approximately 17 kilometres from the Project Area) and in Blackbutt Reserve, Newcastle (approximately 80 kilometres from the Project Area). The population estimate for the grey-headed flying-fox population at Burdekin Park is estimated at approximately 3170 individuals and the population of the Blackbutt Reserve population is estimated at 40,000 individuals (Umwelt 2013c). As the Project Area is not located within 50 kilometres of a population of the grey-headed flying-fox that supports more than 30,000 individuals it is not considered likely that it is habitat critical or essential to the survival of this species.

Two smaller roost camp sites of the grey-headed flying-fox occur at East Cessnock (approximately 60 kilometres south-east of the Project Area) and Lorn (approximately 65 kilometres south-east of the Project Area). In 1990 the East Cessnock population was

estimated at 50,000 individuals; however, all counts since 1990 have recorded less than 100 individuals (Umwelt 2013c). However, it is believed that the East Cessnock populations may currently be in the order of 500 to 2000 individuals. At Lorn, population estimates range from 7000 in 1999 to 1000 in 2011 and 170 in 2012 (Umwelt 2013c).

A detailed assessment of significance for the grey-headed flying-fox is provided in **Section 5.6**.

Yellow-bellied Sheathtail-bat – *Saccolaimus flaviventris*

The yellow-bellied sheathtail-bat is listed as vulnerable under the TSC Act. The species is wide-ranging found across northern and eastern Australia, roosting in tree hollows and buildings.

The species has been recorded in the Project Area during annual monitoring surveys in the years 2007, 2009, 2010, 2011, 2012 and 2013 using call echolocation recording, however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The Proposed Disturbance Area is considered to comprise potential foraging and roosting habitat for this species as part of a wider range in surrounding habitats.

A detailed assessment of significance for the yellow-bellied sheathtail-bat is provided in **Section 5.6**.

East Coast Freetail-bat – *Mormopterus norfolkensis*

The east coast freetail-bat is listed as vulnerable under the TSC Act. The species is found along the east coast from south Queensland to southern NSW and roosts mainly in tree hollows and bark.

Within the Project Area the east coast freetail bat has been recorded roosting within hollows of spotted gum (*Corymbia maculata*) as well as a dead stag (Fly By Night *et al*. 1997-2002).

The species has been regularly recorded throughout the habitats in the Project Area, including within the Proposed Disturbance Area, during annual monitoring surveys between the years 1994 to 2013 (except in 2006), using call echolocation recording and confirming its presence with capture methods (Forest Fauna Surveys and Newcastle Innovation 2014). The species is also the most abundant of the microchiropteran bat species to utilise bat roost boxes in 2011 monitoring year (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded during Umwelt surveys of the Proposed Disturbance Area. The Proposed Disturbance Area is considered to comprise known foraging and roosting habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the east coast freetail-bat is provided in **Section 5.6.**

Little Bentwing-bat – *Miniopterus australis*

The little bentwing-bat is listed as vulnerable under the TSC Act. The species is found along the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW and roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and occasionally buildings.

The species has been tentatively recorded in the Project Area during annual monitoring surveys in 2001 using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area.

The Proposed Disturbance Area is considered to comprise potential foraging habitat for this species as part of a wider foraging range in surrounding habitats however potential roosting habitat for this cave-roosting species does not occur.

A detailed assessment of significance for the little bentwing-bat is provided in **Section 5.6**.

Eastern Bentwing-bat – *Miniopterus schreibersii oceanensis*

The eastern bentwing-bat is listed as vulnerable under the TSC Act. The species is found along the east and north-west coasts of Australia and roosts in caves, tunnels, buildings and other man-made structures.

The species has been recorded in the Project Area every year during annual monitoring surveys (except in 2003 and 2006) using call echolocation recording however no individuals have been captured to confirms its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species is expected to use the Proposed Disturbance Area primarily as foraging habitat with an offsite roost site. A maternity roost of the species, comprising 1000 to 2000 bats (Glen Hoye pers. comm.) was known from underground workings at Cumnock Mine, approximately 6 kilometres south-west of the Project Area. Investigations of the roost site in 2008 found no evidence of roosting bats.

The eastern bentwing-bat was also recorded during Umwelt surveys of the Proposed Disturbance Area. The Proposed Disturbance Area is considered to comprise potential foraging habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the eastern bentwing-bat is provided in **Section 5.6.**

Southern Myotis – *Myotis macropus*

The southern myotis is listed as vulnerable under the TSC Act. The species is found is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria and roost close to water in caves mine shafts, hollow-bearing trees, under bridges and in dense foliage.

The species has been occasionally recorded throughout the habitats of the Project Area, including within the Proposed Disturbance Area, during annual fauna monitoring surveys in the years 1999, 2000, 2005, 2007, 2009 and 2011 using call echolocation recording and capture methods (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded during Umwelt surveys of the Proposed Disturbance Area. The Proposed Disturbance Area is considered to comprise potential foraging and roosting habitat for this species as part of a wider foraging range in surrounding habitats.

A detailed assessment of significance for the southern myotis is provided in **Section 5.6**.

Greater Broad-nosed Bat – *Scoteanax rueppellii*

The greater broad-nosed bat is listed as vulnerable under the TSC Act. The species is mainly found in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland and extends to the coast over much of its range. The species mainly roosts in tree hollows, but also in buildings.

The species has been occasionally recorded throughout the habitats of the Project Area, including within the Proposed Disturbance Area, during annual fauna monitoring surveys in the years 2000, 2001, 2002, 2007, 2004, 2009, 2010, 2011, 2012 and 2013 using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded

during Umwelt surveys of the Proposed Disturbance Area. The Proposed Disturbance Area is considered to comprise an area of foraging and potential roosting habitat for this species.

A detailed assessment of significance for the greater broad-nosed bat is provided in **Section 5.6**.

Large-eared Pied Bat – *Chalinolobus dwyeri*

The large-eared pied bat is listed as vulnerable under the TSC and EPBC Acts. The species is mainly found 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. The species mainly roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the fairy martin (*Petrochelidon ariel*).

The species has been tentatively recorded in the Project Area during annual fauna monitoring surveys in 1999, 2001, 2006 and 2008 using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. All woodland vegetation within the Proposed Disturbance Area is expected to provide potential foraging habitat for this species, however no roosting habitat for this cave roosting species has been identified. The Proposed Disturbance Area is considered to comprise an area of foraging habitat for this species however is unlikely to contain significant breeding and roosting habitat.

A detailed assessment of significance for the large-eared pied bat is provided in **Section 5.6**.

4.2.5 SEPP 44 (Koala Habitat) Assessment Results

No potential koala habitat was recorded within the Proposed Disturbance Area as defined by SEPP 44 as Schedule 2 species listed under the policy were either not recorded or recorded in densities less than 15 per cent of all overstorey species within each community.

Furthermore, no koalas were identified during extensive walking or driving spotlight searches (refer to **Section 3.5**) in the Proposed Disturbance Area and the species has not been recorded during annual fauna monitoring surveys.

4.3 Aquatic Survey Results

A total of 15 dams were identified within the Proposed Disturbance Area, providing habitat for aquatic flora and fauna species. The creek beds and banks of the Project Area are generally sandy, with mobile eroded sands and some gravels. The creeks generally flow during storm events or extended rain periods, washing much eroded sediment downstream.

Due to a low flow regime, Bettys Creek provides limited habitat for fish species, however a wide range of native fish may occur in Bowmans Creek which provides a permanent aquatic habitat for a range of vertebrate an invertebrate species.

4.3.1 Aquatic Habitat and Stream Assessment

4.3.1.1 Bowmans Creek

Bowmans Creek rises in the western foothills of the Mount Royal Range, and its upper catchment is deeply incised in steep bedrock controlled terrain. These reaches of Bowmans

Creek are set in a broad alluvial flood plain and terrace sequence that is up to 1 kilometre wide.

The channel carries an abundant cobble bed load, with grain sizes ranging 50 millimetres to 200 millimetres and well-developed point bar deposits. There are two levels of benches adjacent to the active channel, each with some evidence of former channels. The floodplain is approximately 1 metre above the bed of the active channel and abandoned channel, and is generally 20 metres wide.

A summary of the habitat assessment results at the two replicate surveys undertaken at each of the upstream and downstream locations is given in Tables 1 and 2 of **Appendix D**. However a brief description of the habitat results, including the main physical features of Bowmans Creek is provided below. The terminology used is related directly to the AUSRIVAS habitat assessment proforma.

Bowmans Creek exhibits the greatest diversity of habitats of all drainage systems occurring in the Proposed Disturbance Area. The only proposed disturbance of this area is a proposed bridge and the importance of this habitat was recognised in bridge design, with pylons located outside of the low flow channel. Deep, low flows were recorded in the creek, with moderate water levels present. Pool and run habitats were common, with pool/riffle sequences evident in the low flow channel. Overhanging riparian vegetation was recorded and macrophyte cover was present and variable. Fallen woody debris and snags were also recorded.

Two aquatic survey sites were selected at each of the upstream and downstream locations of the existing bridge over Bowmans Creek to sample aquatic habitat and condition (refer to **Figure 3.2**). Upstream of the bridge, Bowmans Creek consists of a large pool that is shallow and contains a cobble and pebbly substrate. The pool is lined with emergent reeds on one bank. Downstream of the bridge the creek is more constricted initially and is a very shallow system with abundant river substrate (cobble and pebble). There is the presence of algae in this section. Further downstream the creek opens up to a large pooling area which is deeper and more turbid than the upstream environments and contains riparian vegetation. All sections of the creek had very low flow at the time of sampling.

At the time of sampling the water in Bowmans Creek displayed normal water odours with an absence of oils. The turbidity of the water was low to moderate with some sediment plumes present. The sediment of the creek contained traces of oils and anaerobic odours in places and was composed of mostly pebbles, cobbles, gravel, sand and silt in descending order of dominance. Bowmans Creek contained filamentous algae and there was also the presence of periphyton, moss and macrophytes. There is moderate to heavy erosion in the catchment with agricultural and mining usage. Cattle incursion of the creek was observed as the river banks are used for grazing in places and unrestricted cattle access could contribute to the presence of algae observed during the survey.

The AUSRIVAS habitat assessment (Table 2 of **Appendix D**) scores the habitat of Bowmans Creek at 55 and 58 at the two sampling locations indicating that the creek is in fair condition. The upstream sampling location lacks habitat variability and riparian vegetation that reduces the habitat score. The downstream sampling location has considerable bottom scouring and channel alteration. Neither sampling location would be considered to provide good habitat for aquatic fauna. This is in contrast to the Aquatic and Groundwater Dependent Ecosystem Assessment (Eco Logical 2013) that determined Bowmans Creek as having a Riparian Channel and Environmental Assessment score of 34 at three sites, indicating a moderate ecological condition. Sampling undertaken by Eco Logical (2013) was undertaken approximately between 2 and 6 kilometres upstream of the Bowmans Creek aquatic sampling area with an additional sampling location approximately 18 kilometres upstream of the Bowmans Creek sampling sites. The difference in the sampling results indicates that upstream environments of Bowmans Creek are in better condition and have greater habitat

variability. The highly disturbed nature of Bowmans Creek in the Proposed Disturbance Area may be attributed to the construction of the Hebden Road Bridge and other infrastructure such as powerlines that require ongoing maintenance and also the history of agriculture in the Ravensworth area.

Comparison with the aquatic surveys undertaken as part of the Ashton Aquatic Assessment (Anick 2011) downstream of the Project Area indicate that following a major flood event in 2007, when only resilient taxa remained in the lower section of Bowmans Creek between New England Highway and the Hunter River confluence, a stabilisation of habitats and an increase in habitat complexity over time has occurred. As a result, there has been an increase in diversity for macroinvertebrate assemblages, with a shift to include more pollution/instability intolerant taxa, thus indicating a moderate ecological condition similar to those habitats in Bowmans Creek upstream of the Proposed Disturbance Area. As indicated above, it is expected that former and ongoing disturbance of Bowmans Creek in the vicinity of the proposed Bowmans Creek Bridge on Hebden Road reduces the ecological condition of the creek.

4.3.1.2 Bettys Creek

Bettys Creek is a third order stream and minor tributary of Bowmans Creek, occurring in the central portion of the Project Area. Bettys Creek supports well-defined riparian vegetation dominated by swamp oak (*Casuarina glauca*), with rough-barked apple (*Angophora floribunda*) occurring in low numbers. Some minor pools were evident along the creek; however additional aquatic microhabitats were not identified such as pool/riffle sequences. The Creek is ephemeral with short periods of flow common after heavy rain events. The upper reaches of Bettys Creek have been subject to a number of approved diversions.

Bettys Creek generally comprises a narrow channel, with widths in the order of three to five metres. The channel is mostly well vegetated by sedge vegetation, dominated by the introduced sharp rush (*Juncus acutus* subsp*. acutus*)*,* indicating an intermittent flow regime. Bank heights were generally one to three metres and evidence of active erosion was frequently observed.

The ephemeral habitats of Bettys Creek are likely to lack a wide range of aquatic vertebrate and invertebrate species due to an absence of suitable habitat structures and habitat variability.

4.3.2 Aquatic Flora

The Project Area supports very limited aquatic vegetation with low species diversity. This vegetation was not mapped as a separate community due to the very limited extent of the association and the scale of vegetation mapping; rather, it is included as a component of the terrestrial vegetation.

Most creeklines of the Project Area support vegetation that prefers moist or waterlogged soil. In-stream vegetation of each of the ephemeral creeks in the Project Area (Bowmans Creek, and Bettys Creek) was dominated by the introduced sharp rush (*Juncus acutus* subsp. *acutus*), often forming dense infestations and out-competing native instream species. A canopy of swamp oak (*Casuarina glauca*) was generally present along much of the creekline banks within the Project Area.

Bowmans Creek supports the greatest range of aquatic species recorded during the aquatic flora survey due to the permanent nature of the creek. Commonly recorded species included common reed (*Phragmites australis*)*,* cumbungi (*Typha orientalis*), *Juncus* sp., in addition to the introduced sharp rush (*Juncus acutus*) which frequently occurred along the creek. The banks of Bowmans Creek were relatively disturbed with lambs tongue (*Plantago lanceolata*), purpletop (*Conyza bonariensis*) and kikuyu (*Pennisetum clandestinum*) commonly occurring.

Fennel pondweed (*Potamogeton pectinatus*) and water milfoil (*Myriophyllum aquaticum*) were also identified.

The Proposed Disturbance Area supports approximately 15 dams, ranging from small, steep-sided dams through to larger bodies with shallow sides. In all cases, however, the aquatic vegetation occurring within and fringing the dams were found to be very species poor, and frequently very sparsely distributed. Common species recorded in or on the edges of farm dams included swamp lily (*Ottelia ovalis*), water ribbons (*Triglochin procerum*), cumbungi (*Typha orientalis*), lesser joyweed (*Alternanthera denticulata*), water pepper (*Persicaria hydropiper*), dirty Dora (*Cyperus difformis*) and *Juncus* sp. along with the introduced parrots feather (*Myriophyllum aquaticum*) and sharp rush (*Juncus acutus* subsp*. acutus*).

A list of aquatic flora species recorded in the Project Area is provided in the flora species list in **Appendix B**.

4.3.3 Aquatic Fauna

A total of four aquatic fauna species were recorded during the aquatic survey of the Project Area, comprising three vertebrate and one invertebrate species. Five eastern snake-necked turtle (*Cheladonia longicollis*) were recorded in the upstream aquatic sampling location and only a single individual was recorded downstream of Bowmans Creek bridge. A single long-finned eel (*Anguilla reinhardtii*) was recorded while an un-identified larval fish was also recorded at the downstream sampling location. All vertebrate species recorded in the Project Area are listed in **Appendix D**. Only one aquatic macroinvertebrate species was collected, the Palaemonidae shrimp (*Macrobranchium* spp.), albeit in relatively high abundance (36 individuals) (See Table 3 in **Appendix D**).

Surveys conducted in Bowmans Creek in July 2012 by Eco Logical upstream of the Bowmans Creek bridge identified three fish species: Mosquito fish (*Gambusia holbrooki*), long-finned eels (*Anguilla reinhardtii*) and flathead gudgeons (*Philypnodon grandiceps*) and one aquatic mammal: platypus (*Ornithorhynchus anatinus*). The mosquito fish was the most commonly recorded fish recorded during monitoring undertaken by Ashton Coal downstream of the Project Area (Anink 2011), A total of 23 macroinvertebrate taxa were collected during the survey with results indicating a moderately degraded system based on analysis of signal scores (Eco Logical 2012). The macroinvertebrate taxa recorded by Eco Logical (2012) in Bowmans Creek are listed in **Appendix D**.

Previous survey of fish in Bowmans Creek identified a total of nine species, including two species of crustaceans (Roberts and Murray 2005). The most abundant species recorded were the mosquito fish (*Gambusia holbrooki*) and long-finned eel (*Anguilla reinhardtii*) with small numbers freshwater catfish (*Tandanus tandanus*), striped gudgeon (*Gobiomorphus australis*) and the introduced goldfish (*Carassius auratus*) (Roberts and Murray 2005).

The NSW Rivers Survey (Harris and Gerhke 1997) recorded a range of fish species in the Hunter River drainage basin (see **Table 4.10**) that potentially could occur in Bowmans Creek. It is highly unlikely that Bettys Creek would provide suitable aquatic habitat for a wide range of the aquatic fauna recorded in this survey.

Table 4.10 – Vertebrate Fish Species Previously Recorded within the Hunter River Drainage Basin (Harris and Gerhke 1997) that could occur in Bowmans Creek

Common Name	Scientific Name
long-finned eel	*Anguilla reinhardtii*
goldfish	**Carassius auratus*
common carp	**Cyprinus carpio*
mountain galaxias	*Galaxias olidus*
mosquito fish	**Gambusia holbrooki*
striped gudgeon	*Gobiomorphus australis*
Coxs gudgeon	*Gobiomorphus coxii*
sprat	*Herklotsichthys castelnaui*
Australian bass	*Macquaria novemaculeata*
striped mullet	*Mugil cephalus*
freshwater mullet	*Myxus petardi*
bullrout	*Notesthes robusta*
flathead gudgeon	*Philypnodon grandiceps*
dwarf flathead gudgeon	*Philypnodon* sp. 1
freshwater herring	*Potamalosa richmondia*
Australian smelt	*Retropinna semoni*
freshwater catfish	*Tandanus tandanus*

Note: * introduced species

No impediments to fish passage were observed in the immediate vicinity of the Project Area based on on-ground observations and from analysis of topographic maps and aerial photography.

4.3.3.1 Threatened Aquatic Species

The Hunter River catchment provides habitat for the Darling River hardyhead (*Craterocephalus amniculus*) Endangered Population listed under the FM Act. There are no additional listed threatened aquatic species, populations and endangered ecological communities occurring in the Hunter Catchment.

Review of previous aquatic surveys has identified the presence of the Darling River hardyhead (*Craterocephalus amniculus*) within the upper reaches of Bowmans Creek, in 1976 and 1980 (ELA 2013). The species was recorded during aquatic habitat and condition monitoring of Bowmans Creek as part of the Ashton Coal mine environmental monitoring program. Potential habitat for the species was identified in Bowmans Creek within the Project Area, however the species was not recorded during targeted aquatic surveys undertaken in the small area of potential habitat (approximately 100 metre length of Bowmans Creek) within the Proposed Disturbance Area.

4.3.4 Groundwater Dependent Ecosystems

As outlined in the NSW State Groundwater Dependent Ecosystems (GDE) Policy 2002, there are four types of groundwater dependent ecosystems, namely:

- terrestrial vegetation;
- base flows in streams;

- aquifer and cave ecosystems; and
- wetlands.

A review of the Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems (BoM Atlas) was completed in February 2014. This review identified that Bowmans Creek and Glennies Creek were the only two GDEs within the vicinity and downstream of the Project Area.

The following terrestrial vegetation communities are expected to be dependent on shallow groundwater resources during periods of reduce surface water flow:

- Central Hunter Swamp Oak Forest;
- Hunter Lowland Red Gum Forest EEC; and
- Hunter Valley River Oak Forest.

The locations of these communities are shown on **Figure 4.1**. Central Hunter Swamp Oak Forest and Hunter Valley River Oak Forest are located within the Proposed Disturbance Area and 6 hectares would be cleared should the Project be approved.

5.0 Impact Assessment

The Project will result in the clearing of approximately 485 hectares of land which includes 451.5 hectares of native vegetation and 33.5 hectares of disturbed land. A total of 2794 hectares of native vegetation occurs in the Project Area providing known habitat for 29 threatened fauna species, one threatened flora species and approximately 830 hectares of EEC as listed under the TSC Act (refer to **Section 4.1.4**).

The clearing associated with the Project and assessed as part of this Ecological Assessment includes 223.7 hectares of native woodland, forest and riparian vegetation. In addition to the loss of native vegetation communities, the Project will result in the loss of approximately 223.1 hectares of Derived Native Grassland

In addition to actions undertaken by Mount Owen to avoid and minimise impacts on ecological values (refer to **Section 5.1**), significant impact mitigation measures and a Biodiversity Offset Strategy are proposed to ameliorate the impact of the Project on ecological values.

5.1 Project Changes to Avoid and Minimise Impacts

Mount Owen undertook a detailed ecological constraints study to guide the development and detailed design of the Project. Through this process, alternative mining options were considered and Mount Owen has sought to minimise the environmental and community impacts associated with the Project whilst maximising the economic resource recovery.

Key factors in Project design have been designed to ameliorate the impacts on significant ecological features, such as threatened species, EPs, TECs and/or their habitats. The approach to this has been to avoid ecological impact and maximise use of existing disturbed areas as much as possible.

The existing Mount Owen Biodiversity Offset Areas were set aside as an ecological offset for the previous Mount Owen development consent (2004). In addition to the ecological considerations, condition 45e of the current development consent for the Mount Owen Mine provides for the management and protection of Aboriginal archaeological sites within the Biodiversity Offset Area. There are a number of known Aboriginal archaeological sites within the existing Biodiversity Offset Areas including a stone arrangement in the southern portion. Mount Owen recognises the importance of these sites to the Aboriginal community in addition to the biodiversity values contained within the Biodiversity Offset Area and their value to long term conservation and intergenerational equity outcomes. Moreover, Mount Owen takes existing commitments it has made as part of previous mining approvals very seriously and as such is maintaining this commitment for the Project. Accordingly the option to mine coal to the east of the existing North Pit shell into the Biodiversity Offset Area were discounted very early in order to maintain the long term conservation of the offset areas committed to in the 2004 approval.

Additionally, in the far north-east portion of the Proposed Disturbance Area, early designs identified potential impact to the Hunter Lowland Red Gum Forest Endangered Ecological Community. A review of the concept design in that area determined that the Proposed Disturbance Area could be revised and moved further south, thus minimising any impact to the Hunter Lowland Red Gum Forest community.

Finally, the Ravensworth State Forest, New Forest Area and the Southern Remnant Area are all located within the Project Area. The extent of the Proposed Disturbance Area was designed to ensure these three state forest areas were not disturbed as a result of the Project.

The proposed Bowmans Creek Bridge on Hebden Road is a two lane bridge located to the south of the existing single lane bridge across Bowmans Creek. The bridge has been designed to minimise direct impact to the low flow channel of Bowmans Creek by locating the piers and columns outside of this area.

The proposed rail line has been located within the existing approved Glendell Mine disturbance area as far as a practicable and avoids disturbance to the Bettys Creek Habitat Management Area. This design objective has resulted in a reduction in the total disturbance area required for the construction and operation of the proposed rail line. The proposed rail line alignment is also planned to cross Bettys Creek. Mount Owen have designed the bridge to be a single span bridge, which will not require any piers in the existing Bettys Creek, thus reducing the need for direct disturbance within the creek.

Mount Owen also undertakes comprehensive rehabilitation of disturbed land within the Project Area. The primary objective of rehabilitation of disturbed land is to create a stable final landform with acceptable post-mining land use capability. Rehabilitation of the overburden emplacement areas and backfilled pits are conducted progressively over the life of the mine, as an integral component of mining operations. All rehabilitation works are scheduled to occur progressively as soon as practicable after mining disturbance. In recognition of the importance of vegetation corridors to regional biodiversity, the rehabilitation strategy has been designed to link rehabilitation areas to the established and proposed offset areas and existing remnant vegetation (refer to **Sections 6.2**).

5.2 Impact of the Project on Ecological Values

5.2.1 Summary of Ecological Values

The Project Area contains significant ecological features and values. It is located within a large area of remnant vegetation on the central Hunter Valley floor, a landscape which has been heavily cleared and disturbed over a long period of time. Whilst analysis of historical aerial photography confirms that the majority of the Proposed Disturbance Area is regrowth less than 20 years old, the vegetation remnants of the type and size occurring in the Proposed Disturbance Area and wider Project Area are important at local and regional scales.

The ecological values identified in the Project Area that have been considered in determining the impact of the Project and the development of impact mitigation and biodiversity offsetting requirements include:

- high quality threatened species habitat including:
    - 1355 hectares of contiguous native woodland, forest and riparian vegetation that is part of one of the few remaining large remnants in the local area (large remnants being >100 hectares (Peake 2006)). The vegetation of the Project Area is of local and regional importance due to its size and the presence of active regeneration of canopy species. The remnant provides an important corridor in a local and regional context and provides habitat for many species that are unable to persist in small, fragmented remnants;

- important habitat for the spotted-tailed quoll (*Dasyurus maculatus*). The species has been recorded many times within the Project Area and the surrounding locality, with breeding records identified in 2012 for the local population on Bowmans Creek west of the Project Area;
- 223.7 hectares of woodland habitat for threatened woodland birds and micro-bats including brown treecreeper (*Climacteris picumnus victoriae*), grey-crowned babbler (*Pomatostomus temporalis temporalis*), diamond firetail (*Stagonopleura guttata*), east coast freetail-bat (*Mormopterus norfolkensis*) and southern myotis (*Myotis macropus*);
- 131.9 hectares of woodland habitat with hollow bearing tree densities (75 hollows per hectare), which is a limited resource across the Hunter Valley, providing hollow dependent fauna habitat including threatened species habitat; and
- winter flowering woodland foraging habitat for the endangered swift parrot (*Lathamus discolor*) and potential foraging habitat for the critically endangered regent honeyeater (*Anthochaera phrygia*) in the central Hunter Valley.

- Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC recorded extensively within the Proposed Disturbance Area and Project Area (refer to **Figure 4.1**); and

- Central Hunter Grey Box– Ironbark Woodland EEC recorded in small patches in the Proposed Disturbance Area and wider Project Area (refer to **Figure 4.1**).

5.2.2 Summary of Ecological Impacts

Based on the ecological values of the Proposed Disturbance Area and wider Project Area summarised in **Section 5.2.1**, the Project is likely to result in a substantial impact on ecological values. Although an extensive impact mitigation strategy will be undertaken, a Biodiversity Offset Strategy will be required to address the residual impacts of the Project. The Project will result in the removal of approximately 451.5 hectares of native vegetation, including (approximately) 159.3 hectares of Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC (including the Planted variant) and 223.1 hectares of Derived Native Grassland.

A range of indirect impacts have also been considered in the ecological impact assessment, including (but not limited to) erosion and sedimentatation impacts on aquatic and terrestrial ecosystems, impacts relating to the deposition of dust, increased noise and fugitive light emissions, changes to weed and vertebrate pest species abundance and distribution and the impact of bushfire. The indirect impacts of the Project were considered in the preparation of assessments of significance for threatened species and ecological communities considered to be potentially impacted by the Project (refer to **Appendices E** and **F**).

The Project will result in a 17 per cent reduction in the size of a regionally significant large remnant of vegetation and habitats within the Project Area. This remnant provides a known dispersal corridor and important habitat for a range of flora and fauna in a region that has been historically widely disturbed and fragmented as a result of agriculture and mining activities.

The reduction of the size of the remnant will likely result in the disruption of fauna movement and reduce the area of occupancy for a wide range of flora and fauna species in the local area including 29 threatened fauna species listed under the TSC Act (of which six are also listed under the EPBC Act), an additional threatened fauna species listed under the EPBC Act and two EECs listed under the TSC Act (refer to **Section 5.6**).

5.3 Impact of the Project on Flora Species

A total of 355 flora species were recorded during flora surveys, of which approximately 26 per cent were not native to the area. The diversity of species recorded in the Proposed Disturbance Area and Project Area is considered likely to be greater than in surrounding areas due to the extent of clearing for agriculture, expansion of mining operations and lack of natural regeneration in actively used portions of the local area. The relative size and condition of remnant vegetation in the Project Area has resulted in a high level of species diversity compared to surrounding landscapes.

The Project is not likely to result in a substantial impact on species diversity in the Project Area as the high quality, in-tact communities in Ravensworth State Forest and adjacent Mount Owen Biodiversity Offset Areas will not be directly impacted as a result of the Project.

No threatened flora species were identified within the Proposed Disturbance Area.

5.4 Impact of the Project on Vegetation Communities

The dominant vegetation community in the Proposed Disturbance Area is Derived Native Grassland. **Table 5.1** summarises the area of each vegetation community to be removed as a result of the Project. A range of impact mitigation measures have been formulated to minimise the impact of vegetation loss, as discussed in **Section 6.0**.

Table 5.1 – Area of Each Vegetation Community to be removed as a Result of the Project

Formation	Vegetation Community	Area of Vegetation to be Removed (ha)
Derived Native Grassland	Derived Native Grassland	223.1
Forest and Woodland	Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC	131.9
	Central Hunter Bulloak Forest Regeneration	54.0
	Planted Ironbark – Spotted Gum – Grey Box Forest EEC	27.4
	Central Hunter Grey Box - Ironbark Woodland EEC	4.4
Shrubland	Kunzea Closed Shrubland	4.7
Riparian	Hunter Valley River Oak Forest	0.2
	Central Hunter Swamp Oak Forest	5.8
	Total	**451.5**

5.4.1 Impact on Forest and Woodland Communities

As discussed in **Section 2.3**, the Project Area is located in a region that has been subject to a long history of vegetation clearing, for agricultural purposes such as grazing, and in the last 50 years for open cut coal mining. This has led to the current condition where the woodlands and forested communities in the region have become highly fragmented. The remnant vegetation in the Project Area is one of the largest remnant areas of native woodland and forest vegetation in the central Hunter Valley floor and the Project will increase fragmentation of this vegetation in the locality by the reduction of currently vegetated corridors.

The Project will result in the removal of approximately 217.7 hectares of woodland and forest communities (refer to **Table 5.1**). The Project Area contains approximately 1270 hectares of woodland and forest communities, of which the Project will remove approximately 17 per cent.

The impact of the Project on TSC Act listed EECs such as Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC and Central Hunter Grey Box - Ironbark Woodland EEC is discussed in **Section 5.8**.

5.4.2 Impact on Riparian Vegetation

Riparian vegetation occurs within the Project Area along Bowmans Creek and Bettys Creek and associated tributaries. Riparian vegetation in the central Hunter Valley has also been historically cleared and fragmented. Agricultural activities have lead to high levels of weed infestation and erosion due to livestock access. The Project is likely to contribute to the fragmentation of these vegetation communities in the locality.

The Project will result in the removal of approximately 6.0 hectares of riparian vegetation from the Proposed Disturbance Area. This includes 5.8 hectares of Central Hunter Swamp Oak Forest along Bettys Creek to allow for the proposed rail line construction and 0.2 hectares of Hunter Valley River Oak Forest along Bowmans Creek for the proposed Bowmans Creek bridge duplication. The wider Project Area contains approximately 85.3 hectares of riparian vegetation, of which the Project will remove 14 per cent. The removal of 6.0 hectares of riparian vegetation as part of the Project is considered unlikely to be significant from a local or regional perspective.

None of the riparian vegetation communities recorded in the Proposed Disturbance Area conform to any EECs listed on the TSC or EPBC Acts.

5.4.3 Impact on Shrubland Communities

Approximately 4.7 hectares of Kunzea Closed Shrubland will be removed from within the Proposed Disturbance Area. This community is considered to be a variant of Central Hunter Ironbark – Spotted Gum – Grey Box-Forest that has developed due to ground disturbance. The community has low species diversity and the loss of this community is not expected to be significant at a local or regional scale.

5.4.4 Impact on Derived Native Grasslands

The Derived Native Grassland identified within the disturbance footprint is a community that has been significantly affected by past clearing, grazing practices and mining activities. Despite this, the Derived Native Grassland community in the Project Area and Proposed Disturbance Area has a predominately native species composition.

The Project will result in the removal of 223.1 hectares of Derived Native Grassland. The impact on this community will predominately occur in the disturbance footprint for the North Pit continuation. The wider Project Area contains approximately 1433 hectares of Derived Native Grassland, of which the Project will remove approximately 16 per cent. The removal of 223.1 hectares of Derived Native Grassland as part of the Project is considered unlikely to be significant from a local or regional perspective, due to the dominance of Derived Native Grassland communities in the Hunter Valley.

The Derived Native Grassland community within the Proposed Disturbance Area does not conform to any EECs listed on the TSC and EPBC Acts.

5.5 Impact of the Project on Fauna Habitat and Fauna Species

The Project will result in the loss of up to approximately 451.5 hectares of native habitat within the Proposed Disturbance Area. This comprises approximately 217.7 hectares of woodland and forest habitat, 6.0 hectares of riparian habitat, 223.1 hectares of native grassland habitat and 4.7 hectares of other minor habitat. Native vegetation communities occurring in the Project Area, including the Proposed Disturbance Area provide a substantial and important area of habitat for native fauna species.

5.5.1 Woodland and Forest Habitat

The removal of approximately 217.7 hectares of woodland and forest habitat within the Proposed Disturbance Area represents a considerable loss of fauna habitat and represents a decrease of the area of remnant vegetation in the Project Area. The majority of this habitat constitutes foraging habitat in the form of canopy vegetation, tree trunks and large branches and bark subsurfaces. Associated with the extensive tree canopies of this habitat are moderate levels of leaf litter coverage, as well as fallen timber. Such features form important foraging and shelter resources for fauna species, including threatened species recorded in the Proposed Disturbance Area and Project Area. Other habitat features such as an open to moderately dense mid-understorey and shrub layer provide additional resources for foraging and nesting for the threatened woodland bird species known to occur.

The relatively high abundance of large hollow-bearing trees in the woodland and forest habitat within the Proposed Disturbance Area provides value as roosting and nesting habitat for hollow-dependent species. The woodland habitat is likely to be most valuable to both hollow-dependent and non-hollow-dependent threatened species such as the squirrel glider (*Petaurus norfolcensis*), brush-tailed phascogale (*Phascogale tapoatafa*), grey-crowned babbler (*Pomatostomus temporalis temporalis*), hooded robin (*Melanodryas cucullata cucullata*) and speckled warbler (*Chthonicola sagittata*). The Proposed Disturbance Area is likely to provide important habitat for threatened microbat species such as the east coast freetail-bat (*Mormopterus norfolkensis*) and southern myotis (*Myotis macropus*).

The loss of approximately 217.7 hectares of woodland and forest habitat has the potential to have a significant impact on native fauna species assemblages and in particular the range of woodland and forest-dependent threatened fauna species recorded in the Proposed Disturbance Area. These are further assessed, by species, in **Section 5.8** and **Appendices E** and **F**.

5.5.2 Riparian and Aquatic Habitat

The loss of approximately 6.0 hectares of riparian and aquatic habitat is related primarily to the removal of 5.8 hectares of Central Hunter Swamp Oak Forest along Bettys Creek for the proposed rail line construction, 0.2 hectare of Hunter Valley River Oak Forest along Bowmans Creek for the proposed Bowmans Creek bridge duplication and 15 farm dams located in open landscapes.

These small areas of riparian habitat are important in the landscape as this habitat would be most valuable as flyways for threatened micro-bat species such as the threatened east coast freetail-bat (*Mormopterus norfolkensis*) and small woodland birds such as the brown treecreeper (*Climacteris picumnus victoriae*). Additionally, riparian vegetation provides likely movement habitat for the spotted-tailed quoll (*Dasyurus maculatus*) and connectivity between known habitats for this species and other species across the Project Area and to/from proximate habitats. The loss of approximately 6.0 hectares of this habitat is not expected to be significant considering the availability of similar habitats in the wider locality, however may result in adverse impacts to particular species that may be reliant on the

dispersal routes that riparian vegetation provides in the fragmented Hunter Valley floor landscape.

The Project will result in the loss of approximately 15 farm dams and the ephemeral aquatic habitat. Significant numbers of farm dams and ephemeral and permanent aquatic habitat will remain unaffected in the wider Project Area and aquatic species and habitats and the native fauna species dependent on those habitats will not be significantly impacted.

5.5.3 Derived Native Grassland Habitat

The removal of approximately 223.1 hectares of Derived Native Grassland habitat within the Proposed Disturbance Area represents a considerable loss of fauna habitat. Grassland habitat is most likely to provide open foraging habitat for fauna species occurring in adjoining vegetated refuge areas. It is likely that these open areas provide foraging habitat for a number of threatened fauna species, however this would be as sub-optimal, modified habitat only. Such habitat is most likely to benefit species that favour woodland margins and open areas such as the hooded robin (*Melanodryas cucullata cucullata*), as well as species that would benefit from ecotones for foraging, such as the little eagle (*Heiraaetus morphnoides*) and masked owl (*Tyto novaehollandiae*). It is unlikely that this vegetation community would form the primary foraging resource for any threatened fauna species identified within the Proposed Disturbance Area or Project Area. In excess of 1200 hectares of grassland habitat will be retained in the Project Area and the loss of 223.1 hectares as a result of the Project is not expected to be significant from a fauna habitat perspective.

5.5.4 Shrubland Habitat

A small area of Kunzea Closed Shrubland occurs in the disturbance footprint of the North Pit continuation. The Project will remove approximately 4.7 hectares of this habitat. Shrubland habitat is likely to provide closed foraging and refuge habitat for fauna species occurring in adjoining open grassland or adjacent woodland areas. It is possible that the closed shrubland provides habitat for a number of threatened fauna species, however this would be as sub-optimal, disturbed habitat only. Such habitat is most likely to benefit small woodland birds such as the diamond firetail (*Stagonopleura guttata*) and common small mammal species. The loss of this habitat is not expected to be significant considering the availability of other high quality habitats in the wider Project Area and local area.

5.6 Impact of the Project on Existing Biodiversity Offset Areas and Habitat Corridors

The Project has been designed to avoid impacts on existing Mount Owen Biodiversity Offset areas in addition to Bettys Creek Habitat Management Area and the ecological values of the existing offset areas will not be directly impacted.

A habitat corridor, known as the Southern Wildlife Corridor, was previously established as part of the 1994 Project approval immediately south of the currently approved North Pit, within the proposed Disturbance Area. The Southern Wildlife Corridor was established in 1994 to join retained vegetation to the west of the then mining area (known as the Southern Remnant), a 45 hectare remnant capable of supporting ecological diversity, with remnant vegetation associated with Ravensworth State Forest to the east and additional remnant vegetation to the south-east of the then mining area.

In 2004, approval was granted to impact 35 hectares of the Southern Remnant which resulted in a reduction of the Southern Remnant to 10 hectares. It was considered that the remaining 10 hectares would not likely support viable fauna populations for all species;

although it would provide a valuable seed source and habitat once reconnected through mine rehabilitation thus providing increased value in the medium to long term. Whilst it was acknowledged that the Southern Wildlife Corridor was established in 1994 to form the primary link between the southern and northern remnants of the Ravensworth State Forest, the success of the 2004 offset strategy including the currently approved biodiversity offset areas (refer to **Figure 1.2**) did not include the Southern Wildlife Corridor and moreover was not dependant on the restoration of the Southern Wildlife Corridor. The current biodiversity offset areas provide alternative links to the vegetation to the south east. Similar to the currently approved rehabilitation strategy, reinstatement of a corridor through mine rehabilitation is a key consideration in the design of the mine rehabilitation, as described in **Section 6.2**.

5.7 Impact of the Project on Groundwater Dependent Ecosystems

As outlined in **Section 4.3.4**, there are three terrestrial vegetation communities that are expected to be dependent on shallow groundwater resources during periods of reduced surface water flow. The surface water assessment completed for the Project (refer to Section 5.5 of the EIS) identified that the changes in annual flow volumes associated with proposed changes to catchment areas for Yorks Creek, Swamp Creek, Bettys Creek and Main Creek are considered to be small within the context of ephemeral streams. The changes in annual flow volumes are also considered to be small on a regional scale, with the change in flows being less than the seasonal and annual variations in flow volumes comparing dry years to wet years. Thus, reductions in surface water flow to the three terrestrial vegetation communites identified in **Section 4.3.4** are expected to be negligible which further reduces the potential for the communities potentially dependent on shallow groundwater resources to be adversely impacted.

An assessment of the impact of the Project on groundwater systems has been undertaken by Jacobs (2014) and is summarised in Section 5.6 of the EIS. Potential impacts to GDEs could results from leakage from alluvial aquifers and changes to baseflows or from groundwater drawdowns in alluvial and hard rock aquifers.

The groundwater modelling predicts that the Project will result in minor leakage from the alluvial aquifers associated with Main Creek, a tributary of Glennies Creek and Bettys Creek, a tributary of Bowmans Creek. The predicted reductions in groundwater flow to the Main Creek and Bettys Creek alluvial aquifers are minimal, with estimates representing less than 0.2 per cent of baseflow contributions. Peak incremental losses for the Main Creek alluvium are predicted to be less than 15 ML/year. Peak losses for the Bettys Creek alluvium are predicted to be less than 6 ML/year. The predicted direct impact to Bowmans creek and Glennies Creek alluvium will be negligible.

There is predicted to be negligible impact to the alluvial aquifers of Bowmans Creek and Glennies Creek as a result of the Project, the only two GDEs identified on the BoM Atlas. The drawdown in the Bettys Creek and Main Creek alluvial aquifers is limited to the upper reaches of these creek systems where the volume of alluvium is relatively small compared to other reaches of the creeks. Greater than 2 metres drawdown is predicted in some areas, such as in an area on Main Creek where a narrowing of the alluvium channel amplifies the drawdown impact. The impact of this drawdown on the creek systems is considered to be minimal as the assessment identified that the significance of these alluvial aquifers is limited, with both creeks having low flow volumes, ephemeral surface water flow, and they largely act as drainage courses for local runoff.

Based on the outcomes of the Groundwater Assessment, the Project is not expected to result in an adverse impact on GDEs identified in the Project Area as leakage from alluvial aquifers and changes to base flows in drainage lines are expected to be minimal; and there is predicted to be negligible drawdown impact to the alluvial aquifers of Bowmans and Glennies Creeks as a result of the Project.

5.8 Impact of the Project on Threatened Species, Populations and Ecological Communities

The basic principles of reducing impacts on threatened species are to:

1. avoid direct impacts and retain habitat;

2. minimise impacts where ever possible;

3. mitigate or ameliorate impacts and as a last resort;

4. compensate or offset for any unavoidable impacts.

Section 5.1 describes the impact avoidance measures implemented during project planning. The following sections provide a detailed assessment of the significance of impacts related to the Project on threatened species, EPs and EECs using the relevant tests of significance under State (EP&A Act) and Commonwealth (EPBC Act) legislation. In accordance with the relevant legislation and guidelines, the following assessments do not take into account the mitigation measures documented in **Section 6.0** or the Biodiversity Offset Strategy described in **Section 7.0**.

The precautionary principle has been consistently applied when assessing the potential impacts of the Project on threatened and migratory species and communities. The Environmental Planning and Assessment Regulation defines the precautionary principle as:

> Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
>
> In the application of the precautionary principle, public and private decisions should be guided by:
>
> (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and
> (ii) an assessment of the risk-weighted consequences of various options.

Further, the EPBC Act Significant Impact Guidelines 1.1 states the following:

> When deciding whether or not a proposed action is likely to have a significant impact on a matter of national environmental significance, the precautionary principle is relevant. Accordingly, where there is a risk of serious or irreversible damage, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on a matter of national environmental significance.

In light of the above, where there was lack of scientific certainty, the maximum potential impact was assumed. The development of mitigation and offset strategies were based on the outcomes of the impact assessment, as displayed in **Figure 1.4**. The precautionary principle was also applied in the development of the mitigation and offset strategies to ensure that

uncertainties were compensated for with more robust mitigation or more substantial offset outcomes.

The application of the precautionary principle described above is illustrated in **Figure 5.1** below.

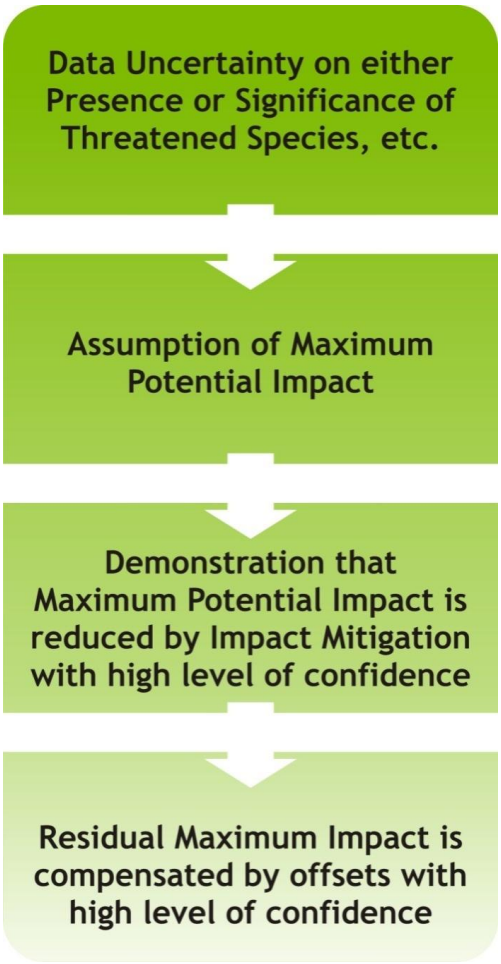

Figure 5.1 – Application of the Precautionary Principle to the Impact Assessment and Development of Mitigation and Offset Strategies

The potential level of impact on threatened species and TECs was assessed using the 'seven part test' as detailed in Section 5A of the EP&A Act (including terrestrial species listed under the TSC Act and aquatic species listed under the FM Act) and an 'Assessment of Significance' under the EPBC Act. The assessments of significance were undertaken following an initial screening process to identify species that may be potentially affected by the Project (refer to **Appendix A**), with a consequential full assessment of the likely significance of impacts being completed for these species (refer to **Appendices E** and **F**).

The assessments of significance do not take into account the range of impact mitigation strategies and biodiversity offsets proposed for the Project, rather they consider the impacts of the Project without any mitigation or offsetting, consistent with the requirements of both State and Commonwealth significant impact assessment guidelines (DECC 2007; Department of the Environment 2013). The Assessment of Significance was completed for the threatened species and TECs listed in **Table 5.2** and **Table 5.3**, either due to their recorded presence or the presence of potential habitat in the Proposed Disturbance Area, and the potential for the species or TECs to be affected. Further detail regarding the

assessments of significance is provided below in the remaining subsections of **Section 5.8** and in **Appendices E** and **F**.

5.8.1 Threatened Species Assessed Under the Environmental Planning and Assessment Act 1979

An Assessment of Significance was completed for the TSC Act threatened species and TECs listed in **Table 5.2**, either due to their recorded presence or the presence of potential habitat in the Proposed Disturbance Area, and the potential for the species or TECs to be affected. Further detail regarding the assessments of significance is provided below in the remaining subsections of **Section 5.8** and in **Appendix E**.

Table 5.2 - Threatened Species and EECs for which an Assessment of Significance was undertaken under the EP&A Act

Species/Community Name	**Species Listed under the TSC Act**	
	Assessed Under the EP&A Act (7 Part Test)	**Significant Impact?**
Threatened Flora Species		
Ozothamnus tesselatus	✓	×
Endangered Ecological Communities		
Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	✓	×
Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	✓	Potential Significant Impact
Endangered Populations		
Darling River hardyhead (*Craterocephalus amniculus*) population in the Hunter River Catchment	✓	×
Threatened Fauna Species		
swift parrot *Lathamus discolor*	✓	×
spotted-tailed quoll *Dasyurus maculatus*	✓	Likely Significant Impact
green and golden bell frog *Litoria aurea*	✓	×
koala *Phascolarctos cinereus*	✓	×
grey-headed flying-fox *Pteropus poliocephalus*	✓	×
large-eared pied bat *Chalinolobus dwyeri*	✓	×
Australian painted snipe *Rostratula australis*	✓	×
little eagle *Heiraaetus morphnoides*	✓	×
spotted harrier *Circus assimilis*	✓	×

Table 5.2 - Threatened Species and EECs for which an Assessment of Significance was undertaken under the EP&A Act (cont.)

Species/Community Name	Species Listed under the TSC Act	
	Assessed Under the EP&A Act (7 Part Test)	Significant Impact?
little lorikeet *Glossopsitta pusilla*	✓	×
powerful owl *Ninox strenua*	✓	×
masked owl *Tyto novaehollandiae*	✓	Potential Significant Impact
brown treecreeper *Climacteris picumnus victoriae*	✓	Potential Significant Impact
speckled warbler *Chthonicola sagittata*	✓	Potential Significant Impact
black-chinned honeyeater *Melithreptus gularis gularis*	✓	×
grey-crowned babbler *Pomatostomus temporalis temporalis*	✓	Potential Significant Impact
varied sittella *Daphoenositta chrysoptera*	✓	Potential Significant Impact
hooded robin *Melanodryas cucullata cucullata*	✓	Potential Significant Impact
scarlet robin *Petroica boodang*	✓	×
flame robin *Petroica phoenicea*	✓	×
diamond firetail *Stagonopleura guttata*	✓	Potential Significant Impact
brush-tailed phascogale *Phascogale tapoatafa tapoatafa*	✓	Potential Significant Impact
squirrel glider *Petaurus norfolcensis*	✓	Likely Significant Impact
yellow-bellied sheathtail bat *Saccolaimus flaviventris*	✓	Potential Significant Impact
east coast freetail-bat *Mormopterus norfolkensis*	✓	Potential Significant Impact
little bentwing-bat *Miniopterus australis*	✓	×
eastern bentwing-bat *Miniopterus schreibersii oceanensis*	✓	×
southern myotis *Myotis macropus*	✓	Potential Significant Impact
greater broad-nosed bat *Scoteanax rueppellii*	✓	Potential Significant Impact

The Project will result in the loss of a substantial and important area of habitat for a range of woodland-dependent threatened fauna species recorded in the Proposed Disturbance Area and wider Project Area. The loss of 217.7 hectares of woodland/forest, 6.0 hectares of riparian habitat and 223.1 hectares of Derived Native Grassland is considered likely to result in the reduction in the local population of the threatened species recorded in the Proposed Disturbance Area. The size of this remnant is considered sufficient to support those woodland dependent species that are known to be threatened by habitat fragmentation and isolation. Based on the threatened species assessment detailed in **Appendix E**, the Project is considered likely to result in significant impact on the spotted-tailed quoll (*Dasyurus maculatus*) and squirrel glider (*Petaurus norfolcensis*). It is noted that the impact of the Project on the spotted-tailed quoll is not considered to be significant at the Commonwealth level (refer to **Section 5.8.3** and **Appendix F**).

The Project will potentially result in a significant impact on the following additional threatened fauna species:

- masked owl (*Tyto novaehollandiae*);
- brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- speckled warbler (*Chthonicola sagittata*);
- grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- varied sittella (*Daphoenositta chrysoptera*);
- hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- diamond firetail (*Stagonopleura guttata*);
- brush-tailed phascogale (*Phascogale tapoatafa*);
- yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*);
- east coast freetail-bat (*Mormopterus norfolkensis*);
- southern myotis (*Myotis macropus*); and
- greater broad-nosed bat (*Scoteanax rueppellii*).

In addition, Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC is considered to be potentially significantly impacted.

These species and Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC have been categorised as 'potentially significantly impacted' as there are a range of factors that reduce the certainty as to whether the Project will result in a significant impact. These factors include (but are not limited to) certainty regarding the importance of habitat utilisation in the Proposed Disturbance Area; the cryptic nature of many of these species; and the uncertainty regarding the local populations of these species occurring within and beyond the Proposed Disturbance Area. When considering impacts on Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC, consideration was given to the proposed extent of clearing; the extent of the community that would remain in the Project Area; the remaining extent of the community in the Central Hunter; and the degree of fragmentation affecting the community.

The potential for a significant impact cannot be ruled out based on current knowledge and therefore, following application of the precautionary principle, a total of seven threatened bird species, five threatened mammal species and one EEC (refer to **Table 5.2**) are considered

to be potentially significantly impacted (without mitigation) by the Project (refer to **Appendix E**).

5.8.2 Threatened Species Assessed Under the Fisheries Management (FM) Act 1994

No FM Act listed threatened aquatic flora or fauna species were recorded within the Proposed Disturbance Area however, potential habitat for the Darling River hardyhead (*Craterocephalus amniculus*) Endangered Population in the Hunter Catchment was identified in Bowmans Creek. No additional threatened aquatic species, populations or EECs have potential to occur within the Proposed Disturbance Area.

The proposed construction of the Bowmans Creek bridge has been designed to minimise the disturbance within the vicinity of the creek bank with the piers for the proposed bridge being designed to sit outside of the low flow channel of Bowmans Creek. Erosion and sedimentation controls would be installed prior to the commencement of construction works and accordingly there are no long term potential impacts anticipated. The assessment concluded that temporary short term indirect impacts associated with the construction of the Hebden Road bridge duplication are unlikely to result in an adverse effect on the Darling River hardyhead Endangered Population in the Hunter River catchment.

5.8.3 SEPP 44 Assessment

The area is not considered to be core koala habitat as defined under SEPP 44, and the preparation of a Koala Plan of Management is not required. Obligations under SEPP 44 are not required for the Project.

5.8.4 Threatened Species Assessed under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999

Under the Commonwealth EPBC Act, the approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on matters of national environmental significance (MNES). These matters are:

- listed threatened species and communities;
- migratory species protected under international agreements;
- Ramsar wetlands of international importance;
- the Commonwealth marine environment;
- the Great Barrier Reef Marine Park;
- World Heritage properties;
- National Heritage places;
- nuclear actions; and
- a water resource, in relation to coal seam gas development and large coal mining development.

The Action (that is the proposed activities in the Proposed Disturbance Area) was deemed to comprise a ‘Controlled Action’ by the Commonwealth Department of the Environment on

24 October 2013, due to the potential for significant impacts on the following matters protected under the EPBC Act:

- listed threatened species and communities;
- listed migratory species; and
- a water resource, in relation to coal seam gas development and large coal mine development.

The Department of the Environment also determined that the Action be assessed through accreditation of the NSW Government assessment process. Supplementary DGRs were issued on 8 November 2013 and a detailed response to each of the matters raised is addressed in the MNES report included as Appendix 4 of the EIS.

The EPBC Act lists criteria which are used to determine whether an action is likely to have a significant impact on MNES. These criteria are addressed in the Assessment of Significance provided in **Appendix F** and included the EPBC Act listed species identified in **Table 5.3** below.

Based on previous survey and ecological monitoring of the Project Area and surveys undertaken by Umwelt within the Proposed Disturbance Area as part of the current Action, the listed threatened species which are known to have been recorded in the Project Area and Proposed Disturbance Area are included in **Table 5.3**.

Table 5.3 – EPBC-listed Threatened Species Recorded within the Project Area and Proposed Disturbance Area

Species	Recorded within Project Area	Recorded within Proposed Disturbance Area	Last known record	Number of sampling periods species recorded
swift parrot (*Lathamus discolor*)	Yes	No	2014	3
spotted-tailed quoll (*Dasyurus maculatus maculatus*)	Yes	Yes	2013	14
green and golden bell frog (*Litoria aurea*)	Yes	No	1999	5
New Holland mouse (*Pseudomys novaehollandiae*)	Yes	No	2007	5
grey-headed flying-fox (*Pteropus poliocephalus*)	Yes	Yes	2010	8
large-eared pied-bat (*Chalinolobus dwyeri*)	Yes (tentative record)	No	1999	4
koala (*Phascolarctos cinereus*)	Yes	Yes	2012	3
Ozothamnus tesselatus	Yes	No	2003	1

Potential habitat for the regent honeyeater (*Anthochaera phrygia*) and Australian painted snipe (*Rostratula benghalensis australis*) has also been identified.

For those threatened species recorded in the Project Area or considered to be potentially impacted by the Action, an Assessment of Significance was undertaken in accordance with the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines – Matters of National Environmental Significance (Department of the Environment 2013) and EPBC Act Policy Statement 3.18 Significant Impact guidelines for the vulnerable green and golden bell frog *Litoria aurea* (DEWHA 2009b) to determine whether the Project would result in a significant impact on threatened species.

Critically Endangered and Endangered Species

Swift Parrot and Regent Honeyeater

Swift parrots historically occurring in the box/gum habitats of the Project Area and potentially occurring regent honeyeaters are considered to comprise part of a population, as defined by the Significant Impact Guidelines 1.1 (Department of the Environment 2013). The Action is not expected to result in a significant impact on these endangered species as the Action will not:

- lead to a long-term decrease in the size of a population; or
- fragment an existing population into two or more populations; or
- adversely affect habitat critical to the survival of a species; or
- disrupt the breeding cycle of a population; or
- modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline; or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat; or
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

The loss of approximately 163.7 hectares (approximately 0.00015 per cent of potential habitat within the Hunter Valley) of potential box-ironbark woodland habitat will result in a reduction of the potential area of occupancy for the populations of the swift parrot and the potentially occurring population of the regent honeyeater, however is unlikely to substantially reduce the area of known occupancy. Therefore, it is considered unlikely that the Action would result in a significant impact on the swift parrot or potentially occurring regent honeyeater.

Spotted-tailed Quoll

A small local population of a broader Barrington Footslopes (southern and western footslopes) regional population of the spotted-tailed quoll occurs in the Mount Owen locality and within the Project Area the species has mainly been recorded in Ravensworth State Forest. Den sites and latrine sites have been recorded within the Project Area and more broadly along Bowmans Creek 6 kilometres to the west of the Project Area, however den sites have not been recorded in the Proposed Disturbance Area. In late 2012 a successful breeding event was recorded at Bowmans Creek. No breeding has been recorded in or close to the Project Area; however, active den sites in the Project Area have been located in stockpiled timber associated with ongoing Mount Owen forested mine rehabilitation and

adjacent to or within the intact native vegetation of Ravensworth State Forest. No active den sites have been located within the Proposed Disturbance Area. The spotted-tailed quoll has been recorded using mine rehabilitation as part of a broader foraging/home range that is centred on native woodland/forest habitat and the ongoing use of forested mine rehabilitation and forested regeneration areas indicates that the species is likely to persist in the future.The exotic grassland-dominated rehabilitation areas associated with the BNP and proposed RERR Mining Area disturbance areas are not considered to provide suitable foraging or denning habitat features or habitat value for the species. During April to July 2013 an individual male spotted-tailed quoll was recorded using woodland habitats at five locations within the Proposed Disturbance Area.

The Action is not expected to result in a significant impact on the spotted-tailed quoll as the Action will not:

- lead to a long-term decrease in the size of a population; or
- fragment an existing population into two or more populations; or
- adversely affect habitat critical to the survival of a species; or
- disrupt the breeding cycle of a population; or
- modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline; or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat; or
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

The Action will result in the loss of approximately 223.7 hectares of woodland, forest and riparian habitat and 223.1 hectares of derived native grassland habitat for the spotted-tailed quoll, which is a reduction in potential area of occupancy. While the Action will remove habitat for this species, the area of habitat to be removed is not important, notable, or of consequence, in accordance with the Significant Impact Guidelines 1.1 (Department of the Environment 2013) and it will not lead to a significant reduction in habitat for the species.

Based on the information provided above, the Action is unlikely to result in a significant impact on the spotted-tailed quoll.

Australian Painted Snipe

Australian painted snipe potentially occurring in dam and riparian habitats of the Project Area is not considered to comprise a population of the species, in accordance with the Significant Impact Guidelines 1.1 (Department of the Environment 2013). The Action is not expected to result in a significant impact on this endangered species as the Action will not:

- lead to a long-term decrease in the size of a population; or
- result in a reduction of the area of occupancy of the species; or
- fragment an existing population into two or more populations; or

- adversely affect habitat critical to the survival of a species; or
- disrupt the breeding cycle of a population; or
- modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline; or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat; or
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

The loss of approximately 0.6 hectares of highly modified and degraded riparian habitat and farm dams that are scattered across the Project Area will not result in an adverse impact on a population of the Australian painted snipe.

Vulnerable Species

In relation to vulnerable species, the Project Area is considered to provide habitat for an 'important population' of the potentially occurring green and golden bell frog and the New Holland mouse.

Green and Golden Bell Frog

The Upper Hunter Important Population of the green and golden bell frog is of high importance for the species being at the western limit of the species distribution along the east coast of NSW and being one of only two inland populations persisting. Therefore, the potential habitat for the species in the Project Area occurs within the limits of an important population of the species, as described by the Significant Impact Guidelines 1.1 (Department of the Environment 2013) and Significant Impact Guidelines for the vulnerable green and golden bell frog *Litoria aurea* (DEWHA 2009). The Action is not expected to result in a significant impact on the green and golden bell frog as the Action will not:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population, or
- fragment an existing important population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of an important population, or
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat; or
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

The loss of dams and associated terrestrial habitat that may be utilised by individuals occurring within the Upper Hunter Important Population of green and golden bell frog is not considered likely to result in a significant impact on the species due to the species not being positively recorded in the Project Area since 1999, despite annual monitoring undertaken by recognised experts in the identification and ecology of the species and since it is considered highly likely that the precipitous state of the Upper Hunter population is directly due to the impact of disease rather than habitat or other ecological factors (Forest Fauna Surveys and Newcastle Innovation 2014). The Action will not impact known habitat for the species.

New Holland Mouse

The presence of the New Holland mouse within the Project Area is considered to comprise part of an important population of the species as the majority of records of the species occur within coastal areas and habitats. The Atlas of NSW Wildlife identifies five records of the species at Mount Owen and one near Jerrys Plains in the upper Hunter Valley and a number of records in the Kurri Kurri/Cessnock area. Non-coastal habitats in the Hunter Valley are expected to provide a diffuse area of habitat for the species where habitat conditions are appropriate. Therefore, the record of the New Holland mouse in the Project Area represents part of an important population occurring within the upper Hunter Valley.

The Action is not expected to result in a significant impact on the New Holland mouse as the Action will not:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population; or
- fragment an existing important population into two or more populations; or
- adversely affect habitat critical to the survival of a species; or
- disrupt the breeding cycle of an important population; or
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline; or
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat; or
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

The Action is unlikely to result in a significant impact upon an important population of the New Holland mouse as the Action is not considered likely to impact habitats currently occupied by the species and substantial areas of potential, non-preferred habitat occurs within the expected extent of the important population occurring in the upper Hunter Valley.

Vulnerable Species for Which the Project Area does not Provide Important Habitat

While the koala, large-eared pied bat, grey-headed flying-fox and *Ozothamnus tesselatus* have all been recorded in the Project Area or are considered to potentially occur due to the identification of suitable habitat, an important population, as defined by the Significant Impact Guidelines 1.1 (Department of the Environment 2013) was not identified. The Assessment of Significance concluded that the Action is not likely to result in a significant impact on an important population of a vulnerable species as the reduction in habitat proposed as part of

the Action will not lead to a long-term decrease in the size of an important population, reduce the area of occupancy of an important population, increase fragmentation, or impact breeding such that an important population is likely to decline.

The outcome of the Assessment of Significance in relation to threatened species listed under the EPBC Act concluded that the Action is not likely to result in a significant impact on any of the threatened species known, or considered to potentially occur in the Project Area.

Migratory Species

A total of 12 migratory species were identified on the Protected Matters Search Tool as known, may or are likely to occur within the Project Area and seven of those species have been recorded during surveys of the Project Area. The migratory species that are known to occur or considered to have the potential to occur were considered in the Assessment of Significance in **Appendix F**, undertaken in accordance with the Significant Impact Guidelines 1.1 (Department of the Environment 2013).

The Project Area is not considered to comprise important habitat for any of the identified migratory species, and therefore the Action is not likely to substantially modify or destroy important migratory species habitat; disrupt the lifecycle of an ecologically significant proportion of a migratory species; or result in an invasive species that is harmful to migratory species becoming established within the Project Area. The Action is not expected to result in a significant impact on migratory species.

5.9 Cumulative Impact Considerations

As discussed in **Section 5.1**, the Proposed Disturbance Area and the surrounding Project Area have been subject to a range of historic disturbances from land clearing, agriculture and mining. Over the last decade, Mount Owen Complex has experienced modifications at both the Mount Owen and Glendell Mines. The history of land clearing, agriculture and mining has resulted in an incremental loss of vegetation and fauna habitat across the broader Ravensworth locality. This cumulative loss of habitat has placed further pressure on local threatened flora and fauna species and ecological communities.

Surrounding developments such as the Ravensworth Operations Project and the Ashton Coal Project have resulted in the incremental loss of a range of fauna and flora habitats in the central Hunter Valley. The incremental loss of these habitats in the central Hunter Valley has resulted in the remnant vegetation in the Project Area becoming one of few remaining large remnants that supports fauna habitats with a reasonable degree of ecological integrity, although most are somewhat modified. In acknowledgement of the impacts to these habitats losses, recently approved developments have been required to undertake substantial biodiversity mitigation and offsetting actions, together with significant habitat rehabilitation programs.

The cumulative impact of the Project and surrounding developments, particularly the Liddell Coal Operations Extension Project is taken into consideration in the assessments of significance documented in **Appendices E** and **F**. Threats to species listed under the TSC Act, FM Act and EPBC Act include those that are cumulative in nature, and the assessments undertaken implicitly consider the contribution of cumulative impacts on these species.

The overall cumulative impact of the Project is addressed in the EIS.

6.0 Impact Mitigation Strategy

Mount Owen has sought to avoid and minimise potential impacts on the ecological values of the Project Area throughout the project planning process. This has included avoidance and minimisation of disturbance of key vegetation communities and fauna habitats. These avoidance measures are described in detail in **Section 5.1**.

The ecological impact assessment documented in **Section 5.0** concluded that, without appropriate mitigation and offsetting, the Project would have a likely significant impact on two mammals and a potentially significant impact on seven threatened bird species, five mammal species and one EEC at the State level (refer to **Table 5.2**).

Mount Owen has committed to the design and implementation of a comprehensive strategy to mitigate the unavoidable impacts of the Project. Further to this, a comprehensive biodiversity offset strategy has been developed, which includes the protection and enhancement of native vegetation and threatened species habitat, to develop a positive long-term outcome for the threatened species and key ecological features affected by the Project. The proposed biodiversity offset strategy is documented in **Section 7.0**.

This section details the mitigation strategies that are designed to minimise impacts on significant ecological features in the areas to be disturbed as part of the Project.

6.1 Actions to Maintain Ecological Value in the Project Area

Mount Owen currently complete ecological management actions across the Project Area as identified in the Mount Owen Flora and Fauna Management Plan (Xstrata Coal and Thiess 2006) and the Landscape Management Plan (Xstrata Mount Owen 2011). As part of the requirements of these Plans, the following specific control measures are considered to be integral to the protection and preservation of the ecological features of the Project Area:

- understanding existing flora and fauna characteristics prior to any new development through the undertaking of baseline studies at feasibility and baseline phases;
- rehabilitation of disturbed and mined land as soon as practical;
- ensuring appropriate erosion and sediment control systems are in place to prevent damage to flora and fauna from erosion and unnatural flooding events; and
- extensive seasonal monitoring of flora and fauna.

Each of these existing control measures contributes to the maintenance of habitat quality across the Project Area.

In addition to the above, weed and pest animal management occurs across the Mount Owen Complex, as needed or identified as part of the ecological monitoring recommendations. These works involve targeted weed removal using a variety of techniques and feral animal control in accordance with all relevant government approvals.

6.1.1 General Ecological Management Strategies

A range of management strategies are used by Mount Owen to limit impacts on native flora and fauna in the Project Area. These strategies are currently detailed in the Mount Owen Complex Flora and Fauna Management Plan and will be incorporated into a revised and consolidated Landscape Management Plan should the Project be approved. The Landscape

Management Plan will be reviewed and updated within 12 months of any Project approval. The strategies will include:

- feral animal and weed control;
- rehabilitation of disturbed areas with species characteristic of extant vegetation communities (as further addressed in **Section 6.2**);
- use of native species in revegetation, and the linkage and integration of rehabilitation areas with existing vegetated areas to improve ecological function and provide appropriate fauna habitat, except in areas identified for improved pasture (as addressed in **Section 6.2.2**);
- management of erosion and sedimentation to ensure that adjoining vegetation communities and aquatic systems are not adversely impacted (as addressed in the Main Text of the EIS);
- adaptive management, as required, if a previously unrecorded or assessed threatened species is identified in the Proposed Disturbance Area during operations;
- ongoing monitoring and maintenance of revegetation works and habitat enhancement activities; and
- an adaptive approach to ongoing monitoring of native flora and fauna (as discussed in **Section 8.0**).

6.1.1.1 Weed Control

Weed species could be inadvertently brought into Mount Owen Complex with imported materials, or could invade naturally through removal of native vegetation. The presence of weed species has the potential to be a major impediment to revegetation and regeneration activities. In addition to this, the presence of weed species within the existing Mount Owen Biodiversity Offset Areas has the potential to significantly decrease the value of this vegetation to native species, particularly threatened species.

Existing weed management controls at Mount Owen will be incorporated into the Project. Noxious and other undesirable weed species within the Project Area will be controlled to an acceptable level, and where possible eliminated, through an integrated approach involving a combination of chemical and physical control methods, and careful pasture management (Xstrata Mount Owen 2011).

6.1.1.2 Feral Animal Control

Introduced fauna species such as foxes, rabbits, pigs, dogs and feral cats could increase within the Project Area due to increased disturbance. Clearing, thinning of vegetation and the creation of tracks through existing dense vegetation might assist the penetration of introduced fauna species such as pigs, cats and foxes, and allow them to establish in new areas. An increase in feral species within Mount Owen has the potential to increase impacts on existing native species, particularly via predation and habitat destruction. In addition to this, a number of introduced herbivores have been recorded within Mount Owen Complex, and are likely to be competing with native species and causing considerable damage to native vegetation.

Foxes and wild dogs represent a substantial threat to the ongoing persistence of the spotted-tailed quoll. Recommended fox and wild dog management practices, in accordance with the Mount Owen Landscape Management Plan include:

- no 1080 baiting;
- contract shooting; and
- specialised trapping.

Regular monitoring of revegetation and regeneration areas will be undertaken to determine the impact of feral animals, particularly on vegetation establishment. Feral animal control works will be undertaken periodically to ensure the suppression of feral animals, and will consider ecological impacts.

6.1.1.3 Bushfire Management

The vegetation that will be retained and regenerated/rehabilitated will require appropriate bushfire management to protect life and property, while providing necessary protection to the significant ecological features identified. Bushfire management strategies are currently detailed in the Mount Owen Complex Bushfire Management Plan and will be incorporated into a revised and consolidated Landscape Management Plan should the Project be approved. The Landscape Management Plan will be reviewed and updated within 12 months of any Project approval.

6.2 Rehabilitation

The aim of the rehabilitation of the Proposed Disturbance Area will be to re-establish those vegetation communities and fauna habitats currently recorded and connect, as far as practicable, the habitat areas to the north and south of the Proposed Disturbance Area with a vegetated corridor. A range of preliminary criteria relating to biodiversity issues has been developed to direct the rehabilitation activities. Rehabilitation biodiversity objectives will be used in rehabilitation planning, and will:

- provide for the safety of employees and the public during and following the closure of the mining operations;
- comprise a sustainable final landform and use that can co-exist with surrounding land uses;
- re-establish vegetation consistent with extant vegetation communities of the Proposed Disturbance Area within the post-mining landform;
- re-establish fauna habitats consistent with extant fauna habitats of the Proposed Disturbance Area within the post-mining landform;
- use native grasses in establishment of grassland areas in the rehabilitated landform; and
- not preclude other potential post mining land use options should they be determined to be viable and preferable as part of the detailed mine closure planning process.

Rehabilitation will be conducted progressively over the life of the mine, as an integral component of mining operations. All rehabilitation works will be scheduled to commence as soon as practicable after disturbance and reformation of the landscape. This approach will minimise the disturbed area at any point in time and hence reduce the ecological impact of the Project.

The post-mining areas will be progressively rehabilitated to self-sustaining native vegetation communities, in accordance with a rehabilitation strategy. It is expected that the existing Landscape Management Plan (that contains the Rehabilitation and Offset Management Plan

(ROMP)) (Xstrata Mount Owen 2011) will be updated, post-approval. The proposed final land use for the post-mining areas aims to partially emulate the pre-mining environment, predominately returning woodland communities cleared for the Project but also comprising areas of potential agricultural land and will enhance local and regional ecological linkages across Mount Owen Complex with proximate areas. Rehabilitation works will use local provenance endemic species (for native communities), where practicable, including consideration of seed availability.

A substantial number of studies of rehabilitation have been completed at the Mount Owen Complex. Since 1996, 12 Honours Degrees and three PhD Degree candidates from the University of Newcastle have been conducting research at Mount Owen which has aided the development of the Ravensworth State Forest Vegetation Complex (RSFVC) Research Program. This program comprises two sub-programs, that is, the Forest-Woodland Reconstruction Research Program and the Biodiversity Offsets Research Program (BORP). The objectives of the Forest-Woodland Reconstruction Research Program are to understand plant function within the RSFVC, seek solutions to problems in the 'New Forest' and remnant vegetation areas within the Mount Owen Complex while understanding barriers to enable the success in the reconstruction of forest and woodland. The Forest-Woodland Reconstruction Research Program studies continued to progress in 2010 and 2011 reporting in July 2010 that plant diversity in the Ravensworth State Forest remnants and the rehabilitation areas have more than doubled the number of plant species present to 481 since studies in plant diversity have commenced.

6.2.1 Rehabilitation Strategy

Rehabilitation of post-mining areas will be completed as soon as practicable after shaped areas become available, and will target Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC which is expected to be potentially significantly impacted by the Project and currently occurs within the proposed rehabilitation area.

The proposed final rehabilitation plan (refer to **Section 7.6**) shows the final conceptual composition of the post-mining vegetation types. The proposed final rehabilitation plan shows that some of the flatter portions of the proposed final landform may be established for potential viable agricultural use. Whilst these areas will be established as native vegetation as part of the rehabilitation strategy, measures such as additional soil amelioration works may be undertaken in the areas to promote the potential for future agricultural use post mining. Approximately 518 hectares of rehabilitation is proposed as part of the Project, in addition to rehabilitation commitments resulting from previous project approvals. The total area of post mining rehabilitation for the Mount Owen Complex will be approximately 1900 hectares.

The rehabilitation program implemented will be continually reviewed over the life of the Project with the aim of achieving an effective, sustainable rehabilitation outcome. These indicative areas may therefore change as an outcome of this detailed rehabilitation program.

Within the target vegetation community the density of plantings will be varied to create a variegated landscape to increase the value of rehabilitation for local fauna species. The range of densities for each vegetation community will remain within the documented natural variation levels of each vegetation community.

6.2.2 Preliminary Rehabilitation Criteria

Rehabilitation completion criteria have been established in order to guide the rehabilitation works to ensure the ecological objectives of the rehabilitation, as detailed in **Section 6.2**, are met. The rehabilitation completion criteria have been developed to be in accordance with the completion criteria for the Mount Owen and Glendell Mines, as described in the Landscape

Management Plan (Xstrata Mount Owen 2011) and the Glencore Xstrata Standard 5.13 Closure Criteria Development and Rehabilitation Monitoring.

The preliminary rehabilitation criteria, as outlined in **Table 6.1**, have been developed to meet the rehabilitation and mine closure objectives as outlined in the EIS. These criteria will be used as the basis for further refinement following the implementation of rehabilitation and biodiversity monitoring programs. The full preliminary closure criteria are presented in the main text and the following criteria specifically relate to biodiversity and the establishment of self-sustaining native vegetation communities.

Table 6.1 – Preliminary Project Closure and Rehabilitation Criteria that Relate to Biodiversity Values

Landform Establishment
• no significant erosion is present that would constitute a safety hazard or compromise the capability of supporting the end land use;
• Drainage structures (including drainage lines established in the final landform) are stable and there is no evidence of overtopping or significant scouring as a result of runoff ; and
• surface layer to be free of any hazardous materials.
Water
• runoff water quality from rehabilitation areas is within the range of water quality data recorded from analogue sites and does not pose a threat to downstream water quality.
Vegetation
• revegetation areas contain flora species assemblages characteristic of the desired native vegetation community;
• second generation tree seedlings are present, or are likely to be, based on monitoring in comparable older rehabilitation sites (i.e. evidence of fruiting of native species observed);
• more than 75 per cent of trees are healthy and growing as indicated by long term monitoring;
• there is no significant weed infestation such that weeds do not comprise a significant proportion of species in any stratum.
Fauna
• rehabilitated areas provide a range of vegetation structural habitats (e.g. eucalypts, shrubs, ground cover, developing litter layer etc.) to encourage use by native fauna species.
Bushfire hazard
• Appropriate bushfire hazard controls have been implemented on the advice from the NSW Rural Fire Service.

Progress in meeting the completion criteria will be considered in mine closure planning and reported to relevant agencies, as required.

6.2.3 Local Provenance

Seed and tube stock of local, preferably on-site, provenance will be used in rehabilitation. Local provenance will enable no net loss of the genetic integrity of the vegetation communities as a result of the Project. Mount Owen currently sources a portion of its native seed stock on site for use in rehabilitation.

6.3 Fauna Habitat Re-instatement

Following the completion of topsoiling and seeding in rehabilitation areas Mount Owen will re-establish ground fauna habitat through the relocation of cleared vegetation and rocks in

targeted rehabilitation areas. This will contribute to the more rapid development of fauna species diversity in the medium to long term as vegetation re-establishment progresses.

Once the rehabilitated vegetation communities are of sufficient maturity, supplementary arboreal habitat will be installed.

Once the rehabilitated vegetation communities are of sufficient maturity, nest boxes will be installed to supplement arboreal habitat. Nest boxes will be maintained within rehabilitation areas for the life of the mine to ensure that hollow-roosting and nesting species are able to inhabit rehabilitated areas. The design of nest boxes will include a range of boxes suitable for the full range of arboreal fauna species known to occur within the Project Area prior to mining. An assessment of the suitability of rehabilitated areas will be undertaken as part of annual rehabilitation monitoring to determine when the rehabilitation is sufficiently mature enough to support populations of hollow dependent fauna species, as well as the size and type of nest boxes/tree hollows that are suitable.

Dams will be constructed in the post-mining landform to facilitate the re-colonisation of woodland fauna communities. Dams generally provide a source of permanent water in the landscape and associated fauna species such as frogs and invertebrates will constitute suitable prey for many additional fauna species such as reptiles. Increasing the habitat complexity and range of micro habitats occurring in the post-mining landscape will result in the increased utilisation of the rehabilitation by a much wider range of fauna species thereby meeting the objective of the re-establishment of fauna habitats and threatened species habitats in the post-mining land form.

6.3.1 Protection and Management of Arboreal Species and Habitat

A robust tree felling procedure is implemented at Mount Owen Complex to minimise the potential for impacts on native fauna species (including threatened species) as a result of the clearing of hollow-bearing trees. This procedure is detailed in the existing Flora and Fauna Management Plan and will be updated and consolidated within the Landscape Management Plan within 12 months of any Project approval.

This procedure includes:

- comprehensive pre-clearing surveys, no more than two weeks prior to felling. This will include marking of hollow-bearing trees, as well as any other notable features such as fallen timber, hollow logs or boulders suitable for salvage; active nests, dreys or dens requiring consideration; and seed-bearing trees for salvage. Surveys will include detailed searches for threatened flora and fauna species, including micro-bats;

- removal of non hollow-bearing trees/vegetation as close to the hollow-bearing tree felling date as possible (in order to discourage fauna usage of the area). It is not considered necessary for a suitably experienced and licensed person to be present to supervise such works, providing pre-clearing surveys have been completed within the designated timeframe;

- detailed hollow-bearing tree felling procedures, including (but not limited to):

    - supervision of all hollow-bearing tree felling works and licensed person. If an ecological issue is encountered, this person is to advise on the most appropriate measures to ensure minimal impact on fauna species, particularly threatened species;

    - visual canopy inspection on the day of the felling of hollow-bearing trees for fauna species and active nests;

- shaking of hollow-bearing tree (with heavy machinery) for at least 30 seconds to encourage resident fauna to abandon tree, prior to felling;
- lowering of hollow-bearing trees as gently as possible with heavy machinery;
- inspection of all hollows in felled trees;
- capture of any displaced/injured fauna;
- release of unharmed fauna into nearby secure habitats;
- injured fauna to be assessed and taken to wildlife carer, if necessary;
- felled trees to be rolled so that the number of hollows blocked against the ground are minimised;
- all felled trees to remain in place overnight to allow any unidentified fauna to escape; and
- salvage of suitable hollows for treatment and installation within rehabilitation and revegetation areas as compensatory habitat, where practicable.

All personnel who will capture/handle/house and/or transport native fauna species (injured or uninjured) will be appropriately licensed under the requirements of the NSW Animal Ethics Committee.

Site personnel (particularly vehicle operators) will be briefed on fauna awareness issues and will be required to report incidents involving injury to native wildlife. Assistance from a wildlife carer or veterinarian will be sought if injured native wildlife are encountered.

6.3.2 Spotted-tailed Quoll Habitat Enhancement

Given the known presence of a spotted-tailed quoll (*Dasyurus maculatus maculatus*) population in the Project Area, the following habitat enhancement measures will be undertaken within the proposed Stringybark Creek Habitat Corridor (refer to **Section 7.4**) that are proposed to assist the persistence of this species at Mount Owen, and broader local area:

- salvage of trees felled during construction works and emplacement within the Stringybark Creek Habitat Corridor (refer to **Section 7.0**) as log piles. This will increase the amount of potential foraging and denning habitat for this species in the local area. It is notable that two currently known den sites at Mount Owen and the known breeding den located at Liddell, to the west of the Project Area, are located in similar log piles; and

- salvage and placement of large rocks and boulders into piles as further potential denning habitat.

7.0 Biodiversity Offset Strategy

A Biodiversity Offset Strategy is proposed to compensate for residual impacts on those species, vegetation communities and ecological features that are likely to be, or could potentially be, significantly impacted by the Project. The Biodiversity Offset Strategy has been developed in accordance with the DGRs (refer to **Section 1.4**) as follows: *A comprehensive offset strategy for the development including a justification of how the strategy would maintain or improve the terrestrial and aquatic biodiversity values of the region in the medium to long term, and how the strategy would be integrated with the Upper Hunter Strategic Assessment process.* The Biodiversity Offset Strategy has also been prepared in accordance with the *Principles for the Use of Biodiversity Offsets in NSW*, in accordance with the Project DGRs.

The OEH submission to the DGRs (dated 4 March 2013) states that the biodiversity impacts of the Project can be assessed using either the BioBanking Assessment Methodology (Scenario 1) or a detailed biodiversity assessment (Scenario 2). This Biodiversity Offset Strategy has been prepared in accordance with Scenario 2 and Mount Owen will not be seeking a BioBanking Statement under Part 7A of the TSC Act.

Mount Owen has, where possible, modified the Project to avoid and minimise ecological impacts, and a range of impact mitigation strategies have been included in the Project to mitigate the impact on ecological values (refer to **Section 6.0**). Impact avoidance, minimisation and mitigation strategies have resulted in the reduction of impacts on threatened and migratory species and EECs.

This section documents the approach that has been taken to develop this comprehensive Biodiversity Offset Strategy, and provides information on how the biodiversity offset strategy will compensate for significant or potentially significant impacts on species, communities and ecological features at the State level. A framework on how the Biodiversity Offset Strategy will be implemented and monitored is also provided.

As stated in **Section 6.0**, the precautionary principle has been considered in the development of the mitigation and offsetting strategies, due to uncertainty and data deficiencies for some threatened species and vegetation communities with the potential to be significantly impacted by the Project. The precautionary principle assumes the maximum potential impact is applied to these species in the impact assessment and therefore drives robust requirements for mitigation and offsetting.

The objectives of the Biodiversity Offset Strategy are to:

- maintain or improve the terrestrial and aquatic biodiversity values of the region in the medium to long term;
- identify land-based offsets that contain as many as possible of the threatened vegetation communities, threatened flora species, threatened fauna species, and potential and actual habitat for threatened species impacted by the Project;
- identify land-based offsets that are strategically located;
- identify land-based offsets in which an environmental gain can be made via appropriate management strategies;
- secure offsets in perpetuity;

- to develop a management strategy for the proactive environmental management of the proposed offset sites, but with appropriate consideration of the existing rural nature of the area;

- as a minimum provide a suite of offsets (land-based and non land-based) that have the same ecological value as the residual impacts of the Project on threatened vegetation communities, threatened flora species and threatened fauna species and their habitats; and

- demonstrate how the strategy would be integrated with the Upper Hunter Strategic Assessment process.

The key components of the Biodiversity Offset Strategy include the following land-based components:

- long-term conservation of a 367 hectare property located adjacent to existing Mount Owen Biodiversity Offset Areas, known as the Cross Creek Offset Site (refer to **Figure 7.1**). The Cross Creek Offset Site provides targeted 'like for like' vegetation and threatened fauna habitats and opportunities for environmental improvement. It is strategically located in the vicinity of a number of existing and proposed Glencore biodiversity offset areas;

- long-term conservation of a 303 hectare property located in the Manobalai region, known as the Esparanga Offset Site (refer to **Figure 7.2**). The Esparanga Offset Site adjoins Manobalai Nature Reserve in a priority conservation area located in the Great Eastern Ranges and the Upper Hunter Strategic Assessment priority areas and provides high conservation value vegetation communities and 'like for like' threatened fauna habitat;

- Stringybark Creek Habitat Corridor regeneration strategy that will provide a 97.5 hectare corridor that links existing high quality habitat associated with the existing Mount Owen Biodiversity Offset Areas and Ravensworth State Forest with adjacent corridors and proposed conservation areas at Glencore's Liddell Operations to the west of the Project Area. The Stringybark Creek Habitat Corridor includes key commitments relating to the establishment of spotted-tailed quoll habitat; and

- on-site mine rehabilitation that comprises key commitments to native vegetation community re-establishment and fauna habitat augmentation.

The ecological and strategic biodiversity values of the Cross Creek and Esparanga Offset Sites are discussed in detail in **Section 7.3**. **Section 7.4** describes the commitment from Mount Owen to regenerate the Stringybark Creek Habitat Corridor with key commitments related to the establishment of spotted-tailed quoll habitat that will link existing biodiversity offset areas and the values of existing Mount Owen mine rehabilitation. The ecological values that the proposed mine rehabilitation will contribute to the Biodiversity Offset Strategy is described in **Section 7.5**.

7.1 General Industry Approaches to Biodiversity Offsetting

7.1.1 'Traditional' Approaches

Over the course of the last 10 years or more, biodiversity offsets have been used in NSW as an effective measure to compensate for developmental impacts on biodiversity. Biodiversity offsets are often used where there will be a residual impact on biodiversity once impact avoidance, minimisation and mitigation have all been implemented to reduce impacts.

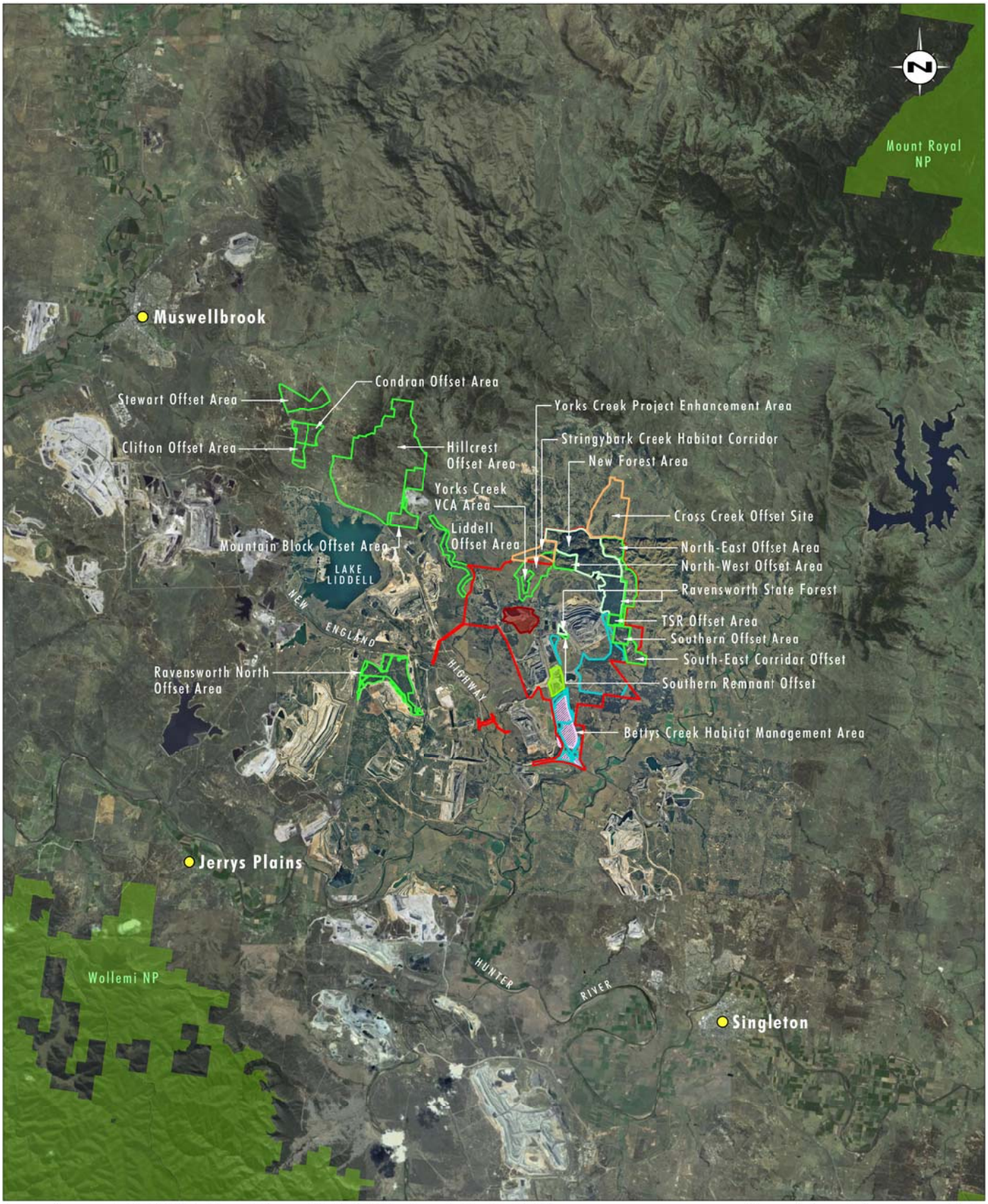

Image Source: AAM (2013), Mount Owen (2012-2013), Google Earth (2008)
Data Source: Mount Owen (2014), Department of Lands (2013)

0 2.5 5.0 10 km
1:250 000

Legend

- Project Area
- Referral Area
- Proposed RERR Mining Area
- Bayswater North Pit
- Approved Glencore Offsets
- Proposed Mount Owen Offsets
- Bettys Creek Habitat Management Area
- Ravensworth State Forest
- National Park

FIGURE 7.1

Strategic Location of Cross Creek Offset Site in the Mount Owen Offset Cluster

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20141024 9.55

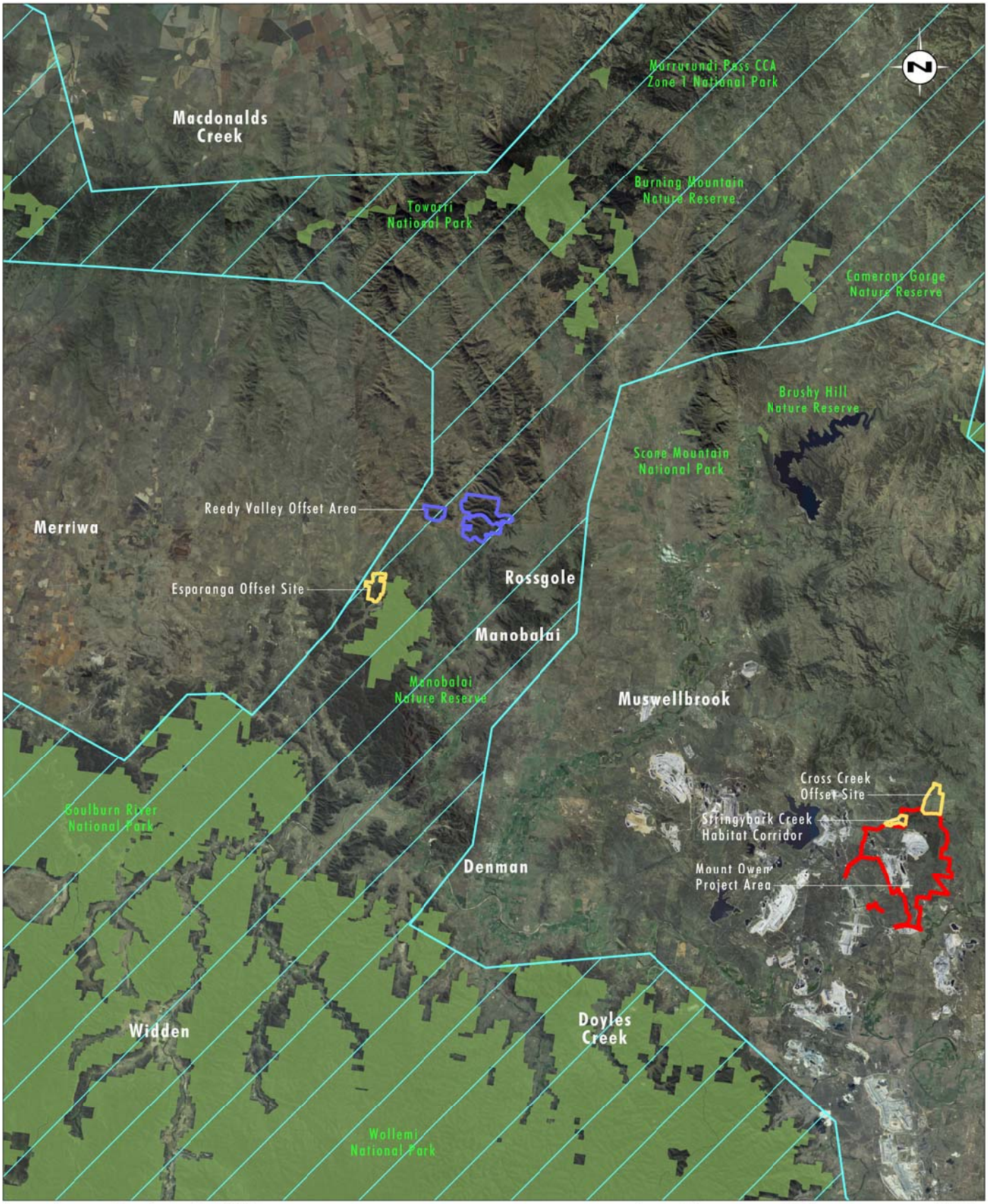

Image Source: Google Earth (2004)
Data Source: Mount Owen (2014), DECC (2008), Department of Lands (2009)

Legend

- Project Area
- Proposed Mount Owen Offsets
- Bulga Offset Area
- National Parks and Reserves
- Great Eastern Ranges Conservation Corridor Initiative

FIGURE 7.2

Strategic Location of the Esparanga Offset Site in the Glencore Manobalai Offset Cluster

File Name (A4): R03/3109_819.dgn
20140822 13.46

While there have been no consistent, universally applied guidelines, it has generally been accepted that, in principle, biodiversity offsets should be:

- located as close as possible to the areas subject to impact, depending on the availability and suitability of such areas;
- appropriately monitored and managed for biodiversity outcomes;
- appropriately protected;
- at least as large as the area impacted; and
- designed to lead to a net gain in biodiversity values in the medium to long term.

Although these principles are not universally employed, it is recognised that they form an appropriate approach around which individual development offsets are assessed, even if it is not always possible to achieve all elements. In the past, biodiversity offsetting has taken the form of:

- developers managing land that is set aside for biodiversity conservation;
- developers donating appropriate land to OEH or other similar bodies for biodiversity conservation; and
- financial contributions to the government to fund land purchases for biodiversity conservation, or to fund biodiversity land enhancement projects, or funding to other organisations to implement threatened species recovery actions, and to undertake research and monitoring.

7.1.2 NSW Offsetting Principles and Policies

The NSW Government is currently developing a new approach to guide how biodiversity offsets are established for major projects (state significant development and state significant infrastructure). Still in its draft form, the draft NSW Biodiversity Offsets Policy for Major Projects is designed to clarify, standardise and improve the biodiversity offsetting for major project approvals. The Policy will (when formally applied to major projects) be applied to all developments and infrastructure that are considered to be significant to the state under theEP&A Act. The NSW Biodiversity Offsets Policy for Major Projects includes a credit calculator called the Framework for Biodiversity Assessment (the FBA) which calculates the number of biodiversity credits required in order to offset the project. As the Policy has not been formally released and does not currently include a component to calculate the credit value of potential offset site, no assessment of the proposed offset area against the principles of the NSW Biodiversity Offsets Policy for Major Projects has been undertaken.

In June 2011, OEH released the NSW OEH Interim Policy on Assessing and Offsetting Biodiversity Impacts of Part 3A, State Significant Development (SSD) and State Significant Infrastructure (SSI) (OEH 2011). The interim policy acknowledges that proposals assessed as State significant projects under the EP&A Act do not have to meet the ‘improve or maintain’ standard, which is required under the BioBanking scheme, nevertheless, adopts the use of the BioBanking Assessment Methodology (BBAM) for the purpose of:

- quantifying and categorising the biodiversity values and impacts of State significant projects;
- establishing, for benchmarking purposes, the offsets that would be required if the State significant project had been expected to meet the improve or maintain standard; and

- providing a structured approach to determining how proposals may, in lieu of meeting the improve or maintain standard, meet one of two alternative standards established under this policy.

The Policy provides for a range of mechanisms to be used to implement offsets (i.e. not only BioBanking credits) in view of the currently limited supply of biodiversity credits on the market. The Policy describes three possible outcomes that proposals should strive to meet depending on the circumstances. These outcomes are:

- Tier 1 – Improve or maintain with offsets calculated via the BioBanking calculator;
- Tier 2 – No net loss with offsets calculated via the BioBanking calculator; or
- Tier 3 – Mitigated net loss with offsets calculated by the BioBanking calculator but then amended by offset variation criteria to a minimum land offset to clearing ratio of 2:1.

This Biodiversity Offset Strategy has been prepared in accordance with Tier 3 of the Policy, in accordance with the OEH submission to the DGRs. In considering whether the mitigated net loss standard is appropriate, consideration is given to:

- whether the credits required by the BioBanking calculator are available on the market;
- whether alternative offset sites (other than credits) are available on the market; and
- the overall cost of the offsets and whether these costs are reasonable given the circumstances.

The Project is seeking a Tier 3 Mitigated Net Loss offset scenario due to the lack of suitable credits required by the Project being on the market and the availability of suitable BioBanking offset sites in the Hunter Region. Due to the identification of suitable land-based offsets within the Project approval timeframe and the development of an offset to clearing ratio of greater than 2:1, a Tier 3 Mitigated Net Loss outcome is considered appropriate to offset the residual impacts of the Project.

7.1.2.1 Principles for the Use of Biodiversity Offsets in NSW

Currently, the OEH guidelines *Principles for the Use of Biodiversity Offsets in NSW* (DECC 2008) provide a formal approach through which biodiversity offsetting can be measured. The NSW Government has recently developed (August 2013) the following seven principles to be used in assessing impacts to biodiversity and determining acceptable offsets for state significant development and state significant infrastructure projects.

1. Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.
2. Offset requirements should be based on a reliable and transparent assessment of losses and gains.
3. Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.
4. Offsets must be additional to other legal requirements.
5. Offsets must be enduring, enforceable and auditable.

6. Supplementary measures can be used in lieu of offsets.

7. Offsets can be discounted where significant social and economic benefits accrue to NSW as a consequence of the proposal.

Section 7.8 details how the above OEH (OEH 2013) biodiversity offsetting principles for State Significant Development have been taken into account and addressed in the development of the Biodiversity Offset Strategy. The Biodiversity Offset Strategy is consistent with the principles for the use of biodiversity offsets in NSW.

7.1.3 BioBanking

The NSW Government developed the BioBanking scheme with the intent of developing a more consistent approach to biodiversity offsetting. It forms an alternative approach against which developments can be assessed and through which proponents can achieve appropriate biodiversity offsetting outcomes without having ongoing management or legal responsibility for the offset areas. Although participation in BioBanking is voluntary and is not the proposed offsetting approach for the Project, the principles underpinning BioBanking were considered in the early development of the Biodiversity Offset Strategy.

The BioBanking Assessment Methodology (BBAM) works through applying a rule-based approach to determine the likely impact a development will have on biodiversity, and through then calculating the number of *biodiversity credits* (comprising *ecosystem credits* and/or *threatened species credits*) that are required to be purchased to offset the development's impact. The credits are purchased from registered BioBanking Sites and the funds generated from the purchase are invested in the NSW Government's Environmental Trust and then distributed to the BioBanking site manager(s) in perpetuity to achieve a set of previously-agreed management actions at that/those site(s). This process is known as credit retirement, and once the developer has purchased all of the necessary credits, their development has been offset and they have no further responsibility to any biodiversity offsetting requirements. BioBanking sites will be protected, managed and funded in-perpetuity from the Environmental Trust.

7.1.4 Commonwealth Environmental Offsets Policy

In October 2012 the Australian Government released the EPBC Act Environmental Offsets Policy (DSEWPC 2012). The policy relates to all protected matters under the EPBC Act including adversely impacted heritage values, and applies to offsetting requirements in terrestrial and aquatic (including marine) environments.

The Policy has five key aims:

- to ensure the efficient, effective, timely, transparent, proportionate, scientifically robust and reasonable use of offsets under the EPBC Act;

- to provide proponents, the community and other stakeholders with greater certainty and guidance on how offsets are determined and when they may be considered under the EPBC Act;

- to deliver improved environmental outcomes by consistently applying the policy;

- to outline the appropriate nature and scale of offsets and how they are determined; and

- to provide guidance on acceptable delivery mechanisms for offsets.

The policy includes the provision that at least 90 per cent of offset points must be earned from direct (i.e. land-based) offsets, while the remainder can be earned through indirect measures (e.g. funding or relevant recovery actions). Deviation from the 90 per cent direct offset requirement will only be considered in limited circumstances.

While this reinforces the move to direct offsets, the concept of 'advanced offsets' has been introduced. These are a supply of offsets for potential future use, transfer or sale, established before any impact is undertaken. While an advanced offset can reduce an overall future offset requirement, it does not influence whether or not an action referred under the EPBC Act will be determined as acceptable.

The policy requires that the 'conservation gain' for the impacted protected matter, which is delivered by the offset, is to be new or additional to what is already required by a duty of care or to any environmental planning laws at any level of government.

Importantly, the policy makes use of an impact and offsets calculator which is designed to determine the ecological costs of a development, termed 'impact points', together with the likely ecological benefit of offset sites, termed 'offset points' in order to assess the relative value of proposed offset packages. An assessment of the Biodiversity Offset Strategy in relation to the principles governing the Policy is provided in **Section 7.7.2** and an assessment of the 'impact points' and 'offset points' generated has been undertaken and is provided in **Section 7.9**.

7.1.5 Upper Hunter Strategic Assessment

The Upper Hunter Strategic Assessment is a joint initiative of the NSW and Commonwealth governments, working with the coal mining industry to improve the planning of new or expanded coal mines which have the potential to impact biodiversity. By identifying and addressing important biodiversity issues before mine applications are lodged, environmental outcomes will be improved; the assessment process will be streamlined; and there will be greater certainty for the community, industry and government (OEH 2013).

Considerable conservation benefits can be gained by taking a proactive approach to managing cumulative impacts to biodiversity in advance of inevitable project-by-project applications for future coal mining. These benefits will include:

- availability of comprehensive information on biodiversity values within lease boundaries well in advance of mine planning. This should allow impacts to be **avoided** to the fullest extent practicable;
- guidelines to **mitigate** impacts on listed threatened species and ecological communities during the mine construction and operation phases;
- a framework for the **offsetting** of unavoidable impacts including the creation of a pooled offset fund, the identification of regional priorities for investment and the promotion of innovative ways to facilitate the private supply of offsets; and
- a framework for the ecological **restoration** of lands at the completion of mining.

In addition, the strategic assessment potentially offers significant efficiency savings for industry and regulators as separate Commonwealth assessment and approval will not be required and all biodiversity requirements will be clearly spelt out in the biodiversity plan.

The BioCertification Assessment Methodology (BCAM) is used to determine whether biodiversity certification under the Upper Hunter Strategic Assessment will improve or maintain biodiversity values. BCAM assesses the loss of biodiversity values on land

proposed for biodiversity certification and the impact, or likely impact, of proposed conservation measures on land proposed for biodiversity conservation (including conservation measures that are proposed to be implemented in the future).

Unfortunately, the Upper Hunter Strategic Assessment will not be finalised within the proposed approval schedule for the Project. Nevertheless, consideration was given to the aims and objectives of the Upper Hunter Strategic Assessment in offsetting impacts to biodiversity, including consideration of the location of the likely priority offset areas. Further, the BCAM assessment process was applied to the Project, to ensure the outcomes are consistent with the direction of the Upper Hunter Strategic Assessment. The outcomes of the BCAM assessment for the Project Area summarised in **Section 7.11**.

7.2 Framework for Developing the Biodiversity Offset Strategy

Currently there are no formal guidelines available from the relevant government authorities that provide strict guidance on precisely how to develop biodiversity offset strategies, except in the case of the BBAM for NSW BioBanking assessments and approvals and the generic EPBC Act impact and offsets calculator (DSEWPC 2012). As discussed in **Section 7.1.2**, the draft NSW Biodiversity Offsets Policy for Major Projects is being developed to clarify, standardise and improve the biodiversity offsetting for major project approvals. Rather, the relevant authorities have documentation that provides general guidance on the development of offset strategies. The Biodiversity Offset Strategy was developed in consideration of the aforementioned EPBC Environmental Offsets Policy (**Section 7.1.4**) and the OEH Principles (**Section 7.1.2.1**). Consideration was also given to the strategic direction of the Upper Hunter Strategic Assessment via application of the BCAM process.

7.2.1 General Approaches and Ecological Considerations

Unless there is a specific driver for species or habitat-based offsetting, or specific features that require offsetting, it is typical that vegetation communities are the main drivers for developing offset areas. It is usual practice to consider vegetation community offsets in terms of an 'offset ratio'. The offset ratio is expressed as a simple comparison of the area of the offset compared to the area of the impact. There are currently no relevant guiding documents that establish rules for offset ratios. Rather it is usually through consideration of the relative significance of impact on ecological values and variable application of precedents from previous SSD approvals that offset ratios have been developed and applied over time. As discussed above, the Project is seeking a Tier 3 Mitigated Net Loss offset at a clearing ratio of greater than 2:1.

The application of offset ratios to species and populations of species is much less practical, in that the investigation of compensatory habitat opportunities for species and populations is poorly informed by area-based rules or ratios. Population sizes, demographics, linkages for genetic exchange and species and habitat resilience are more relevant, if less quantifiable, than area-based calculations.

The following matters are relevant when developing offsetting targets for species, populations or communities:

- the level of historical loss (overall reduction) of the species, population or vegetation community;
- the range of the species, population or vegetation community, e.g. widespread or short-range endemic;

- current area of occupancy (footprint) of the vegetation community or population sizes and number of populations;
- the condition (or 'health') of the vegetation community, population or species;
- the representativeness of the vegetation community/habitat, i.e. how well the subject area represents the diversity of forms of the vegetation community (all vegetation communities are inherently variable over space and time);
- the degree of fragmentation and size, shape and landscape setting of fragments of the vegetation community or population;
- the range, degree and duration of threats to which the species, population or vegetation community is subject;
- the proportion of the species, population or vegetation community that is protected in conservation reserves;
- the likely resilience over time of the species, population or vegetation community;
- whether or not 'similar', i.e. closely-related (as demonstrated through pattern analyses where possible) vegetation communities are appropriate to use as surrogates for the target community (including consideration of matters such as their floristic and structural similarity, geographical proximity, and faunal similarity); and
- the strategic location of vegetation communities, considering matters such as their position in relation to ecological linkages and conservation areas.

It is not always possible to obtain reliable data for many of the above matters; however it is appropriate that they are at least intuitively considered when developing offset targets.

As the relative impact on the subject species, population or vegetation community increases, that is, as the entity becomes more 'irreplaceable', the proportion of the offset area to impact area typically increases. The degree of 'irreplaceability' is generally recognised by the level of listing under NSW and/or Commonwealth legislation afforded to the subject entity, although this is subject to whether or not the entity has been nominated for listing. In some cases however this is not strictly true, as in certain areas a species, population, community or broad ecological value might be more or less significant or more important than in other parts of its range.

For the Project most of the key offset drivers (those species, communities and other ecological entities that are likely to, or could potentially, be significantly impacted by the project) are in fact threatened species, rather than communities, and simple ratios do not apply easily to species or populations of species. The Biodiversity Offset Strategy therefore strives to provide targeted habitat conservation and restoration initiatives that are tailored to each of the impacted species, communities and ecological features that are likely to be, or could potentially be, significantly impacted by the Project. The species, communities and ecological values for which there will be a residual impact once impact avoidance, minimisation and mitigation measures are taken into account are described in **Section 7.2.4.1.**

7.2.2 Existing Offsetting at Mount Owen

Previous developments at Mount Owen have implemented a range of offsetting strategies for the threatened species and communities that occur (refer to **Figure 7.1**).

As discussed in **Section 3.0**, the original approval for development of Mount Owen was granted in November 1991. A modification to the original approval was granted in July 1994, which involved an extension to the south-east of the approved mining area. This area included Ravensworth State Forest, which was identified as a local and regionally significant remnant of natural vegetation and habitat for native flora and fauna. The Mount Owen extension approved in 1994 permitted clearing of approximately 240 hectares (or about 55 per cent) of Ravensworth State Forest. As part of the approval conditions, the New Forest area was established comprising a 430 hectare area that was generally cleared of native woodland and forest vegetation at that time. The New Forest area was subsequently revegetated as compensation for the loss of 240 hectares of Ravensworth State Forest. These regenerated communities and habitats were transferred to Forests NSW in December 2003 and are zoned as Forest Management Zone 2 under Forests NSW's Forest Management Zoning system. Mount Owen Mine retains responsibility for management and maintenance of the New Forest Area in accordance with DA 14-1-2004.

Mount Owen gained approval in 2004 for the expansion of mining operations that included the disturbance of an additional 35 hectares of Ravensworth State Forest and 59 hectares of additional woodland and forest vegetation. The project identified a likely significant impact on the squirrel glider, brown treecreeper, eastern bentwing-bat, east coast freetail bat and the southern myotis. To offset the significant impact of the project on threatened fauna species, Mount Owen developed a comprehensive Biodiversity Offset Strategy in consultation with regulatory authorities and other key stakeholders. The Strategy included an additional 415 hectares of offset land that adjoins Ravensworth State Forest and the New Forest area and includes approximately 100 hectares of established woodland. Since that time the Southern Remnant Offset, totalling 4 hectares, has also been established (**Figure 7.1**). Strategic areas have been actively planted and the biodiversity offset areas are managed to promote natural revegetation of native vegetation communities and to protect threatened species habitat in the long term. The existing Biodiversity Offset Strategy incorporates seven individual offset areas (refer to **Table 7.1** and **Figure 1.2**) covering a total area of 419 hectares.

Table 7.1 - Biodiversity Offset Areas Established as Part of the 2004 Mount Owen Continued Operations EIS and Approvals Process

Offset Area	Area (hectares)
Northwest Offset	72
Northeast Offset	93
Southeast Offset	61
TSR Offset	27
Forest East Offset	84
Southeast Corridor Offset	78
Southern Remnant Offset	4
Total	**419**

The 2004 Strategy was developed with specific focus on threatened species habitat, in particular that of hollow-dependent fauna species such as the masked owl (*Tyto novaehollandiae*), brown treecreeper (*Climacterispicumnus victoriae*), spotted-tailed quoll (*Dasyurus maculatus*), squirrel glider (*Petaurus norfolcensis*), east coast freetail-bat (*Mormopterus norfolkensis*), greater broad-nosed bat (*Scoteanax rueppellii*) and southern myotis (*Myotis adversus*).

7.2.2.1 Vegetation Community and Fauna Habitat Reconstruction Initiatives

A key component of the 2004 Mount Owen Biodiversity Offset Strategy (Umwelt 2004) was commitments made to vegetation community re-establishment and fauna habitat reconstruction initiatives. The key commitments are described below.

Vegetation Community Regeneration

Approximately 175 hectares of Derived Native Grassland has been regenerated through the planting of canopy species, characteristic of Central Hunter Ironbark – Spotted Gum – Grey Gum Forest, the predominant vegetation community occurring within the local area. Planting was undertaken within the New Forest Area and the southern wildlife corridor as part of the 1994 development consent. An additional 132.5 hectares was identified as part of the 2004 Biodiversity Offset Strategy as requiring active vegetation community regeneration.

The regeneration of native vegetation communities has been a successful impact mitigation measure at Mount Owen and regenerated communities provide high quality vegetation and fauna habitats.

Green and Golden Bell Frog Habitat Construction

In accordance with Condition 43 of the 2004 project approval, Mount Owen was required to create alternative habitat for the green and golden bell frog in the Biodiversity Offset Areas, to enhance the existing habitat for the species and implement a captive breeding program if the frog is rediscovered within the site. The green and golden bell frog habitat creation project has included the establishment of alternate areas of habitat for the green and golden bell frog within the offset areas with habitat parameters specific to the species. While these constructed habitats have been very successful in providing additional amphibian habitat in the Mount Owen Complex, the green and golden bell frog has not been recorded.

Nest Box Installation

Nest box utilisation has been a successful impact mitigation strategy at Mount Owen and 19 species are known to utilise nest boxes, with high levels of usage by the squirrel glider (*Petaurus norfolcensis*) and the east coast freetail-bat (*Mormopterus norfolkensis*) for which the implementation of a nest box strategy was a key impact mitigation measure. Other key species that are known to use nest boxes in vegetation community regeneration sites include the threatened brush-tailed phascogale, which was recorded using a nest box for the first time in 2011, juvenile lace monitors, and the yellow-footed antechinus, along with breeding records of the threatened brown treecreeper.

7.2.2.2 Summary of 2004 Mount Owen Biodiversity Offset Strategy Outcomes

The existing Biodiversity Offset Areas are progressing towards a biodiversity outcome of 415 hectares of woodland/forest vegetation, in addition to 968 hectares of mine rehabilitation proposed as part of the 2004 Project and 430 hectares of New Forest area. An assessment of similarity between rehabilitation, revegetation and regeneration areas and the EEC determination for Central Hunter Ironbark – Spotted Gum – Grey Box Forest has identified that areas of revegetation and regeneration in the New Forest Area and existing Biodiversity Offset Areas are characteristic of the target vegetation community (Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC) and meet the rehabilitation objectives and preliminary completion criteria detailed in the Landscape Management Plan (Xstrata Mount Owen 2011). At this stage the rehabilitation is assessed as strongly trending towards the Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC, as evidenced by: the native species recorded in most strata (a reasonable proportion when compared to the EEC determination); the rehabilitation EEC proportions are getting close to the proportions shown by

regeneration; and there is reasonable evidence of natural recruitment of native species in the rehabilitation.

Monitoring of the fauna species diversity and habitat provided by the rehabilitation and regeneration sites in the existing Mount Owen Biodiversity Offset Areas, the New Forest Area and mine rehabilitation between 1996 and present is clearly demonstrating that actively managed rehabilitation and regeneration can provide a moderate to high quality habitat for native fauna species from each of the main vertebrate fauna groups, including threatened species, in a relatively short timeframe. The existing Biodiversity Offset Areas, New Forest Area and mine rehabilitation locations provide habitat for key threatened species, such as the powerful owl, which is regularly recorded in the New Forest Area as well as threatened woodland birds and micro-bats. The proximity of high quality vegetation communities and fauna habitats associated with Ravensworth State Forest provides connectivity with rehabilitation and regeneration sites at Mount Owen. This provides a source of species from which establishing populations can recruit or an area of core habitat from which species' can utilise the habitats provided by mine rehabilitation and regenerating areas to fulfil part of their life cycle requirements. For example, the hooded robin utilises habitats within mine rehabilitation at Mount Owen in this way; with core habitat centred on Ravensworth State Forest and exploitation of foraging habitat within proximate rehabilitated communities. Rehabilitation sites and regeneration sites in particular often provide greater structural diversity compared to remnant forest as regenerating overstorey species form a relatively dense mid-storey underneath the canopy, providing fauna habitat niches that no longer occur in remnant vegetation.

7.2.3 Contribution of Vegetation Types to Offsetting Requirements – Use of Substitution Ratios

Where possible, vegetation communities to be impacted have been offset with the same vegetation communities, commonly referred to as using 'like-for-like' communities. However like-for-like communities are not readily available for offsetting in the Hunter Valley at the scale required for the Project. In the Hunter Valley, suitable land based offsets are not always available that contain the same vegetation communities that will be impacted by a development. It has become increasingly commonplace that 'related' vegetation types are used to compensate for impacts on a threatened ecological community. This approach is valid where there is some ecological relationship/similarity between the target community and that with which it is offset. Similarity can be measured through floristic, habitat or geographic relationship. In addition, where the threat status of the 'related' community is higher there is a conservation rationale to suggest that including it in an offset package for a less threatened community is appropriate, within reason.

The approach to offsetting for the Project has sought to initially seek 'like-for-like' communities within the local area – subject to there being opportunities to afford them long-term protection – and then to seek non-local areas where long-term protection can be more readily afforded to the same and 'related' vegetation communities. It is important to note that the use of related vegetation communities is only included where there is a robust ecological and conservation argument for the use of those communities, at a reduced ratio, in the offset package.

Where like-for-like communities were not available at the Esparanga and Cross Creek offset sites, vegetation communities with similar structural and floristic characteristics were used at a range of 'substitution ratios' to build the offset package for each impacted vegetation community. Individual substitution ratios were assigned to each vegetation community which had similar floristic and structural characteristics as an impacted community. Substitution ratios comprise a de-valuing of a vegetation community's contribution to the offset package, where that community is not the same or very similar to the target community. Hence, at best

a community can have a 1.0 substitution ratio (where it is the same or very similar) or, for example 0.125 (where the similarity is markedly less relevant).

Substitution ratios were assigned on a hierarchical scale based on the similarity between the vegetation community to be impacted and the vegetation community to be used as an offset. The following attributes were taken into consideration:

- level of regional clearing (as determined by the BioBanking Vegetation Types Database);
- vegetation formation type (as determined by the BioBanking Vegetation Types Database); and
- floristic and structural similarity of the vegetation types.

Substitution ratios were also applied to Derived Native Grassland communities that would be managed to regenerate to woodland communities.

As a result of the use of substitution ratios, a much larger area of land is required to offset an area of impact. For example, if a substitution ratio of 0.25 is used, the area of the community used to offset the impacted vegetation community will be four times the area of the impact, to achieve a 1 to 1 offset ratio. The increase in the area of offset due to the use of substitution ratios has a significant indirect benefit for fauna and flora species that occur in the offset communities, increasing the area of conservation well above that achieved using like-for-like offsets.

7.2.4 Biodiversity Offset Strategy Development and Options Assessment

7.2.4.1 Preliminary Assessment of Ecological Values to be Addressed

A preliminary ecological values assessment and impact assessment was undertaken during project planning to determine the potential impact of the Project on ecological values. The need for a Biodiversity Offset Strategy was identified early in project planning as refinements to the Proposed Disturbance Area and the implementation of a range of impact mitigation strategies were not considered likely to be sufficient to counterbalance the impacts of the Project on all ecological values. The overall process was used to consider and assess ecological impacts, and the role that impact avoidance, minimisation, mitigation and offsetting have in counterbalancing impacts.

The Project will result in the loss of habitat for a range of woodland dependent bird and micro-bat species, the hollow-dependent squirrel glider and brush-tailed phascogale, the masked owl and spotted-tailed quoll. In addition, the Project will result in the loss of approximately 159.3 hectares of TSC Act listed Central Hunter Ironbark - Spotted Gum – Grey Box Forest EEC, 4.4 hectares of TSC Act listed Central Hunter Grey Box – Ironbark Woodland EEC and 60 hectares of non-threatened woodland and forest vegetation communities (refer to **Section 5.4**). Many of these matters are synonymous, e.g. the loss of Central Hunter Ironbark - Spotted Gum – Grey Box Forest EEC also represents the loss of habitat for the woodland-dependent birds and micro-bats, hollow-dependent fauna species, large forest owls and the spotted-tailed quoll. Accordingly, the Biodiversity Offset Strategy has been developed to compensate for residual significant or potentially significant impacts of the Project on these species, habitats or features.

Following on from the application of impact avoidance, minimisation and mitigation measures (refer to **Sections 5.0** and **6.0**), **Table 7.2** provides a summary of each of the threatened species, communities and features that could be significantly affected by the Project and how they will be affected, as well as the habitat they require. The means through which these species are addressed by the Biodiversity Offset Strategy are documented in the remainder of the report with a summary tabulation of the specific elements of the Strategy in **Tables 7.11**, **7.12** and **7.13**.

Table 7.2 – Significant Ecological Features Addressed in the Biodiversity Offset Strategy

Ecological Feature	Area of Impact (hectares)	Habitat Requirements
Spotted-tailed quoll	223.7 hectares of moderate quality native woodland/forest/riparian habitat 223.1 hectares of low quality Derived Native Grassland habitat	Occupies a range of forested habitats, most frequently at ecotones between closed and open forests. Requires maternal denning sites for breeding and abundance of food resources in the form of birds and small mammals and relatively intact vegetation in which to forage.
Habitat for hollow-dependent arboreal fauna: • squirrel glider; and • brush-tailed phascogale.	131.9 hectares of forest and woodland habitat with approximately 75 hollows per hectare	Inhabits a variety of mature or old growth habitats, including box, box-ironbark woodlands, river red gum forest, and blackbutt-bloodwood forest with heath understorey. Habitat can include mixed species stands with a shrub or acacia mid-storey, and abundant tree hollows for refuge and nest sites.
Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC, including the planted variant	159.3 hectares of which 27.4 comprises a planted variant	The EEC occurs on Permian sediments in the Hunter Valley and typically forms an open forest to woodland on slopes and undulating hills.
Central Hunter Grey Box - Ironbark Woodland EEC	4.4 hectares	The EEC occurs on Permian sediments in the Hunter Valley and typically forms on slopes and undulating hills.
Potential habitat for migratory winter birds: • swift parrot; and • regent honeyeater.	163.7 of winter-flowering eucalypt dominated woodland/forest	Generally occur in temperate eucalypt woodlands and open forests, commonly recorded from box-ironbark eucalypt associations, wet lowland coastal forests dominated by swamp mahogany, spotted gum and riverine *Casuarina* woodlands.
Known habitat for the following threatened woodland bird species: • brown treecreeper; • hooded robin; • grey-crowned babbler; • speckled warbler; • diamond firetail; and • varied sittella.	223.7 hectares of woodland/forest/riparian habitat Includes 131.9 hectares of potential breeding habitat (tree hollows) for the brown treecreeper.	General habitat includes a range of eucalypt-dominated communities with a grassy or shrubby understorey, including woodland and forest. Large, well connected remnants are important habitat components.

Table 7.2 – Significant Ecological Features Addressed in the Biodiversity Offset Strategy (cont.)

Ecological Feature	Area of Impact (hectares)	Habitat Requirements
Known hollow-dependent micro-bat species: • east coast freetail-bat; • greater broad-nosed bat; • eastern false pipistrelle; and • southern myotis.	223.7 hectares of woodland/forest habitat. Includes 131.9 hectares of potential roosting/breeding habitat (tree hollows).	Utilise general woodland habitats, particularly those with hollow-bearing trees for roosting and breeding. Forage over a range of habitats, but generally in proximity to water resources.
Known habitat for the threatened masked owl	223.7 hectares of woodland/forest/riparian and 223.1 hectares of Derived Native Grassland foraging habitat Includes 131.9 hectares of potential roosting/breeding habitat (tree hollows)	Generally recorded from open forest habitat with sparse mid-storey but patches of dense, low ground cover. It is also recorded from ecotones between wet and dry eucalypt forest, along minor drainage lines and near boundaries between forest and cleared land

7.3 Land-based Biodiversity Offset Sites

Two land based offset sites are proposed to offset the residual impacts of the Project, along with the revegetation of a fauna habitat corridor and postmining rehabilitation. Comprehensive field-based ecological surveys were undertaken on both Cross Creek and Esparanga Offset Sites, generally in accordance with the DEC (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft*. The details of the types and extent of field surveys is provided in **Appendix G**.

Two general areas provide the focus of the Glencore strategic offset approach, being the Manobalai Offset Cluster and Mount Owen Offset Cluster (refer to **Figures 7.1** and **7.2**). Of key importance is the location of these offset clusters in relation to key landscape features such as adjoining vegetation remnants, National Parks, Crown Land, government initiatives (such as the Great Eastern Ranges Initiative), and other existing Glencore offset areas.

The Cross Creek Offset Site and Stringybark Creek Corridor Offset Site are strategically located as the property adjoins the existing Mount Owen Biodiversity Offset Area and New Forest area. This will allow Glencore to build on existing high quality Biodiversity Offset Areas, and facilitate the expansion of a movement corridor linking adjoining Mount Owen offset properties to the north and west towards Glencore's Liddell Operations proposed offset areas and the Glencore Ravensworth Operations Hillcrest Offset Area to the north west (refer to **Figure 7.1** for location of adjacent conservation and biodiversity offset areas).

A significant biodiversity asset of the Esparanga Offset Site comes from its position in the regional landscape, particularly its proximity (adjoining) to Manobalai Nature Reserve and its location within the corridor proposed as part of the Great Eastern Ranges Initiative (refer to **Figure 7.2**). It is also considered likely that this area will form part of the focus for Upper Hunter Strategic Assessment priority offset areas. The Esparanga Offset Site is also located in proximity to the Reedy Valley Offset site for Glencore's Bulga Optimisation Project (refer to **Figure 7.2**).

The land-based components of the Biodiversity Offset Strategy are described in the following **Sections 7.3.1**, **7.3.2** and **7.3.3**.

7.3.1 Cross Creek Offset Site

The Cross Creek property is located immediately adjacent to the Mount Owen offset areas and comprises 367 hectares (refer to **Figure 7.1**) of existing grazing land. A comprehensive assessment of the ecological values of the Cross Creek Offset Site was undertaken in 2012 and 2013, with the details of the survey effort provided in **Appendix G** and on **Figure 7.3**.

7.3.1.1 Flora Species

A total of 136 species were recorded within the Cross Creek Offset Site, of which 99 (73 per cent) were native and 37 (27 per cent) were introduced species. A full list of the flora species recorded during surveys of the Cross Creek Offset Site is presented in **Appendix G**.

Of the total flora species recorded, two species were from Filicopsida (ferns) and 134 from Magnoliopsida (flowering plants), of which 39 were from sub-class Liliidae (monocots) and 95 from sub-class Magnoliidae (dicots). Flora species were recorded from a wide representation of plant families, 45 in total (including two sub-families).

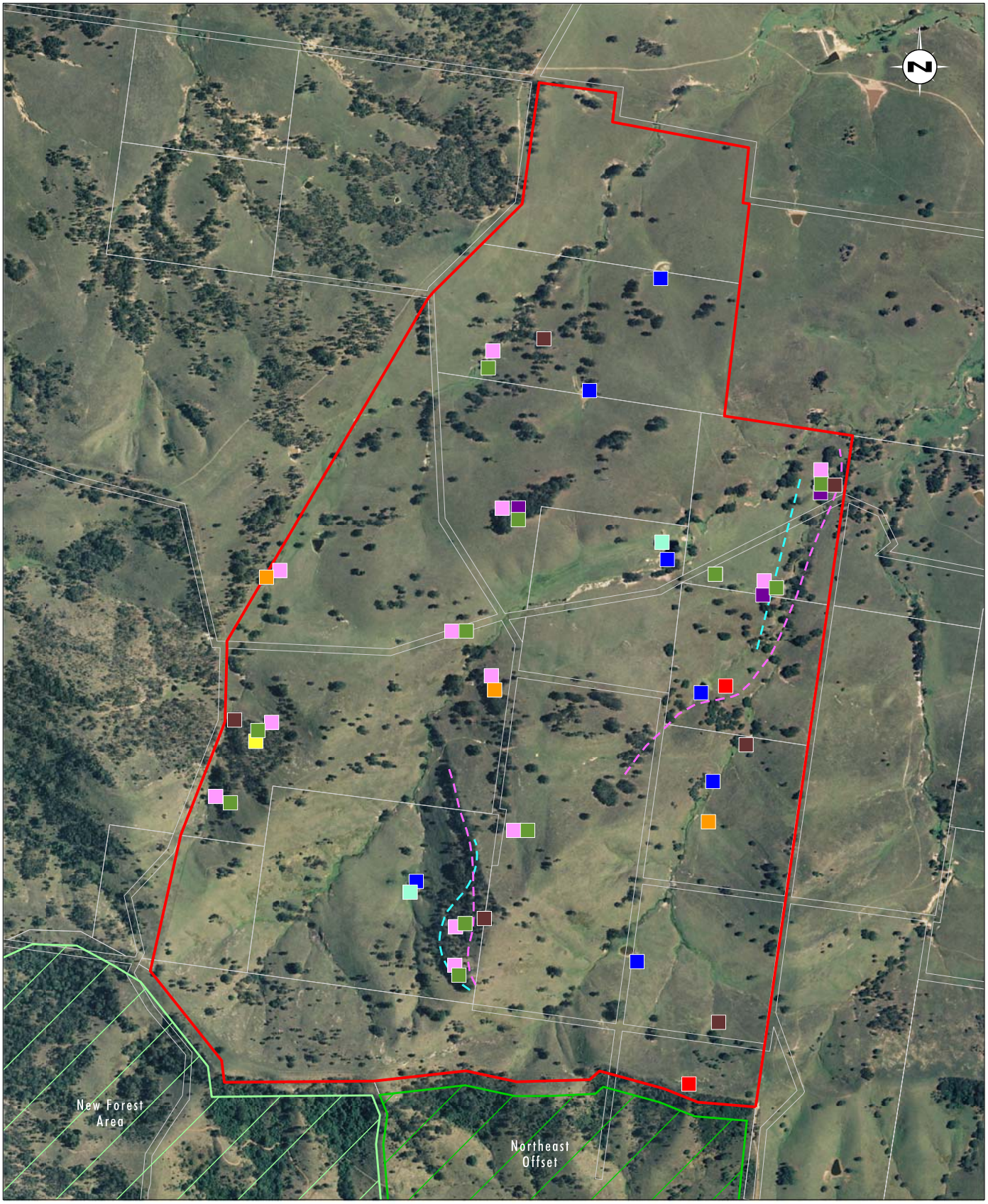

Image Source: Mount Owen (2012)
Data Source: Mount Owen (2013)

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Legend

- Cross Creek Offset Site
- Existing Offset Area
- Ravensworth State Forest
- Hair Funnel Line
- Spotlighting Transect
- Amphibian Survey
- Anabat
- Diurnal Reptile Search
- Habitat Assessment
- Rapid Vegetation Assessment
- Systematic Plot-based Survey
- Targeted Winter Bird Survey
- Bird Survey
- Call Playback

FIGURE 7.3

Cross Creek Flora and Fauna Survey Effort

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20131202 15.48

Several weed species were recorded in the Cross Creek Offset Site including African olive (*Olea europaea* subsp. *cuspidata*), cobblers pegs (*Bidens pilosa*), spear thistle (*Cirsium vulgare*), and prickly pear (*Opuntia stricta* var. *stricta*), although they were recorded in relatively low abundance.

Threatened Flora Species

No threatened flora species listed under the TSC or EPBC Acts were recorded during the field surveys undertaken for this assessment.

7.3.1.2 Vegetation Communities

Surveys of the Cross Creek Offset Site identified two distinct vegetation communities and a variant of one of the communities identified. These vegetation communities were aligned with vegetation map units as described in the Hunter Remnant Vegetation Project (Peake 2006), where possible and also the Greater Hunter Native Vegetation Mapping (Sivertsen *et al*. 2011).

The woodland areas in the Cross Creek Offset Site comprise Central Hunter Ironbark – Spotted Gum – Grey Box Forest (refer to **Figure 7.4**). A red gum variant of this community, dominated by Blakelys red gum (*Eucalyptus blakelyi*) was identified in riparian areas within the Cross Creek Offset Site. The majority of the Cross Creek Offset Site contains Derived Native Grassland, which is likely to have once comprised Central Hunter Ironbark – Spotted Gum – Grey Box Forest.

Central Hunter Ironbark – Spotted Gum – Grey Box Forest is consistent with Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions, listed as an EEC under the TSC Act.

Table 7.3 – Vegetation Communities Present on the Cross Creek Offset Site

Vegetation Community	Area Within the Cross Creek Offset Site (ha)
Central Hunter Ironbark – Spotted Gum – Grey Box Forest	37.2
Red Gum variant	14.5
Native Grassland	315.3
Total	**367**

Central Hunter Ironbark – Spotted Gum – Grey Box Forest

Central Hunter Ironbark – Spotted Gum – Grey Box Forest, including the Red Gum Variant occurs across the Cross Creek Offset Site, on all slopes and aspects covering an area of approximately 51.7 hectares.

The community is dominated by narrow-leaved ironbark (*Eucalyptus crebra*), spotted gum (*Corymbia maculata*) and occasionally grey box (*Eucalyptus moluccana*). Understorey species were relatively sparse, however commonly recorded species include spiny bush-pea (*Pultenaea spinosa*), broom bitter pea (*Daviesia genistifolia*), native olive (*Notelaea microcarpa* var. *microcarpa*) and green wattle (*Acacia irrorata*). The ground cover was moderately dense and included poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), weeping grass (*Microlaena stipoides* var. *stipoides*), kangaroo grass (*Themeda australis*) many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), nodding chocolate lily (*Dichopogon fimbriatus*), eastern nightshade (*Solanum pungetium*) and kidney weed (*Dichondra repens*).

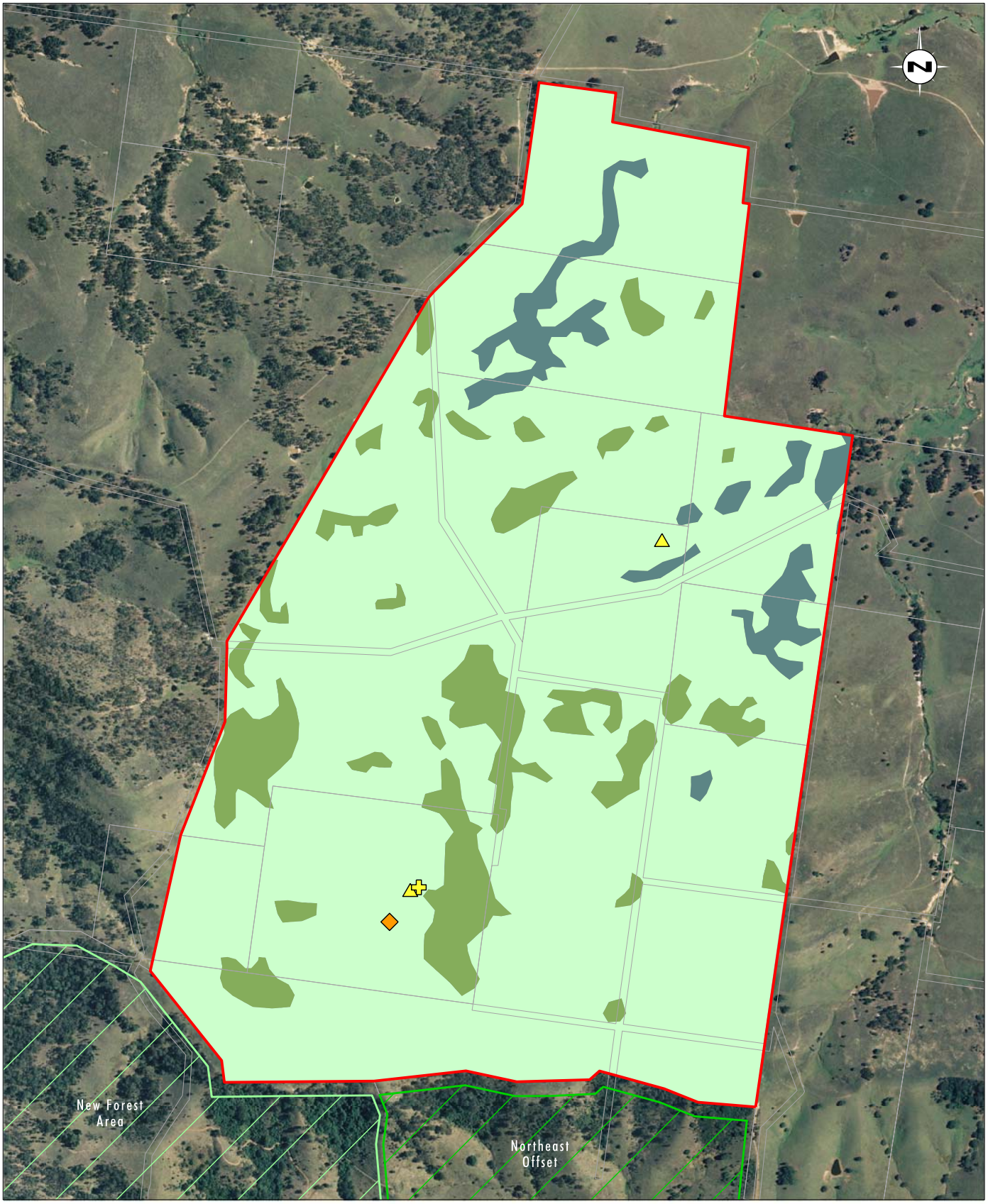

Image Source: Mount Owen (2012)
Data Source: Mount Owen (2013)

0 250 500 750m
1:15 000

Legend

- Cross Creek Offset Site
- Existing Offset Area
- Ravensworth State Forest
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest (EEC - TSC Act)
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest Red Gum Variant (EEC - TSC Act)
- Derived Native Grassland
- Eastern Bentwing-bat
- Eastern Freetail-bat
- Grey-crowned Babbler

FIGURE 7.4

Cross Creek
Key Ecological Features

File Name (A4): R03/3109_581.dgn
20131202 15.49

This vegetation community often contained noxious weeds including African olive (*Olea europaea* subsp. *cuspidata*) and prickly pear (*Opuntia stricta* var*. stricta*). Additional weed species included fireweed (*Senecio madagascariensis*), spear thistle (*Cirsium vulgare*), purpletop (*Verbena bonariensis*), cobblers pegs (*Bidens pilosa*) and lambs tongues (*Plantago lanceolata*).

A Blakelys red gum (*Eucalyptus blakelyi*) variant of this community occurred along drainage lines within the property, comprising 14.5 hectares. Other less common canopy species recorded within the variant included rough-barked apple (*Angophora floribunda*), thin-leaved stringybark (*Eucalyptus eugenioides*), broad-leaved ironbark (*Eucalyptus fibrosa*) and grey gum (*Eucalyptus punctata*). Shrub and groundcover species were generally consistent with Central Hunter Ironbark – Spotted Gum – Grey Box Forest described above. The extent of the community variant is shown on **Figure 7.4**.

This community is consistent with Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC.

Derived Native Grassland

The Derived Native Grassland community is the most widespread community on the Cross Creek Offset Site and is an artefact of previous agricultural activities on the property and comprises approximately 315.3 hectares. It is likely that the grassland once comprised Central Hunter Ironbark – Spotted Gum – Grey Box Forest and it is likely that the forest community will eventually regenerate with the absence of grazing.

Derived Native Grassland is composed of native and introduced grasses and forbs including kangaroo grass (*Themeda australis*), barbed wire grass (*Cymbopogon refractus*), slender rat's tail grass (*Sporobolus creber*)*,* and Australian bluebell (*Wahlenbergia gracilis*). Introduced species recorded include shivery grass (*Briza minor*), fireweed (*Senecio madagascariensis*) and *Petrorhagia nanteuilii.*

This community contains the highest diversity and abundance of weed species on the Cross Creek Offset Site. However, the community still contains a moderate diversity and abundance of native flora species.

7.3.1.3 Threatened Flora Species, Endangered Flora Populations and Threatened Ecological Communities

No threatened flora species or endangered populations were recorded at the Cross Creek Offset Site.

As discussed in **Section 7.3.1.2**, Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC was mapped within the Cross Creek Offset Site and covers approximately 52.7 hectares.

7.3.1.4 Fauna Habitats and Species

The fauna habitats and species recorded within the Cross Creek Offset Site are described below.

7.3.1.5 Fauna Habitat

The assessment of terrestrial fauna habitat identified a range of habitat characteristics which contribute to the distribution, abundance and diversity of terrestrial fauna within the Cross

Creek Offset Site. The broad habitat types recorded within the Cross Creek Offset Site consisted of woodland, grassland, riparian and aquatic habitat.

Woodland Habitat

Woodland communities occur across approximately 51.7 hectares of the Cross Creek Offset Site with regenerating and occasional mature trees dominating. The eucalypt species present within the woodland habitat provide seasonal foraging resources for a number of nectarivorous bird species and mammals, as well as insectivorous birds. The eucalypt species present also provide a nesting resource for small birds.

Hollow-bearing trees were present throughout the woodland, but in low densities due to the dominance of relatively young eucalypts in the canopy. Hollow-bearing trees were mainly located on the flats adjacent to the main drainage line through the Cross Creek Offset Site. These hollows likely provide nesting habitat for a number of bird species, arboreal mammals and micro-bats. The shrub layer within this habitat type ranges from sparse to moderate density, providing shelter for a number of small woodland birds. Scattered logs and rocks within the woodland habitat type provide refuge and foraging habitat for reptiles, amphibians and small terrestrial mammals. The grassy understorey provides foraging habitat for macropods and omnivorous birds.

Grassland Habitat

Grassland habitat is the most widespread habitat type across the Cross Creek Offset Site, providing habitat for a variety of native fauna species. The areas of open grassland provide a foraging resource for macropods and a hunting resource for micro-bats and birds of prey. This habitat type also provides foraging and refuge habitat for a number of small mammal, reptile species and amphibians.

Riparian Habitat

The riparian habitat that occurs along the small unnamed tributary of Cross Creek is dominated by Blakelys red gum (*Eucalyptus blakelyi*), spotted gum (*Corymbia maculata*) and rough-barked apple (*Angophora floribunda*). The mature eucalypts identified along the creek line within this habitat type provide a seasonal foraging resource for arboreal mammals and nectarivorous birds. These large eucalypts also provide a foraging habitat for insectivorous birds, and foraging and roosting resources for micro-bats. The shrub layer, although sparse, provides a foraging and refuge resource for small birds. The grassy understorey provides a foraging and refuge resource for reptiles and amphibians. Some water was present within the generally ephemeral drainage line, providing a water source for native fauna as well as a foraging, refuge and breeding resource for amphibians.

Aquatic Habitat

Aquatic habitat is present in the form of the unnamed tributary of Cross Creek running through the Cross Creek Offset Site and several farm dams. The ephemeral creek and farm dams provide a water source for native fauna and a foraging and refuge resource for a diverse and abundant number of amphibian species, particularly where fringing vegetation is present. The farm dams would also provide foraging habitat for local micro-bat species.

7.3.1.6 Fauna Species

A total of 74 fauna species were recorded during surveys of the Cross Creek Offset Site. An outline and discussion of the species recorded within each of the four major fauna groups is

presented in the following sections. A list of all fauna species recorded within the Cross Creek Offset Site is presented in **Appendix G** of this report.

Amphibians

Eleven species of frog were recorded in the Cross Creek Offset Site during field surveys, comprising two species of Myobatrachidae (ground-dwelling frogs) and three from Hylidae (tree frogs). The most commonly recorded species included common eastern froglet (*Crinia signifera*) and dwarf tree frog (*Litoria fallax*).

A list of all amphibian species recorded in the Cross Creek Offset Site is provided in **Appendix G**.

Reptiles

Three reptile species were recorded within the Cross Creek Offset Site during field surveys. These were the snake-necked turtle (*Chelodina longicollis*), eastern bearded dragon (*Pogona barbata*) and grass skink (*Lampropholis delicata*). Substantial exposed rock and outcropping along the steep ridges of the Cross Creek Offset Site provides considerable habitat for reptiles and it is expected that many other species would occur.

Birds

Forty-eight bird species were recorded in the Cross Creek Offset Site during field surveys. Twenty-six families were represented with the Meliphagidae (honeyeaters) being the most diverse, recording seven species.

Some of the more frequently observed bird species recorded in woodland communities included the channel-billed cuckoo (*Scythrops novaehollandiae*), eastern rosella (*Platycercus eximius*), Australian magpie (*Gymnorhina tibicen*), grey butcherbird (*Cracticus torquatus*), Australian raven (*Corvus coronoides*) and white-winged chough (*Corcorax melanorhamphos*).

One threatened bird species listed as vulnerable under the TSC Act, the grey-crowned babbler (*Pomatostomus temporalis temporalis*), was recorded in the Cross Creek Offset Site during the surveys.

A list of all bird species recorded in the Cross Creek Offset Site is provided in **Appendix G**.

Mammals

Twelve mammal species were recorded within the Cross Creek Offset Site during field surveys with the most species-rich family (Vespertilionidae) recording five species.

Native ground-dwelling mammals are represented by three species, eastern grey kangaroo (*Macropus giganteus*), common wallaroo (*Macropus robustus*) and red-necked wallaby (*Macropus rufogriseus*).

One arboreal mammal species, common brushtail possum (*Trichosurus vulpecula*), was recorded.

Two threatened mammal species, listed as vulnerable under the TSC Act, were recorded within the Cross Creek Offset Site, including eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) and east coast freetail-bat (*Mormopterus norfolkensis*).

Two introduced species, the European rabbit (*Oryctolagus cuniculus*) and the black rat (*Rattus rattus*), was also recorded.

A list of all mammal species recorded in the Cross Creek Offset Site is provided in **Appendix G**.

7.3.1.7 Threatened Fauna Recorded

Three threatened fauna species, all listed as vulnerable under the TSC Act, were recorded within the Cross Creek Offset Site during the field surveys. These were:

- grey-crowned babbler (*Pomatostomus temporalis temporalis*) (Vulnerable – TSC Act);
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable – TSC Act); and
- east coast freetail-bat (*Mormopterus norfolkensis*) (Vulnerable – TSC Act).

The locations of these species records are shown in **Figure 7.4**.

The results of the OEH Atlas of NSW Wildlife database search and Department of Environment Protected Matters Search Tool also identified an additional 23 listed threatened and five listed migratory species that have the potential to occur within 10 kilometres of the Cross Creek Offset Site.

Table 7.4 – Threatened species previously recorded/likely to occur within the Cross Creek Offset Site

Common Name ***Scientific Name***	**Status**		**Likelihood of Occurrence at the Cross Creek Offset Site**
	TSC Act	**EPBC Act**	
green and golden bell frog *Litoria aurea*	E	V	Low (potential habitat, historic records within 5 km)
little eagle *Hieraaetus morphnoides*	V	-	High (potential habitat, records within 2 km)
Australian painted snipe *Rostratula australis*	E	MAR MIG	Low (unlikely habitat, records within 10 km)
little lorikeet *Glossopsitta pusilla*	V	-	High (potential habitat, records within 2 km)
swift parrot *Lathamus discolor*	E	E MAR	Moderate (potential habitat, records within 2 km)
masked owl *Tyto novaehollandiae*	V	-	Moderate (potential habitat, records within 2 km)
brown treecreeper (eastern subsp.) *Climacteris picumnus victoriae*	V	-	High (potential habitat, records within 2 km)
speckled warbler *Chthonicola sagittata*	V	-	High (potential habitat, records within 2 km)

Table 7.4 – Threatened species previously recorded/likely to occur within the Cross Creek Offset Site (cont.)

Common Name ***Scientific Name***	**Status**		**Likelihood of Occurrence at the Cross Creek Offset Site**
	TSC Act	**EPBC Act**	
regent honeyeater *Anthochaera phrygia*	CE	E	Low (potential habitat, no local records)
black-chinned honeyeater (eastern subsp.) *Melithreptus gularis gularis*	V	-	Moderate (potential habitat, records within 2 km)
grey-crowned babbler (eastern subsp.) ***Pomatostomus temporalis temporalis***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
varied sittella *Daphoenositta chrysoptera*	V	-	Moderate (potential habitat, records within 2 km)
scarlet robin *Petroica boodang*	V	-	Moderate (potential habitat, records within 2 km)
flame robin *Petroica phoenicea*	V	MAR	Low (potential habitat, records within 2 km)
hooded robin (south-eastern form) *Melanodryas cucullata cucullata*	V	-	Low (potential habitat, records within 2 km)
diamond firetail *Stagonopleura guttata*	V	-	Moderate (potential habitat, records within 2 km)
spotted-tailed quoll (SE mainland population) *Dasyurus maculatus maculatus*	V	E	High (likely habitat, records within 1 km)
koala *Phascolarctos cinereus*	V	V	Moderate (potential habitat, records within 4 km)
squirrel glider *Petaurus norfolcensis*	V	-	Low (unlikely habitat, records within 2 km)
brush-tailed phascolgale *Phascogale tapoatafa*	V	-	Low (unlikely habitat, records within 2 km)
grey-headed flying-fox *Pteropus poliocephalus*	V	V	Moderate (potential habitat, records within 2 km)
east coast freetail-bat ***Mormopterus norfolkensis***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 2 km)
eastern bentwing-bat ***Miniopterus schreibersii oceanensis***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 2 km)

Table 7.4 – Threatened species previously recorded/likely to occur within the Cross Creek Offset Site (cont.)

Common Name *Scientific Name*	**Status**		**Likelihood of Occurrence at the Cross Creek Offset Site**
	TSC Act	**EPBC Act**	
eastern long-eared bat *Nyctophilus timoriensis* (south-eastern form)	V	V	High (potential habitat, records within 2 km)
large-eared pied bat *Chalinolobus dwyeri*	V	V	Moderate (potential habitat, records within 2 km)
New Holland mouse *Pseudomys novaehollandiae*	-	V	Low (unlikely habitat, records within 2 km)
Hastings River mouse *Pseudomys oralis*	E	E	Low (unlikely habitat, no local records)

Key:
E = Endangered
V = Vulnerable
EP = Endangered Population
EEC = Endangered Ecological Community
CEEC = Critically Endangered Ecological Community
TSC = *Threatened Species Conservation Act* 1995
EPBC = *Environment Protection and Biodiversity Conservation Act* 1999
MAR = Marine species listed under the EPBC Act
MIG = migratory Species listed under the EPBC Act

7.3.1.8 Summary of the Ecological Values of the Cross Creek Offset Site

The Cross Creek Offset Site contains a total area of 367 hectares, of which 51.7 hectares comprises Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC listed under the TSC Act. The remaining area of the property, approximately 315.3 hectares, comprises native grassland, which is likely to have once supported Central Hunter Ironbark – Spotted Gum – Grey Box Forest. Most of the grassland areas are likely to naturally regenerate into a functional woodland ecosystem over time, with the strategic management of stock on the property. Some active management is likely to be required to regenerate the Cross Creek Offset Site into a woodland community due to the high level of clearing the property has been subject to. The regeneration of the woodland community would provide a significant environmental gain as an outcome of offsetting for the Project, balanced with the immediate outcome of protecting 51.7 hectares of Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC, a community that will be potentially significantly impacted by the Project. The provision of a 'like for like' offset, i.e. offsetting the vegetation type impacted with the same vegetation type, is a key outcome of the inclusion of the Cross Creek Offset Site in the Biodiversity Offset Strategy.

Although much of the vegetation is relatively young and hollow-bearing trees are present only in low abundance, the general health of the vegetation is good and the diversity and abundance of introduced flora species is generally low. The grassland community contains a relatively high diversity of native flora species and these areas are considered likely to regenerate into Central Hunter Ironbark – Spotted Gum – Grey Box Forest, providing grazing and other pressures, are minimised. The ongoing regeneration of the Cross Creek Offset Site will allow hollow-dependent fauna species to colonise from adjacent Biodiversity Offset

Areas once the vegetation is mature enough for populations of these species. This will result in a substantial gain for hollow-dependent fauna species in the central Hunter Valley, especially as hollow-bearing trees are a limiting resource in the local area due to the long history of vegetation clearance for agriculture and the time required for mature trees to develop tree hollows.

The Cross Creek Offset Site also provides a direct, 'like for like' land-based offset for three threatened species that are potentially significantly impacted by the Project and for an additional cave-roosting threatened bat that will also be impacted through the loss of habitat (although not significantly) as a result of the Project.

7.3.2 Esparanga Offset Site

The Esparanga Offset Site is located in the Manobalai locality of the Hunter Valley (refer to **Figure 7.2**), approximately 40 kilometres by road north-west of Muswellbrook, and 65 kilometres by road south-west of Scone. It is accessible from Dry Creek Road via Ridgeland Road, in Manobalai. A detailed ecological survey was conducted at the Esparanga Offset Site in 2012 and 2013 with the details of the survey effort provided in **Appendix G** and on **Figure 7.5**.

The historic land use of the Esparanga Offset Site has been agricultural, primarily cattle and sheep grazing. The property has been maintained as a landholding for agricultural purposes since the late 1800s. Currently the Esparanga Offset Site is maintained by Glencore and utilised for cattle grazing. Large portions of the property (approximately 60 per cent) comprise native vegetation cover.

7.3.2.1 Natural Features

The Esparanga Offset Site contains an array of basalt, sandstone and conglomerate outcropping, primarily along the lower slopes and within the semi-regular ridgelines that line the elevated sections. These ridgelines, which form an escarpment in elevated areas, contain numerous caves, overhangs and cracks and fissures. The caves are primarily shallow to moderate depressions in the ridgelines formed by erosion over time.

The many gullies within the Esparanga Offset Site range from gradual to steep in slope and are generally dry with few aquatic or inundation dependant flora species present. These gullies contain drainage lines which generally remain dry but would provide ephemeral creeks in times of high rainfall. There are a few small farm dams scattered on the lower slopes and upper plateaux of the Esparanga Offset Site, in areas cleared for livestock grazing.

The alluvial flats and lower slopes trend from open grassland, to grassland with scattered trees to woodland areas, representing several different vegetation community types, which are discussed in **Section 7.3.2.3**. The mid-slope areas tend to be dominated by forest and woodland, with woodland dominating above the ridgelines.

The following sections describe the flora diversity recorded from the Esparanga Offset Site, in addition to significant ecological values such as threatened species, endangered populations, TECs and any records of regional significance.

7.3.2.2 Flora Species

In total, 255 plant species have been recorded in the Esparanga Offset Site during flora surveys. Plants were recorded from four major vascular plant classes, being: cycads, conifers, ferns and flowering plants and included trees, shrubs, forbs, grasses, sedges, rushes, reeds, ferns, lithophytes, epiphytes, mistletoes, vines and twiners.

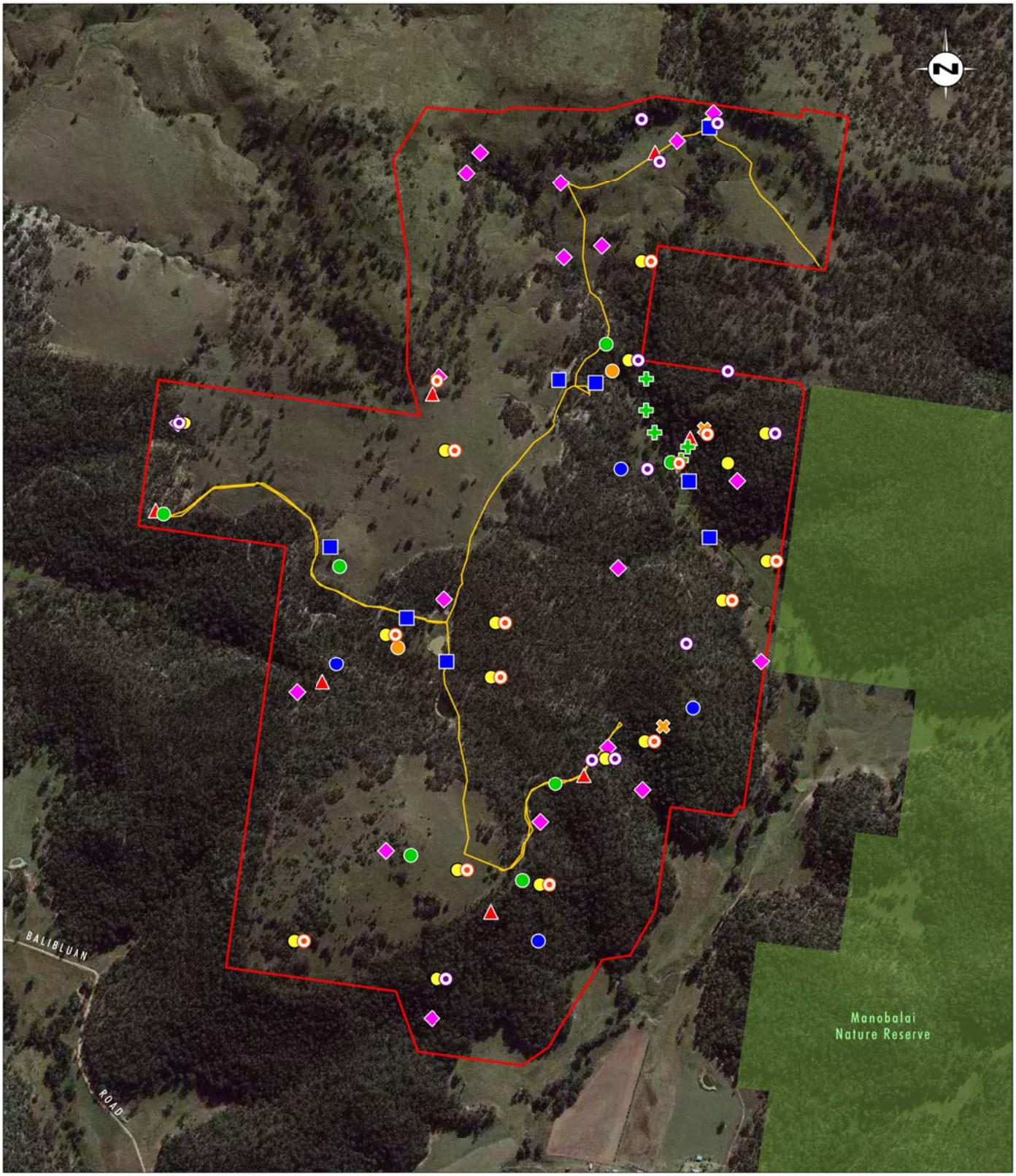

Image Source: Mount Owen (2009)
Data Source: Mount Owen (2013)

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Legend

- Esparanga Offset Site
- Manobalai Nature Reserve

Fauna Survey:

- Full Fauna Site Surveys
  - Habitat Assessment
  - Diurnal Bird Survey
  - Diurnal Reptile Survey
  - Amphibian Survey
  - Spotlight Survey
  - Hair Funnels
  - Call Playback
- Driving Spotlight Survey
- Targeted Fauna Site Surveys
  - Habitat Assessment
  - Diurnal Bird Survey
  - Diurnal Reptile Survey
  - Amphibian Survey
- Anabat Location
- Hair Funnel Line
- Remote Camera
- Targeted Winter Bird Survey
- Additional Habitat Assessment
- Additional Spotlight and Call Playback Survey
- Additional Diurnal Bird Survey and Diurnal Reptile and Amphibian Survey

Flora Survey:

- Systematic Plot-based Survey
- Rapid Vegetation Assessment

FIGURE 7.5

Esparanga Flora and Fauna Survey Effort

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20140815 12.26

A full list of flora species recorded within the Esparanga Offset Site is provided in **Appendix G**. Poaceae (grasses) was the most speciose family with 45 species recorded, followed by Asteraceae (daisies) with 33 species recorded, Fabaceae (Faboideae) (pea flowers) with 23 species recorded and Myrtaceae (eucalypts and paperbarks) with eight species recorded.

Of the 255 species recorded, 38 (15 per cent) were not native. Introduced species recorded include paspalum (*Paspalum dilatatum*), saffron thistle (*Carthamus lanatus*), spear thistle (*Cirsium vulgare*), horehound (*Marrubium vulgare*) and African olive (*Olea europaea* subsp. *cuspidata*).

7.3.2.3 Vegetation Communities

Nine vegetation communities were delineated in the Esparanga Offset Site, the locations of which are shown in **Figure 7.6**. All of the mapped vegetation communities, except Derived Native Grassland, are naturally-occurring, although many of these have been significantly modified due to extensive clearing and regeneration. **Table 7.5** lists the vegetation communities identified within the Esparanga Offset Site and the extent of each of these vegetation communities.

Table 7.5 – Vegetation Communities Recorded in the Esparanga Offset Site

Vegetation Community	Area Within the Esparanga Offset Site (ha)
Upper Hunter White Box - Ironbark Grassy Woodland	46
Spotted Gum Open Forest Complex on Sandstone	3.2
Shrubby White Box Woodland	9.2
Red Gum Open Forest on Alluvium/Colluvium	2.7
Narrabeen Sheltered Dry Forest	59.3
Narrabeen Ironbark Woodland	91
Derived Native Grassland (White Box Woodland)	85.1
Derived Native Grassland (Red Gum Open Forest on Alluvium/Colluvium)	5.9
Derived Native Grassland (Narrabeen Ironbark Woodland)	0.4
Total	**302.8**

Most vegetation communities are widespread in the local area, while some occur much more extensively across a broader range of over 100 kilometres. Some communities, however, have a more restricted local occurrence. In general, communities occurring on Triassic conglomerate and basalt-derived soils are well represented in the local area, while those restricted to riparian zones are less well represented.

Detailed descriptions are provided below for all of the vegetation communities identified within the Esparanga Offset Site.

Red Gum Open Forest on Alluvium/Colluvium

Red Gum Open Forest on Alluvium/Colluvium, occurs on alluvial flats associated with drainage lines within the Esparanga Offset Site (refer to **Figure 7.6**).

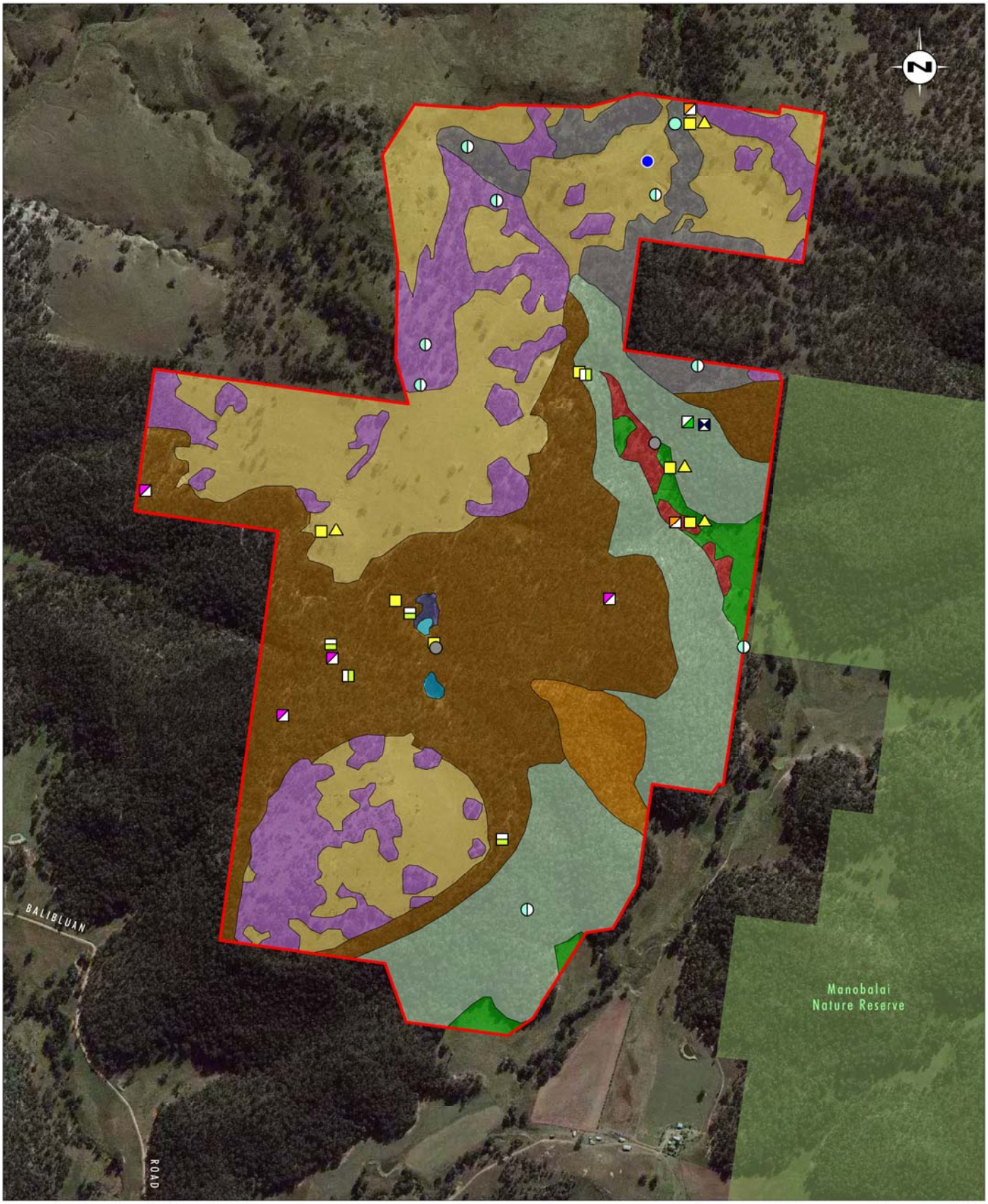

Image Source: Mount Owen (2009)
Data Source: Mount Owen (2013)

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Legend

- Esparanga Offset Site
- Manobalai Nature Reserve
- Derived Native Grassland (Narrabeen Ironbark Woodland)
- Derived Native Grassland (Red Gum Open Forest on Alluvium/Colluvium)
- Derived Native Grassland (White Box Woodland)
- Narrabeen Ironbark Woodland
- Narrabeen Sheltered Dry Forest
- Red Gum Open Forest on Alluvium/Colluvium
- Spotted Gum Open Forest Complex on Sandstone
- Shrubby White Box Woodland
- Water Body
- Upper Hunter White Box - Ironbark Grassy Woodland
- Brown Treecreeper (eastern subspecies)
- Yellow-bellied Sheathtail-bat
- Eastern Bentwing-bat
- Eastern Cave Bat
- Large-eared Pied Bat
- Little Lorikeet
- Scarlet Robin
- Speckled Warbler
- Spotted-tailed Quoll
- Squirrel Glider
- Varied Sittella
- Tiger Orchid

FIGURE 7.6

Esparanga
Key Ecological Features

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Blakely's red gum (*Eucalyptus blakelyi*) is the dominant canopy species present; however, rough-barked apple (*Angophora floribunda*) and narrow-leaved ironbark (*Eucalyptus crebra*) also occur in reasonable densities. The canopy is generally up to 26 metres in height with 20 to 30 per cent canopy cover.

A mid-sparse sub-canopy (to 20 per cent canopy cover) of regenerating canopy species and forest oak (*Allocasuarina torulosa*) and rusty fig (*Ficus rubiginosa*) was recorded to a height of 10 metres.

A moderately sparse shrub layer (to 20 per cent canopy cover), up to 2.5 metres in height, occurs with species including velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), coffee bush (*Breynia oblongifolia*) and narrow-leaved geebung (*Persoonia linearis*).

The ground layer is typically dense (to 50 per cent cover), but is dominated by introduced flora species. Dominant species includes cobblers pegs (*Bidens pilosa*), fireweed (*Senecio madagascariensis*) and cotton bush (*Gomphocarpus fruticosis*). Native grasses and forbs were present but were not dominant, namely weeping grass (*Microlaena stipoides* var. *stipoides*) and slender rats tail grass (*Sporobolus creber*).

Red Gum Open Forest on Alluvium/Colluvium is affiliated with Ironbark on Alluvium, which occurs adjacent to this community, outside the Esparanga Offset Site, slightly up slope in drier environments. Some understorey species are shared between these communities.

Red Gum Open Forest on Alluvium/Colluvium identified in the Esparanga Offset Site does not conform to any TECs under the EPBC or TSC Act due to the absence of a predominantly native ground layer.

Spotted Gum Open Forest Complex on Sandstone

Spotted Gum Open Forest Complex on Sandstone is an open forest, generally 16 to 23 metres in height, with 15 to 35 per cent canopy cover. The dominant canopy species is spotted gum (*Corymbia maculata*) and narrow-leaved ironbark (*E. crebra*), with grey gum (*E. punctata*) and narrow-leaved stringybark (*Eucalyptus sparsifolia*) occurring infrequently.

The sub-canopy layer is scattered throughout, characterised by an open canopy (10 per cent canopy cover), to 8 metres in height. Commonly occurring species include shiny-leaved canthium (*Psydrax odoratum*), narrow-leaved geebung (*Persoonia linearis*) and native cherry (*Exocarpos cupressiformis*).

The shrub layer is moderately dense (30 per cent canopy cover), to 3 metres in height. This stratum becomes dense in small patches often on skeletal soils where trees are less dominant. Common shrubs recorded include blunt beard-heath (*Leucopogon muticus*), forest oak (*Allocasuarina torrulosa*), urn heath (*Melichrus urceolatus*), rough guinea flower (*Hibbertia aspera*) and *Acacia undulifolia*.

The ground cover is open to dense, with between 30 and 70 per cent cover. A range of forbs, ferns and grasses characterise the community including berry saltbush (*Einadia hastata*), poison rock fern (*Cheilanthes sieberi* subsp*. sieberi*), wiry panic (*Entolasia stricta*), wiregrass (*Aristida jerichoensis* var. *jerichoensis*) and spiked sida (*Sida subspicata*).

Spotted Gum Open Forest Complex on Sandstone occurs on Narrabeen sandstone and sandy soils on exposed ridges. Spotted Gum Open Forest Complex on Sandstone is affiliated with Narrabeen Ironbark Woodland and Narrabeen Sheltered Dry Forest, where these communities occur on Narrabeen sandstone and share many common understorey species.

This community does not conform to any TECs listed under the TSC or EPBC Act.

Narrabeen Ironbark Woodland

Narrabeen Ironbark Woodland is typically a dry, open forest-woodland, generally 10 to 19 metres tall, with 10 to 30 per cent cover. The dominant canopy species is narrow-leaved ironbark (*Eucalyptus crebra*) and red ironbark (*E. fibrosa*), however grey gum (*E. punctata*) and black cypress pine (*Callitris endlicheri*) can occur in ecotonal areas with Narrabeen Sheltered Dry Forest. Rough-barked apple (*Angophora floribunda*) can occur less frequently, on lower slopes where this community grades into Ironbark Woodland on Alluvium/Colluvium.

The shrub layer typically comprises a sparse to mid-dense sclerophyllous shrub stratum, generally up to 3 metres in height, with between 10 and 40 per cent cover. This stratum becomes dense in small patches often on skeletal soils where trees are less dominant. Common and dominant shrubs recorded were blunt beard-heath (*Leucopogon muticus*), varnish wattle (*Acacia verniciflua*), urn-heath (*Melichrus urceolatus*), sticky daisy-bush (*Olearia elliptica*), *Choretrum* species A, prickly shaggy pea (*Podolobium ilicifolium*), sifton bush (*Cassinia quinquefaria*), narrow-leaved geebung (*Persoonia linearis*), *Acacia undulifolia*, green wattle (*Acacia deanei* subsp. *deanei*) and scaly phebalium (*Phebalium squamulosum* subsp. *lineare*).

The ground cover is typically dry and open to moderately dense, with between 25 and 60 per cent cover. A range of forbs, ferns and grasses characterise the community including poison rock fern (*Cheilanthes sieberi* subsp*. sieberi*), rough saw-sedge (*Gahnia aspera*), weeping grass (*Microlaena stipoides* var. *stipoides*), pomax (*Pomax umbellata*), forest hedgehog grass (*Echinopogon ovatus*), wiry panic (*Entolasia stricta*), purple wiregrass (*Aristida ramosa*), yellow burr-daisy (*Calotis lappulacea*), variable saw-sedge (*Lepidosperma laterale*) and many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*).

Narrabeen Ironbark Woodland occurs on Narrabeen sandstone and sandy soils on exposed ridges. Narrabeen Ironbark Woodland is closely related to Narrabeen Sheltered Dry Forest, with which it intergrades, particularly in slope positions and on shallow soils with a high percentage of sandstone outcropping. Narrabeen Ironbark Woodland is also closely related to Ironbark Woodland on Alluvium/Colluvium which occurs on lower slopes outside the Esparanga Offset Site. However, unlike Ironbark Woodland on Alluvium/Colluvium, Narrabeen Ironbark Woodland occurs on Narrabeen sandstone and the understorey has a mid-dense sclerophyllous shrub layer.

This community does not conform to any TECs listed under the TSC or EPBC Act.

Narrabeen Sheltered Dry Forest

Narrabeen Sheltered Dry Woodland is characterised by a moderately dense canopy (to 40 per cent canopy cover), dominated by grey gum (*Eucalyptus punctata*), narrow-leaved ironbark (*E. crebra*) and red ironbark (*E. fibrosa*) with various association with rough-barked apple (*Angophora floribunda*), Blakelys red gum (*E. blakelyi*) and narrow-leaved stringybark (*E. sparsifolia*). This community occurs to 22 metres in height on lower slopes in protected gullies and to 10 metres in more exposed locations on the upper slopes.

The sub-canopy layer is open to moderately dense (5 to 30 per cent canopy cover), 8 to 12 metres in height. Commonly occurring species include forest oak (*Allocasuarina torulosa*), red ash (*Alphitonia excelsa*), kurrajong (*Brachychiton populneus* subsp. *populneus*) and black cypress pine (*Callitris endlicheri*). Sweet pittosporum (*Pittosporum undulatum*) and native cherry (*Exocarpos cupressiformis*) also occur infrequently.

The shrub layer is typically open however is occasionally found in dense stands; occurring between 10 and 40 per cent canopy cover, and a height of 2 to 4 metres. Common species include native blackthorn (*Bursaria spinosa* subsp. *spinosa*), *Dodonaea triangularis*, velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), prickly Moses (*Acacia brownii*), coffee bush (*Breynia oblongifolia*), narrow-leaved geebung (*Persoonia linearis*), blunt beard-heath (*Leucopogon muticus*) and Australian indigo (*Indigofora australis*).

The groundcover is moderately dense however open in rocky outcroppings, occurring between 20 and 60 per cent cover. Common species include pomax (*Pomax umbellata*), berry saltbush (*Einadia hastata*), blue flax lily (*Dianella caerulea* var. *caerulea*), open summer-grass (*Digitaria diffusa*), weeping grass (*Microlaena stipoides* var. *stipoides*), *Rytidosperma monticola*, variable saw-sedge (*Lepidosperma laterale*) and poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*).

Narrabeen Sheltered Dry Forest occurs throughout the Esparanga Offset Site on Narrabeen sandstone, primarily on south facing slopes. Due to the steep slopes and poor quality ground cover for livestock grazing, this community is generally in good condition. Narrabeen Sheltered Dry Forest is affiliated with Narrabeen Ironbark Woodland, where it shares common canopy and understory species; however slope aspect, dominance of grey gum (*E. punctata*) and dominance of sub-canopy species clearly separate these communities where they adjoin.

This community does not conform to any TECs listed under the TSC or EPBC Act.

Upper Hunter White Box – Ironbark Grassy Woodland

Upper Hunter White Box – Ironbark Grassy Woodland is restricted to the fertile Tertiary basalt-derived soils on the upper slopes of the Esparanga Offset Site, which have been largely cleared for agricultural purposes and have been historically grazed (refer to **Figure 7.4**). It is characterised by the predominance of the white/grey box intergrade (*Eucalyptus albens – moluccana*), 12 to 20 metres in height. The canopy is generally open, with a canopy cover of approximately 10 to 40 per cent. Regeneration of white box in the understorey is present in some locations where grazing pressure has been reduced. Other canopy species such as grey box (*E. moluccana*), yellow box (*E. melliodora*), narrow-leaved ironbark (*E. crebra*) and Blakelys red gum (*E. blakelyi*) can occur infrequently.

The shrub layer is typically open to moderately dense (10 to 30 per cent canopy cover), to 4 metres in height. Commonly recorded species within the understorey include velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), cooba (*Acacia salicina*), native blackthorn (*Bursaria spinosa* subsp. *spinosa*), shiny-leaved canthium (*Psydrax odoratum*), sifton bush (*Cassinia quinquefaria*) and flannel weed (*Abutilon oxycarpum*).

The ground cover is usually dense (up to 70 per cent cover) with a diversity of native grasses and forbs. Commonly recorded species include purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa decipiens*), snowgrass (*Poa seiberiana* var. *sieberiana*), speargrass (*Austrostipa scabra* subsp. *scabra*), wallaby grass (*Rytidosperma bipartitum*), barbed wire grass (*Cymbopogon refractus*), plump windmill grass (*Chloris ventricosa*), biddy biddy (*Acaena novae-zelandiae*), kidney weed (*Dichondra repens*), *Vittadinia sulcata*, stinking pennywort (*Hydrocotyle laxiflora*), *Glycine tabacina*, native geranium (*Geranium solanderi*), yellow burr-daisy (*Calotis lappulacea*) and tufted bluebell (*Wahlenbergia communis*). Due to the disturbance history of the community and the fertility of the soil, perennial weed species can be common to abundant in some areas. Dominant weed species include saffron thistle (*Carthamus lanatus*), Paddys lucerne (*Sida rhombifolia*), horehound (*Marrubium vulgare*) and stinking Roger (*Tagetes minuta*).

Upper Hunter White Box – Ironbark Grassy Woodland occurs on undulating hills on the upper slopes and some lower slopes of the Esparanga Offset Site. Upper Hunter White Box – Ironbark Grassy Woodland is closely related to Shrubby White Box Woodland. Shrubby White Box Woodland occurs on steeper slopes and in sheltered gullies where grazing has been reduced and the understorey is dominant. These communities share many common species in the understorey and ground cover.

Upper Hunter White Box – Ironbark Grassy Woodland follows nomenclature of Peake (2006). This community conforms to the TSC Act listed *White Box – Yellow Box – Blakely's Red Gum Woodland* EEC as intergrades of white box (*E. albens*) and grey box (*E. moluccana*) are clearly mentioned in the NSW Scientific Committee's Final Determination on this EEC. The EPBC Act listing *White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland* CEEC previously excluded intergrades from the final determination however this issue has become unclear following a letter from the Commonwealth Threatened Species Scientific Committee in December 2010 (DSEWPC 2010) noting that intergrades of eucalypt species are widely accepted and that recording an intergrade in what otherwise would be determined a TEC under the EPBC Act does not exclude the area from protection. This letter is not conclusive, however, and it is possible that the only legally defensible position is that of the original Listing Advice. For the purposes of this Project this community is considered to conform to the EPBC Act listed *White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland* CEEC.

Shrubby White Box Woodland

Shrubby White Box Woodland occurs on the fertile Tertiary basalt-derived soils on the upper slopes of the Esparanga Offset Site (refer to **Figure 7.6**). This community is characterised by an open canopy (to 30 per cent cover), to 20 metres in height, dominated by white/grey box intergrade (*Eucalyptus albens – moluccana*). Other canopy species may occur in ecotonal areas, such as narrow-leaved ironbark (*E. crebra*), Blakelys red gum (*E. blakelyi*), grey box (*E. moluccana*) and rough-barked apple (*Angophora floribunda*). A variable sub-canopy of regenerating canopy species and kurrajongs (*Brachychiton populneus* subsp. *populneus*) was also common, occurring to 15 metres in height and 20 per cent cover.

The shrub layer is typically dense (20 to 60 per cent canopy cover) to 4 metres in height. Commonly recorded species within the understorey include velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), cooba (*Acacia salicina*), *Choretrum* species A, native blackthorn (*Bursaria spinosa* subsp. *spinosa*), shiny-leaved canthium (*Psydrax odoratum*) and western boobialla (*Myoporum montanum*).

The ground cover was variable, ranging from open to dense (up to 60 per cent cover) with commonly recorded species including purple biddy biddy (*Acaena novae-zelandiae*), kidney weed (*Dichondra repens*), stinking pennywort (*Hydrocotyle laxiflora*), *Glycine tabacina*, native geranium (*Geranium solanderi*), yellow burr-daisy (*Calotis lappulacea*), tufted bluebell (*Wahlenbergia communis*), wiregrass (*Aristida ramosa*), red grass (*Bothriochloa macra*), *Rytidosperma monticola*, plump windmill grass (*Chloris ventricosa*) and red grass (*Bothriochloa decipiens*).

Intorduced flora species were also common in this community, comprising up to 20 per cent of the understorey vegetative cover. Common species included cobblers pegs (*Biden pilosa*), spear thistle (*Cirsium vulgare*), capeweed (*Arctotheca calendula*) and flatweed (*Hypochaeris radicata*).

Shrubby White Box Woodland occurs on undulating to steep slopes and sheltered gullies, generally in areas less likely to be cleared for grazing. Shrubby White Box Woodland is closely related to Upper Hunter White Box – Ironbark Grassy Woodland and Derived Native Grassland (White Box Woodland). These communities occur on undulating slopes more

suitable to grazing and therefore have been subject to more intense land clearing. As a result, the canopy and understorey of Shrubby White Box Woodland has greater cover abundance. These communities share a similar canopy and understorey species.
Shrubby White Box Woodland does not conform to the TSC or EPBC Act listed TECs based on the dominance of shrub layer occurring throughout this community. The intent of the TSC and EPBC Act listings were to protect naturally occurring White Box – Yellow Box – Blakely's Red Gum grassy woodlands on undulating slopes where clearing for agricultural practices threatened the occurrence of this community. In effect, those areas of this community that are largely devoid of a shrub layer, or have on a sparse shrub layer, are covered by the TEC listings, while those that are shrubby are not covered.

Derived Native Grassland (White Box Woodland)

Derived Native Grassland occurs on relatively fertile Tertiary basalt-derived soils on the upper slopes of the Esparanga Offset Site (refer to **Figure 7.6**), in areas that are likely to have once been dominated by white box (*Eucalyptus albens*), white/grey box intergrade (*Eucalyptus albens – moluccana*), Blakelys red gum (*E. blakelyi*), or a combination of these species, based on the current (post-disturbance) distribution of these species.

This community typically lacks a canopy or shrub layer, however scattered trees and shrubs can occur, such as white/grey box intergrade (*Eucalyptus albens – moluccana*), cooba (*Acacia salicina*), velvet mock olive (*Notelaea microcarpa* var. *microcarpa*) and shiny-leaved canthium (*Psydrax odoratum*). The ground cover is composed of native and introduced grasses and forbs. Commonly recorded species include purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa decipiens*), snowgrass (*Poa seiberiana* var. *sieberiana*), yellow burr-daisy (*Calotis lappulacea*) and tufted bluebell (*Wahlenbergia communis*).

Derived Native Grassland is closely related to Upper Hunter White Box – Ironbark Grassy Woodland, as it is likely to have once been part of this community prior to clearing. This community generally occurs where the slope is gradual, which is more suited to livestock grazing and therefore been subject to intense clearing.

This community conforms to the TSC Act listed *White Box – Yellow Box – Blakely's Red Gum Woodland* EEC as intergrades of white box (*E. albens*) and grey box (*E. moluccana*) are clearly mentioned in the final determination on this EEC. As discussed previously, the EPBC Act listing *White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland* CEEC previously excluded intergrades from the final determination. For the purposes of this project, this community is considered to conform to the EPBC Act listed *White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland* CEEC.

Derived Native Grassland (Narrabeen Ironbark Woodland)

Derived Grassland (Narrabeen Ironbark Woodland) occurs in a small isolated area in the centre of the Esparanga Offset Site that is likely to have once comprised Narrabeen Ironbark Woodland (refer to **Figure 7.6**).

Commonly recorded species in this community include threeawn speargrass (*Aristida vagans*), rough saw-sedge (*Gahnia aspera*), variable saw-sedge (*Lepidosperma laterale*), many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*) and poison rock fern (*Cheilanthes sieberi* subsp*. sieberi*). The community contains similar ground cover species to that which is commonly found in Narrabeen Ironbark Woodland, although the abundance of grasses and introduced species is usually higher.

This community does not conform to any TECs listed under the TSC or EPBC Act.

Derived Native Grassland (Red Gum Open Forest on Alluvium/Colluvium)

This derived grassland community occurs on the lower slopes and drainage line located on the eastern boundary of the Esparanga Offset Site (refer to **Figure 7.6**). It is likely that this grassland is derived from Red Gum Open Forest on Alluvium/Colluvium.

This community is composed of a mix of native and introduced grasses and forbs and is largely devoid of mature and regenerating trees. Commonly recorded native species include slender rat's tail grass (*Sporobolus creber),* weeping grass (*Microlaena stipoides* var. *stipoides*) and Indian weed (*Sigesbeckia orientalis* subsp. *orientalis).* Weed species in this community include cobblers pegs (*Bidens pilosa),* spear thistle (*Cirsium vulgare*), horehound (*Marrubium vulgare*), prickly pear (*Opuntia stricta),* fireweed (*Senicio madagascarensis)* and flaxleaf fleabane (*Conyza bonariensis)* as well as various introduced pasture grass species.

Derived Grassland comprises a similar ground cover to that which is commonly found in Red Gum Open Forest on Alluvium/Colluvium, although the occurrence of introduced species is usually higher.

The grassland community conforms to the TSC Act listed *White Box – Yellow Box – Blakely's Red Gum Woodland* EEC and the EPBC Act listed *White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland* CEEC. This Derived Grassland variant is derived from the adjacent Red Gum Open Forest on Alluvium/Colluvium), however, the grassland comprises a predominantly native ground layer which is distinctly lacking in the remnant forest and subsequently prevented it from conforming with the TEC listings.

7.3.2.4 Threatened Flora Species, Endangered Flora Populations and Threatened Ecological Communities

Those species recorded, or considered to have the potential to occur within the Esparanga Offset Site are listed in **Table 7.6**.

Table 7.6 - Threatened Flora Species, Endangered Populations or TECs with Potential to Occur in the Esparanga Offset Site

Species/EP or TEC	Status	Likelihood of Occurrence in the Esparanga Offset Site
painted diuris *Diuris tricolor*	V (TSC Act)	Moderate (potential habitat, records within 10 km)
scant pomaderris *Pomaderris queenslandica*	E (TSC Act)	High (likely habitat, previously recorded within 500 metres)
Singleton mint bush *Prostanthera cineolifera*	V (TSC Act) V (EPBC Act)	Low (potential habitat, records within 20 km)
weeping myall *Acacia pendula* in the Hunter Catchment	EP (TSC Act)	Moderate (potential habitat, records within 10 km)
tiger orchid ***Cymbidium canaliculatum* population in the Hunter Catchment**	**EP (TSC Act)**	**Recorded by Umwelt** (known habitat, records within 10 km)
Table Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion	EEC (TSC Act)	Moderate

Table 7.6 - Threatened Flora Species, Endangered Populations or TECs with Potential to Occur in the Esparanga Offset Site (cont.)

Species/EP or TEC	Status	Likelihood of Occurrence in the Esparanga Offset Site
White Box – Yellow Box – Blakely's Red Gum Woodland	**EEC (TSC Act)**	**Recorded by Umwelt**
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	**CEEC (EPBC Act)**	**Recorded by Umwelt**

Key:
E = Endangered
V = Vulnerable
EP = Endangered Population
EEC = Endangered Ecological Community
CEEC = Critically Endangered Ecological Community
TSC = *Threatened Species Conservation Act* 1995
EPBC = *Environment Protection and Biodiversity Conservation Act* 1999

7.3.2.5 Threatened Flora Species

No threatened flora species were recorded in the Esparanga Offset Site during surveys; however scant pomaderris (*Pomaderris queenslandica*) is known to occur on adjacent properties.

7.3.2.6 Endangered Flora Populations

One endangered flora population was recorded in the Esparanga Offset Site, being *Cymbidium canaliculatum* population in the Hunter Catchment (refer to **Figure 7.6**). This flora population is listed under the TSC Act.

7.3.2.7 Threatened Ecological Communities

As discussed in **Section 7.3.5.3**, two TECs were recorded in the Esparanga Offset Site. These communities are displayed in **Figure 7.6** and include:

- *White Box – Yellow Box – Blakely's Red Gum Woodland EEC*; and
- *White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland* CEEC.

7.3.2.8 Fauna Survey Results

A detailed fauna assessment was undertaken on the Esparanga Offset Site during 2012 and 2013. The fauna survey methodology is presented on **Figure 7.5** and is detailed in **Appendix G**.

Several general fauna habitat types were identified during surveys within the Esparanga Offset Site. Each of these broad habitat types has a range of characteristics that influence the habitat value, and the range of fauna species that are likely to be identified within each type. The broad habitat types recorded within Esparanga consist of woodland and forest, and grassland habitat.

Woodland and Forest Habitat

The Woodland and Forest habitat is highly variable, comprising a number of communities that are generally structurally and floristically diverse. Despite this variance in communities, the habitat they provide is comparable across the formation. This habitat type is the most abundant in Esparanga, covering approximately 209 hectares (69 per cent). Scattered mature trees were identified in a generally even spaced pattern across the Esparanga Offset Site, as expected due to the long history of agriculture.

This habitat contains a number of specific habitat resources for bird species, including threatened species. A moderate abundance of mistletoe (*Amyema* spp.) provides resources for specialist species such as the potentially occurring, nomadic painted honeyeater (*Grantiella picta*). Winter-flowering canopy trees are moderately widespread and provide potential resources for winter migrants such as the swift parrot (*Lathamus discolor*). The diversity of flowering canopy trees throughout the woodland formation provides a year-round resource for nectarivorous birds, particularly honeyeaters and lorikeets, such as the little lorikeet (*Glossopsitta pusilla*), as well as arboreal mammals including squirrel glider (*Petaurus norfolcensis*). Such flowering resources attract large numbers of insects which provide foraging habitat for a diversity of threatened micro-bats. Many of the understorey species are valuable flowering resources utilised by a diversity of nectarivorous bird species. Bird assemblages are likely to vary considerably according to such seasonal flowering events.

Mature hollow-bearing trees occur infrequently throughout this habitat, however these habitat trees provide a moderate abundance of hollow resources. Hollows range in size from small (26 to 50 millimetres diameter) to large (100 to 300 millimetres diameter). Hollow-bearing trees within the Esparanga Offset Site provide potential nesting resources for large arboreal mammals, owls, micro-bats and other hollow-dependent fauna. She-oaks (*Casuarina* spp.) although not well represented at the habitat assessment sites, occur patchily and provide foraging habitat for cockatoos and parrots, including potential habitat for the threatened glossy black-cockatoo (*Calyptorhynchus lathami*).

Large amounts of leaf litter, rocky areas, low vegetation and fallen timber provide protection and foraging resources for small terrestrial mammals, such as antechinus, and reptiles. Fallen timber is particularly important in open areas fringing grassland, as it provides valuable foraging perches for species such as the potentially occurring hooded robin (southern form) (*Melanodryas cucullata cucullata*), where they forage in the grasslands, then return regularly to woodland areas for cover. The moderately dense shrub and canopy layers provide excellent habitat for arboreal mammals, such as possums and gliders.

Ephemeral creeklines occur throughout this habitat type which would provide water resources in medium to high rainfall events. The shrub layer is generally more dense in the creekline habitat which provides cover and food resources for small insectivorous bird species such as the speckled warbler (*Chthonicola sagittata*).

Escarpments and shallow cave systems occur in this habitat type. Cave specialist micro-bat species were recorded throughout Esparanga. It is likely that the cave systems in the offset site provide refuge, and potential roosting/maternity sites for cave specialist micro-bat species, including the eastern cave bat (*Vespadelus troughtoni*), listed as Vulnerable under the TSC Act. This species is known to have a small home ranges radiating from roost/maternity caves.

Grassland Habitat

Grassland habitat occurs on the lower and upper slopes of the Esparanga Offset Site covering approximately 91.5 hectares (31 per cent). Canopy trees were typically absent from

this habitat type however occasional mature trees were recorded, which potentially provides hollow resources and woody debris for bird and reptile species.

A scattered shrub layer contained a low level of species and structural diversity. Ground cover was dominated by grass and sedge cover. Areas of soil, litter, lichen, and boulder/solid rock ground cover were recorded. Grassland habitat areas typically comprised a mix of native species which provides foraging habitat for macropods and for omnivorous birds.

Areas of rock on rock and a moderate amount of litter at the base of trees and loose tree bark were recorded. Ephemeral creeklines occur throughout this habitat type which provides water resources for a variety of native animals during periods of high rainfall.

The large areas of open grassland provide a foraging resource for macropods and a hunting resource for owls and micro-bats. Small mammals such as antechinus (*Antechinus* spp.) are provided foraging habitat as well as refuge habitat within the dense grass layers. This habitat type also provides foraging and refuge habitat for a number of reptile species and amphibians.

7.3.2.9 Fauna Species Recorded

A total of 117 fauna species have been recorded in Esparanga. An outline and discussion of the species recorded within each of the four major fauna groups is presented in the following sections.

A list of all fauna species recorded within Esparanga is presented in **Appendix G** of this report. This species list was compiled from data recorded during field surveys undertaken by Umwelt in 2012 as part of the Baseline Ecological studies of Esparanga in 2013.

Birds

A total of 75 bird species have been recorded in the Esparanga Offset Site. Thirty-three families are represented with Meliphagidae (honeyeaters) and Acanthizidae (Australasian warblers) recording nine species, the Psittacidae (parrots) recording five species and the Petroicidae (robins) and Artamidae (butcherbirds, magpie and currawong) each with four species.

Some of the more frequently observed bird species recorded in woodland communities included the yellow-rumped thornbill (*Acanthiza chrysorrhoa*), yellow thornbill (*Acanthiza nana*), weebill (*Smicrornis brevirostris*), yellow-faced honeyeater (*Lichenostomus chrysops*), noisy friarbird (*Philemon corniculatus*), spotted pardalote (*Pardalotus punctatus*), golden whistler (*Pachycephala pectoralis*), white-throated treecreeper (*Cormobates leucophaea*), Australian magpie (*Gymnorhina tibicen*) and Australian raven (*Corvus coronoides*).

Nocturnal birds are represented in Esparanga with a total of three species recorded and include the Eastern barn owl (*Tyto alba*), southern boobook (*Ninox novaeseelandiae*) and Australian owlet nightjar (*Aegotheles cristatus*).

The sulphur-crested cockatoo (*Cacatua galerita*), wedge-tailed eagle (*Aquila audax*) and Australian pipit (*Anthus novaeseelandiae*) were commonly recorded in grassland habitats and open areas.

Farm dams provided a permanent area of aquatic habitat for Australian wood duck (*Chenonetta jubata*) and Australasian grebe (*Tachybaptus novaehollandiae*).

One introduced bird species was recorded: the common starling (*Sturnus vulgaris*). This species was recorded on only one occasion.

Thirteen threatened bird species are predicted to occur in Esparanga on the basis of the presence of suitable habitat. Five of these species have been recorded including the speckled warbler (*Chthonicola sagittata*), brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), scarlet robin (*Petroica boodang*), varied sittella (*Daphoenositta chrysoptera*) and little lorikeet (*Glossopsitta pusilla*). The location of threatened bird species recorded in the Esparanga Offset Site are shown on **Figure 7.6**.

Of the 75 species recorded, eight species are listed on international migratory species conventions. These species are protected under the schedules of the EPBC Act which have been formulated to protect migratory and marine species listed under international conventions. All eight species recorded are listed as marine only. These species are included in **Appendix G**.

Reptiles

Nine species have been recorded within the Esparanga Offset Site, comprising a total of three reptile families, with the skink family (Scincidae) and gecko family (Gekkonidae) being the most well represented each with four species.

The most commonly encountered reptile species was the copper-tailed skink (*Ctenotus taeniolatus*) and the thick-tailed gecko (*Underwoodisaurus milii*). The snake-necked turtle (*Chelodonia longicollis*) was commonly recorded in dams.

No threatened reptile species have been recorded or are expected to occur in the Esparanga Offset Site.

Amphibians

Five amphibian species were recorded during surveys, including the common eastern froglet (*Crinia signifera*) and Bibron's toadlet (*Pseudophryne bibronii*). Four of the frog species were from the family Myobatrachidae, while the remaining species broad-palmed frog (*Litoria latopalmata*) was from the family Hylidae.

No threatened or introduced amphibian species have been recorded in the Esparanga Offset Site.

Mammals

Twenty-eight mammal species have been recorded within the Esparanga Offset Site with the most common family (Vespertilionidae) recording 10 species.

Four arboreal mammal species has been recorded, including the common brush-tailed possum (*Trichosurus vulpecula*) and the common ringtail possum (*Pseudocheirus peregrinus*). The threatened squirrel glider (*Petaurus norfolcensis*) and the sugar glider (*Petaurus breviceps*) were also recorded. Ground-dwelling mammals are represented by four species with the most commonly recorded including the yellow-footed antechinus (*Antechinus flavipes*) and common wombat (*Vombatus ursinus*). Analysis of hair samples also identified the presence of state and Commonwealth listed threatened spotted-tailed quoll (eastern subspecies) (*Dasyurus maculatus maculatus*).

Fifteen species of micro-bats were recorded in Esparanga with the most commonly identified copmprising Goulds wattled bat (*Chalinolobus gouldii*), eastern cave bat (*Vespadelus troughtoni*) and the little forest bat (*Vespadelus vulturnus*).

Four species of macropod are known to occur in the Esparanga Offset Site comprising the eastern grey kangaroo (*Macropus giganteus*), common wallaroo (*Macropus robustus*),

swamp wallaby (*Wallabia bicolor*) and red-necked wallaby (*Macropus rufogriseus*). Each of these species was principally observed in the open grassland areas, however, were also less frequently recorded in the woodland communities.

Two introduced mammal species have been recorded within Esparanga being European rabbit (*Oryctolagus cuniculus*) and European red fox (*Vulpes vulpes*). Although no other introduced species were recorded, there is some potential for others to occur including fallow deer (*Dama dama*), brown hare (*Lepus capensis*) and pigs (*Sus scrofa*).

7.3.2.10 Threatened Fauna Records

A total of 10 threatened fauna species have been recorded in the Esparanga Offset Site. A table of all threatened fauna species known to occur or predicted to occur is provided in **Table 7.7.** No endangered fauna populations were recorded during surveys and none are expected to occur.

Table 7.7 - Threatened Fauna Species Recorded or with Potential to occur in the Esparanga Offset Site

Species	Status		Likelihood of Occurrence at the Esparanga Offset Site
	TSC Act 1995	EPBC Act 1999	
BIRDS			
regent honeyeater *Anthochaera phrygia*	CE	E	High (likely foraging habitat, records within 4 km)
swift parrot *Lathamus discolor*	E	E MAR	Moderate (potential foraging habitat, records within 20 km)
hooded robin (south-eastern form) *Melanodryas cucullata cucullata*	V	-	High (potential habitat, records within 1 km)
scarlet robin ***Petroica rosea***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
flame robin *Petroica phoenicea*	V	-	High (potential habitat, records within
diamond firetail *Stagonopleura guttata*	V	-	High (potential habitat, records within 10 km)
grey-crowned babbler (eastern subspecies) *Pomatostomus temporalis temporalis*	V	-	High (potential habitat, records within 5 km)
varied sittella ***Daphoenositta chrysoptera***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
black-chinned honeyeater (eastern subspecies) *Melithreptus gularis gularis*	V	-	High (potential habitat, records within 7 km)

Table 7.7 - Threatened Fauna Species Recorded or with Potential to occur in the Esparanga Offset Site (cont.)

Species	Status		Likelihood of Occurrence at the Esparanga Offset Site
	TSC Act 1995	EPBC Act 1999	
painted honeyeater *Grantiella picta*	V	-	High (potential habitat, records within 10 km)
glossy black-cockatoo *Calyptorhynchus lathami*	V	-	High (likely habitat, records within 3 km)
gang-gang cockatoo *Callocephalon fimbriatum*	V	-	High (potential habitat, records within 7 km)
turquoise parrot *Neophema pulchella*	V	-	High (potential habitat, records within 6 km)
little lorikeet ***Glossopsitta pusilla***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
masked owl *Tyto novaehollandiae*	V	-	High (likely habitat, other records within 1 km)
speckled warbler ***Chthonicola sagittata***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
powerful owl *Ninox strenua*	V	-	High (likely habitat, other records within 1 km)
barking owl *Ninox connivens*	V	-	High (potential habitat, records within 4 km)
spotted harrier *Circus assimilis*	V	-	Moderate (potential habitat, records within 10 km)
little eagle *Hieraaetus morphnoides*	V	**-**	Moderate (potential habitat, records within 10 km)
brown treecreeper **(eastern subspecies)** ***Climacteris picumnus victoriae***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
MAMMALS			
spotted-tailed quoll ***Dasyurus maculatus***	**V**	**E**	**Recorded by Umwelt** (known habitat, other records within 5 km)
koala *Phascolarctos cinereus*	V	V	High (likely habitat, record within 1 km)

Table 7.7 - Threatened Fauna Species Recorded or with Potential to occur in the Esparanga Offset Site (cont.)

Species	Status		Likelihood of Occurrence at the Esparanga Offset Site
	TSC Act 1995	EPBC Act 1999	
squirrel glider ***Petaurus norfolcensis***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
brush-tailed rock-wallaby *Petrogale penicillata*	E	V	High (potential habitat, records within 1 km)
grey-headed flying-fox *Pteropus poliocephalus*	V	V	Moderate (potential habitat, Umwelt record within 15 km)
yellow-bellied sheathtail bat ***Saccolaimus flaviventris***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
greater broad-nosed bat *Scoteanax rueppellii*	V	-	Moderate (potential habitat, records within 25 km)
east coast freetail-bat *Mormopterus norfolkensis*	V	-	High (potential habitat, records within 5 km)
eastern bentwing-bat ***Miniopterus schreibersii oceanensis***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
little bentwing-bat *Miniopterus australis*	V	-	Moderate (potential habitat, records within 15 km)
greater long-eared bat (SE form) *Nyctophilus timoriensis*	V	V	High (likely habitat, records within 2 km)
large-eared pied bat ***Chalinolobus dwyeri***	**V**	**V**	**Recorded by Umwelt** (known habitat, other records within 1 km)
eastern false pipistrelle *Falsistrellus tasmaniensis*	V	-	Moderate (potential habitat, records within 15 km)
southern myotis *Myotis macropus*	V	-	Moderate (potential habitat, records within 20 km)
eastern cave bat ***Vespadelus troughtoni***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)

Key:

E = Endangered, V = Vulnerable, EP = Endangered Population, EEC = Endangered Ecological Community, CEEC = Critically Endangered Ecological Community, TSC = *Threatened Species Conservation Act* 1995, EPBC = *Environment Protection and Biodiversity Conservation Act* 1999, MAR = Marine species listed under the EPBC Act, MIG = Migratory species listed under the EPBC Act

7.3.2.11 Summary of the Ecological and Strategic Biodiversity Values of the Esparanga Offset Site

As discussed above, two general areas provide the focus of the strategic offset approach being undertaken by Glencore, being the Manobalai Offset Cluster and Mount Owen Offset Cluster. Of key importance is the location of these offset clusters in relation to key landscape features such as adjoining vegetation remnants, National Parks, Crown Land, Government Initiatives (such as the Great Eastern Ranges Initiative), and other Glencore managed offset areas.

A significant biodiversity asset of the Esparanga Offset Site comes from its position in the landscape, particularly its proximity to Manobalai Nature Reserve and its location within the corridor proposed as part of the Great Eastern Ranges Initiative. It is also considered reasonably likely that the area will form part of the Upper Hunter Strategic Assessment priority offset area. The inclusion of the Esparanga Offset Site as part of the Biodiversity Offset Strategy is of strategic benefit as securing privately owned land in this corridor for conservation purposes is a major conservation priority for the NSW Government.

The Esparanga Offset Site provides a direct, 'like-for-like' offset for the vast majority of the fauna species that are expected to be impacted by the Project, including the squirrel glider and the spotted-tailed quoll, both of which are expected to be significantly impacted as a result of the Project. The Esparanga Offset Site also provides substantial high quality habitat for woodland dependent bird and bat species and provides a range of additional high conservation value attributes such as potential roost sites for cave roosting bats and a known record of the tiger orchid (*Cymbidium canaliculatum*) EP in the Hunter Valley.

High quality vegetation communities have been recorded in the Esparanga Offset Site that will result in the conservation of high conservation priority communities as a result of the Project.

Opportunity also exists at the Esparanga Offset Site for environmental gain initiatives, including the regeneration of approximately 90 hectares of Derived Native Grassland habitat, 137 hectares of which conforms to the very high conservation value White Box Woodland and Derived Native Grassland EEC and CEEC (refer to **Sections 7.3.5.3** and **7.5.3.4**).

7.4 Stringybark Creek Habitat Corridor Establishment

The restoration of spotted-tailed quoll habitat and Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC is a key component of the Project Biodiversity Offset Strategy. Stringybark Creek has been identified as a priority area for habitat restoration for the spotted-tailed quoll and Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC, along with other targeted fauna species that will also benefit from habitat restoration initiatives such as woodland birds and bats, including the swift parrot and regent honeyeater. The Stringybark Creek Habitat Corridor is approximately 97.5 hectares in area and will focus on the creation of substantial foraging and denning habitat for the spotted-tailed quoll (*Dasyurus maculatus maculatus*) which is known to utilise drainage lines as movement and dispersal corridors (refer to **Figures 7.1** and **7.7**).

It is proposed to restore a linear riparian strip along Stringybark Creek, consistent with Central Hunter Swamp Oak Forest and Drainage Flat Red Gum Woodland, with the remainder of the corridor restored to be consistent with Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC, the dominant vegetation community in the Project Area.

Habitat restoration works will be undertaken for the spotted-tailed quoll along the proposed Stringybark Creek Habitat Corridor (being approximately 800 metres wide along the majority of its length), which occurs to the north-west of the Project Area. Works will include a mixture of tree plantings and emplacement of habitat structures such as log piles (replicating that containing the known den site in mine rehabilitation) adjacent to Stringybark Creek. The objective of the Stringybark Creek Habitat Corridor will be to link the existing Biodiversity Offset Areas in the north of the Project Area, with native vegetation corridors established on rehabilitated mine land and restored habitats along Bowmans Creek at Liddell Mine, to the west of the Project Area. The establishment of the habitat corridor will facilitate movement of the spotted-tailed quoll (*Dasyurus maculatus maculatus*) and other fauna species (including threatened fauna species) from existing Mount Owen biodiversity offset areas to other remnant native vegetation areas in the region such as the Hillcrest Offset Area managed by Glencore's Ravensworth Surface Operations (refer to **Figure 2.1**) to the north-west of the Project Area and the Mountain Block Offset Area and Bowmans Creek Riparian Corridor proposed as part of the current Liddell Continued Operations Project, which are proposed as offsets for the spotted-tailed quoll.

The restoration and regeneration of vegetation communities and fauna habitat has been a highly successful impact mitigation strategy previously at Mount Owen (refer to **Section 7.5.1** below) and the spotted-tailed quoll has been recorded regularly in regenerated woodland habitats in existing offset areas at Mount Owen.

An inspection of the Stringybark Creek Habitat Corridor was undertaken in October 2013 to describe the extent, type and condition of vegetation communities and fauna habitats occurring within the proposed Stringybark Creek Habitat Corridor, to determine the extent of potential habitat for the spotted-tailed quoll and to ascertain land management issues in relation to revegetation, regeneration and weed and pest management. A total of two vegetation quadrats were sampled during the inspection targeting the extent and floristic composition of vegetation communities. The preliminary flora and fauna survey methodology is presented on **Figure 7.7** and is detailed in **Appendix G**. The site inspection provided a 'snap shot' of the ecological characteristics of the Stringybark Creek Habitat Corridor however, does not provide a detailed examination of the site. Further detailed baseline surveys are proposed as part of the development of the Offset Management Plan, which will include baseline fauna surveys and more detailed land management studies. A summary of the results of the preliminary inspection of the Stringybark Creek Habitat Corridor are provided below.

7.4.1.1 Vegetation Communities

Six vegetation communities were recorded in the Stringybark Creek Habitat Corridor, comprising five communities of native vegetation and approximately 8 hectares dominated by African Olive (*Olea europaea* subsp. *cuspidata*). The extent of each of the vegetation communities is shown on **Figure 7.8** and summarised in **Table 7.8** and detailed descriptions of each community is provided below. In addition to the vegetation communities listed below, the Stringybark Creek Habitat Corridor includes approximately 2.9 hectares of disturbed land and open water associated with farm dams.

Table 7.8 – Vegetation Communities Recorded in the Stringybark Creek Habitat Corridor

Vegetation Community	Area Within the Stringybark Creek Habitat Corridor (ha)
Native Vegetation	
Spotted Gum – Narrow-leaved Ironbark Forest (EEC)	21.6
Derived Native Grassland	58.8
Drainage Flat Red Gum Woodland (EEC)	1.0
Depauperate Dry Rainforest	4.7
Swamp Oak Forest	0.5
Non-native Vegetation	
African Olive Infestation	8.0
Total	**94.6**

Spotted Gum – Narrow-leaved Ironbark Forest (EEC)

The Spotted Gum – Narrow-leaved Ironbark Forest was the dominant treed vegetation community identified within the Stringybark Creek Habitat Corridor, totalling 21.6 hectares. This forest community occurred on moderate to steep slopes (to 22 degrees) on southerly to westerly aspects.

The community was characterised by a tall, mid-dense canopy of narrow-leaved ironbark (*Eucalyptus crebra*) and broad-leaved ironbark (*Eucalyptus fibrosa*) to 25 metres in height and 30 per cent cover, with sub-dominant species including spotted gum (*Corymbia maculata*) and grey gum (*Eucalyptus punctacta*). A sub-canopy of recruiting canopy species was common in the community.

A mid-sparse understorey (to 25 per cent cover), between 1 and 5 metres in height was recorded, typically including the native shrubs rusty pomaderris (*Pomaderris ferruginea*), coffee bush (*Breynia oblongifolia*), bulloak (*Allocasuarina luehmannii*), blackthorn (*Bursaria spinosa* subsp. *spinosa*), white dogwood (*Ozothamnus diosmifolius*) and silver-stemmed wattle (*Acacia parvipinnula*). The introduced species African olive (*Olea europaea* subsp. *cuspidata*) was also common in the understorey, especially in areas that were adjacent to stands of the African Olive Infestation (refer to **Figure 7.8**).

The community supported a mid-dense groundlayer (to 40 per cent cover) that was dominated by native grasses and forbs. Common species included barbed wiregrass (*Cymbopogon refractus*), kangaroo grass (*Themeda triandra*), purple wiregrass (*Aristida ramosa*), spear grass (*Austrostipa scabra*) and tall chloris (*Chloris ventricosa*). A number of introduced flora species were also common throughout the ground stratum, with galenia (*Galenia pubescens*), prickly pear (*Opuntia stricta* subsp. *stricta*) and narrow-leaved cotton bush (*Gomphocarpus fruticosus*) dominant.

This community most closely aligns with the Peake (2006) vegetation community Central Hunter Ironbark – Spotted Gum – Grey Box Forest based on the assemblage of flora species, structural characteristics and location within the Hunter Valley. However it also shows similarities with the Barrington Footslopes Dry Spotted Gum Forest with, at times, an increased shrub cover and some slight differences in flora species assemblages including Port Jackson fig (*Ficus rubiginosa*), large mock olive (*Notelaea longifolia*), common cassinia (*Cassinia aculeata*), kurrajong (*Brachychiton populneus* subsp. *populneus*) and *Phyllanthus virgatus*.

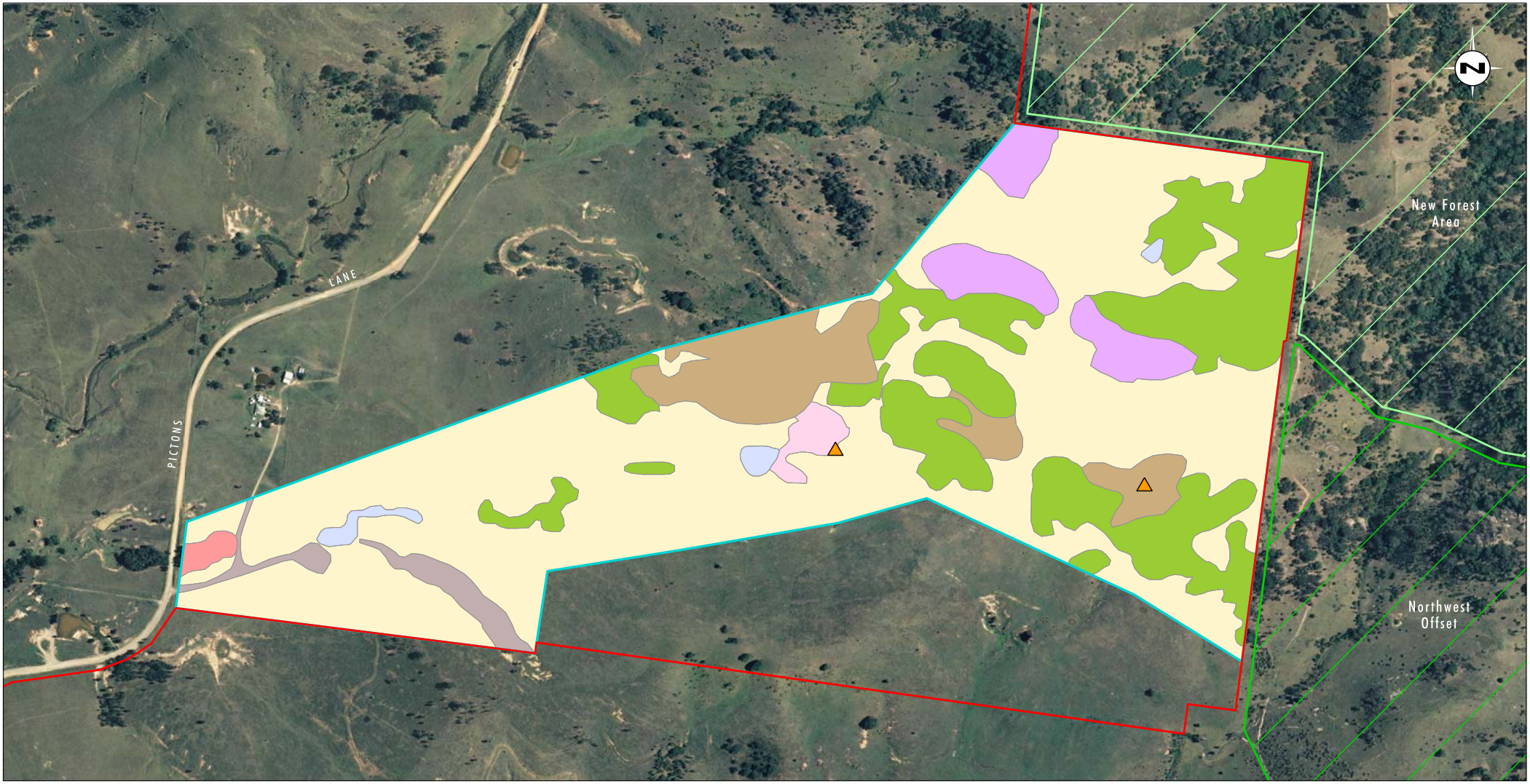

Image Source: Mount Owen (2012)

0 100 250 500m
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Legend

- Project Area
- Existing Biodiversity Offset Area
- Ravensworth State Forest
- Stringybark Creek Habitat Corridor
- Drainage Flat Red Gum Woodland (EEC)
- Spotted Gum - Narrow-leaved Ironbark Forest (EEC)
- Swamp Oak Forest
- African Olive Infestation
- Depauperate Dry Rainforest
- Derived Native Grassland
- Water Body
- Disturbed Land
- Speckled warbler

FIGURE 7.8

Stringybark Creek Habitat Corridor Key Ecological Features

File Name (A4): R03/3109_732.dgn
20140815 12.37

These variations were not pronounced enough to warrant separating the areas into different vegetation communities. Instead, it is considered that Stringybark Creek Habitat Corridor is located within an ecotone between vegetation communities recognised in the Central Hunter and those associated with the Barrington footslopes.

This community is consistent with Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC, listed under the TSC Act. The community recorded within the Stringybark Creek Habitat Corridor and described above supports a canopy dominated by species identified within the EEC Final Determination, namely narrow-leaved ironbark (*Eucalyptus crebra*) and spotted gum (*Corymbia maculata*). A number of understorey and groundlayer species identified within the Final Determination were also recorded in the community, including coffee bush (*Breynia oblongifolia*), bulloak (*Allocasuarina leuhmannii*), silver-stemmed wattle (*Acacia parvipinnula*), barbed wiregrass (*Cymbopogon refractus*) and kangaroo grass (*Themeda triandra*).

Derived Native Grassland

Derived Native Grassland was the dominant vegetation community recorded on the Stringybark Creek Habitat Corridor, totalling 58.8 hectares. It occurred on the relatively fertile Tertiary basalt-derived soils of the lower slopes in areas that were likely to have once been dominated by Spotted Gum – Narrow-leaved Ironbark Forest. Many canopy species of this remnant community occur as scattered trees on the lower slopes of the Derived Native Grassland.

Scattered trees recorded within the Derived Native Grassland included narrow-leaved ironbark (*Eucalyptus crebra*), broad-leaved ironbark (*Eucalyptus fibrosa*) and spotted gum (*Corymbia maculata*). Forest red gum (*Eucalyptus tereticornis*) was also recorded in proximity to Stringybark Creek.

Derived Native Grassland typically lacked a shrub layer; however scattered shrubs occurred, including velvet mock olive (*Notelaea microcarpa* var. *microcarpa*) and small-leaved bluebush (*Maireana microphylla*). The ground cover is composed of native and introduced grasses. Commonly recorded species include purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa macra*), barbed wiregrass (*Cymbopogon refractus*), Rhodes grass (*Chloris gayana*) and kikuyu grass (*Pennisetum clandestinum*).

Derived Native Grassland is closely related to Spotted Gum – Narrow-leaved Ironbark Forest, as it is likely to have been derived from this community following clearing for agricultural activities. This community therefore most closely aligns with the Peake (2006) vegetation community Central Hunter Ironbark – Spotted Gum – Grey Box Forest in a derived grassland form.

This community does not conform to any TECs listed under the TSC or EPBC Acts.

Drainage Flat Red Gum Woodland (EEC)

A mid-high to tall open forest dominated by forest red gum (*Eucalyptus tereticornis*) and rough-barked apple (*Angophora floribunda*). Scattered narrow-leaved ironbark (*Eucalyptus crebra*) and spotted gum (*Corymbia maculata*) trees were recorded upslope of the creekline in the ecotone between this community and the Spotted Gum – Narrow-leaved Ironbark Forest. Drainage Flat Red Gum Woodland totalled 1.0 hectare within the Stringybark Creek Habitat Corridor.

A shrub layer was generally present and characterised by native shrubs and African olive. Commonly occurring shrub species include sickle wattle (*Acacia falcata*), velvet mock olive

(*Notelaea microcarpa* var. *microcarpa*), small-leaved bluebush (*Maireana microphylla*), white dogwood (*Ozothamnus diosmifolius*) and pepper tree (*Schinus areira*).

The relatively sparse understorey was dominated by grasses and forbs, including native and introduced flora species. Common species include barbed wiregrass (*Cymbopogon refractus*), kangaroo grass (*Themeda australis*), speargrass (*Austrostipa scabra* var. *scabra*), weeping grass (*Microlaena stipoides* var. *stipoides*), kidney weed (*Dichondra repens*), winter apple (*Eremophila debilis*), Narrawa burr (*Solanum cinereum*), blady grass (*Imperata cylindrica*) and *Glycine tabacina*. Weed species such as common prickly pear (*Opuntia stricta* var. *stricta*), flaxleaf fleabane (*Conyza bonariensis*), fireweed (*Senecio madagascariensis*), common sowthistle (*Sonchus oleraceus*) and spear thistle (*Cirsium vulgare*) were recorded in relatively low abundance.

This community was recorded at a single location within the Stringybark Creek Habitat Corridor on the lower slopes and upper section of Stringybark Creek. It very broadly conforms to the MU 24 – Hunter Lowland Red Gum Forest described by Peake (2006).

River-flat Eucalypt Forest is listed as an EEC under the TSC Act and the Drainage Flat Red Gum Woodland community described in the Stringybark Creek Habitat Corridor conforms to the description of this EEC provided by the NSW Scientific Committee.

Depauperate Dry Rainforest

Depauperate Dry Rainforest was restricted within the Stringybark Creek Habitat Corridor, occurring only on protected (generally south facing) rocky slopes. The community comprised an area of 4.7 hectares.

The sheltered vegetation was characterised by a sparse, emergent canopy dominated by spotted gum (*Corymbia maculata*), grey gum (*Eucalyptus punctacta*), forest red gum (*Eucalyptus tereticornis*) and rusty fig (*Ficus rubiginosa*). Additional tree species that occurred scattered through the community or small groups included narrow-leaved stringybark (*Eucalyptus sparsifolia*) and rough-barked apple (*Angophora floribunda*). This community also supported elements of the Spotted Gum – Narrow-leaved Ironbark Forest community it due to its proximity and the small size of the Depauperate Dry Rainforest remnant.

A dense shrub layer was recorded with species including sweet pittosporum (*Pittosporum undulatum*), coffee bush (*Breynia oblongifolia*), grey myrtle (*Backhousia myrtifolia*), native peach (*Trema tomentosa*) and velvet mock olive (*Notelaea microcarpa* var. *microcarpa*). A single silky oak (*Grevillea robusta*) was also recorded bordering this community. The introduced shrub species, African olive (*Olea europaea* subsp. *cuspidata*) was also common within the community.

The sparse ground cover was recorded within the community as a result of the dense shrub layer and high cover of organic litter. Common species included barbed wiregrass (*Cymbopogon refractus*), kangaroo grass (*Themeda australis*), blady grass (*Imperata cylindrica*) and purple wiregrass (*Aristida ramosa*).

Depauperate Dry Rainforest very broadly conforms to the Upper Hunter Depauperate Dry Rainforest described by Peake (2006). It is not consistent with any listed TECs under the TSC Act or EPBC Act.

Swamp Oak Forest

A small stand of Swamp Oak Forest was recorded on the lowest section of Stringybark Creek near Picton Lane (**Figure 7.8**), covering an area of 0.5 hectares. The community was

characterised by a closed canopy dominated by swamp oak (*Casuarina glauca*). Emergent forest red gum (*Eucalyptus tereticornis*) trees were recorded along with the introduced pepper tree (*Schinus areira*.
The understorey was relatively disturbed and shrubs were largely absent. The banks of the creek have been severely modified by undercutting erosion, which is a likely result from period of high water flow and lack of stabilising native shrubs.

The groundcover was sparse, with only several grasses and forbs recorded during the field survey. The dominant native flora species included weeping grass (*Microlaena stipoides* var. *stipoides*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*) and kidney weed (*Dichondra repens*). Introduced flora species included scarlet pimpernel (*Anagallis arvensis*), spear thistle (*Cirsium vulgare*), fireweed (*Senecio madagascariensis*) and galenia (*Galenia pubescens*).

This community conforms to Central Hunter Swamp Oak Forest described by Peake (2006). It does not conform to any TECs listed under the TSC Act or EPBC Act.

African Olive Infestation

A total of 8.0 hectares of African Olive Infestation was recorded in the Stringybark Creek Habitat Corridor. The community occurs on the upper, south to south-east facing slopes and is characterised by dense stands (to 70 per cent cover) of African olive (*Olea europaea* subsp. *cuspidata*) to approximately 3 metres in height. Emergent narrow-leaved ironbark (*Eucalyptus crebra*) and spotted gum (*Corymbia maculata*) were scattered throughout the community, occurring to approximately 15 metres in height.

Although uncommon, where the cover of African olive was reduced, a sparse cover (to 10 per cent) of native shrubs was recorded, namely blackthorn (*Bursaria spinosa* subsp. *spinosa*) and coffee bush (*Breynia oblongifolia*).

A mid-dense groundlayer (to 50 per cent cover) was recorded that was dominated by native grasses and forbs. Dominant species included barbed wire grass (*Cymbopogon refractus*), kangaroo grass (*Themeda australis*) and purple wiregrass (*Aristida ramosa*). Introduced weed species were also common throughout the groundlayer of this community, with veined verbena (*Verbena rigida*), prickly pear (*Opuntia stricta* var. *stricta*), creeping pear (*Opuntia humifusa*) and stinking Roger (*Tagetes minuta*) being the most dominant species.

Although this community is characterised by the introduced shrub, African olive, the elements of native vegetation that remain present suggest this area is most closely aligned with the Spotted Gum – Narrow-leaved Ironbark Forest which was recorded adjacent to the African Olive Infestation.

This community does not conform to any TECs listed under the TSC or EPBC Act.

7.4.1.2 Threatened Flora Species, Endangered Flora Populations and Threatened Ecological Communities

Preliminary flora surveys and vegetation mapping of the Stringybark Creek Habitat Corridor were undertaken in October 2013 to inform the development of the Corridor and to identify vegetation communities of high conservation value. The preliminary surveys did not identify any threatened flora species or EPs within the area proposed for the Corridor. Two communities mapped during the preliminary flora surveys are considered to conform to scientific committee determinations of EECs, including:

- Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC (mapped as Spotted Gum – Narrow-leaved Ironbark Forest); and

- River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South east Corner Bioregions EEC (mapped as Drainage Flat Red Gum Woodland).

Threatened flora species, endangered populations and EECs recorded, or with potential to occur in the Stringybark Creek Habitat Corridor are listed in **Table 7.9**.

Table 7.9 – Threatened Flora Species, EPs and EECs Recorded or with Potential to Occur in the Stringybark Creek Habitat Corridor

Species/EP or TEC	Status		Likelihood of Occurrence in the Stringybark Creek Habitat Corridor
	TSC Act 1995	EPBC Act 1999	
slaty red gum *Eucalyptus glaucina*	V	V	Moderate (potential habitat, records within 10 km)
Ozothamnus tesselatus	V	V	Moderate (potential habitat, records within 5 km)
weeping myall *Acacia pendula* in the Hunter Catchment	EP	-	Moderate (potential habitat, records within 5 km)
tiger orchid *Cymbidium canaliculatum* population in the Hunter Catchment	EP	-	Moderate (potential habitat, records within 5 km)
River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South east Corner Bioregions	**EEC**	**-**	**Recorded by Umwelt** (known habitat, other records within 5 km)
Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	**EEC**	**-**	**Recorded by Umwelt** (known habitat, other records within 5 km)

Key:

E = Endangered, V = Vulnerable, EP = Endangered Population, EEC = Endangered Ecological Community, TSC = *Threatened Species Conservation Act* 1995, EPBC = *Environment Protection and Biodiversity Conservation Act* 1999

7.4.1.3 Fauna Species and Habitats

A fauna habitat inspection was undertaken in October 2013 to describe the extent and type of fauna habitats occurring within the proposed Stringybark Creek Habitat Corridor and to determine the extent of potential habitat for the spotted-tailed quoll. The inspection included the completion of three habitat and condition assessments that recorded data relating to habitat condition, such as erosion and the presence of weeds and pest species; and also the presence of targeted fauna habitat characteristics such as tree hollows, caves or potential perch sites, and general measures of fauna habitat such as the composition of vegetation communities. Opportunistic recording of native and introduced fauna species was also undertaken. The fauna survey methodology is presented on **Figure 7.7** and is detailed in **Appendix G**.

Several general fauna habitat types were identified during surveys, each of which exhibit a range of characteristics that influence the habitat value and range of fauna species that are likely to occur. The broad habitat types recorded within the Stringybark Creek Habitat Corridor consist of woodland and forest, grassland habitat and riparian habitat.

Woodland and Forest Habitat

The Woodland and Forest habitat is highly variable, comprising a number of communities that are generally structurally and floristically diverse. Despite this variance in communities, the habitat they provide is comparable across the formation. This habitat type covers 34.3 hectares (36 per cent) of the Stringybark Creek Habitat Corridor. Scattered mature trees were identified sparsely across the landscape, in a generally even spaced pattern, as is expected due to the long history of agriculture in the local area.

Woodland and forest habitat includes dry rainforest elements and contains a number of specific habitat resources for bird species, including threatened species. A moderate abundance of mistletoe (*Amyema* spp.) provides resources for specialist species and winter-flowering canopy trees are moderately widespread and provide potential resources for winter migrants such as the swift parrot (*Lathamus discolor*). The diversity of flowering canopy trees throughout the woodland formation provides a year-round resource for nectarivorous birds, particularly honeyeaters and lorikeets, such as the potentially occurring little lorikeet (*Glossopsitta pusilla*), as well as arboreal mammals such as the squirrel glider (*Petaurus norfolcensis*) which is known to occur in proximate habitats. Such flowering resources attract large numbers of insects which provide foraging habitat for a diversity of micro-bats and insectivorous birds. Many of the understorey species are valuable flowering resources utilised by a diversity of nectarivorous bird species. Bird assemblages are likely to vary considerably according to such seasonal flowering events.

Mature hollow-bearing trees occur infrequently throughout this habitat, however where they occur these habitat trees provide a moderate abundance of hollow resources ranging in size from small (26 to 50 millimetres diameter) to large (100 to 300 millimetres diameter). Hollow-bearing trees provide potential nesting resources for large arboreal mammals, owls, micro-bats and other hollow-dependent fauna.

Large amounts of leaf litter, rocky areas, low vegetation and fallen timber provide protection and foraging resources for small terrestrial mammals, such as antechinus and reptiles. Fallen timber is particularly important in open areas fringing grassland, as it provides valuable foraging perches for species such as the potentially occurring hooded robin (southern form) (*Melanodryas cucullata cucullata*), where they forage in the grasslands and return regularly to woodland areas for cover. The moderately dense shrub and canopy layers is likely to provide high quality habitat for arboreal mammals, such as possums and gliders.

Grassland Habitat

Grassland habitat occurs on the majority of the Stringybark Creek Habitat Corridor, covering an area of 58.83 hectares (62 per cent). Canopy trees were typically absent from this habitat type however occasional mature trees were recorded, providing potential hollow resources and woody debris for bird, mammal and reptile species.

Ground cover was dominated by a variety of native and introduced grass species. Areas of soil, litter, lichen, and boulder/solid rock ground cover were recorded. Grassland habitat areas typically comprised a mix of native species which provides foraging habitat for macropods and omnivorous birds.

Areas of rock on rock and a moderate amount of litter at the base of trees and loose tree bark were also recorded in this habitat formation. Ephemeral creeklines occur throughout this

habitat type providing water resources for a variety of native animals during periods of high rainfall.

The large areas of open grassland provide a likely foraging resource for macropods and a hunting resource for owls and micro-bats. Small mammals such as antechinus (*Antechinus* spp.) are provided foraging habitat as well as refuge habitat within the dense grass layers. This habitat type also provides foraging and refuge habitat for reptile species and amphibians.

Riparian Habitat

Ephemeral creeklines occur within the Stringybark Creek Habitat Corridor with a number of large dams providing a permanent water source. Riparian habitat was generally found to occur in a highly disturbed state with continuous canopy lacking across the site; however numerous mature red gums (*Eucalyptus tereticornis*) and rough-barked apple (*Angophora floribunda*) were recorded. The habitat type is dominated by swamp oak (*Casuarina glauca*) in the lower reaches of Stringybark Creek. In total, 2.4 hectares (2 per cent) of this habitat was recorded within the Stringybark Creek Habitat Corridor.

The mature eucalypts identified along river flats within this habitat type provide a seasonal foraging resource for arboreal mammals and nectarivorous birds. These large eucalypts also provide a foraging habitat for insectivorous birds, and foraging and roosting resources for micro-bats. The scattered hollow-bearing trees within this habitat type are likely to provide a nesting resource for a range of bird species as well as arboreal mammals and micro-bats with hollow bearing trees sparsely recorded. The shrub layer, although sparse in density, provides a foraging and refuge resource for small birds such as the speckled warbler (*Chthonicola sagittata*) (refer to **Figure 7.8**). The grassy understorey provides a foraging and refuge resource for reptiles and amphibians. Some water was present within the generally ephemeral riparian habitat type, providing a drinking resource for native fauna as well as a foraging, refuge and breeding resource for amphibians.

Threatened Fauna Species

One threatened fauna species, the speckled warbler (*Chthonicola sagittata*), was recorded during the site inspection at two locations (refer to **Figure 7.8**). An assessment of the habitat characteristics of the proposed Stringybark Creek Habitat Corridor confirmed the presence of potential habitat for the spotted-tailed quoll that is linked the known habitat within existing Mount Owen biodiversity offset areas.

Table 7.10 lists those threatened species for which existing and (proposed) regenerated habitats within the Stringybark Creek Habitat Corridor provide known or potential habitat.

Table 7.10 – Threatened Fauna Species Recorded or with Potential to occur in the Stringybark Creek Habitat Corridor

Species	Status		Likelihood of Occurrence in the Stringybark Creek Habitat Corridor
	TSC Act 1995	EPBC Act 1999	
Amphibians			
green and golden bell frog *Litoria aurea*	E	V	Low (potential habitat, historic records within 3 km)

Table 7.10 – Threatened Fauna Species Recorded or with Potential to occur in the Stringybark Creek Habitat Corridor (cont.)

Species	Status		Likelihood of Occurrence in the Stringybark Creek Habitat Corridor
	TSC Act 1995	EPBC Act 1999	
BIRDS			
regent honeyeater *Anthochaera phrygia*	CE	E	Moderate (potential foraging habitat, records within 20 km)
black-necked stork *Ephippiorhynchus asiaticus*	E	-	Low (unlikely habitat, records within 6 km)
red goshawk *Erythrotriorchis radiates*	CE	V	Moderate (potential habitat, records within 7 km)
swift parrot *Lathamus discolor*	E	E MAR	High (potential foraging habitat, records within 3 km)
hooded robin (south-eastern form) *Melanodryas cucullata cucullata*	V	-	High (likely habitat, records within 2 km)
blue-billed duck *Oxyura australis*	V	-	Moderate (unlikely habtiat, records within 4 km)
scarlet robin *Petroica rosea*	V	-	High (likely habitat, records within 2 km)
flame robin *Petroica phoenicea*	V	-	High (likely habitat, records within 3 km)
Australian painted snipe *Rostratula benghalensis australis*	E	E MAR MIG	Low (unlikely habtiat, records within 60 km)
diamond firetail *Stagonopleura guttata*	V	-	High (likely habitat, records within 2 km)
freckled duck *Stictonetta naevosa*	V	-	Low (unlikely habitat, records within 7 km)
red-backed button-quail *Turnix maculosus*	V	-	Moderate (potential habitat, records within 10 km)
grey-crowned babbler (eastern subspecies) *Pomatostomus temporalis temporalis*	V	-	High (likely habitat, records within 2 km)
varied sittella *Daphoenositta chrysoptera*	V	-	High (likely habitat, records within 3 km)
black-chinned honeyeater (eastern subspecies) *Melithreptus gularis gularis*	V	-	High (likely habitat, records within 3 km)
little lorikeet *Glossopsitta pusilla*	V	-	High (potential foraging habitat, records within 3 km)
masked owl *Tyto novaehollandiae*	V	-	High (potential foraging habitat, records within 3 km)

Table 7.10 – Threatened Fauna Species Recorded or with Potential to occur in the Stringybark Creek Habitat Corridor (cont.)

Species	Status		Likelihood of Occurrence in the Stringybark Creek Habitat Corridor
	TSC Act 1995	EPBC Act 1999	
speckled warbler ***Chthonicola sagittata***	**V**	**-**	**Recorded by Umwelt** (known habitat, other records within 1 km)
powerful owl *Ninox strenua*	V	-	High (potential foraging habitat, records within 3 km)
barking owl *Ninox connivens*	V	-	Moderate (potential foraging habitat, records within 10 km)
spotted harrier *Circus assimilis*	V	-	High (potential foraging habitat, records within 4 km)
little eagle *Hieraaetus morphnoides*	V	-	High (potential foraging habitat, records within 4 km)
brown treecreeper (eastern subspecies) *Climacteris picumnus victoriae*	V	-	High (likely habitat, records within 3 km)
MAMMALS			
spotted-tailed quoll *Dasyurus maculatus*	V	E	High (likely habitat, records within 1 km)
brush-tailed phascogale *Phascogale tapoatafa*	V	-	High (likely habitat, records within 2 km)
koala *Phascolarctos cinereus*	V	V	Moderate (potential habitat, records within 8 km)
squirrel glider *Petaurus norfolcensis*	V	-	Moderate (potential habitat, records within 6 km)
brush-tailed rock-wallaby *Petrogale penicillata*	E	V	Low (unlikely habitat, records within 20 km)
grey-headed flying-fox *Pteropus poliocephalus*	V	V	Moderate (potential habitat, record within 5 km)
New Holland mouse *Pseudomys novaehollandiae*	-	V	Moderate (potential habitat, records within 4 km)
yellow-bellied sheathtail bat *Saccolaimus flaviventris*	V	-	High (potential habitat, records within 2 km)
greater broad-nosed bat *Scoteanax rueppellii*	V	-	Moderate (potential habitat, records within 8 km)
east-coast freetail-bat *Mormopterus norfolkensis*	V	-	High (likely habitat, records within 1 km)
little bentwing-bat *Miniopterus australis*	V	-	Moderate (potential habitat, records within 10 km)

Table 7.10 – Threatened Fauna Species Recorded or with Potential to occur in the Stringybark Creek Habitat Corridor (cont.)

Species	Status		Likelihood of Occurrence in the Stringybark Creek Habitat Corridor
	TSC Act 1995	EPBC Act 1999	
south-eastern long-eared bat *Nyctophilus corbeni*	V	V	Low (potential habitat, records within 25 km)
large-eared pied bat *Chalinolobus dwyeri*	V	V	Moderate (potential habitat, records within 20 km)
eastern false pipistrelle *Falsistrellus tasmaniensis*	V	-	High (potential habitat, records within 5 km)
southern myotis *Myotis macropus*	V	-	High (potential habitat, records within 5 km)
eastern bentwing-bat *Miniopterus schreibersii oceanensis*	V	-	High (likely habitat, records within 4 km)
eastern cave bat *Vespadelus troughtoni*	V	-	High (likely habitat, records within 4 km)

Key:

CE = Critically Endangered, E = Endangered, V = Vulnerable, EP = Endangered Population, EEC = Endangered Ecological Community, TSC = *Threatened Species Conservation Act* 1995, EPBC = *Environment Protection and Biodiversity Conservation Act* 1999, MAR = Marine species listed under the EPBC Act, MIG = Migratory species listed under the EPBC Act

7.4.1.4 Summary of the Ecological and Strategic Biodiversity Values of the Stringybark Creek Habitat Corridor

The Stringybark Creek Habitat Corridor is strategically located adjacent to existing Mount Owen Biodiversity Offset Areas and in proximity to Glencore managed conservation areas located to the north west of the Project Area associated with Liddell Operations and Ravensworth Surface Operations (refer to **Figure 7.1**).

Stringybark Creek was identified as a priority restoration area for the Project due the presence of a degraded riparian corridor that could provide a linkage for the spotted-tailed quoll between areas of known habitat along Bowmans Creek proposed for in-perpetuity conservation as part of the Liddell Biodiversity Offset Strategy (Umwelt 2013a) and existing Mount Owen Biodiversity Offset Areas. It is proposed to reinstate woodland communities within the Derived Native Grassland communities of the Habitat Corridor with the proposed restoration/regeneration works expected to facilitate the movement of spotted-tailed quoll individuals within the local population of the species across the broader landscape and aid in dispersal of juveniles.

The Stringybark Creek Habitat Corridor currently provides approximately 35.8 hectares of moderate quality spotted-tailed quoll woodland/forest habitat that generally occurs on slopes adjacent to the existing Mount Owen Biodiversity Offset Areas, along with 58.8 hectares of Derived Native Grassland habitat that the species may use as it moves across the landscape. In accordance with the known habitat preferences of the species, it is expected to utilise the woodland/forest and Derived Native Grassland communities along Stringybark Creek. The in-perpetuity conservation of the Stringybark Creek Habitat Corridor will ensure that an additional area 58.8 hectares of preferred movement habitat (that is riparian

corridors) for the species are regenerated/restored and managed for the species in the long term.

In addition to the stated objective of spotted-tail quoll habitat restoration, the proposed regeneration of Derived Native Grassland communities within the Corridor to woodland commensurate with Central Hunter Ironbark - Spotted Gum – Grey Box Forest EEC will also positively benefit many of the threatened species and vegetation communities that are likely to be impacted as a result of the Project, including Central Hunter Ironbark - Spotted Gum – Grey Box Forest EEC, threatened woodland birds and micro-bats, threatened arboreal fauna including the squirrel glider (*Petaurus norfolcensis*) and the brush-tailed phascogale (*Phascogale tapoatafa*) and the masked owl (*Tyto novaehollandiae*).

7.5 Additional Strategies to Maintain or Improve the Conservation Values of Proposed Biodiversity Offset Sites

Each of the three proposed land-based Biodiversity Offset Sites (Cross Creek Offset Site, Esparanga Offset Site and the Stringybark Creek Habitat Corridor) will be subject to passive and active regeneration activities in order to improve ecological value and threatened species habitat and increase the area of native woodland and forest that will be conserved in the long-term.

The objectives of the regeneration of the Biodiversity Offset Areas are to:

- re-establish vegetation consistent with extant vegetation communities and the likely pre-European extant vegetation;
- re-establish fauna habitats consistent with extant fauna habitats of the Biodiversity Offset Areas; and
- re-establish habitat for those threatened fauna species that are likely to be impacted as a result of the Project.

The detailed approach to the regeneration of the Biodiversity Offset Areas will be documented in the existing Rehabilitation and Offset Management Plan. The Rehabilitation and Offset Management Plan will be revised within 12 months of Project approval and will be updated to incorporate the proposed additional Biodiversity Offset Areas and management commitments. The following sections provide an overview of the likely approaches to vegetation community and fauna habitat regeneration.

7.5.1 Vegetation Community Re-establishment

Regeneration of vegetation communities in the proposed Offset Areas is expected to result in the establishment of approximately 20 year old vegetation over the life of the Project. Based on the age class of the areas of regrowth vegetation characteristic of the Project Area (refer to **Section 2.3**), regenerated communities of an approximately 20 year age class are considered likely to provide significant ecological values in a regional context.

The proposed vegetation community and fauna habitat re-establishment at each of the three land-based offset sites will include the following restoration actions:

- all planting or seeding within revegetation areas will be designed with structural and floristic diversity suitable to meet the benchmark vegetation community targets;

- where practicable, revegetation will involve the use of local provenance seed that will either be utilised for direct seeding or for the propagation of tubestock for planting;

- revegetation areas will be subject to a formal care and maintenance program that will be developed to include the control of weeds, replacement of failed plantings, bushfire protection etc; and

- revegetation areas will be subject to formal monitoring program (success/failure, as well as floristic monitoring) that will be developed to include a feedback loop to achieve continual improvement in the methodology and results.

The extent of proposed vegetation community and fauna habitat re-establishment at each of the proposed Biodiversity Offset Area is provided in **Table 7.11** below. The total area of each target community for regeneration is shown in **Table 7.12**.

Table 7.11 - Proposed Vegetation Community Re-establishment in Biodiversity Offset Areas

Biodiversity Offset Site	Current Vegetation Community	Area (hectares)	Target Vegetation Community
Cross Creek	Derived Native Grassland	315.3	Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC
Esparanga	Derived Native Grassland (White Box Woodland)	85.1	Upper Hunter White Box - Ironbark Grassy Woodland EEC
	Derived Grassland (Red Gum Open Forest on Alluvium/Colluvium)	5.9	Red Gum Open Forest on Alluvium/Colluvium EEC
Stringybark Creek Habitat Corridor	Derived Native Grassland	43.8	Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC
	Derived Native Grassland	15	River-flat Eucalypt Forest EEC

Table 7.12 - Cumulative Total of Target Vegetation Communities Including Extant Vegetation and Areas of Proposed Community Re-establishment

Target Vegetation Community	Proposed Impact Area	Extant Area of Community in Biodiversity Offset Sites	Area proposed for Re-establishment	Total Area
Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC	159.3	51.7	359.1	410.8
Upper Hunter White Box - Ironbark Grassy Woodland EEC	0	46	85.1	131.1
Red Gum Open Forest on Alluvium/Colluvium EEC	0	2.7	5.9	8.6
River-flat Eucalypt Forest EEC	0	1.0	15	16

It is noted that 2.7 hectares of Red Gum Open Forest on Alluvium/Colluvium is mapped within the Esparanga Offset Site however this community does not conform to the scientific committee EEC determination for White Box Yellow Box Blakely's Red Gum Woodland due to the absence of a predominantly native groundcover and therefore is not included in the calculations in **Table 7.12** as an area of extant vegetation. River-flat Eucalypt Forest has been targeted for re-establishment as it is expected to provide an area of improved habitat

quality for the spotted-tailed quoll in a currently degraded area within the Stringybark Creek Habitat Corridor.

7.5.2 Re-instatement of Fauna Habitat

The re-instatement of fauna habitat is a critical component of the proposed woodland and forest regeneration initiatives that are proposed to maintain or improve the biodiversity values of the Biodiversity Offset Areas in the long term. Regeneration of vegetation communities in accordance with the strategy outlined in **Table 7.11** will also provide an increased area of fauna habitat in the long term. A number of targeted fauna habitat re-instatement measures have been identified to specifically target those threatened fauna species that are expected to be impacted by the Project. The extent and location of habitat augmentation will be detailed in the updated Offset Management Plan. Habitat augmentation will include:

- provision of supplementary and augmented habitat for the spotted-tailed quoll in the Stringybark Creek Habitat Corridor in accordance with strategies outlined in **Section 6.3.2**;

- appropriate management of cattle grazing in Biodiversity Offset Areas;

- installation of nest boxes to supplement arboreal fauna habitat to offset impacts to hollow-dependent threatened fauna species. Once regenerated communities are structurally mature, nest boxes will be installed in similar densities to those in unaffected vegetation on the site. Nest box design will consider the full range of hollow-dependent species known or expected to occur in the Offset Areas, in particular hollow-dependent threatened fauna species such as the squirrel glider (*Petaurus norfolcensis*) and threatened tree-roosting woodland birds and micro-bats and the masked owl;

- placement of salvaged tree hollows in rehabilitation areas, where practicable. The re-instated density of salvaged tree hollows and nest boxes in rehabilitation areas will be carried out taking into consideration the carrying capacity of the rehabilitated vegetation in which the boxes are being established;

- consideration of the structural diversity of regenerating vegetation communities (e.g. ground layer, shrub layer, small tree and canopy layers) to provide a range of structural habitat attributes and therefore habitat niches in regenerated communities; and

- weed and feral animal control in accordance with **Sections 6.1.1.1** and **6.1.1.2**.

7.6 Contribution of On-site Rehabilitation

Mount Owen has committed to undertaking a final landform rehabilitation strategy (refer to **Section 6.2** above and **Section 5.16** of the main EIS report) across the Project Area to mitigate the impacts that would occur as a result of the Project. The rehabilitation of post-mining areas is predicted to provide a long-term benefit to the ecological values of the Project Area and wider locality. This key impact mitigation measure (refer to **Section 6.2**) supplements the Biodiversity Offset Strategy and contributes to substantially mitigating the impact of the Project, and therefore reducing the size and nature of the offsets required to counterbalance residual impacts. Details of the proposed site rehabilitation are provided in **Section 6.2** and the proposed final landform in shown on **Figure 7.9**

The rehabilitation of the Project Area would primarily involve the establishment of the Central Hunter Spotted Gum - Grey Box – Ironbark Forest EEC.

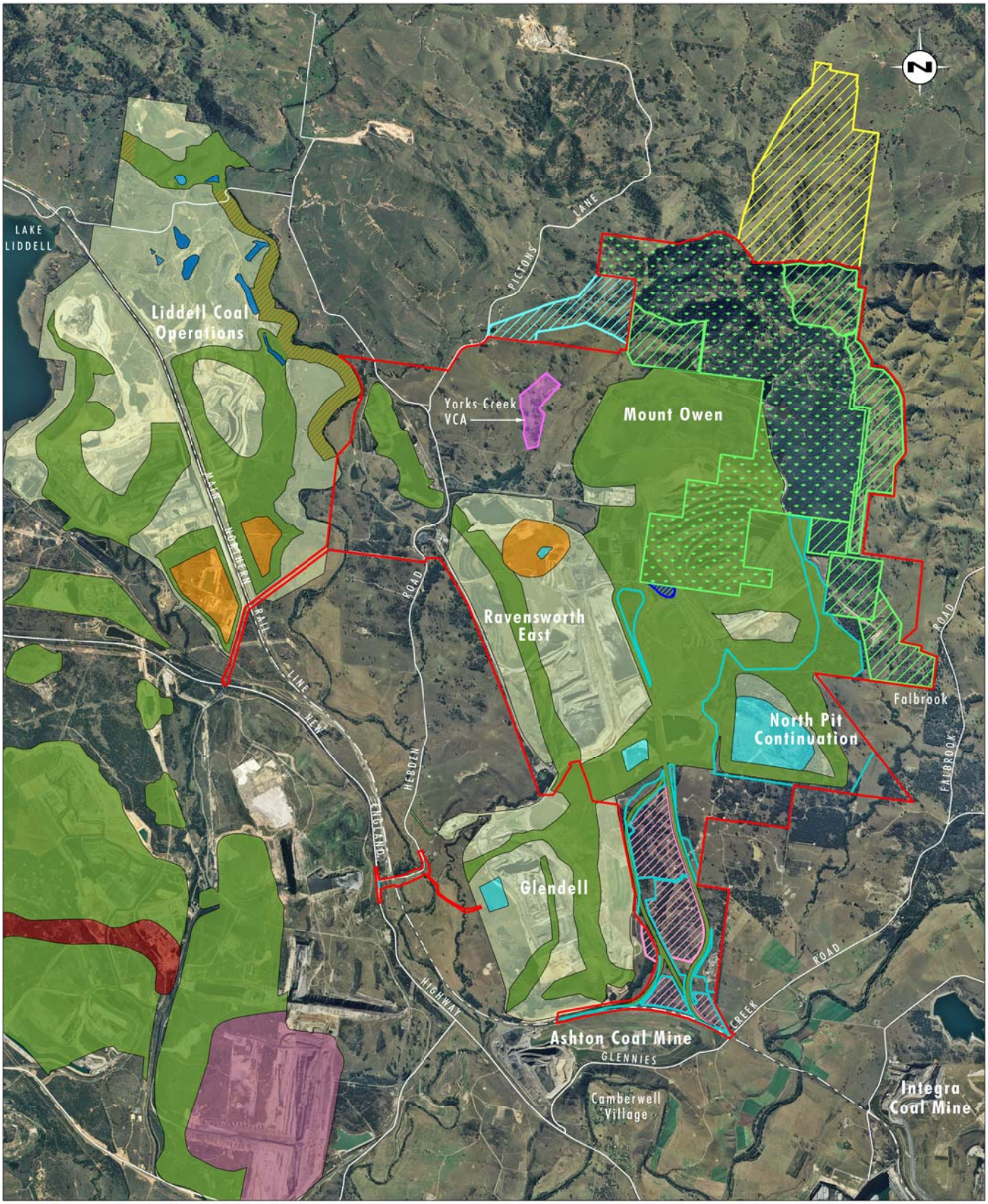

Image Source: Mount Owen (2012-2013)
Data Source: Mount Owen (2014)

0 1.0 2.0 4.0km
1:75 000

Legend

- Project Area
- Proposed Disturbance Area
- Yorks Creek VCA
- Final Void Water Level
- Native Woodland
- Open Grassland (Potential grazing areas) with pockets of Native Vegetation
- Grassland for Stabilisation
- Ravensworth State Forest
- Proposed Corridor Habitat Enhancement on Non-Mined land (Liddell Coal Operctions)
- Existing Biodiversity Offset Area
- Proposed Cross Creek Biodiversity Offset Area
- Bettys Creek Habitat Management Area
- Southern Remnant Biodiversity Offset Area
- Stringybark Creek Habitat Corridor
- Grazing
- Riparian / Wetland
- Water Storage

FIGURE 7.9

Mount Owen Continued Operations Project Proposed Post Mining Land Use

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On-site rehabilitation of the Project Area will be undertaken according to the best practice techniques developed by the University of Newcastle and Glencore at Mount Owen (Nussbaumer *et. al.* 2012). Best practice techniques for the establishment of target vegetation communities in previously mined areas include:

- using topsoil from target communities;
- use of suitable topsoil substitutes, such as pasture subsoil, which has proven an effective growth medium at Mount Owen in the absence of topsoil for target communities;
- using provenance seed and developing a seed collection program;
- scalping and ripping of un-prepared restoration lands rather than direct seeding;
- seeding prior to reliable rainfall;
- determining appropriate seeding rates following on-site trails;
- appropriate use of fertilizer (preventing excessive fertilizer use from disrupting root-microbe associations in the soil);
- the use of artificial habitat structures such as stag trees, roost or nest boxes, and mounds of rocks or logs;
- long-term monitoring to determine if rehabilitation is developing towards the rehabilitation objectives and to refine completion criteria over time;
- monitoring to detect cryptic species;
- long term monitoring to determine if the rehabilitated ecosystems are capable of withstanding natural stresses such as drought, fire and flood; and
- adaptive management whereby monitoring results inform ongoing rehabilitation practices.

7.6.1 Review of Rehabilitation Success at Mount Owen Complex

An assessment of mine rehabilitation and regeneration activities at Mount Owen was undertaken (Umwelt 2013b) to report on the ecological value of the rehabilitated vegetation communities, particularly in the context of vegetation community re-establishment and threatened species habitat. A targeted flora survey and condition assessment was undertaken in selected mine rehabilitation and vegetation areas across the Mount Owen North Pit rehabilitation area, the New Forest Area and existing Mount Owen Biodiversity Offset Areas, to provide context and certainty surrounding the inclusion of proposed mine rehabilitation and regeneration works in the proposed Biodiversity Offset Strategy. Following collection of the flora and condition assessment data, a thorough assessment of fauna monitoring results in relation to mine rehabilitation and habitat regeneration was undertaken, particularly focussing on the statistical analysis that is undertaken annually as part of the fauna monitoring. The key outcomes of the assessment (Umwelt 2013b) are provided below.

The assessment of similarity between rehabilitation, revegetation and regeneration areas and the EEC determination for Central Hunter Ironbark – Spotted Gum – Grey Box Forest identified that areas of revegetation and regeneration in the New Forest Area and Biodiversity Offset Areas conform to the scientific committee determination of Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC and therefore meet the rehabilitation objectives and site preliminary completion criteria detailed in the Landscape Management

Plan (Xstrata Mount Owen 2011). At this stage, the mine rehabilitation was assessed as trending towards the Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC.

Monitoring of the fauna habitat provided by the rehabilitation and regeneration sites at Mount Owen is clearly demonstrating that actively managed rehabilitation and regeneration can provide a high quality habitat for native fauna species from each of the main vertebrate fauna groups and including threatened species.
Annual fauna monitoring has measured the diversity of threatened species utilising forest, regeneration and rehabilitation monitoring sites. A total of 29 species listed under either the TSC or EPBC Act have been recorded at Mount Owen. Of the 29 threatened species recorded, 13 have been recorded in forest regeneration monitoring sites and 11 in post mining rehabilitation sites.
Threatened species that have been recorded in mine rehabilitation include the spotted-tailed quoll and New Holland mouse and threatened species such as the squirrel glider, masked owl and grey-crowned babbler have each been regularly recorded in regeneration monitoring sites.

Mount Owen has had considerable success in re-establishing vegetation communities on mine spoil. Mount Owen has worked closely with researchers from the University Of Newcastle with the initial goal of the Mount Owen mine research program to re-establish sustainable nutrient acquisition and cycling using natural root-microbe associations. This project soon expanded to include research into the use of available bulk materials and amelioration techniques for mine rehabilitation when forest topsoil would eventually run out. The rehabilitation strategy at Mount Owen has also benefited from the results of research such as a doctorate project through the University of Queensland titled ‘Enhancing Eucalypt Forest Re- establishment on Coal Mined Land at Mount Owen’. Mount Owen has also participated in several Australian Coal Association Research Program (ACARP) projects on mine site rehabilitation. In collaboration with the University of Newcastle, Mount Owen has embarked on a research program that will lead to the most effective methods to establish dry sclerophyll and other native forest communities on rehabilitated overburden dumps.

Since commencement, research has continued to develop as part of the Ravensworth State Forest Complex Research Program, with over forty experiments and investigations currently established. Mount Owen is now listed as a ‘Highly Commended’ site on the Global Restoration Network of the Society for Ecosystem Restoration, International.

The assessment of the ecological values of rehabilitated formerly mined land and those areas that have been subject to vegetation community and fauna habitat reconstruction programs demonstrates that rehabilitated land can create quality vegetation communities and fauna habitats that includes threatened fauna species and EEC habitat.

7.6.2 Contribution of Mine Rehabilitation to the Biodiversity Offset Strategy

The ecological value of successful post-mining rehabilitation areas will contribute to the overall biodiversity offset strategy for the Project. However areas of post mining rehabilitation are given a reduced weighting compared to regeneration of existing vegetation communities, due to the time lag involved and the recognition that creating vegetation communities on mine spoil is more challenging than regenerating a vegetation community in a location where it previously occurred. A weighting of 0.5 has been applied to every hectare of post-mining rehabilitation to be created so that the value of the post-mining rehabilitation can be determined and contribute to the biodiversity offset strategy.

The approximate area of vegetation that would be rehabilitated progressively over the life of the mine, in addition to the currently approved area for rehabilitation, comprises 518 hectares, which represents the minimum area that will be rehabilitated to native woodland/forest communities with the total rehabilitation area for the Project (excluding final

void) being in the order of 1,900 hectares. Some of this total area may be used for post mining land uses such as agriculture and therefore to provide a conservative estimate, these areas have been excluded from the calculation of rehabilitation contribution to the biodiversity offset strategy.

It is proposed to re-establish Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the post-mining landform, consistent with current rehabilitation practices undertaken at Mount Owen. Conceptually identified areas of post mining rehabilitation are shown on **Figure 7.9**. **Figure 7.9** also identifies areas that have been nominated for the rehabilitation of pasture to facilitate the future use of parts of the post-mining landform as agricultural land.

7.7 Summary of Biodiversity Offset Strategy

The Biodiversity Offset Strategy was developed for the Project in a manner consistent with Commonwealth and State offsetting policies. The objectives of the Biodiversity Offset Strategy are described in **Section 7.0**. **Tables 7.13** to **7.15** provide a summary of the Biodiversity Offset Strategy for the Project for vegetation communities and for key threatened fauna species impacted by the Project. **Table 7.15** includes consideration of mine rehabilitation outcomes in an offsetting context. The inclusion of rehabilitation in biodiversity offsetting is increasing in importance and proponents, including Mount Owen (refer to **Section 7.6**) are demonstrating improved outcomes and increasing confidence in relation to the re-establishment of key vegetation communities and fauna habitats. Mine rehabilitation is also being incorporated into the Upper Hunter Strategic Assessment as a means for mining proponents in the Hunter Valley to offset impacts to biodiversity.

Table 7.13 – Offsetting Outcomes for Vegetation Communities Impacted by the Project

Impact and Offset Scenario	Impact Area (ha)	Cross Creek Offset Site (ha)	Esparanga Offset Site (ha)	Stringybark Creek Habitat Corridor (ha)	Total Offset Area (ha)	Offset Ratio
Woodland Impacts Offset With Woodland	223.7	51.7	211.4	27.8	290.9	1.3:1
Woodland Impacts Offset With Woodland and Regenerated DNG	223.7	367	303	94.6	764.6	3.4:1
Central Hunter Ironbark – Spotted Gum – Grey Box Forest Impacts Offset With Woodland and Regenerated DNG Areas	159.3	367	114.3	43.8	525.1	3.3:1

State and Commonwealth biodiversity offset policies focus on the ability to find like-for-like offsets for the Project, particularly like-for-like vegetation communities. It is widely acknowledged that in the Hunter Valley, like-for-like offsets for vegetation communities at the scale required for the Project are not reasonably available. Given the unavailability of potentially suitable like-for-like offsets for the Project described in the EIS, potential offset sites were found that contained similar vegetation communities and fauna habitats. The use

of vegetation communities of a similar type (or a type of higher conservation priority) is consistent with OEH's *NSW Offset Principles for Major Projects (state significant development and state significant infrastructure)* seven principles (OEH 2013) (refer to **Section 7.1.2.1**).

The Biodiversity Offset Strategy for the Project includes 432.4 hectares of like-for-like Central Hunter Ironbark – Spotted Gum - Grey Box Forest EEC (woodland and regenerated DNG areas in the Cross Creek Offset Site and Stringybark Creek Habitat Corridor) and 114.3 hectares of high conservation value vegetation communities with similarity to Central Hunter Ironbark – Spotted Gum - Grey Box Forest EEC on the Esparanga Offset Site when using the discounting factor process (substitution ratios) that is discussed in **Section 7.2.3**.

Table 7.14 provides a summary of the threatened fauna offsetting outcomes for the Project.

Table 7.14 – Key Threatened Fauna Offsetting Outcomes for the Project

Impact and Offset Scenario	Impact Area (ha)	Cross Creek Offset Site (ha)	Esparanga Offset Site (ha)	Stringybark Creek Habitat Corridor (ha)	Total Offset Area (ha)	Offset Ratio
Spotted-tailed Quoll[1] Woodland and DNG Impacts Offset with Eucalypt Woodland and DNG areas	223.7 woodland 223.1 DNG	367	303	94.6	764.6	1.7:1
Squirrel Glider and Brush-tailed Phascogale Eucalypt Woodland Impacts Offset with Eucalypt Woodland	131.9	51.7	211.4	27.8	290.9	2.2:1
Threatened Woodland Birds and Micro-bats Woodland and Forest Impacts Offset with Woodland and Forest Areas	223.7	51.7	211.4	27.8	290.9	1.3:1

Table 7.14 – Key Threatened Fauna Offsetting Outcomes for the Project (cont.)

Impact and Offset Scenario	Impact Area (ha)	Cross Creek Offset Site (ha)	Esparanga Offset Site (ha)	Stringybark Creek Habitat Corridor (ha)	Total Offset Area (ha)	Offset Ratio
Threatened Woodland Birds and Micro-bats Woodland and Forest Impacts Offset with Woodland, Forest and regenerated DNG	223.7	367	303	94.6	764.6	3.4:1
Masked Owl Woodland and DNG Impacts Offset with Eucalypt Woodland and DNG	223.7 woodland 223.1 DNG	367	303	94.6	764.6	1.7:1
Regent Honeyeater, Swift Parrot and Koala Habitat Eucalypt Forest Impacts Offset with Eucalypt Forest	163.7	51.7	212	27.3	291.0	1.8:1
Regent Honeyeater, Swift Parrot and Koala Habitat Eucalypt Forest Impacts Offset with Eucalypt Forest and regenerated DNG	163.7	367	303	94.6	764.6	4.7:1

Note 1: The offset ratio for the spotted-tailed quoll considers the impact of the loss of moderate quality woodland/forest habitats along with impacts associated with low quality grassland habitats. The offset ratio for the spotted-tailed quoll rises from 1.7 :1 to 3.4:1 when low quality grassland habitat is removed from the impact calculations.

7.7.1.1 Mine Rehabilitation

As discussed above, mine rehabilitation is also considered a crucial component of the overall Biodiversity Offset Strategy as it will provide a substantial future area of local habitat, future improved local connectivity and is focussed on reinstating large areas of the key affected vegetation communities and fauna habitat. The mine rehabilitation strategy will contribute

approximately 518 hectares of Central Hunter Ironbark – Spotted Gum - Grey Box – Forest, in addition to that currently existing or approved. The total Biodiversity Offset Strategy, including rehabilitation, is outlined in **Table 7.15**.

Table 7.15 – Biodiversity Offset Package with Rehabilitation

	Area of Impact (ha)	Biodiversity Offset Strategy Total Offset Area Without Rehabilitation	Biodiversity Offset Strategy Total Offset Area Including Rehabilitation[1]
Woodland Impacts Offset with Woodland, Regenerated DNG and Rehabilitation	223.7	764.6	1,023.6
Spotted Gum - Ironbark –Grey Box Forest Impacts Offset With Spotted Gum - Ironbark –Grey Box Forest, DNG and Spotted Gum - Ironbark –Grey Box Forest Rehabilitation Areas (like-for-like)	159.3	432.4	691.4
Spotted Gum - Ironbark –Grey Box Forest Impacts Offset With Woodland, DNG and Rehabilitation Using Similar Vegetation Communities	159.3	546.7	805.7

1 = Consistent with the approach in the EIS and as discussed with DPE and OEH, for this 'similar vegetation' calculation, rehabilitation was given a discounted per hectare ratio value of 0.5 (i.e. every 1 hectare of rehabilitated woodland is counted as 0.5 hectares for offsetting purposes).

Further discussion regarding mine rehabilitation and its suitability for inclusion in the Biodiversity Offset Strategy is included in **Section 7.5**.

7.8 Assessment of the Biodiversity Offset Strategy Against Offsetting Guidelines

The following section documents the Biodiversity Offset Strategy against the state and federal guidelines for biodiversity offsetting.

7.8.1 Assessment of the Biodiversity Offset Strategy against the Principles for Biodiversity Offsetting (OEH 2013)

Section 7.1.1 documents the OEH (2013) *Principles for Biodiversity Offsetting in NSW* for State Significant Developments. The following provides an assessment of the Project Biodiversity Offset Strategy against these principles.

1. Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.

Offsets sit within a hierarchy of 'avoid, minimise, offset'. The first priority in a development proposal is always to avoid any unnecessary impact to biodiversity. Where impacts cannot be avoided, a reasonable attempt should be made to minimise the impact as much as possible. After all feasible measures have been taken to avoid or minimise

> impacts to biodiversity, offsets should be used to compensate for any remaining impacts (OEH 2013).

The Project has been designed to avoid disturbance to the ecological features of the Project Area where possible, whilst maintaining the economic feasibility and practicality of all components of the Project. **Section 5.1** documents the key project avoidance measures undertaken as part of the Project. Where impact on ecological features has been unavoidable, a robust impact mitigation strategy has been provided that addresses the mitigation of these impacts in the long term (refer to **Section 6.0**).

Other key impact mitigation strategies include sediment and erosion control, weed and feral animal control, general operation controls such as dust, noise, surface water and groundwater management and a comprehensive tree felling procedure to limit impacts on hollow-dependent threatened fauna species.

2. Offset requirements should be based on a reliable and transparent assessment of losses and gains.

> Offsetting decisions should be based on a reliable and transparent assessment of the loss in biodiversity due to the development proposal and the likely gain in biodiversity through the offset. For terrestrial biodiversity, established assessment tools, such as the BioBanking Assessment Methodology, are considered best practice. This methodology is currently being reviewed and refined to ensure it is as robust as possible (OEH 2013).

The Biodiversity Offset Strategy has been developed through detailed consideration of known impacts on known records of threatened and TECs (including their habitats), which have been identified and discussed in detailed in **Sections 4.0** and **5.0**. The selection of the Biodiversity Offset Areas took into account such identified impacts, and identified preferences based on the ability of such available areas to appropriately address such impacts. The potential for restoration and recreation of substantial areas of threatened species habitat was also prioritised in the selection of the Biodiversity Offset Areas.

The area of impact has been derived from detailed GIS mapping of project boundaries and impact areas, and the ecological survey, mapping and impact assessments have been completed by qualified ecologists with considerable experience in the region. Extensive surveying has been undertaken at appropriate seasonal times to adequately determine the likely subject species.

The BioCertification and EPBC Act Offsets Calculator assessments conducted as part of the Biodiversity Offset Strategy provide a quantifiable and reliably estimated assessment of the adequacy of the Biodiversity Offset Strategy in relation to the impacts of the Project on ecological values. These assessments suggest that the land-based offset sites are substantial and exceed the offsetting requirements outlined by the relevant government offsetting polices and will provide suitable offsetting for the TSC and EPBC Act-listed ecological communities, flora, fauna and migratory species impacted by the Project.

All relevant ecological features of the offset sites are quantifiable and, where the information is available, are presented in such a manner in this report. The quantification is documented in **Tables 7.1** and **7.2** of this report.

3. Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.

> Offsets should reflect the biodiversity values, including threatened species and their habitat, that are being lost. This should be on a like-for-like basis for NSW-listed species and ecological communities that are also nationally listed. Like-for-like is preferable for ecological communities, threatened species and their habitat that are only listed in NSW.

> However, where offset sites that are exactly like-for-like are not reasonably available, offsets may include vegetation communities of a similar type or a type of a higher conservation priority, or threatened species of a higher conservation priority (OEH 2013).

The development of the Biodiversity Offset Strategy has been based on addressing the identified ecological impacts of the Project (refer to **Section 5.0**). These impacts have been identified via a thorough survey and assessment process, which has been described in detail within this document. Following the identification of impact, the Biodiversity Offset Strategy has been designed to provide mitigation actions targeted at each of the major impacts. **Table 7.1** clearly documents the key ecological species, communities and features that would be impacted by the Project and are hence targeted for offsetting.

The Biodiversity Offset Strategy for the Project includes 432.4 hectares of like-for-like Central Hunter Ironbark – Spotted Gum - Grey Box Forest EEC (woodland and regenerated DNG areas) and 114.3 hectares of high conservation value vegetation communities with similarity to Central Hunter Ironbark – Spotted Gum - Grey Box Forest EEC when using the discounting factor process (substitution ratios) that is discussed in **Section 7.2.3**.

The Biodiversity Offset Strategy provides a direct, 'like-for-like' offset for all key threatened fauna species that are likely to be adversely impacted by the Project.

4. Offsets must be additional to other legal requirements.

> The biodiversity protection and management requirements of an offset must be in addition to any legal requirements already in place for biodiversity on that land. This includes, for example, any existing legal restrictions on clearing under the *Native Vegetation Act 2003.* Improvements in the condition of native vegetation not currently required by other legislation would count as an offset (OEH 2013).

The land-based offsets proposed as part of the Biodiversity Offset Strategy do not overlap with any other legal requirements or government funded protection or habitat restoration program on those sites. All offset sites are located on currently non-reserved land and will add a substantial area into long-term conservation.

5. Offsets must be enduring, enforceable and auditable.

> Offset sites must be subject to good governance arrangements to ensure they are not inadvertently developed in the future. This includes having an appropriate plan of management, resourcing for management, legal security and accountability mechanisms. For terrestrial offsets, a BioBanking Agreement or addition to the NSW national parks system are the preferred mechanisms for securing an offset site. The purchase and retirement of biodiversity credits under the BioBanking Scheme, where appropriate credits are available, also meets the requirement for good governance arrangements.
>
> Suitable offsets must be determined prior to approval. However the offset does not need to be finalised (e.g. be purchased or have relevant protection over it) prior to approval, providing it is subject to a suitable mechanism that will remain enforceable after the project has been completed (OEH 2013).

The Biodiversity Offset sites will be secured for long-term conservation. The mechanism for securing this conservation will be determined in consultation with the relevant government agencies. Currently Mount Owen envisages that all three land-based offset sites would be managed in a manner consistent with the existing Mount Owen Biodiversity Offset Areas.

6. Supplementary measures can be used in lieu of offsets.

> For terrestrial offsets, supplementary measures can be used in lieu of offsets in situations where land based offsetting is not feasible or practical. The supplementary measure must be relevant to the biodiversity value being impacted. The monetary value of a supplementary measure is to be determined by an appropriate method that is repeatable and transparent. Examples of supplementary measures include the provision of funds for:
>
> - Biodiversity research or surveys
> - Recovery of threatened species
> - Community education and awareness programs
>
> Supplementary measures may also be used to compensate for impacts on aquatic biodiversity (OEH 2013).

The Biodiversity Offset Strategy does not propose supplementary measures.

7. Offsets can be discounted where significant social and economic benefits accrue to NSW as a consequence of the proposal.

> While an outcome in which biodiversity values are improved or maintained is preferred, it is acknowledged that in some circumstances flexibility may be required, especially in the context of a project providing significant social or economic benefits to NSW (OEH 2013).

The Biodiversity Offset Strategy has not been discounted.

7.8.2 Assessment of the Biodiversity Offset Strategy against the Commonwealth Environmental Offsets Policy 2012

As documented in **Section 7.1.4**, the Commonwealth's position on offsetting was formalised in October 2012, as outlined in the Environmental Offset Policy (DSEWPC 2012). This section provides an assessment of the Biodiversity Offset Strategy proposed as part of the Project against the Environmental Offset Policy.

1. Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.

The Biodiversity Offset Strategy has been developed with the aim to maintain or improve the biodiversity values of the surrounding region in the medium to long term. With the various impact mitigation and offset strategies to be employed as part of the Project, it is likely that such an improvement will occur, particularly given that the three land-based offset components are strategically located adjacent to or close to existing conservation reserves and biodiversity offset areas. The Biodiversity Offset Strategy also includes substantial commitments to habitat restoration and regeneration resulting in an increase in woodland and forest habitats and key threatened species habitats in the long term.

The Biodiversity Offset Sites will be secured for long-term conservation. The mechanism for securing this conservation will be determined in consultation with the relevant government agencies. Currently Mount Owen envisages that all three sites would be managed in accordance with the existing Mount Owen Biodiversity Offset Areas.

2. Suitable offsets must be built around direct offsets but may include other compensatory measures.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets that occur within the Hunter Region. The Biodiversity Offset Strategy will result in the long-term

conversation of 767.5 hectares. The Biodiversity offset Strategy does not propose any additional compensatory measures

3. Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.

The level of statutory protection that applies to the significantly, or potentially significantly impacted MNES was considered during project planning to ensure that adequate offsets were obtained, commensurate with the status of the threatened or migratory species. The result is a suitable biodiversity offset for impacted species, as detailed in **Tables 7.2**, **7.13**, **7.14** and **7.15**.

4. Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.

Section 5.6 and **Tables 7.2, 7.13, 7.14** and **7.15** concisely document the area of impact on Matters of National Environmental Significance, together with the relevant ecological features within each offset that is proposed for each Matter of National Environmental Significance. These show that the Biodiversity Offset Strategy is at least commensurate with the magnitude of impacts and delivers an outcome that is better than 'like for like.' Additionally, the results of the EPBC Act Offsets Calculator show that the proposed Biodiversity Offset Strategy exceeds the minimum 90 per cent direct offset requirement for significantly impacted species listed under the EPBC Act. As stated before, it is envisaged that the Biodiversity Offset Strategy will deliver net biodiversity gains in the medium and long term.

5. Suitable offsets must effectively account for and manage the risks of the offset not succeeding.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets that occur within the Hunter Region. The land-based offset sites have been determined to provide known habitat for those species that are affected by the Project, rather than potential habitat, thereby reducing the risk that habitat utilisation of the offset sites will be limited by unmeasured factors.

Additionally, a positive feedback loop between monitoring and adaptive management of the land-based offset sites will be established. Thresholds for key monitoring parameters will be proposed, together with trigger points or threshold exceedance levels to ensure that there are clear points at which a review of the monitoring and management approach is enacted. The management of the ecological components of the Project will be responsive to any new ecological data that may arise through the ecological monitoring of the Biodiversity Offset Sites, or any other studies completed as part of the Project.

6. Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.

As discussed above, the land-based offsets proposed as part of the Project do not overlap with any other government funded protection or habitat restoration program. All offset sites are located on currently non-reserved land and will add a significant area into the reserve system.

7. Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.

The Biodiversity Offset Strategy allows for the up-front protection and pro-active conservation management of the Biodiversity Offset Areas, to provide immediate compensation for loss of habitat from the Proposed Disturbance Area. Each of the land-based offset components of

the Biodiversity Offset Strategy has been secured on land wholly owned by Glencore as offset sites prior to the approval of the Project. It is anticipated that for all three land-based components, a management plan will be prepared following project approval, restoration would be undertaken, and the offset sites would be conserved under an appropriate conservation mechanism that will be determined in consultation with relevant authorities.

The area of impact has been derived from detailed GIS mapping of project boundaries and impact areas, and the ecological survey, mapping, impact assessments and design of the Biodiversity Offset Strategy have been completed by qualified ecologists with considerable experience in the region ensuring that the Strategy is scientifically robust, transparent and reasonable.

8. Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

As the Biodiversity Offset Strategy is being proposed as an integral component of the Project, it is expected that the commitments in this strategy will be included within the project approval conditions, and any other legally binding consents. **Section 8.0** documents the elements that will be included in detailed Monitoring Programs for each offset component, and it is anticipated that regular auditing of offset sites will be undertaken.

7.9 Summary of Commonwealth EPBC Offsets Calculator

As discussed in **Section 7.1.4**, in October 2012, the Department of the Environment released the policy document titled EPBC Act Environmental Offsets Policy (DSEWPC 2012). The Policy relates to all protected matters under the EPBC Act including adversely impacted heritage values and applies to offsetting requirements in terrestrial and aquatic (including marine) environments, however the calculator tool is only relevant to EPBC Act listed threatened communities and flora and fauna species.

An assessment of the offsetting value of the proposed Biodiversity Offset Sites for the Matters of National Environmental Significance (MNES) identified in the Supplement to the Director-General's Requirements has been undertaken. The MNES are:

- spotted-tailed quoll (*Dasyurus maculatus maculatus*);
- swift parrot (*Lathamus discolor*);
- regent honeyeater (*Anthochaera phrygia*);
- koala (*Phascolarctos cinereus*);
- green and golden bell frog (*Litoria aurea*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- New Holland mouse (*Pseudomys novaehollandiae*); and
- grey-headed flying-fox (*Pteropus poliocephalus*).

An assessment for the green and golden bell frog was not undertaken as the Project is not expected to impact the species in any way, and therefore no direct offsets are proposed. The other threatened species listed above were considered to represent the key drivers for determining the extent of offsets and the adequacy of land-based offset sites proposed, as

they were recorded or were considered to potentially occur in the Project Area; required specific habitat features; and in the case of the spotted-tailed quoll, represented the maximum area of impacted habitat. The key components of the Offsets Assessment Guide that influenced the outcomes of the assessment included offset security, proposed revegetation/regeneration, present and ongoing threats and overall confidence in the outcomes of the predictions made, especially in relation to predicted environmental gains.
Data relevant to the threatened species were entered into the Offsets Assessment Guide in the form of a function-embedded excel spreadsheet to help with an initial understanding of the adequacy of the land-based offset sites in offsetting the residual impacts of the Project. The results of the EPBC Offsets Calculator assessment are summarised in **Table 7.16** below and indicate that the proposed land-based offset sites provide a more than adequate offset for the EPBC Act-listed species considered likely to be impacted by the Project.

Table 7.16 – EPBC Offset Calculator Outcomes for MNES

Species Assessed by Offset Calculator	**Calculated Proportion of Impact Addressed by Offsets**			
	Cross Creek Offset Site	**Stringybark Creek Habitat Corridor**	**Esparanga Offset Site**	**Total Value of Offset Sites**
spotted-tailed quoll *Dasyurus maculatus maculatus* (woodland impacts)	73 %	12 %	22 %	**107 %**
spotted-tailed quoll *Dasyurus maculatus maculatus* (grassland impacts)	42 %	33 %	31 %	**106 %**
swift parrot *Lathamus discolor*	130 %	31 %	69 %	**230 %**
regent honeyeater *Anthochaera phrygia*	129 %	30 %	59 %	**218 %**
koala *Phascolarctos cinereus*	196 %	46 %	93 %	**335 %**
large-eared pied bat *Chalinolobus dwyeri*	155 %	40 %	110 %	**305 %**
New Holland mouse *Pseudomys novaehollandiae*	733 %	159 %	437 %	**1,329 %**
grey-headed flying-fox *Pteropus poliocephalus*	86 %	23 %	46 %	**155 %**

Note: Percentage numbers combine woodland and regenerated grassland offsets unless otherwise noted and are rounded to the nearest whole number. Exact calculations are provided in **Appendix H**.

High values were generated for the grassland areas to be regenerated into eucalypt woodland, which is a function of a large increase in habitat quality as Derived Native Grassland areas are managed back to woodland over a 20 year period. For the swift parrot, regent honeyeater, koala and large-eared pied bat, the return of Derived Native Grassland areas to woodland areas would provide in excess of 400 hectares of additional eucalypt-dominated woodland habitat capable of providing suitable foraging habitat.

The exception for high excesses in habitat values is the spotted-tailed quoll, which is known to also utilise the Derived Native Grassland habitats of the proposed disturbance area. This additional impact substantially increased the impact numbers required to be offset in the

calculator. Two hundred and six per cent of the grassland impacts for the species are offset by regenerating grassland to high quality woodland habitats at the proposed offset sites. The excess offset percentages for grassland beyond the required 100 per cent were then applied to the shortfall for offsetting woodland impacts, which increased woodland offsets to from 49 per cent to 107 per cent.

The improvement of the habitat quality scores across all sites requires active regeneration of eucalypt-dominated woodland vegetation, which will substantially increase the area of suitable habitat available for these species as well as improving connectivity between the offset sites and surrounding habitat. The likely reduction of future habitat quality of these offset sites, without the provision of the offset, is derived from the likely ongoing threats at the sites such future mining related development and the invasion and establishment of African olive (*Olea europaea* subsp. *cuspidata*) which can result in the suppression of native species growth and regeneration which limits biodiversity and resources for target threatened fauna species. Active management of this species will be a key management factor in maintaining and improving the habitat on these sites as part of the Biodiversity Offset Strategy.

The above results from the EPBC Offset Assessment Guide indicates that the proposed offset sites for the Project provides in excess of 100 per cent of the offsetting requirements for the predicted impacts of the Project on the spotted-tailed quoll, swift parrot, regent honeyeater, koala and large-eared pied bat which exceeds the minimum 90 per cent direct offset requirement for these species under the Environmental Offsets Policy.

7.10 Integration of Biodiversity Offset Strategy with UHSA

The Project Area is located is located approximately 19 kilometres north-west of Singleton, NSW within the Hunter/Central Rivers Catchment Management Authority (CMA), along with each of the four offset sites. Three of the offset sites (Cross Creek Offset Site, Stringybark Creek Habitat Corridor and Mine Rehabilitation) occur within 4 kilometres of the Project Area, despite the Cross Creek Offset Site occurring in a different CMA subregion. The Esparanga Offset Site is located some 55 kilometres north-west of the Project Area.

Combined, the proposed offset sites will maintain and/or improve the biodiversity values of the region in the medium to long term. The Esparanga Offset Site is a high quality property that provides significant amounts of remnant vegetation as well as several key threatened species being impacted by the Project. The Cross Creek Offset Site provides relatively conservative amounts of remnant vegetation but is well situated to increase regional connectivity, being located at the northern extent of Ravensworth State Forest. Similarly, Sringybark Creek Habitat Corridor is not dominated by remnant vegetation, but the revegetation of the site, coupled with the abatement of threats from weed invasion, mean that it will provide significant regional connectivity for the spotted-tailed quoll, a key threatened species being affected by the Project. In addition, these three offset sites provide derived native grasslands that are in suitable condition to return to native treed vegetation, further increasing regional connectivity. Lastly, rehabilitation of the Project Area following mining is proposed with the objective of reinstating woodland vegetation that is consistent with the vegetation communities known ot occur in the Project Area This will be undertaken based on the significant experience that Mount Owen has in restoring woodland and forest communities on post-mined land.

The Biodiversity Offset Strategy is consistent with the aims and objectives of the Upper Hunter Strategic Assessment in terms of the quantum, composition and location of the offset sites, including the use of mine rehabilitation.

A comparative BioCertification assessment will be provided to DPE and OEH.

7.11 Summary of Biodiversity Offset Strategy

The Project identified the need for a comprehensive Biodiversity Offset Strategy to compensate for the residual significant impacts that could not be avoided or mitigated. The Biodiversity Offset Strategy described in this document has outlined the proposed offsetting components that have demonstrated an appropriate and valuable offsetting outcome in achieving the goals to:

- avoid and minimise potential impacts on ecological values as a result of the Project;
- mitigate potential impacts within the Project Area;
- maintain or improve the biodiversity values of the surrounding region in the medium to long term;
- maintain or improve the viability of threatened species that could be significantly affected by the Project through the securing and/or restoration of habitat in the Hunter Valley; and
- ensure that there are no residual net impacts on key threatened species and ecological communities in the long term as a result of the construction and operation of the Project.

The Biodiversity Offset Strategy will be implemented only if the Project is approved and constructed.

8.0 Monitoring Commitments

The aim of the ecological monitoring program will be to assess the adequacy of the Impact Mitigation Strategy (refer to **Section 6.0**) and the Biodiversity Offset Strategy (refer to **Section 7.0**). This will require the design and implementation of a rigorous and systematic monitoring program that includes a positive feedback loop, to allow for the adaptive management of all aspects of the monitoring program.

Currently annual ecological monitoring is undertaken at Mount Owen and focuses on the monitoring of flora and fauna species across remnant vegetation sites, and regeneration and rehabilitation sites.

As part of the revision of the existing LMP for this Project it is proposed that the existing monitoring in the Project Area be reviewed and expanded to include the proposed Biodiversity Offset Areas. This review will consider all existing commitments, and will review the existing monitoring program to develop a consolidated, cost effective yet informative approach to ecological monitoring for the Project. Attention will be paid to making best use of the existing long-term data sets for the Project Area, while ensuring all monitoring is targeted to features that:

- provide a good indication of the status of the environmental value that the operation aims to protect;
- are relatively simple to measure and are reproducible;
- allow for floristic composition and structure to be monitored over time using basic statistical analysis;
- specifically targets those threatened species and EECs significantly or potentially significantly impacted by the Project;
- allow for comparison to reference (control) sites; and
- are cost effective.

Details on the monitoring program will be documented within the revised LMP, to be completed post-approval, and prior to the commencement of mining works in the Project Area. This document will contain the specific requirements of the monitoring program, including methods to be used, monitoring frequencies and locations.

The outcomes of the ecological monitoring program will be reported in the Annual Review and be made available on the Mount Owen website.

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Personal Communications

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APPENDIX A

Threatened Species Assessment

Appendix A – Threatened Species Assessment

Threatened species, endangered populations, and threatened ecological communities (TECs) listed under the TSC Act and/or EPBC Act recorded or considered likely to occur within 10 kilometres of the Project Area have been identified based on the results of the searches of the OEH Atlas of NSW Wildlife Database and the Department of Environment Protected Matters Database as well as the results of the literature review described in Section 3.1 of the Ecological Assessment report.

Table 1 contains the results of these searches for threatened flora species, TECs and endangered flora populations.

Table 2 contains the results of the searches for threatened fauna species and endangered fauna populations.

Table 3 contains the results of the searches for migratory and marine species listed under international conventions.

Tables 1, **2** and **3** contain the relevant ecological details for threatened flora, TECs, threatened fauna and marine and migratory species (as described in OEH 2014, Department of the Environment 2014 and DPI 2014). These tables contain information including habitat requirements, known range and reservation within conservation reserves in the region, as well as an assessment as to whether the entity is likely to occur in the Project Area and whether there is the potential for the entity to be impacted by the Project. It should be noted that some species are listed in both **Table 2** and **Table 3** as they are listed under both threatened species legislation and international migratory conventions. In these cases the information presented is identical, except for the legal listing (which are relevant to the table under which they are listed).

An assessment of significance was prepared in accordance with the requirements of the TSC and EPBC Acts for each threatened and migratory species or ecological community recorded or for which there is the potential for impact as a result of the Project. These assessments of significance are provided in **Appendices E** and **F**.

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Threatened Flora Species						
slaty red gum *Eucalyptus glaucina*	V (EPBC) V (TSC)	Typically grows in grassy woodland on deep, moderately fertile and well-watered soil and can be locally frequent but very sporadic.	Occurs near Casino and from Taree to Broke in the North Coast botanical subdivision.	This species is not known from any conservation reserves in the region.	Despite the substantial amount of field sampling that has been conducted across the Project Area, only one specimen has been recorded in 1998, which has subsequently been removed by approved mining operations. It is therefore unlikely that this species occurs in the proposed disturbance area. An impact on this species is considered to be very unlikely.	No
Euphrasia arguata	CE (EPBC) CE (TSC)	Specific habitat information for this species is scarce. The species was re-discovered in 2008 in the NSW North-western Slopes and tablelands in eucalypt forest with a mixed grass and shrub understorey and also in grassy areas along rivers.	This species was presumed to be extinct until it was rediscovered in 2008. When present, it was recorded from as far south as Bathurst and as far north as Walcha. It was believed to occur in the botanical subdivisions of the North Coast, Northern Tablelands, Central Tablelands, North Western Slopes and Central Western Slopes.	This species is not known to occur in reserves in the region.	This species has not been recorded within the Project Area despite substantial field survey. The species is considered unlikely to occur and therefore the potential for a significant impact on this species is unlikely.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
tall velvet sea-berry *Haloragis exalata* subsp. *velutina*	V (TSC) V (EPBC)	This species prefers damp places near watercourses and in woodland on the steep rocky slopes of gorges.	This species occurs on the north coast of NSW and southeastern Queensland.	This species is not known to occur in reserves in the region.	This species has not been recorded within the Project Area despite substantial field survey. The species is considered unlikely to occur and therefore the potential for a significant impact on this species is unlikely.	No
Ozothamnus tesselatus	V (EPBC) V (TSC)	Dry sclerophyll forest and woodlands.	This species was formerly restricted to a few locations north of Rylstone. However in 2003 it was recorded in Ravensworth State Forest, which borders the north-east corner of the Project Area.	Goulburn River NP Ravensworth SF	There is a record of this species from within Ravensworth SF that occurs within the Project Area. The species has not been recorded in the proposed disturbance area and is not expected to be impacted by the Project.	**Yes**
leek-orchid *Prasophyllum* sp. Wybong	CE (EPBC)	This species generally occurs in grassy and scrubby habitats in open eucalypt woodland and grasslands.	This species is endemic to NSW, from which there are only seven known populations from near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield. It is not known to occur outside the Sydney Basin, New England Tablelands, Brigalow Belt South and NSW South Western Slopes bioregions. Its area of occupancy is estimated at 1.5 km^2.	This species is not known from any conservation reserves in the region.	The Project Area provides suitable habitat for this species, but it has not been recorded within the Project Area despite substantial, targeted field survey. There is no potential for this species to be impacted.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Illawarra greenhood *Pterostylis gibbosa*	E (EPBC) E (TSC)	All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage.	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra).	This species is not known to occur in any reserves in the region.	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area despite substantial, targeted field survey. There is no potential for this species to be impacted.	No
Siahs backbone *Streblus pendulinus*	E (EPBC)	This species occurs in warmer rainforest, mostly along watercourses, north from Milton. Listing advice for this species indicates that the species is endangered on Norfolk Island and taxonomic revisions may have unintentionally included mainland occurrences of the species. For the purposes of this assessment it is assumed that the listing relates only to the Norfolk Island population of the species.	There are a number of known records of this species occurring in the Muswellbrook and Singleton areas. The closest records occur approximately 10 kilometres north of the Project Area.	Barrington Tops NP Yengo NP	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
austral toadflax *Thesium australe*	V (EPBC) V (TSC)	This species occurs in grassland or grassy woodland and is often found in damp sites in association with kangaroo grass (*Themeda australis*). This species is a root parasite that takes water and some nutrient from other plants, especially kangaroo grass.	This species is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania, Queensland and in eastern Asia. Occurs also at Anvil Hill, NSW.	This species is not known from any conservation reserves in the region.	The Project Area does not provide suitable habitat for this species with very low levels of *Themeda australis* recorded during flora surveys. The species has not been recorded at the proposed disturbance area. There is no potential for a significant impact on this species.	No
Endangered Flora Populations						
Eucalyptus camaldulensis population in the Hunter catchment	EP (TSC)	River red gums are located on the banks and floodplains of watercourses on alluvial soils. This endangered population may occur with *Eucalyptus tereticornis, Eucalyptus melliodora, Casuarina cunninghamiana* subsp*. cunninghamiana* and *Angophora floribunda.*	The Hunter population occurs as far east as Hinton, east of Maitland, west to Bylong, and north to near Scone. Currently only 28 populations are known in the Hunter Valley, covering an area of only 83 hectares and constituting about 1,840 trees, and occurring over a range of at least 2000 km^2.	This population is not known to occur in any reserves in the region.	The Project Area does not provide suitable habitat for this population, and it has not been recorded despite substantial, targeted field surveys. There is no potential for a significant impact on this population.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Cymbidium canaliculatum population in the Hunter Catchment	EP (TSC)	This species occurs within dry sclerophyll forests and woodlands of tablelands and western slopes, growing in hollows of trees. It is usually found occurring singly or as a single clump, typically between 2 and 6 metres above the ground.	The population of *Cymbidium canaliculatum* in the Hunter Catchment is at the south-eastern limit of the geographic range for this species.	This population is not known to occur in any reserves in the region.	Despite the substantial amount of field sampling that has been conducted across the Project Area, only one specimen has been recorded east of Hebden Road near the West Pit. The single plant recorded does not occur in the proposed disturbance area and therefore an impact on this population is considered to be unlikely.	No
Acacia pendula population in the Hunter catchment	EP (TSC)	Grows on major river floodplains on heavy clay soils, sometimes as the dominant species and forming low open woodlands. Within the Hunter catchment it typically occurs on heavy soils, sometimes at the margins of small floodplains, but also in more undulating locations remote from floodplains, such as at Jerrys Plains.	There are in the order of 40 to 50 naturally occurring remnants of the *A. pendula* population in the Hunter catchment. These range as far east as Warkworth, and as far west as Kerrabee, west of Sandy Hollow.	This population is not known to occur in any reserves in the region.	Despite the substantial amount of field sampling that has been conducted across the Project Area, Acacia pendula is only known from within Ravensworth State Forest with an additional specimen recorded near Swamp Creek. The two recorded plants do not occur in the proposed disturbance area and therefore a significant impact on this population is considered to be unlikely.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Threatened Ecological Communities						
River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South east Corner Bioregions	EEC (TSC)	Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains.	This EEC occurs in the NSW North Coast, Sydney Basin and South-east corner bioregions. The Project Area is within the known distribution of this species.	There are no known occurrences of this EEC within the conservation reserves of the region.	This community has been recorded in the south of the Project Area, however does not occur within the proposed disturbance area. There is no potential for a significant impact on this community.	No
Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	EEC (TSC)	The EEC occurs on Permian sediments in the Hunter Valley and typically forms a woodland to open forest on slopes and undulating hills. Dominated by narrow-leaved ironbark (*Eucalyptus crebra*) and grey box (*E. moluccana*) with a moderately dense to dense ground layer dominated by grasses and forbs.	Located in the NSW North Coast and Sydney Basin Bioregions	There are no known occurrences of this EEC within the conservation reserves of the region.	This community has been recorded in the proposed disturbance area and the community is potentially sensitive to the Project.	**Yes**

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	EEC (TSC)	The EEC occurs on Permian sediments in the Hunter Valley and typically forms an open forest to woodland on slopes and undulating hills. Dominated by narrow-leaved ironbark (*Eucalyptus crebra*), spotted gum (*Corymbia maculata*) and grey box (*E. moluccana*) with a sparse to moderately dense ground layer dominated by numerous forbs and a few grasses.	Located in the NSW North Coast and Sydney Basin Bioregions.	Belford NP	This community has been recorded in the proposed disturbance area and the community is potentially sensitive to the Project.	**Yes**

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC (TSC)	Associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. Generally occurs below 20 m (rarely above 10 m) elevation.	Known from parts of the LGAs of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby, Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these LGAs. Major examples once occurred on the floodplains of the Clarence, Macleay, Hastings, Manning, Hunter, Hawkesbury, Shoalhaven and Moruya Rivers.	Pambalong NR Hunter Wetlands NP	The Project Area does not provide suitable habitat for this community and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this community.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	EEC (TSC)	This ecological community generally occurs at the interface of Narrabeen Sandstone and Permian sediments in the Hunter Valley and typically forms a low to mid-high woodland. The community is characterised by an overstorey of slaty gum (*Eucalyptus dawsonii*) and/or grey box (*E. moluccana*) with a moderately dense to dense shrub stratum. The ground layer is generally sparse to very sparse and generally species poor.	Located in the Sydney Basin Bioregion.	Wollemi NP Goulburn River NP	The Project Area does not provide suitable habitat for this community and it has not been. There is no potential for a significant impact on this community.	No
Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	EEC (TSC)	Occurs on gentle slopes arising from depressions and drainage flats on Permian sediments of the Hunter Valley floor.	Recorded from Maitland, Cessnock and Port Stephens LGAs (in the Sydney Basin Bioregion) and Muswellbrook and Singleton LGAs (in the NSW North Coast Bioregion) but may occur elsewhere in these bioregions. The Mount Owen Complex is within the known distribution of this EEC.	Ravensworth SF	This community has been recorded in the north of the Project Area in Ravensworth State Forest, however does not occur within the proposed disturbance area. There is no potential for a significant impact on this community.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Lowland Rainforest of Subtropical Australia	CEEC (EPBC)	This community occurs on basalt soils, alluvial soils, floodplain alluvia and occasionally on enriched rhyolitic soils and basaltically enriched metasediments. It is mostly found in areas below 300 m above sea level with annual rainfall >1,300 mm. Canopy vegetation is usually dominated by bangalow palm (*Archontophoenix cunninghamiana*), cabbage palm (*Livistona australis*), *Syzygium floribundum* and weeping lilly pilly (*Waterhousea floribunda*). Remnants are generally less than 10 ha in size.	This CEEC primarily occurs from Maryborough in Queensland to the Clarence River (near Grafton) in NSW. It also occurs in isolated stands between the Clarence River and Hunter River, including the Bellinger Valley. It is known to occur in the Hunter-Central Rivers and Northern Rivers Catchment Management Areas.	This CEEC is not known to occur in conservation reserves in the Region	The Project Area does not provide suitable habitat for this community and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this community.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands and White Box – Yellow Box – Blakely's Red Gum Woodland	CEEC (EPBC) EEC (TSC)	This ecological community occurs in areas where rainfall is between 400 and 1,200 mm per annum, on moderate to highly fertile soils at elevations of 170 metres to 1,200 metres.	This EEC occurs in an arc along the western slopes and tablelands of the Great Dividing Range from Southern Queensland through NSW to central Victoria. It occurs in the Brigalow Belt South, Nandewar, New England Tableland, South Eastern Queensland, Sydney Basin, NSW North Coast, South Eastern Highlands, South East Corner, NSW South Western Slopes, Victorian Midlands and Riverina Bioregions.	Towarri NR Manobalai NR Goulburn River NP Wollemi NR	Field surveys have targeted the presence of this community and no evidence of its presence has been identified. The community is not considered likely to occur. There is no potential for a significant impact on this community.	No
Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	EEC (TSC)	Weeping Myall Woodlands occur in a range from open woodlands to woodlands, generally 4-12 m high, in which weeping myall (*Acacia pendula*) trees are the sole or dominant overstorey species.	The EEC occurs in a small stand on heavy, brown clay soil at Jerrys Plains in the Hunter Valley, in the South Hunter Province of the Sydney Basin Bioregion.	This EEC is not known from any conservation reserves in the region.	The proposed disturbance area does not provide suitable habitat for this community and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this community.	No

Table 1 - Threatened Flora Species and Ecological Communities Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Weeping Myall – Coobah – Scrub Wilga Shrubland	CEEC (EPBC)	This TEC consists of weeping myall (*Acacia pendula*) with coobah (*Acacia salicina*) and scrub wilga (*Geijera salicifolia*). Yarran (*Acacia omalophylla*) and stiff canthium (*Canthium buxifolium*) are also present in the small tree/shrub layer. The ground stratum is dense and primarily grassy. Grasses include kangaroo grass (*Themeda triandra/australis*), wallaby grass (*Austrodanthonia* spp.), snow grass (*Poa sieberiana*) and barbed wire grass (*Cymbopogon refractus*).	The TEC occurs in a small stand on heavy, brown clay soil at Jerrys Plains in the Hunter Valley, in the South Hunter Province of the Sydney Basin Bioregion.	This TEC is not known to occur in any conservation reserves in the region.	The Project Area does not provide potential habitat for this community. There is no potential for a significant impact on this community.	No

E:	endangered	R:	rare (ROTAP)
C:	recorded in a conservation reserve (ROTAP)	ROTAP:	Rare or Threatened Australian Plants
CEEC:	critically endangered ecological community	TSC:	*Threatened Species Conservation Act 1995*
EEC:	endangered ecological community	V:	vulnerable
EPBC:	*Environment Protection and Biodiversity Conservation Act 1999*	2:	species found over <100km (ROTAP)
NP:	National Park		

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Amphibians						
green and golden bell frog *Litoria aurea*	V (EPBC) E (TSC)	Occurs among vegetation in permanent water bodies (Cogger 2000), particularly where bullrush (*Typha* spp.) and spikerush (*Eleocharis* spp.) occur. Known to occur in degraded water bodies such as brick-pits and industrial sites.	Occurs in eastern and south-eastern NSW to far eastern Victoria, largely at low altitudes (Cogger 2000). Once widespread, it is now largely restricted to isolated coastal populations. The Project Area is at the western limit of the species distribution.	Hunter Wetlands NP	This species has been recorded previously within the Project Area (last confirmed record dated 1999) and habitats identified in the Project Area occur within limits of the upper Hunter important population of the species.	**Yes**
Booroolong Frog *Litoria booroolongensis*	E (EPBC) E (TSC)	Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults occur on or near cobble banks and other rock structures within stream margins. This species shelters under rocks or amongst vegetation near the ground on the stream edge.	The Booroolong frog is restricted to NSW and north-eastern Victoria, predominantly along the western-flowing streams of the Great Dividing Range. It has disappeared from the Northern Tablelands and is now rare throughout most of the remainder of its range. Most recent records are from the south-west slopes of NSW.	Mt Royal NP	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No
stuttering frog *Mixophyes balbus*	E (TSC) V (EPBC)	This species is generally found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range.	This species occurs along the east coast of Australia from southern Queensland to north-eastern Victoria.	Mt Royal NP Barrington Tops NP	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Reptiles						
broad-headed snake *Hoplocephalus bungaroides*	E (TSC) V (EPBC)	This species shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring and moves to shelters in hollows in large trees within 200 m of escarpments in summer.	This species is largely confined to Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and Shoalhaven groups, within the coast and ranges in an area within approximately 250 km of Sydney.	This species is not known from any conservation reserves in the region.	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No
Birds						
blue-billed duck *Oxyura australis*	V (TSC)	This species prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover.	Widespread in NSW, but most common in the southern Murray-Darling Basin area.	This species is not known from any conservation reserves in the region.	The species has been previously recorded near Liddell, west of the Project Area. The proposed disturbance area provides some marginal habitat for the species by way of small farm dams, however it has not been recorded after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
freckled duck *Stictonetta naevosa*	V (TSC)	This species prefers permanent freshwater swamps and creeks with heavy growth of cumbungi, lignum or tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. This species generally rests in dense cover during the day, usually in deep water. Nesting usually occurs between October and December but can take place at other times when conditions are favourable. The nests are usually located in dense vegetation at or near water level.	The freckled duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. This species may also occur as far as coastal NSW and Victoria during adverse conditions in permanent parts of its range.	The species is not known from any conservation reserves in the region.	The species has been previously recorded at Lake Liddell, west of the Project Area. The proposed disturbance area provides some marginal habitat for the species by way of small farm dams, however it has not been recorded after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No
Australasian bittern *Botaurus poiciloptilus*	E (EPBC) E (TSC)	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleoacharis* spp.).	This species may be found over most of the state except for the far north-west.	Hunter Wetlands NP	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
black-necked stork *Ephippiorhynchus asiaticus australis*	E (TSC)	Prefers shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands.	In Australia, black-necked storks are widespread in coastal and sub-coastal northern and eastern Australia, south to central-eastern NSW and with vagrants recorded at scattered sites well away from the coast.	The species is not known from any conservation reserves in the region.	This species has been previously recorded near Bowmans Creek west of the Project Area. The proposed disturbance area provides some suitable habitat for the species, however it has not been recorded in these areas after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No
Australian painted snipe *Rostratula benghalensis australis*	E (EPBC) E (TSC)	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowall, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin.	Hunter Wetlands NP Pambalong NR	The Project Area does not provide known habitat for this species however it has been recently recorded along Bowmans Creek. Although there is little potential for it to occur in the proposed disturbance area and to be impacted by the proposed works, the species may be sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
eastern bristlebird *Dasyornis brachypterus*	E (TSC) E (EPBC)	In NSW the habitat occurs in open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone.	There are three main populations of the species occurring in Northern QLD, Southern QLD/northern NSW and on the NSW/Victorian border.	The species is not known from any conservation reserves in the region.	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No
spotted harrier *Circus assimilis*	V (TSC)	Preferred habitat includes open grassy woodland, grassland, inland riparian woodland and shrub steppe. Although mostly associated with native grasslands it has also been identified in agricultural farmland. Their nest is made in a tree and composed of sticks. Individuals of this species are sparsely distributed throughout Australia and occur as a single population.	The spotted harrier can be found throughout mainland Australia except for areas of dense forest on the coast, escarpments and ranges and rarely ever in Tasmania.	Ravensworth SF Wollemi NP	This species has been recorded in the Project Area on one occasion by Umwelt during surveys of the proposed disturbance area near the Bowmans Creek rail bridge. It has also been previously recorded near Liddell, west of the Project Area and in the southern portions of Ravensworth State Forest. The proposed disturbance area provides suitable foraging habitat for the species. The species is potentially sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
black falcon *Falco subniger*	V (TSC)	This species inhabits woodland, scrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. The species usually feeds on other birds, but also some small mammals.	The black falcon is found sparsely across northern, eastern, southern and central Australia. In NSW, it is mainly known from inland regions, but has been recorded on the tablelands and coast.	This species is not known to occur in any reserves in the region	The species has not been recorded within the Project Area. The proposed disturbance area provides some marginal foraging habitat for the species, however it has not been recorded after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No
red goshawk *Erythrotriorchis radiates*	V (EPBC) CE (TSC)	Red Goshawks inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, *Melaleuca* swamp forest and riparian *Eucalyptus* forest of coastal rivers.	This species is distributed sparsely through northern and eastern Australia, from the western Kimberley Division of northern Western Australia to north-eastern Queensland and south to far north-eastern NSW, and with scattered records in central Australia. The species is very rare in NSW, extending south to about 30°S, with most records north of this, in the Clarence River Catchment, and a few around the lower Richmond and Tweed Rivers. Formerly, it was at least occasionally reported as far south as Port Stephens.	This species is not known to occur in any reserves in the region	A historical record of this species occurs near Mt Pleasant, 6 km east of the Project Area. The proposed disturbance area provides some suitable foraging habitat for the species, however it has not been recorded after many years of annual fauna monitoring. There is no potential for a significant impact on this species	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
little eagle *Heiraaetus morphnoides*	V (TSC)	This species is typically identified in open eucalypt forests, woodlands and open woodlands, and other areas where prey are plentiful. They nest in tall living trees within remnant patches. This species occurs as a single population within Australia.	The little eagle is distributed throughout mainland Australia except for the most densely forested parts of the Great Dividing Range escarpment.	Ravensworth SF Mt Royal NP	This species has been previously recorded at the Project Area. The proposed disturbance area provides suitable foraging and nesting habitat for the species. The species is potentially sensitive to the impacts of the Project.	**Yes**
red-backed button-quail *Turnix maculosa*	V (TSC)	The species inhabits grasslands, open and savannah woodlands with grassy ground layer, pastures and crops of warm temperate areas, typically only in regions subject to annual summer rainfall greater than 400 mm. In NSW, it is said to occur in grasslands, heath and crops. The species prefers sites close to water, especially when breeding.	This species extends discontinuously from the Kimberley region of Western Australia, through the Top End of the Northern Territory and the southern Gulf of Carpentaria, to Cape York peninsula and eastern Queensland and central-eastern and north-eastern NSW.	This species is not known to occur in any reserves in the region.	A historical record of this species occurs near Mt Pleasant, 5 km east of the Project Area. The proposed disturbance area provides suitable foraging habitat for the species, however it has not been recorded after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
little lorikeet *Glossopsitta pusilla*	V (TSC)	This species can be found in dry-open eucalypt forests and woodlands, and has been identified in remnant vegetation, old growth vegetation, logged forests, and roadside vegetation. The little lorikeet usually forages in small flocks, not always with birds of its own species. It nests in hollows, mostly in living smooth-barked apples.	This species is distributed from just north of Cairns, around the east coast of Australia through to Adelaide. In NSW this species is found from the coast to the western slopes of the Great Dividing Range, extending as far west as Albury, Dubbo, Parkes and Narrabri.	Ravensworth SF Barrington Tops NP Wollemi NP Manobalai NR	This species has been previously recorded within the Project Area and the proposed disturbance area. The proposed disturbance area provides suitable foraging and nesting habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
swift parrot *Lathamus discolor*	E (EPBC) E (TSC)	Often visits box-ironbark forests, feeding on nectar and lerp (Garnett and Crowley 2000). In NSW, typical feed species include mugga ironbark, grey box, swamp mahogany, spotted gum, red bloodwood, narrow-leaved red ironbark, forest red gum and yellow box (Swift Parrot Recovery Team 2001).	Breeds in Tasmania, migrating to the mainland in May to August, mainly foraging in Victoria and NSW (Swift Parrot Recovery Team 2001). In NSW, it has been recorded from the western slopes region along the inland slopes of the Great Dividing Range, as well as forests along the coastal plains from southern to northern NSW (Swift Parrot Recovery Team 2001). The Project Area is within the known distribution of this species.	Ravensworth SF	The Project Area provides limited suitable foraging habitat for this species. The species has been recorded within the Project Area in 2005, 2007 and 2014. The species is potentially sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
regent honeyeater *Anthochaera phrygia*	E (EPBC) CE (TSC)	Semi-nomadic, generally occurs in temperate eucalypt woodlands and open forests, commonly recorded from box-ironbark eucalypt associations, wet lowland coastal forests dominated by swamp mahogany, spotted gum and riverine *Casuarina* woodlands.	Patchily distributed across the eastern states of Australia, from Adelaide, to Dalby, Queensland, and from the coast to the western foothills of the Great Dividing Range (Garnett and Crowley 2000). The Project Area is within the known distribution of this species.	Wollemi NP Goulburn River NP Pokolbin SF Yengo NP Werakata NP	The Project Area provides some potential foraging habitat for this species. Despite extensive field surveys in the Project Area, it has not been recorded. The species is potentially sensitive to the impacts of the Project.	**Yes**
barking owl *Ninox connivens*	V (TSC)	Habitat for this species includes dry forests and woodlands, often in association with hydrological features such as rivers and swamps.	The barking owl is distributed sparsely throughout temperate and semi-arid areas of mainland Australia; however it is most abundant in the tropical north. Most records for this species occur west of the Great Dividing Range.	Wollemi NP Goulburn River NP	A historical record of this species occurs near Mt Pleasant, 5 km east of the Project Area. The proposed disturbance area provides suitable foraging habitat for the species, however it has not been recorded after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
powerful owl *Ninox strenua*	V (TSC)	The powerful owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. It generally requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation.	The powerful owl occurs in eastern Australia, mostly on the coastal side of the Great Dividing Range, from south western Victoria to Bowen in Queensland.	Ravensworth SF Wollemi NP Yengo NP Mt Royal NP Belford NP Manobalai NR Barrington Tops NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
masked owl *Tyto novaehollandiae*	V (TSC)	Generally recorded from open forest habitat with sparse mid-storey but patches of dense, low ground cover. It is also recorded from ecotones between wet and dry eucalypt forest, along minor drainage lines and near boundaries between forest and cleared land (Kavanagh 2004).	Occurs sparsely throughout the continent and nearby islands, including Tasmania and New Guinea (Kavanagh 2002).	Ravensworth SF Mt Royal NP Yengo NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
eastern grass owl *Tyto longimembris*	V (TSC)	Found in areas of tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath, and cane grass, or sedges on floodplains.	The grass owl has been recorded in all mainland states of Australia, although it is most common in north and north-east Australia. In NSW this species is most likely to be found in the north-east of the state in coastal areas from the Queensland-NSW border through to Sydney; and with several outlying records from inland areas, some as far west as Broken Hill.	This species is not known to occur in any reserves in the region.	A recent record of this species occurs near Liddell, 6 km west of the Project Area. This record is atypical for the Hunter Valley as this species typically occurs in coastal areas, however it is known to experience fluctuations in distribution in response to prey species populations. It has not been recorded in the proposed disturbance area after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No
brown treecreeper (eastern subsp.) *Climacteris picumnus victoriae*	V (TSC)	Typical habitat for this species includes drier forests, woodlands, scrubs, with fallen branches; river red gums on watercourses and around lake-shores; paddocks with standing dead timber; and margins of denser wooded areas (Pizzey and Knight 1997). This species prefers areas without dense understorey.	This species occurs over central NSW, west of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys.	Ravensworth SF Wollemi NP Manobalai NR	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging and nesting habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
speckled warbler *Chthonicola saggitata*	V (TSC)	In NSW, occupies eucalypt and cypress woodlands, generally on the western slopes of the Great Dividing Range. Inhabits woodlands with a grassy understorey, leaf litter and shrub cover, often on ridges or gullies (Garnett and Crowley 2000).	The speckled warbler has a distribution from south-eastern Queensland, through central and eastern NSW to Victoria.	Ravensworth SF Wollemi NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging and nesting habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
black-chinned honeyeater (eastern subsp.) *Melithreptus gularis gularis*	V (TSC)	In NSW, it is mainly found in woodlands with annual rainfall of 400-700 mm containing box-ironbark associations and river red gum (Garnett and Crowley 2000). It is also known from drier coastal woodlands of the Cumberland Plain, Western Sydney and in the Hunter, Richmond and Clarence valleys.	Found mainly west of the Great Dividing Range through NSW into southern Queensland, and south into Victoria and South Australia.	Ravensworth SF Wollemi NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
grey-crowned babbler (eastern subsp.) *Pomatostomus temporalis temporalis*	V (TSC)	Habitat for this species includes open forest and woodland, acacia scrubland and adjoining open areas (Garnett and Crowley 2000).	Occurs on the western slopes and plains of NSW. Isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra.	Ravensworth SF Wollemi NP Belford NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging and nesting habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
varied sittella *Daphoenositta chrysoptera*	V (TSC)	The varied sittella can typically be found in eucalypt forests and woodlands, especially of rough-barked species and mature smooth-barked gums with dead branches. It can also be identified in mallee and acacia woodlands. This species builds a cup shaped nest made of plant fibres and spiders webs which is placed at the canopy level in the fork of a living tree.	The varied sittella is a sedentary species that inhabits the majority of mainland Australia with the exception of the treeless deserts and open grasslands. Its NSW distribution is basically continuous from the coast to the far west.	Ravensworth SF Wollemi NP Manobalai NR Barrington Tops NP Goulburn River NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging and potential nesting habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
hooded robin (south-eastern form) *Melanodryas cucullata cucullata*	V (TSC)	Hooded robins are found in lightly timbered woodland, mainly dominated by acacia and/or eucalypts.	Hooded robins are found extensively over much of mainland Australia, but are more commonly found in south-eastern Australia from Adelaide to Brisbane.	Ravensworth SF Wollemi NP Goulburn River NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
scarlet robin *Petroica boodang*	V (TSC)	This robin can be found in woodlands and open forests from the coast through to inland slopes. The birds can sometimes be found on the eastern fringe of the inland plains in the colder months of the year. Woody debris and logs are both important structural elements of its habitat. It forages from low perches on invertebrates either on the ground or in woody debris or tree trunks.	The scarlet robin can be found in south-eastern Australia, from Tasmania to the southern end of Queensland, to western Victoria and southern South Australia.	Ravensworth SF Wollemi NP Barrington Tops NP Goulburn River NP Putty SF	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
flame robin *Petroica phoenicea*	V (TSC)	This species is known to breed in moist eucalypt forests and woodlands. It can usually be seen on ridges and slopes in areas where there is an open understorey layer. This species migrates during the winter to more lowland areas such as grasslands where there are scattered trees, as well as open woodland of the inland slopes and plains.	This robin is located in south-eastern Australia from the Queensland border to Tasmania and into Victoria as well as south-east South Australia.	Ravensworth SF Wollemi NP Barrington Tops NP Goulburn River NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
diamond firetail *Stagonopleura guttata*	V (TSC)	Habitat includes a range of eucalypt-dominated communities with a grassy understorey, including woodland, forest and mallee (Garnett and Crowley 2000). Populations appear unable to persist where remnants are less than 200 hectares in area.	In NSW, it mainly occurs west of the Great Dividing Range, although populations are known from drier coastal areas such as the Cumberland Plain and the Hunter, Clarence, Richmond and Snowy River valleys.	Ravensworth SF Wollemi NP Goulburn River NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging and nesting habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
malleefowl *Leipoa ocellata*	V (EPBC) E (TSC)	The mallefowl is typically found in semi-arid and arid areas of temperate Australia, in shrubland and low woodlands dominated by dense but discontinuous mallee vegetation. They are usually on loamy or sandy soils with an annual average rainfall between 200 and 450 mm. The mallefowl has been known to forage in open grassland and farmland areas; and breeds in areas with plentiful leaf litter.	The mallefowl is distributed across southern Australia. Typically found west of the Great Dividing Range, from the Pilliga south-west through to the Griffith and Wentworth districts. A small number of records have been identified from east of the Great Dividing Range in the Goulburn River NP.	This species is not known to occur in any reserves in the region.	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Mammals						
spotted-tailed quoll *Dasyurus maculatus*	E (EPBC) V (TSC)	Habitat for this species is highly varied, ranging from sclerophyll forest, woodlands, coastal heathlands and rainforests. Records exist from open country, grazing lands and rocky outcrops. Suitable den sites including hollow logs, tree hollows rocky outcrops or caves.	In NSW the spotted-tailed quoll occurs on both sides of the Great Dividing Range, with the highest densities occurring in the north east of the state. It occurs from the coast to the snowline and inland to the Murray River. The Project Area is within the known distribution of this species.	Wollemi NP Yengo NP Mt Royal NP Belford NP Barrington Tops NP	The Project Area provides suitable habitat for this species and it has been previously recorded in the Project Area and the proposed disturbance area. The species is sensitive to the impacts of the Project.	**Yes**
brush-tailed phascogale *Phascogale tapoatafa*	V (TSC)	This species prefers dry sclerophyll open forest with a sparse groundcover of herbs, grasses, shrubs or leaf litter. This species also inhabits heath, swamps, rainforests and wet sclerophyll forests.	This species has a patchy distribution around the coast of Australia. In NSW it is more frequently found in forest on the Great Dividing Range in the north-east and south-east of the State. There are also a few records from central NSW.	Mt Royal NP Barrington Tops NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable foraging, denning and dispersal habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
brush-tailed rock-wallaby *Petrogale penicillata*	V (EPBC) E (TSC)	This species occupies rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. It browses on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. This species shelters or basks during the day in rock crevices, caves and overhangs and is most active at night.	The brush-tailed rock-wallaby was once abundant and ubiquitous throughout the mountainous country of south-eastern Australia. Its distribution roughly followed the Great Dividing Range for 2,500 km from the Grampians in West Victoria to Nanango in south-east Queensland, with outlying populations in coastal valleys and ranges to the east of the divide, and the slopes and plains as far west as Cobar in NSW and Injune (500 km north-west of Brisbane) in Queensland.	This species is not known to occur in any reserves in the region.	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for this species to be impacted by the Project.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
koala *Phascolarctos cinereus*	V (EPBC) V (TSC)	This species inhabits eucalypt forest and woodland, with suitability influenced by tree species and age, soil fertility, climate, rainfall and fragmentation patterns. The species is known to feed on a large number of eucalypt and non-eucalypt species; however it tends to specialise on a small number in different areas. *Eucalyptus tereticornis, E. punctata, E. cypellocarpa, E. viminalis, E. microcorys, E. robusta, E. albens, E. camaldulensis* and *E populnea* are some preferred species.	The koala has a fragmented distribution throughout eastern Australia, with the majority of records from NSW occurring on the central and north coasts, as well as some areas further west. It is known to occur along inland rivers on the western side of the Great Dividing Range. The Project Area is within the known distribution of this species.	Wollemi NP Yengo NP Mt Royal NP Manobalai NR Barrington Tops NP	This species has been previously recorded within the Project Area, in 1980; 1994 and most recently in 2012 when an individual was recorded in grassland on the corner of the New England Highway and Hebden Road. There is some limited potential for the species to occur in the proposed disturbance area and to be impacted by the Project.	**Yes**
squirrel glider *Petaurus norfolcensis*	V (TSC)	Inhabits a variety of mature or old growth habitats, including box, box-ironbark woodlands, river red gum forest, and blackbutt-bloodwood forest with heath understorey. It prefers mixed species stands with a shrub or acacia mid-storey, and requires abundant tree hollows for refuge and nest sites.	The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria.	Ravensworth SF Wollemi NP Yengo NP Mt Royal NP	This species has been previously recorded within the Project Area and the proposed disturbance area. The proposed disturbance area provides suitable habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
New Holland mouse *Pseudomys novaehollandiae*	V (EPBC)	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey and vegetated sand dunes. The species peaks in abundance during early to mid stages of vegetation succession typically induced by fire.	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. In 2006 there were known to be 6 - 8 meta-populations of the species (NSW Atlas of Wildlife, VIC Atlas of Wildlife, TAS Natural Values Atlas). A recent record of this species was made in Ravensworth State Forest, adjacent to the north east corner of the Project Area. Across the species' range, the total population size of mature individuals is estimated to be less than 10,000 individuals	This species is not known to occur in conservation reserves in the region.	Rehabilitated and disturbed habitats in the Project Area provides potential habitat for this species and the species was recorded during fauna monitoring surveys between 2003 and 2007. There is potential for the species to be impacted by the Project.	**Yes**
Hastings River mouse *Pseudomys oralis*	E (EPBC) E (TSC)	Known to inhabit a variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs. Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops. Nests may be in either gully areas or ridges and slopes.	This species has a patchy distribution along the east side of the Northern Tablelands and great escarpment of north-east NSW, usually but not always at elevations between 500 m and 1,100 m. Also recorded in south-east Queensland.	Mt Royal NP Barrington Tops NP	The Project Area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
grey-headed flying-fox *Pteropus poliocephalus*	V (EPBC) V (TSC)	This species feeds on a variety of flowering and fruiting plants, including native figs and palms, blossoms from eucalypts, angophoras, tea-trees and banksias (Tidemann 2002). Camps sites are usually formed in gullies, usually in vegetation with a dense canopy and not far from water (Tidemann 2002).	Recorded along the eastern coastal plain from Bundaberg in Queensland, through NSW and south to eastern Victoria. The Project Area is within the known distribution of this species.	Wallaroo NR Karuah NR Lake Macquarie SCA Glenrock SCA Munmorah SCA	The species has been previously recorded within the Project Area (most recently recorded 2010). Limited foraging habitat occurs in the proposed disturbance area, but no roost sites have been identified. The species is sensitive to the impacts of the Project.	**Yes**
yellow-bellied sheathtail bat *Saccolaimus flaviventris*	V (TSC)	This species forages for insects, flies high and fast over the forest canopy, but lower in more open country. It forages in most habitats across its very wide range, with and without trees; and appears to defend an aerial territory. It roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to use mammal burrows.	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.	Wollemi NP Manobalai NR	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
eastern false pipistrelle *Falsistrellus tasmaniensis*	V (TSC)	This species prefers moist habitats, with trees over 20 m high, and generally roosts in eucalypt tree hollows or under bark.	This species has a range from south eastern Queensland, through NSW, Victoria and into Tasmania, and occurs from the Great Dividing Range to the coast.	Wollemi NP Yengo NP Barrington Tops NP	The species has not been previously recorded in the Project Area. The proposed disturbance area provides some suitable habitat for the species, however it has not been recorded after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No
east coast freetail-bat (syn. eastern freetail-bat) *Mormopterus norfolkensis*	V (TSC)	Occurs mostly in dry eucalypt forest and woodland. Also recorded over a rocky river in rainforest and wet sclerophyll forest (Churchill 2008). Generally roosts in tree hollows, but may use man-made structures (Churchill 2008).	Has a distribution along the east coast of NSW from south of Sydney north into south-east Queensland, near Brisbane (Churchill 2008).	Ravensworth SF Wollemi NP Manobalai NR Belford NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
little bentwing-bat *Miniopterus australis*	V (TSC)	Habitat includes wet and dry sclerophyll forest, rainforest, dense coastal banksia scrub, and *Melaleuca* swamps. Cave-dwelling, often sharing roosts with the eastern bentwing-bat (*Miniopterus scheribersii oceanensis*). Sometimes roost in tree hollows. Forages for small insects beneath the canopy of densely vegetated habitats. May depend on a large colony for the high temperatures required to rear the young. May hibernate over winter in southern parts of their range.	Occurs in coastal areas from Cape York to northern NSW.	Ravensworth SF	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
eastern bentwing-bat *Miniopterus schreibersii oceanensis*	V (TSC)	Habitat varies widely, from rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grasslands (Churchill 2008). Requires caves for roosting and maternity sites.	This species has an eastern distribution from Cape York along the coastal side of the Great Dividing Range, and into the southern tip of South Australia (Churchill 2008).	Ravensworth SF Wollemi NP Belford NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
southern myotis *Myotis macropus*	V (TSC)	Occurs in most habitat types providing they are near to water (Richards 2002). Commonly cave-dwelling, however it is also recorded from tree hollows, dense vegetation, bridges, mines and drains (Churchill 2008).	This is a coastal species, ranging from the Kimberley to South Australia (Churchill 2008).	Ravensworth SF Belford NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides suitable habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
eastern cave bat *Vespadelus troughtoni*	V (TSC)	This species is a cave-roosting bat that is usually found in dry open forest and woodland, near cliffs or rocky overhangs. It has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals, and is occasionally found along cliff-lines in wet eucalypt forest and rainforest.	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.	Wollemi NP Manobalai NR Yengo NP	The species has been previously recorded near Liddell, west of the Project Area. The proposed disturbance area provides some suitable habitat for the species, however it has not been recorded after many years of annual fauna monitoring. There is no potential for a significant impact on this species.	No

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
greater broad-nosed bat *Scoteanax rueppellii*	V (TSC)	The greater broad-nosed bat appears to prefer moist environments such as moist gullies in coastal forests, or rainforest. They have also been found in gullies associated with wet and dry sclerophyll forests and open woodland. It roosts in hollows in tree trunks and branches and has also been found to roost in the roofs of old buildings.	The greater broad-nosed bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands; however it does not occur at altitudes above 500 m.	Wollemi NP Yengo NP Barrington Tops NP	This species has been previously recorded within the Project Area. The proposed disturbance area provides some suitable habitat for the species. The species is sensitive to the impacts of the Project.	**Yes**
large-eared pied bat *Chalinolobus dwyeri*	V (EPBC) V (TSC)	Generally found in a variety of drier habitats, including the dry sclerophyll forests and woodlands, however probably tolerates a wide range of habitats (Hoye and Dwyer 2002). Tends to roost in the twilight zones of mines and caves (Churchill 2008).	Has a distribution from south western Queensland to Bungonia in southern NSW, from the coast to the western slopes of the Great Dividing Range (Churchill 2008, Strahan 2002). The Project Area is within the known distribution of this species.	Watagans NP	The species has been previously recorded within the Project Area. There is potential for it to occur in the proposed disturbance area and to be impacted by the proposed works.	**Yes**

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
eastern long-eared bat (SE form) *Nyctophilus corbeni*	V (EPBC) V (TSC)	Inhabits a variety of vegetation types, including mallee, bulloak (*Allocasuarina luehmanni*) and box/eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark.	Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. The Project Area is within the known distribution of this species.	Manobalai NR Wollemi NP	The species has not been recorded in the Project Area despite targeted, annual fauna monitoring since 1996. The proposed disturbance area does not provide suitable habitat for this species and it has not been recorded in the proposed disturbance area. There is no potential for a significant impact on this species.	No.
Fishes						
silver perch *Bidyanus bidyanus*	V (FM) CE (EPBC)	This species prefers fast-flowing, open waters, especially where there are rapids and races, however they will also inhabit warm, sluggish water with cover provided by large woody debris and reeds.	Silver perch were once widespread and abundant throughout most of the Murray-Darling river system. The most abundant remaining population occurs in the central Murray River downstream of Yarrawonga Weir. There have also been reports of populations in other rivers, including the MacIntyre and Macquarie Rivers in northern NSW and the Warrego River in Queensland,	This is species is not known to occur in any reserves in the region	The closest record of this species occurs approximately 100 kilometres north of the Project Area in the Mooki River. The proposed disturbance area does not provide suitable habitat for this species and no direct disturbance is proposed within Bowmans Creek. There is no potential for a significant impact on this species.	No.

Table 2 - Threatened Fauna Species Recorded or with Potential to Occur within in the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the Region	Potential to Occur/Potential for Impact	Further Assessment Required?
Endangered Fauna Populations						
Darling River hardyhead (*Craterocephalus amniculus*) population in the Hunter River Catchment	EP (FM)	This species is usually found in slow flowing, clear, shallow waters or in aquatic vegetation at the edge of such waters. The species has also been recorded from the edge of fast flowing habitats such as the runs at the head of pools.	The species is rarely recorded in the Hunter catchment but has been found in the headwaters of the Hunter system near Pages River.	This is species is not known to occur in any reserves in the region	The Project Area includes a small area of aquatic habitat in Bowmans Creek. Bowmans Creek provides potentially suitable habitat for this species, but it has not been recorded within the Project Area despite substantial, targeted field survey. There is limited potential for this species to be impacted..	Yes.

CE: critically endangered
E: endangered
EP endangered population
EPBC: *Environment Protection and Biodiversity Conservation Act 1999*
FM *Fisheries Management Act 1994*
NR: Nature Reserve
NP: National Park
SF State Forest
TSC: *Threatened Species Conservation Act 1995*
V: vulnerable

Table 3 – Migratory and Marine Species Listed under International Treaties and Recorded or with Potential to Occur within the Project Area or Local Area

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the region	Potential to Occur/Potential for Impact	Further Assessment Required?
Migratory and Marine Species						
white-bellied sea-eagle *Haliaeetus leucogaster*	MAR (EPBC) MIG (EPBC) CAMBA	These birds are typically sighted perched in tall trees and soaring above bodies of water and land. They are territorial and form permanent breeding pairs.	This species is distributed across Australia, China, India, Indonesia, New Guinea, and South-east Asia. Within Australia it is distributed along and near the coast.	Werakata NP	This species is commonly recorded on the east coast of NSW. The species is regularly recorded in the Project Area during annual monitoring surveys.	**Yes**
white-throated needletail *Hirundapus caudacutus*	MAR (EPBC) MIG (EPBC) CAMBA JAMBA ROKAMBA	This species only occurs in Australia between the months of October and May. It forages on flying insects and drinks whilst in flight. Feeding is typically associated with rising thermal currents typical with storm fronts and bushfires.	This species is distributed over eastern and northern Australia	Wollemi NP Barrington Tops NP Ravensworth SF	This species is commonly recorded across NSW. The species is regularly recorded in the Project Area during annual monitoring surveys.	**Yes**
rainbow bee-eater *Merops ornatus*	MAR (EPBC) MIG (EPBC) JAMBA	The preferred habitat of the rainbow bee-eater is open forests and woodlands, shrublands, and cleared or semi-cleared areas (commonly farmland). These areas are usually in proximity to permanent water, however, during migration this bird may fly over areas of non-preferential habitat.	This species is distributed throughout most of mainland Australia as well as several near-shore islands. It is not found in Tasmania and has only been identified in a thin strip in the most arid regions of central WA.	Werakata NP Manobalai NR Wollemi NP	This species is commonly recorded in the Lower and Central Hunter regions. The species is regularly recorded in the Project Area during annual monitoring surveys.	**Yes**

Table 3 – Migratory and Marine Species Listed under International Treaties and Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the region	Potential to Occur/Potential for Impact	Further Assessment Required?
black-faced monarch *Monarcha melanopsis*	MAR (EPBC) MIG (EPBC) Bonn	This bird occurs in coastal scrub, damp gullies, eucalypt woodlands and rainforests. It can be seen foraging for insects amongst foliage, and builds a deep, cup-shaped nest in a tree fork (3 to 6 m above the ground) which is made up of cobwebs, casuarinas needles, bark, moss and roots.	The black-faced monarch is distributed along the eastern coast of Australia, gradually becoming less common towards the south.	Wollemi NP Putty SF Barrington Tops NP Mt Royal NP	This species is commonly recorded on the east coast of NSW. The species has not been recorded within the Project Area despite extensive, annual fauna monitoring and the species is not expected to occur. There is no potential for a significant impact on this species.	No
spectacled monarch *Monarcha trivirgatus*	MAR (EPBC) MIG (EPBC) Bonn	This species is found in thick understoreys in rainforests, wet gullies and waterside vegetation including mangroves.	This species can be found on the coastal areas of north-eastern and eastern Australia, including coastal islands from Cape York in Queensland to Port Stephens in NSW.	Mt Royal NP Barrington Tops NP	This species is recorded on the east coast of NSW generally north of Port Stephens. The species has not been recorded within the Project Area despite extensive, annual fauna monitoring and the species is not expected to occur. There is no potential for a significant impact on this species.	No

Table 3 – Migratory and Marine Species Listed under International Treaties and Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the region	Potential to Occur/Potential for Impact	Further Assessment Required?
satin flycatcher *Myiagra cyanoleuca*	MAR (EPBC) MIG (EPBC) Bonn	This species typically inhabits wet areas of tall forests, particularly in gullies. The satin flycatcher moves north in the winter and is seldom seen in NSW, Tasmania, Victoria or SA during these times. It nests in loose colonies in broad-based cup-shaped nests on a bare horizontal branch. These nests are constructed from bark, grass, lichen and cobwebs.	The satin flycatcher can be found in both Australia and New Guinea. In Australia it is distributed along the east coast from Cape York through to Tasmania, also covering parts of south-eastern SA.	Wollemi NP Putty SF Barrington Tops NP Mt Royal NP	This species is commonly recorded on the east coast of NSW. The species has not been recorded within the Project Area despite extensive, annual fauna monitoring and the species is not expected to occur. There is no potential for a significant impact on this species.	No
rufous fantail *Rhipidura rufifrons*	MAR (EPBC) MIG (EPBC) Bonn	The rufous fantail typically inhabits areas of dense wet forest, mangrove, rainforest or swamp woodlands. It prefers areas where there is intense shade available and is often seen close to ground. In winter it is seldom found in NSW or Victoria. Nests are about 5 m from the ground in a small cup shape and constructed from thin grasses held together by cobwebs.	This species is distributed across the north and eastern coast of Australia, but is also found in Guam, New Guinea, the Solomon Islands and Sulawesi.	Mt Royal NP Wollemi NP Putty SF Pokolbin SF	This species is commonly recorded in the Lower and Central Hunter regions. The species is occasionally recorded in the Project Area during annual monitoring surveys.	**Yes**

Table 3 – Migratory and Marine Species Listed under International Treaties and Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the region	Potential to Occur/Potential for Impact	Further Assessment Required?
fork-tailed swift *Apus pacificus*	MAR (EPBC) MIG (EPBC) CAMBA JAMBA ROKAMBA	This species is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher. In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas.	The fork-tailed swift can be found throughout Australia during migrating. In Australia it is most common west of the Great Dividing Range. This species is uncommon in Tasmania.	Pokolbin SF	This species is commonly recorded on the east coast of NSW. The species has not been recorded within the Project Area and it is unlikely to utilise the habitats of the proposed disturbance area.	No
eastern great egret *Ardea modesta*	MAR (EPBC) MIG (EPBC) CAMBA JAMBA	The eastern great egret typically inhabits areas of shallow, flowing waters, but also uses damp grasslands and other watered areas. It can be observed both in flocks and on its own, and roost during the night in groups.	The eastern great egret is distributed throughout the world, and is common throughout most areas of Australia, with the exception of extremely arid areas.	Goulburn River NP	This species is commonly recorded across NSW. The species is regularly recorded in the Project Area during annual monitoring surveys.	**Yes**
cattle egret *Ardea ibis*	MAR (EPBC) MIG (EPBC) CAMBA JAMBA	The cattle egret can be found in grasslands, wetlands and woodlands and has never been identified in arid areas. These birds are commonly sighted at garbage dumps and pastures in croplands (especially where poor drainage is present).	The cattle egret is distributed throughout Asia, Africa, Europe and Australia. It is most commonly found in north-eastern WA, the NT and in south-eastern Australia from Bundaberg Queensland through to Port Augusta SA. It has also been identified in Tasmania.	This species is not known from any conservation reserves in the region.	This species is commonly recorded on the east coast of NSW. The species has not been recorded within the Project Area however potential habitat does occur there.	**Yes**

Table 3 – Migratory and Marine Species Listed under International Treaties and Recorded or with Potential to Occur within the Project Area or Local Area (cont.)

Species	Legal Status	Specific Habitat	Distribution in relation to the Project Area	Reservation in the region	Potential to Occur/Potential for Impact	Further Assessment Required?
Lathams snipe *Gallinago hardwickii*	MAR (EPBC) MIG (EPBC) Bonn CAMBA JAMBA ROKAMBA	Lathams snipe can be found in permanent and ephemeral wetlands up to 2000 m above sea level. These water bodies are usually freshwater with low, dense vegetation. It forages in areas of mud with some vegetation cover and roosts nearby. Lathams snipe does not breed in Australia, only passing through for migration.	This species has been recorded from Cape York through to south-east SA. The range of this species extends from inland of the eastern tablelands in south-east Queensland to west of the Great Dividing Range in NSW. Richmond River, NSW is a favourite area for non-breeding birds.	Barrington Tops NP	This species is mainly recorded on the east coast in NSW. The species is occasionally recorded in the Project Area during annual monitoring surveys (Forest Fauna Surveys 2012).	**Yes**
Australian painted snipe *Rostratula benghalensis australis*	MAR (EPBC) MIG (EPBC) CAMBA	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowall, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin.	This species is not known from any conservation reserves in the region.	This species is mainly recorded in selected areas of east coast in NSW. The species has not been recorded within the Project Area and is unlikely to utilise the habitats in the proposed disturbance area, however the species has been recently recorded at Bowmans Creek.	**Yes**

Bonn Bonn Convention
CAMBA China-Australia Migratory Bird Agreement
EPBC Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
JAMBA Japan-Australia Migratory Bird Agreement
MAR marine
MIG migratory
NP National Park
ROKAMBA Republic of Korea-Australia Migratory Bird Agreement
SF State Forest

APPENDIX B

Flora Species List

Appendix B – Flora Species List

The following list was developed from surveys of the Project Area and surrounds as detailed in Section 3.3 of the main report. It includes all species of vascular plants observed during fieldwork completed by Umwelt in 2011, 2012 and 2014. Although substantial, the list will not be comprehensive, because not all species are readily detected at any one time of the year. Many species flower only during restricted periods of the year, and some flower only once in several years. In the absence of flowering material, many of these species cannot be identified, or even detected.

Names of classes and families follow a modified Cronquist (1981) System.

Any species that could not be identified to the lowest taxonomic level are denoted in the following manner:

sp. specimens that are identified to genus level only.

The following abbreviations or symbols are used in the list:

1 to 6 modified Braun-Blanquet cover-abundance score (see Section 3.3.4.1 of main report);

X species recorded in proximity to, but outside of, quantitative floristic quadrat;

✓ species recorded opportunistically during surveys;

asterisk (*) denotes species not native to Mount Owen Complex;

subsp. subspecies;

var. variety; and

Bold font denotes threatened plant species or populations.

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 & 2002) and Wheeler *et al*. (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from PlantNET (Botanic Gardens Trust 2014), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 & 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

Table 1 lists the flora species recorded in quadrats, rapid assessment sites and transect sites recorded as part of the flora survey effort for the Project within the Project Area and surrounds.

Table 2 lists the flora species recorded in quadrats that were sampled as part of surveys for the Upper Hunter Strategic Assessment (Umwelt 2014, in prep) and the Mount Owen Mine Rehabilitation, Regeneration and Revegetation Assessment (Umwelt 2013b) within the Project Area.

The location of these survey points is shown on Figure 3.1 of the main report.

Table 1 – Flora Species Recorded in Quadrat Sites, Rapid Assessment Sites and Transect Sites for the Project

Family	Scientific Name	Common Name	Quadrat Sites																													Rapid Assessment Sites										Transect Sites								
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q100	Q101	DBQ1	DBQ2	R1	R2	R3	R4	R5	R6	R7	R8	R9	DAM1	REHAB1	T1	T2	T3	T4	T5	T6	T7	T8	DNG1
Filicopsida																																																	
Adiantaceae	*Cheilanthes distans*	bristly cloak fern	2					3																								1																	
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*	poison rock fern	3	3	2			3	3	2		2	2	2	1	2	2	2	2	2	2	2	2		2		2	2	2			1	1	1		1	1					✓	✓	✓	✓	✓	✓	✓	✓	
Marsileaceae	*Marsilea drummondii*	common nardoo																																														✓		
Magnoliopsida (Flowering Plants) - Lillidae																																																
Anthericaceae	*Caesia parviflora*	pale grass-lily								2																																						
Anthericaceae	*Caesia* sp.		3																																													
Anthericaceae	*Laxmannia gracilis*	slender wire lily		2				2							1	1				1								2	2					1					1					✓	✓			✓			
Asparagaceae	**Asparagus asparagoides*	bridal creeper									1																																						
Commelinaceae	**Tradescantia fluminensis*	wandering Jew																																													✓		
Cyperaceae	*Cyperus gracilis*	slender flat-sedge						1			2																																						
Cyperaceae	*Fimbristylis dichotoma*	common fringe-sedge																										2																					
Cyperaceae	*Schoenus apogon*	fluke bogrush													2																																		
Hypoxidaceae	*Hypoxis* sp.													1																																			
Iridaceae	**Romulea rosea*								3								2					2	2											1											✓				
Juncaceae	**Juncus acutus* subsp. *acutus*	sharp rush					X																											1					1			✓				✓			
Juncaceae	*Juncus kraussii* subsp. *australiensis*																																						X									✓
Juncaceae	*Juncus* sp.																	2																										✓						
Lomandraceae	*Lomandra filiformis*	wattle matt-rush		1							2																					1										✓						✓	
Lomandraceae	*Lomandra filiformis* subsp. *coriacea*		2																																													
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*												2																																			
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	many-flowered mat-rush	2	3	1						1	3	2	3		2						2					1	1	3	2	3	1					1											
Lomandraceae	*Lomandra* sp.														3					1	2	2																											
Orchidaceae	***Cymbidium canaliculatum***	**tiger orchid**																																														
Orchidaceae	*Microtis* sp.								3										1																										✓						
Orchidaceae	*Pterostylis* sp.														2	2																												✓						
Orchidaceae	*Thelymitra* sp.														1				1																															
Phormiaceae	*Dianella revoluta*												1								2							2																					
Phormiaceae	*Dianella revoluta* var. *revoluta*													2				2											2	3																				
Phormiaceae	*Dianella* sp.		2	2				1		1	2				3	2																		1										✓						
Poaceae	**Aira* sp.																						2																											
Poaceae	*Aristida echinata*														3	3					3																													

Family	Scientific Name	Common Name	Quadrat Sites																													Rapid Assessment Sites											Transect Sites								
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q100	Q101	DBQ1	DBQ2	R1	R2	R3	R4	R5	R6	R7	R8	R9	DAM1	REHAB1	T1	T2	T3	T4	T5	T6	T7	T8	DNG1
Poaceae	*Aristida ramosa*	purple wiregrass																									3		4	2																				✓
Poaceae	*Aristida* sp.		4	3	3			2	3			3	3	3			3		3	3			3				3					1	1	1										✓	✓	✓				✓	
Poaceae	*Aristida vagans*	threeawn speargrass										3	3					3				3						3		2																				
Poaceae	*Austrostipa nodosa*													2																																			
Poaceae	*Austrostipa scabra*	speargrass																									2							1		1								✓					
Poaceae	*Austrostipa scabra* subsp. *falcata*																	3												4	3																			
Poaceae	*Austrostipa scabra* subsp. *scabra*							4			4																								1		1									✓				
Poaceae	*Austrostipa* sp.												1				3		3			3	3																											
Poaceae	*Austrostipa verticillata*	slender bamboo grass				4	4																	4	5						3				1	1				1		X	✓			✓	✓		✓		
Poaceae	*Bothriochloa biloba*	lobed blue-grass																				2					2																							
Poaceae	*Bothriochloa decipiens*	red grass										2		2																																			
Poaceae	*Bothriochloa macra*	red grass																									2																							
Poaceae	*Bothriochloa* sp.												3								1						3																							
Poaceae	**Briza minor*	shivery grass							3								2		2			2	2												1									✓	✓		✓		✓		✓	
Poaceae	**Briza subaristata*																		3				2				2																			✓				
Poaceae	**Bromus catharticus*	prairie grass					2				2															1																					✓				
Poaceae	**Bromus hordeaceus*	soft brome																								2																							
Poaceae	*Chloris truncata*	windmill grass															2		3					2				2	1																	✓				
Poaceae	*Chloris ventricosa*	tall chloris											2														2		2	2																			
Poaceae	*Cleistochloa rigida*													3																																			
Poaceae	*Cymbopogon refractus*	barbed wire grass	3	3					3			3	4	2		2	3	2	4	3		3	4				2	4	3	4	3	1	1	1			1							✓	✓			✓		✓	✓
Poaceae	*Cynodon dactylon*	common couch							2	2			1					1				2	1												1										✓	✓					
Poaceae	*Dichanthium* sp.				1						2																									1													
Poaceae	*Dichelachne micrantha*	shorthair plumegrass															2		2																															
Poaceae	*Dichelachne* sp.			2					3																																								
Poaceae	*Digitaria brownii*	cotton panic grass																									3	2																						
Poaceae	*Echinopogon caespitosus* var. *caespitosus*	tufted hedgehog grass										2		1																																				
Poaceae	*Echinopogon ovatus*	forest hedgehog grass																										2																						
Poaceae	**Ehrharta erecta*	panic veldtgrass																																														✓		
Poaceae	*Elymus scaber*	common wheatgrass																												2	2																	✓	✓
Poaceae	*Eragrostis brownii*	Browns lovegrass										1		2	2	2		1		2		2					2	2																						
Poaceae	*Eragrostis* sp.				2					2			2																																✓					

Family	Scientific Name	Common Name	Quadrat Sites																													Rapid Assessment Sites											Transect Sites								
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q100	Q101	DBQ1	DBQ2	R1	R2	R3	R4	R5	R6	R7	R8	R9	DAM1	REHAB1	T1	T2	T3	T4	T5	T6	T7	T8	DNG1
Poaceae	*Hyparrhenia hirta*	Coolatai grass		4																			2											1																✓	
Poaceae	*Lolium perenne*	perennial ryegrass																								3									1															
Poaceae	*Lolium* sp.			1				2	3	2	2																																							
Poaceae	*Melinus repens*	red Natal grass											2																																			✓	✓			
Poaceae	*Microlaena stipoides* var. *stipoides*	weeping grass				3	4																				3	3																			✓		✓		✓		
Poaceae	*Paspalum dilatatum*	paspalum													1													3																							
Poaceae	*Paspalidium* sp.				1			1																																										
Poaceae	*Pennisetum clandestinum*	kikuyu grass																								3				3	2																					
Poaceae	*Phalaris aquatica*	phalaris											1																																						
Poaceae	*Phragmites australis*	common reed																																			1										✓				
Poaceae	*Poa* sp.		2									1																																						
Poaceae	*Rytidosperma bipartitum*	wallaby grass												2														3																							
Poaceae	*Rytidosperma fulvum*	wallaby grass																										3	3	3													X								
Poaceae	*Rytidosperma monticola*													1													3																							
Poaceae	*Rytidosperma pallidum*	silvertop wallaby grass																			3																														
Poaceae	*Rytidosperma setaceum*	smallflower wallaby grass																			1																														
Poaceae	*Rytidosperma* sp.				2			2						2										4																		X			✓						
Poaceae	*Setaria gracilis*	slender pigeon grass											2																																						
Poaceae	*Setaria* sp.			2			2																																											
Poaceae	*Sporobolus caroli*	fairy grass																																															✓	
Poaceae	*Sporobolus creber*	slender rats tail grass	2							2				1														3	2		1	1											✓								
Poaceae	*Sporobolus* sp.																2																																	
Poaceae	*Themeda australis*	kangaroo grass																										1	2																					
Poaceae	*Vulpia bromoides*	squirrel tail fescue															2					2	2			2																									
Poaceae	*Vulpia muralis*																		2																																
Typhaceae	*Typha orientalis*	broad-leaved cumbungi																																						1										
Typhaceae	*Typha domingensis*	narrow-leaved cumbungi																																							X									
Magnoliopsida (Flowering Plants) - Magnoliidae																																																	
Acanthaceae	*Brunoniella australis*	blue trumpet	2	2	2			2					2													2			2		3			1		1								✓				✓		
Aizoaceae	*Galenia pubescens*	galenia					4	2		2	1										1				2	2	1			3				1	1			1	1	X	X				✓	✓			
Amaranthaceae	*Alternanthera denticulata*	lesser joyweed												2				2						1																										
Amaranthaceae	*Alternanthera* species A																	2																																
Amaranthaceae	*Alternanthera* sp.							1																																										

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			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q100	Q101	DBQ1	DBQ2	R1	R2	R3	R4	R5	R6	R7	R8	R9	DAM1	REHAB1	T1	T2	T3	T4	T5	T6	T7	T8	DNG1
Amaranthaceae	*Nyssanthes* sp.						1																																										
Anacardiaceae	**Schinus areira*	pepper tree																								1																					✓		✓		
Apiaceae	*Centella asiatica*	pennywort				2																																											
Apiaceae	**Cyclospermum leptophyllum*	slender celery				3			2													2	2																						✓					
Apiaceae	*Hydrocotyle* sp.																		2																														
Apocynaceae	*Parsonsia straminea*	common silkpod																																									✓								
Asclepiadaceae	**Gomphocarpus fruticosus*	narrow-leaved cotton bush						1		1			1		1				1				2	1				2		1			1		1									✓						
Asteraceae	**Arctotheca calendula*	Capeweed																1								3																								
Asteraceae	**Aster subulatus*	wild aster																										2	2	1																			
Asteraceae	**Bidens pilosa*	cobblers pegs								1	1																		2																		✓		
Asteraceae	*Calocephalus citreus*	lemon beauty-heads			2						1										2		1				1																						
Asteraceae	*Calotis hispidula*	Bogan flea																2																															
Asteraceae	*Calotis lappulacea*	yellow burr-daisy	3	2							2	2		2						1							1			2		1	1	1		1	1						✓	✓			✓			
Asteraceae	*Cassinia arcuata*	sifton bush							1									2				1					1																						
Asteraceae	*Chrysocephalum apiculatum*	common everlasting		2					2																					1	2					1									✓	✓				✓
Asteraceae	**Cirsium vulgare*	spear thistle				2	3		1		1	1	1	1				1						2	3	3				2				1					1			✓				✓		✓		✓
Asteraceae	**Conyza bonariensis*	flaxleaf fleabane				3		3		2																																	✓			✓	✓		✓		
Asteraceae	*Epaltes australis*	spreading nut-heads																										2																					
Asteraceae	*Euchiton japonicus*	creeping cudweed												2				1	2			2	2				2																						
Asteraceae	*Euchiton involucratus*							2																																									
Asteraceae	**Facelis retusa*									2				2																													✓							
Asteraceae	**Gamochaeta purpurea*	cudweed			1			1	1	1	2																								1				1				✓			✓				
Asteraceae	**Gamochaeta* sp.		2																																													
Asteraceae	*Glossocardia bidens*	cobblers tack																										2																					
Asteraceae	**Hypochaeris radicata*	catsear										1	2				3		3		2	3	3	3	2		2	3	2		2																	
Asteraceae	**Lactuca saligna*	willow-leaved lettuce																																			1												
Asteraceae	**Lactuca serriola*	prickly lettuce									2																																						
Asteraceae	*Ozothamnus diosmifolius*	white dogwood																																										✓						
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey cudweed											1																																				
Asteraceae	**Senecio madagascariensis*	fireweed	3	3	3			3	3	2	3	2	2	2	2	2	3	2	3	2		3	3	3			2	3		3			1	1	1	1	1			1	X		✓	✓	✓	✓	✓	✓		
Asteraceae	*Solenogyne bellioides*		2																									2																					
Asteraceae	**Soliva sessilis*	bindyi															2																																
Asteraceae	**Sonchus oleraceus*	common sowthistle		2		3	3			3	2			1			2								1	2														1	1			✓			✓	✓		✓		✓

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			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q100	Q101	DBQ1	DBQ2	R1	R2	R3	R4	R5	R6	R7	R8	R9	DAM1	REHAB1	T1	T2	T3	T4	T5	T6	T7	T8	DNG1
Asteraceae	*Tagetes minuta*	stinking Roger																1																																	
Asteraceae	*Taraxacum officinale*	dandelion		2	1			2	3	2																									1			1						✓			
Asteraceae	*Taraxacum officinale*																																											✓				
Asteraceae	*Vernonia cinerea*		3							1																					1	1																
Asteraceae	*Vittadinia* sp.					1																																										
Boraginaceae	**Heliotropium amplexicaule*	blue heliotrope																								3																							
Brassicaceae	**Brassica tournefortii*	Mediterranean turnip																								3																							
Brassicaceae	**Lepidium africanum*																										2																						
Cactaceae	**Opuntia aurantiaca*	tiger pear						1		2																1										1													
Cactaceae	**Opuntia humifusa*	creeping pear	2		2			1																					1	1	2		1												✓			✓
Cactaceae	**Opuntia stricta* var. *stricta*	common prickly pear								2		1	2	2				2		1	1			1			1					1												✓	✓		✓			✓
Campanulaceae	*Wahlenbergia communis*	tufted bluebell											1															2																					
Campanulaceae	*Wahlenbergia gracilenta*	annual bluebell																1																															
Campanulaceae	*Wahlenbergia gracilis*	sprawling or Australian bluebell	2	1	2	2		2	3	2																							1	1				1				✓	✓	✓			✓			
Campanulaceae	*Wahlenbergia* sp.																		2			1																											
Campanulaceae	*Wahlenbergia stricta*	tall bluebell																									2		1																			
Campanulaceae	*Wahlenbergia victoriensis*													2																																		
Caryophyllaceae	**Paronychia brasiliana*	Chilean whitlow wort								2																																		✓					
Caryophyllaceae	**Petrorhagia nanteuilii*																1																															
Caryophyllaceae	**Petrorhagia velutina*																																										✓					
Caryophyllaceae	**Stellaria media*	common chickweed																							2	2																				✓		
Casuarinaceae	*Allocasuarina luehmannii*	bulloak		1	4			3		3			2	3	1	1		2		5	4	1					3		3	X	X	1	1	1		1	1						✓	✓			✓		✓	
Casuarinaceae	*Casuarina cunninghamiana* subsp. *cunninghamiana*	river oak																								4									1													
Casuarinaceae	*Casuarina glauca*	swamp oak				4	4																		4							1					1		1			✓			✓			✓		
Chenopodiaceae	*Einadia hastata*	berry saltbush				1		2		2								1						2						2												✓			✓		✓			
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	climbing saltbush	2		1						2							1			1			3											1													
Chenopodiaceae	*Einadia nutans* subsp. *nutans*	climbing saltbush		2				2		2			1																															✓		✓				
Chenopodiaceae	*Einadia polygonoides*																										2																						
Chenopodiace	*Einadia* sp.																																										✓						

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			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q100	Q101	DBQ1	DBQ2	R1	R2	R3	R4	R5	R6	R7	R8	R9	DAM1	REHAB1	T1	T2	T3	T4	T5	T6	T7	T8	DNG1
ae																																																			
Chenopodiaceae	*Enchylaena tomentosa*	ruby saltbush								2	3												2	2			2				3					1	1										✓				✓
Chenopodiaceae	*Maireana enchylaenoides*	wingless bluebush																			1																														
Chenopodiaceae	*Maireana microphylla*	small-leaf bluebush				1	1			2								1																		1										✓	✓			
Chenopodiaceae	*Maireana* sp.																							3																										
Clusiaceae	*Hypericum gramineum*	small St Johns wort	2									2							2				2					2																	✓						
Convolvulaceae	*Convolvulus erubescens*												1																																				
Convolvulaceae	*Dichondra repens*	kidney weed	4	3	2			2	2	3	3	2	3	2				2	2			2		2	2			3	3			1	1			1	1						✓		✓	✓	✓		✓		
Crassulaceae	**Bryophyllum delagoense*	mother of millions									2																																						
Crassulaceae	*Crassula sieberiana*	Australian stonecrop			2			2	2	2							2	2																		1								✓						
Dilleniaceae	*Hibbertia linearis*		2																												1																		
Dilleniaceae	*Hibbertia obtusifolia*	hoary Guinea flower												2	1															2																				
Dilleniaceae	*Hibbertia* sp.																											2																	✓				
Droseraceae	*Drosera peltata*																																												✓					
Epacridaceae	*Astroloma humifusum*	native cranberry												2				2																																	
Ericaceae	*Lissanthe strigosa*	peach heath	3									1			3	3			1	1								1	2																✓	✓					
Euphorbiaceae	*Chamaesyce drummondii*	caustic weed																																										✓						
Fabaceae (Faboideae)	*Chorizema parviflorum*	eastern flame pea														2																																		
Fabaceae (Faboideae)	*Daviesia genistifolia*	broom bitter pea	3									2																																						
Fabaceae (Faboideae)	*Daviesia ulicifolia*	gorse bitter pea		2								2	3	3	3	2			2									3	3		3		1				1					X		✓	✓					
Fabaceae (Faboideae)	*Desmodium* sp.				2																																												
Fabaceae (Faboideae)	*Desmodium varians*	slender tick-trefoil						2	2															2					2																					
Fabaceae (Faboideae)	*Glycine clandestina*														2	2									2																									
Fabaceae (Faboideae)	*Glycine microphylla*												2	2															2																				
Fabaceae (Faboideae)	*Glycine* sp.		2	2		2				2																						1											✓							
Fabaceae (Faboideae)	*Glycine tabacina*											2							2		1		1				2	2																	✓		✓			
Fabaceae (Faboideae)	*Indigofera australis*	Australian indigo											1	1				1														1																	
Fabaceae (Faboideae)	**Medicago* sp.																																														✓				

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Fabaceae (Faboideae)	*Swainsona galegifolia*	smooth Darling pea																																									✓								
Fabaceae (Faboideae)	*Templetonia stenophylla*	leafy templetonia																			1																														
Fabaceae (Faboideae)	**Trifolium repens*	white clover																	2							2																									
Fabaceae (Faboideae)	**Trifolium* sp.								1																																	✓								
Fabaceae (Mimosoideae)	*Acacia amblygona*	fan wattle	3											3	3	2													3																						
Fabaceae (Mimosoideae)	**Acacia saligna*	golden wreath wattle					1																																1						✓				
Fabaceae (Mimosoideae)	*Acacia crassa* subsp. *crassa*											3																																					
Fabaceae (Mimosoideae)	*Acacia deanei* subsp. *deanei*	Deanes wattle																											3																					
Fabaceae (Mimosoideae)	*Acacia decurrens*	black wattle											3																				1																	
Fabaceae (Mimosoideae)	*Acacia falcata*																												2								1												
Fabaceae (Mimosoideae)	*Acacia linearifolia*	narrow-leaved wattle					1																																										
Fabaceae (Mimosoideae)	*Acacia parvipinnula*	silver-stemmed wattle												1																																				
Fabaceae (Mimosoideae)	*Acacia salicina*	cooba																																														✓	
Fabaceae (Mimosoideae)	*Acacia spectabilis*	Mudgee wattle											1																																					
Fabaceae (Mimosoideae)	*Acacia* sp.		1															1																												✓					
Fumariaceae	**Fumaria bastardii*	bastards fumitory																								1																								
Gentianaceae	**Centaurium tenuiflorum*																		2																														
Goodeniaceae	*Goodenia heterophylla*																																												✓					
Goodeniaceae	*Goodenia rotundifolia*							2																				1																					
Goodeniaceae	*Goodenia* sp.													2														1																					
Lamiaceae	*Mentha* sp.									1																																							
Lamiaceae	*Spartothamnella juncea*	bead bush				1																			1																								
Linaceae	*Linum marginale*	native flax																	2																														
Lobeliaceae	*Pratia concolor*	poison pratia					2																																				✓					
Lobeliaceae	*Pratia purpurascens*	whiteroot	3			3	2																		3		2	3															✓				✓	
Loranthaceae	*Dendrophthoe* sp.														1																																		
Loranthaceae	*Lysiana exocarpi* subsp. *exocarpi*																																														✓	
Malvaceae	*Brachychiton populneus* subsp. *populneus*	kurrajong										1																																					
Malvaceae	**Modiola caroliniana*	red-flowered mallow																								2																								
Malvaceae	*Sida corrugata*			2										1							2																								✓					

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Malvaceae	*Sida rhombifolia	Paddys lucerne				3	3			2	3																								1	1			1	1			✓			✓	✓		✓		
Malvaceae	Sida spinosa				1																																												
Malvaceae	Sida sp.																									1																								
Malvaceae	Sida subspicata																															1																
Meliaceae	Melia azedarach	white cedar				1																																									✓		
Myoporaceae	Eremophila debilis	amulla	2		1					2		1	1	2				2			1			2	2		2		2		3															✓			
Myrsinaceae	*Anagallis arvensis	scarlet pimpernel	2	3		3	2	2	2	2				1		1	2		2			2	2					3				1	1	1	1				1	1			✓	✓		✓	✓				
Myrtaceae	Angophora floribunda	rough-barked apple				2	X																												1														
Myrtaceae	Corymbia maculata	spotted gum	3									2		3				4											4	2	4	1	1								X	X		✓	✓						
Myrtaceae	Eucalyptus crebra	narrow-leaved ironbark		4				4		3	3		3	3							2						4					1	1					1				✓	✓	✓			✓			
Myrtaceae	Eucalyptus fibrosa	broad-leaved ironbark	3									3	3					X										X	X		1													✓					
Myrtaceae	Eucalyptus moluccana	grey box	2	X						3	4	3	3											4								1												✓			✓	✓		
Myrtaceae	Eucalyptus tereticornis	forest red gum																						X																								✓	
Myrtaceae	Kunzea ericoides	burgan													6	5																																	
Myrtaceae	Melaleuca sp.											1																																						
Myrtaceae	Melaleuca styphelioides	prickly-leaved tea tree																														1																	
Oleaceae	*Olea europaea subsp. cuspidata	African olive					2	1		1																				1					1	1						✓				✓	✓			
Oleaceae	Notelaea microcarpa var. microcarpa																												3																				
Oxalidaceae	Oxalis pes-caprae																										2																					
Oxalidaceae	Oxalis perennans					1					2		1																														✓	✓							
Oxalidaceae	Oxalis sp.																																	1														
Phyllanthaceae	Breynia oblongifolia	coffee bush																													1																	
Phyllanthaceae	Phyllanthus hirtellus		2																																													
Phytolaccaceae	*Phytolacca octandra	inkweed																1																																
Pittosporaceae	Bursaria spinosa subsp. spinosa	native blackthorn	2									3	2														3	2																					
Plantaginaceae	Plantago debilis		2		1							1																																✓					
Plantaginaceae	Plantago hispida																1																																
Plantaginaceae	*Plantago lanceolata	lambs tongues					3		3	1	3						3		2			3	3			3		2		3					1					1				✓			✓		✓
Plantaginaceae	Veronica plebeia	trailing speedwell								2																																	✓	✓	✓						
Polygonaceae	*Acetosella vulgaris	sheep sorrel																	1																															
Polygonaceae	Persicaria sp.																																														✓		
Polygonaceae	*Rumex crispus	curled dock					2				1																																			✓		
Ranunculaceae	Clematis aristata	old mans beard																													1																		
Rubiaceae	Asperula conferta	common woodruff	3										1						2				2		2			2																					

Family	Scientific Name	Common Name	Quadrat Sites																																Rapid Assessment Sites											Transect Sites								
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q100	Q101	DBQ1	DBQ2	R1	R2	R3	R4	R5	R6	R7	R8	R9	DAM1	REHAB1	T1	T2	T3	T4	T5	T6	T7	T8	DNG1
Rubiaceae	*Galium aparine*	goosegrass					3				2																																					✓		
Rubiaceae	*Galium* sp.					3																		2																										
Rubiaceae	*Opercularia diphylla*																															1																		
Rubiaceae	*Opercularia* sp.			2																																													
Rubiaceae	*Psydrax odorata*	shiny-leaved canthium																											1																					
Salicaceae	*Salix* sp.	willow																																	1															
Sapindaceae	*Dodonaea viscosa*	sticky hop-bush																																								X								
Solanaceae	*Cestrum nocturnum*	lady-of-the-night																								3																									
Solanaceae	*Lycium ferocissimum*	African boxthorn				2																		3	3	3						1					1							✓								
Solanaceae	*Solanum cinereum*	Narrawa burr	2										1	1				3						2			1		2		1	1																		
Solanaceae	*Solanum nigrum*	black-berry nightshade				1	1			2	2													2		2										1	1		1				✓	✓		✓					
Solanaceae	*Solanum prinophyllum*	forest nightshade																							2	3																								
Solanaceae	*Solanum pseudocapsicum*	Madeira winter cherry					1																		2																							✓		
Solanaceae	*Solanum radicans*																									2																								
Solanaceae	*Solanum* sp.					2				2																																	✓								
Stackhousiaceae	*Stackhousia muricata*		2																																														
Stackhousiaceae	*Stackhousia* sp.			2	1				2																																	✓	✓							
Stackhousiaceae	*Stackhousia viminea*	slender stackhousia																	1									2																							
Urticaceae	*Urtica incisa*	stinging nettle																																								✓								
Verbenaceae	*Verbena bonariensis*	purpletop					2																												1				1										
Verbenaceae	*Verbena incompta*	purpletop																					2	1	2																								
Verbenaceae	*Verbena rigida*	veined verbena																																						1									✓
Vitaceae	*Cayratia clematidea*	slender grape																																								✓		✓				

Table 2 – Flora Species Recorded within the Project Area for the Upper Hunter Strategic Assessment Project and the Mount Owen Mine Rehabilitation, Regeneration and Revegetation Assessment

Family	Scientific Name	Common Name	UHSA Quadrats (Umwelt 2014, in prep)											Rehab Assessment (Umwelt 2013b)													
			RAVP03	RAVP05	RAVP06	RAVP07	RAVP08	RAVP032	RAVP033	RAVP034	RAVP035	RAVP036	RAVP037	MOPRQ1	MOPRQ2	MOQ1	MOQ2	MOQ3	MOQ4	MOQ5	MOQ6	MOQ7	MOQ8	MOQ9	RSFQ1	RSFQ2	RSFQ3
Filicopsida																											
Adiantaceae	*Cheilanthes distans*	bristly cloak fern		2		2		2					2						2								
Adiantaceae	*Cheilanthes sieberi subsp. sieberi*	poison rock fern	2		2	2		2	2	2	2	2	2	1	3	2	3	2					1	1	2	2	2
Polypodiaceae	*Dictymia brownii*	strap fern									1																
Magnoliopsida (Flowering Plants) - Lillidae																											
Anthericaceae	*Arthropodium milleflorum*	pale vanilla lily																							2	2	2
Anthericaceae	*Laxmannia gracilis*	slender wire lily	2			2				1	1																
Anthericaceae	*Tricoryne elatior*	yellow autumn-lily				1			1																		
Commelinaceae	*Commelina cyanea*	native wandering Jew	2			2																					
Commelinaceae	*Murdannia graminea*		2							2	1																
Cyperaceae	*Carex inversa*	knob sedge								2		1															
Cyperaceae	**Cyperus aggregatus*			2				2			1																
Cyperaceae	**Cyperus brevifolius*								2	1		1	1															
Cyperaceae	*Cyperus gracilis*	slender flat-sedge	1	2			2			1																	
Cyperaceae	*Fimbristylis dichotoma*	common fringe-sedge	2		2	2			2	2	2	2	2														
Cyperaceae	*Lepidosperma laterale*	variable sword-sedge																					2				
Hypoxidaceae	*Hypoxis hygrometrica*	golden weather-grass							1	1			1														
Juncaceae	**Juncus acutus* subsp. *acutus*	sharp rush		2																							
Juncaceae	*Juncus subsecundus*	finger rush								1																	
Lomandraceae	*Lomandra filiformis*				2	2					1	2															
Lomandraceae	*Lomandra filiformis subsp. filiformis*															1	1	2							2		2
Lomandraceae	*Lomandra filiformis* subsp. *coriacea*	wattle matt-rush	1																								
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	many-flowered mat-rush	1		2	2				1		1	1					2	1	2	1		2			2	
Phormiaceae	*Dianella caerulea*	blue flax- lily																							3	3	2
Phormiaceae	*Dianella longifolia*	blueberry lily			1																						
Phormiaceae	*Dianella revoluta*	blueberry lily	2																							3	
Phormiaceae	*Dianella revoluta* var. *revoluta*	a blue flax-lily													3										2		2
Poaceae	*Aristida personata*									3	3		2														
Poaceae	*Aristida ramosa*	purple wiregrass			2	2		2	4					3	2												
Poaceae	*Aristida* sp.	a wiregrass		2										3	3	3	3	3	3	2	2	1			3	3	3
Poaceae	*Aristida vagans*	threeawn speargrass	3		2	3						3															

Family	Scientific Name	Common Name	UHSA Quadrats (Umwelt 2014, in prep)											Rehab Assessment (Umwelt 2013b)													
			RAVP03	RAVP05	RAVP06	RAVP07	RAVP08	RAVP032	RAVP033	RAVP034	RAVP035	RAVP036	RAVP037	MOPRQ1	MOPRQ2	MOQ1	MOQ2	MOQ3	MOQ4	MOQ5	MOQ6	MOQ7	MOQ8	MOQ9	RSFQ1	RSFQ2	RSFQ3
Poaceae	*Austrostipa scabra*	speargrass			1	3		4				3															
Poaceae	*Austrostipa verticillata*	slender bamboo grass					4	2																			
Poaceae	*Austrostipa* sp.	speargrass																		1							
Poaceae	*Bothriochloa biloba*	lobed bluegrass									2																
Poaceae	*Bothriochloa decipiens*	red grass	2		2							2	2														
Poaceae	*Bothriochloa macra*	red grass		2					3	2					2				1								
Poaceae	*Capillipedium spicigerum*	scented-top grass							1																		
Poaceae	**Chloris gayana*	rhodes grass																		4	4	4	2	2			
Poaceae	*Chloris truncata*	windmill grass								1										1		2	1		2		
Poaceae	*Chloris ventricosa*	tall chloris		2	2					1		2	2		3	1	2	3							2		3
Poaceae	*Cymbopogon refractus*	barbed wire grass	3	2	2	3	2		3	2	2	2	3	3	3	3	3	3	4	2		3	3	3	3	3	3
Poaceae	*Cynodon dactylon*	common couch		5			1	4			1		2								3	3	3	3			
Poaceae	*Dichelachne micrantha*	shorthair plumegrass							1			1					X									1	
Poaceae	*Digitaria brownii*	cotton panic grass	1			2			2				2														
Poaceae	*Digitaria diffusa*	open summer-grass	1			2				1	2																
Poaceae	*Digitaria divaricatissima*	umbrella grass								1																	
Poaceae	*Digitaria parviflora*	small-flowered finger grass							2																		
Poaceae	*Echinopogon caespitosus*	bushy hedgehog-grass			1	1																					
Poaceae	*Echinopogon ovatus*	forest hedgehog-grass													1		2								3	2	2
Poaceae	*Enteropogon acicularis*	curly windmill grass					2					1	2														
Poaceae	*Eragrostis brownii*	Browns lovegrass	2								2							2									
Poaceae	**Eragrostis curvula*	African lovegrass										2															
Poaceae	*Eragrostis elongata*	clustered lovegrass				2			3	2			2														
Poaceae	*Eragrostis leptostachya*	paddock lovegrass										2															
Poaceae	*Eragrostis* sp.	a lovegrass												2	1				1	2				1		1	2
Poaceae	*Eriochloa pseudoacrotricha*	early spring grass		2			2																				
Poaceae	*Imperata cylindrica*	blady grass		2																							
Poaceae	**Melinis repens*	red natal grass							2	2	1			3				1		3	2	2	4				
Poaceae	**Megathyrsus maximus*	guinea grass																						2			
Poaceae	*Microlaena stipoides* var. *stipoides*	weeping grass			2			3	2	3	2								2						3	3	2
Poaceae	*Panicum effusum*	hairy panic	1					2	2			2			2				2				1		2		2
Poaceae	*Panicum* sp.															2	2	2									

Family	Scientific Name	Common Name	UHSA Quadrats (Umwelt 2014, in prep)											Rehab Assessment (Umwelt 2013b)													
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Poaceae	*Paspalidium aversum*	bent summer grass					2																				
Poaceae	*Paspalidium distans*		2		2	2				2		2	2														
Poaceae	*Paspalidium gracile*	slender panic																							2	2	3
Poaceae	**Paspalum dilatatum*	paspalum		2			1		3	1	1		3						4	2							
Poaceae	**Pennisetum clandestinum*	kikuyu grass		2																	3	2					
Poaceae	*Rytidosperma bipartitum*	wallaby grass																					1		2		
Poaceae	*Rytidosperma fulvum*	wallaby grass			2							2			2										3		3
Poaceae	*Rytidosperma* sp.			1													2										
Poaceae	**Setaria parviflora*								3	2	1	2	2														
Poaceae	*Setaria* sp.																					3		2			
Poaceae	*Sporobolus creber*	slender rat's tail grass	2	2				2	1	1	2		3	2	2				2					1			
Poaceae	*Themeda australis*	kangaroo grass												2		2		2	2						2	1	
Magnoliopsida (Flowering Plants) - Magnoliidae																											
Acanthaceae	*Brunoniella australis*	blue trumpet	2	1	2	2				1		1					2	2							3	3	2
Acanthaceae	*Rostellularia adscendens*	pink tongues																									
Aizoaceae	**Galenia pubescens*	galenia		2			3	4														1		1			
Amaranthaceae	*Alternanthera denticulata*	lesser joyweed												1		2	2	2									
Amaranthaceae	**Alternanthera pungens*	khaki weed				1																					
Amaranthaceae	**Gomphrena celosioides*	gomphrena weed		1																							
Anacardiaceae	**Schinus areira*	pepper tree		X																							
Apocynaceae	**Gomphocarpus fruticosus*	narrow-leaved cotton bush	1				1													3	2	3	2	2		1	
Asteraceae	**Aster subulatus*	wild aster		1													1				1	1					
Asteraceae	**Bidens pilosa*	cobblers pegs												2	2	2	2	3	2	2	2	3	2	3			2
Asteraceae	**Bidens subalternans*	greater beggar's ticks					2	2																			
Asteraceae	*Calocephalus citreus*	lemon beauty-heads										2															
Asteraceae	*Calotis lappulacea*	yellow burr-daisy		2	2					2				2	3	1		1							2	1	1
	Cassinia aculeata	dolly bush																							2	1	1
Asteraceae	**Chondrilla juncea*	skeleton weed						1																			
Asteraceae	*Chrysocephalum apiculatum*	common everlasting	2												1	2											
Asteraceae	*Chrysocephalum semipapposum*	clustered everlasting		2		1			1		2	2															
Asteraceae	**Cirsium vulgare*	spear thistle																		2	2	2			1		
Asteraceae	**Conyza*	flaxleaf fleabane																					1	1			

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	bonariensis																										
Asteraceae	**Dittrichia graveolens*	stinkwort																		2							
Asteraceae	**Facelis retusa*								2																		
Asteraceae	*Glossocardia bidens*	cobblers tack	1		2																						
Asteraceae	**Hypochaeris radicata*	catsear		2				2	2	2		1			1	2	2			2	2		2	2			1
Asteraceae	*Lagenophora gracilis*	slender lagenophora																							2	1	
Asteraceae	*Lagenophora stipitata*	common lagenophora			1							1															
Asteraceae	*Ozothamnus diotophyllus*	white dogwood			1																				X		
Asteraceae	**Senecio madagascariensis*	fireweed		2		2	2	2			2	1	2	2	2		2	2	2	2		2	2		2	2	2
Asteraceae	**Silybum marianum*	variegated thistle						1																			
Asteraceae	**Sonchus oleraceus*	common sowthistle		1			1													2	1	1	2				
Asteraceae	**Tagetes minuta*	stinking Roger																			2	2	2	1			
Asteraceae	*Vernonia cinerea*		2		2																						
Asteraceae	*Vittadinia cervicularis*														1												
Asteraceae	*Vittadinia cuneata*	a fuzzweed																									1
Asteraceae	*Vittadinia cuneata* var. *cuneata*	a fuzzweed																							3	1	
Asteraceae	*Vittadinia muelleri*	a fuzzweed					2																				
Asteraceae	*Vittadinia sulcata*																			2		1	1	1			
Boraginaceae	**Heliotropium amplexicaule*	blue heliotrope						2																			
Brassicaceae	**Hirschfeldia incana*	buchan weed																		2	2		2				
Brassicaceae	**Lepidium africanum*	common peppercress						2																			
Brassicaceae	**Rapistrum rugosum*	turnip weed						2																			
Cactaceae	**Opuntia aurantiaca*	tiger pear					2	2																			
Cactaceae	**Opuntia humifusa*	creeping pear												1		1		1						1			1
Cactaceae	**Opuntia stricta* var. *stricta*	common prickly pear	2		1	1		2			1														1	2	1
Campanulaceae	*Wahlenbergia communis*	tufted bluebell			1		1	2				2	1														
Campanulaceae	*Wahlenbergia gracilis*	sprawling bluebell		1				1																			
Campanulaceae	*Wahlenbergia luteola*	bluebell																						1		1	
Caryophyllaceae	**Paronychia brasiliana*	chilean whitlow wort, brazilian whitlow						2																			
Caryophyllaceae	**Stellaria media*	common chickweed																	2	2	1	2		1			
Casuarinaceae	*Allocasuarina*	bulloak	3			3						3				2	3	2									

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			RAVP03	RAVP05	RAVP06	RAVP07	RAVP08	RAVP032	RAVP033	RAVP034	RAVP035	RAVP036	RAVP037	MOPRQ1	MOPRQ2	MOQ1	MOQ2	MOQ3	MOQ4	MOQ5	MOQ6	MOQ7	MOQ8	MOQ9	RSFQ1	RSFQ2	RSFQ3
	luehmannii																										
Casuarinaceae	*Casuarina glauca*	swamp oak					X																				
Chenopodiaceae	*Atriplex semibaccata*	creeping saltbush		1																							
Chenopodiaceae	*Einadia hastata*	berry saltbush					1			1																	
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	climbing saltbush				1																					
Chenopodiaceae	*Einadia nutans* subsp. *nutans*	climbing saltbush									1	2												1			
Chenopodiaceae	*Enchylaena tomentosa*	ruby saltbush		1		1	3					1									2	1		3			
Chenopodiaceae	*Maireana* sp.	cotton bush, bluebush, fissure-weed													1	1		2								2	1
Clusiaceae	*Hypericum gramineum*	small St Johns wort	1									1															
Convolvulaceae	*Convolvulus erubescens*	pink bindweed		1			1																				
Convolvulaceae	*Dichondra repens*	kidney weed	2	2	2	2	2			2		2		2	2	2	2	2	2	3	2	2	1		2	2	3
Crassulaceae	**Bryophyllum delagoense*	mother of millions										2															
Dilleniaceae	*Hibbertia obtusifolia*	hoary guinea flower			2	2												1									
Dilleniaceae	*Hibbertia* sp.														2										2	2	2
Ericaceae	*Lissanthe strigosa*	peach heath	1		1																						
Ericaceae	*Melichrus urceolatus*	urn heath																								3	
Euphorbiaceae	*Chamaesyce drummondii*	caustic weed		1																							
Fabaceae (Faboideae)	*Daviesia ulicifolia*	gorse bitter pea			2	1						1			3	2		2	1		1		2		2	3	1
Fabaceae (Faboideae)	*Desmodium brachypodum*	large tick-trefoil																							1	1	2
Fabaceae (Faboideae)	*Desmodium varians*	slender tick-trefoil	1		1	1																					
Fabaceae (Faboideae)	*Glycine clandestina*	twining glycine	2							1					1										2	2	2
Fabaceae (Faboideae)	*Glycine tabacina*	variable glycine	2	2	2	2	2		1	2		2			1	2	2	2							3	2	
Fabaceae (Faboideae)	*Hardenbergia violacea*	false sarsaparilla								1																	
Fabaceae (Faboideae)	*Kennedia rubicunda*	dusky coral pea																			2						
Fabaceae (Faboideae)	**Medicago* sp.	a medic		1			2																				
Fabaceae (Faboideae)	*Pultenaea microphylla*	a bush pea										2															
Fabaceae (Faboideae)	*Pultenaea spinosa*	a bush pea																					3			2	
Fabaceae (Faboideae)	*Pultenaea* sp.				2																						

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			RAVP03	RAVP05	RAVP06	RAVP07	RAVP08	RAVP032	RAVP033	RAVP034	RAVP035	RAVP036	RAVP037	MOPRQ1	MOPRQ2	MOQ1	MOQ2	MOQ3	MOQ4	MOQ5	MOQ6	MOQ7	MOQ8	MOQ9	RSFQ1	RSFQ2	RSFQ3
Fabaceae (Faboideae)	*Templetonia stenophylla*	leafy templetonia										1															
Fabaceae (Faboideae)	**Trifolium* sp.	a clover						2																			
Fabaceae (Faboideae)	*Zornia dyctiocarpa*				1																						
Fabaceae (Mimosoideae)	*Acacia amblygona*	fan wattle			2										2					3			3			1	
Fabaceae (Mimosoideae)	*Acacia deanei* subsp. *deanei*	Deanes wattle		X																		3					
Fabaceae (Mimosoideae)	*Acacia decurrens*	black wattle																	4				3	2			
Fabaceae (Mimosoideae)	*Acacia elongata*	swamp wattle																				1					
Fabaceae (Mimosoideae)	*Acacia falcata*				2																						
Fabaceae (Mimosoideae)	*Acacia parvipinnula*	silver-stemmed wattle														2	1				2	3			3	3	3
Fabaceae (Mimosoideae)	*Acacia salicina*	cooba										1										2				1	1
Fabaceae (Mimosoideae)	**Acacia saligna*	golden wreath wattle					2													2	3	2		4			
Fabaceae (Mimosoideae)	*Acacia* sp.	wattle			1																3						
Geraniaceae	*Geranium* sp.							1																			
Goodeniaceae	*Goodenia rotundifolia*																								3	4	3
Haloragaceae	*Haloragis heterophylla*	variable raspwort								1																	
Lamiaceae	*Mentha satureioides*	native pennyroyal							2			2															
Lamiaceae	*Spartothamnella juncea*	bead bush														1									2		
Lobeliaceae	*Pratia purpurascens*	whiteroot	1		2										2	2	2	2							1	3	3
Loranthaceae	*Amyema miquelii*	box mistletoe																							1		2
Loranthaceae	*Amyema* sp.	mistletoe		1	2													1									
Malvaceae	*Brachychiton populneus* subsp. *populneus*	kurrajong														2		1							1		
Malvaceae	*Sida corrugata*	corrugated sida												2	2	2		3									
Malvaceae	**Sida rhombifolia*	Paddys lucerne	2	2			2			2						1								1			
Malvaceae	**Verbascum thapsus* subsp. *thapsus*	great mullein												1													
Meliaceae	*Melia azedarach*	white cedar		X																							
Myoporaceae	*Eremophila debilis*	amulla			2	1	1					1								1					2	2	2
Myoporaceae	*Myoporum montanum*	western boobialla		X																							
Myrsinaceae	**Anagallis arvensis*	scarlet pimpernel					2		2	2			2														
Myrtaceae	*Angophora*	rough-barked apple														3	X	2							2		

Family	Scientific Name	Common Name	UHSA Quadrats (Umwelt 2014, in prep)											Rehab Assessment (Umwelt 2013b)													
			RAVP03	RAVP05	RAVP06	RAVP07	RAVP08	RAVP032	RAVP033	RAVP034	RAVP035	RAVP036	RAVP037	MOPRQ1	MOPRQ2	MOQ1	MOQ2	MOQ3	MOQ4	MOQ5	MOQ6	MOQ7	MOQ8	MOQ9	RSFQ1	RSFQ2	RSFQ3
	floribunda																										
Myrtaceae	*Corymbia maculata*	spotted gum		2	3		3			4	4			2		3	3	3	4	3	3	3	3	3	4	3	4
Myrtaceae	*Corymbia* sp.						X																				
Myrtaceae	**Eucalyptus cladocalyx*	sugar gum					X																				
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark	3	1		2						3		3	4	3	4	X								3	3
Myrtaceae	*Eucalyptus dawsonii*	slaty gum					3																				
Myrtaceae	*Eucalyptus fibrosa*	narrow-leaved ironbark		1	3																				4	3	3
Myrtaceae	*Eucalyptus moluccana*	grey box			3	3												2	2								X
Myrtaceae	*Eucalyptus punctata*	grey gum					X									3	X	3									
Myrtaceae	*Eucalyptus tereticornis*	forest red gum	3	3														2									
Nyctaginaceae	*Boerhavia dominii*	tarvine						1																			
Oleaceae	*Notelaea microcarpa* var. *microcarpa*																								2		
Oleaceae	**Olea europaea* subsp. *cuspidata*	African olive					1			2																	
Oxalidaceae	*Oxalis exilis*			2			2		2			1	1														
Oxalidaceae	*Oxalis perennans*																									2	
Phytolaccaceae	**Phytolacca octandra*	inkweed					1														1						
Pittosporaceae	*Bursaria spinosa* subsp. *spinosa*	native blackthorn		2	2									3				1	1	2			1		2	3	2
Plantaginaceae	**Plantago lanceolata*	lambs tongues		2			1			2	1	1		1					1			1					
Plantaginaceae	*Veronica plebeia*	trailing speedwell								2	1	1															2
Polygonaceae	**Acetosella vulgaris*	sheep sorrel																									
Polygonaceae	*Rumex brownii*	swamp dock						1																			
Polygonaceae	*Rumex* sp.	dock					1																				
Portulacaceae	*Portulaca oleracea*	pigweed						2				1															
Ranunculaceae	*Clematis glycinoides*	headache vine																							2		1
Rosaceae	**Rosa rubiginosa*	sweet briar							X																		
Rubiaceae	Asperula conferta	common woodruff																									2
Rubiaceae	*Opercularia diphylla*	stinkweed	1																								
Rubiaceae	*Pomax umbellata*	pomax	1																							3	2
Sapindaceae	*Dodonaea viscosa* subsp. *spatulata*	broad-leaf hopbush																						3			
Solanaceae	*Solanum brownii*	violet nightshade																							1	2	
Solanaceae	**Solanum nigrum*	black-berry nightshade					1			1																	
Solanaceae	*Solanum*	forest nightshade					1									2									2		1

Family	Scientific Name	Common Name	UHSA Quadrats (Umwelt 2014, in prep)											Rehab Assessment (Umwelt 2013b)													
			RAVP03	RAVP05	RAVP06	RAVP07	RAVP08	RAVP032	RAVP033	RAVP034	RAVP035	RAVP036	RAVP037	MOPRQ1	MOPRQ2	MOQ1	MOQ2	MOQ3	MOQ4	MOQ5	MOQ6	MOQ7	MOQ8	MOQ9	RSFQ1	RSFQ2	RSFQ3
	prinophyllum																										
Stackhousiaceae	*Stackhousia sp.*				2	1																					
Stackhousiaceae	*Stackhousia viminea*	slender stackhousia	1								1	1															
Verbenaceae	**Lantana camara*	lantana																							1		1
Verbenaceae	**Verbena bonariensis*	purpletop						2								1	1										
Verbenaceae	**Verbena rigida*	veined verbena						2					2	2					2								

APPENDIX C

Fauna Species List

Appendix C – Fauna Species List

The following list was developed from surveys of the Project Area, including the proposed disturbance area detailed in Section 3.5 of the main report. This species list was compiled from data from the OEH Atlas of NSW Wildlife, species recorded during field surveys undertaken by Umwelt from 2011 to 2014, as well as records from the 18 years of biodiversity monitoring of the Mount Owen Complex by the University of Newcastle (TUNRA and Newcastle Innovation), Forest Fauna Surveys Pty Ltd and Fly By Night Pty Ltd.

The following abbreviations or symbols are used in the list:

asterisk (*)	Denotes species not indigenous to Mount Owen Complex;
carat (^)	Denotes a tentative species record;
subsp.	Subspecies;
MAR	Listed marine species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
MIG	Listed migratory species under the EPBC Act;
V	Vulnerable under Schedule 2 of the *Threatened Species Conservation Act 1995* (TSC Act); and
E	Endangered under Schedule 1 of the TSC Act;

Birds recorded were identified using descriptions in Slater *et al.* (2003) and the scientific and common name nomenclature of BirdLife International Taxonomic Checklist (2013) (formerly Birds Australia). Reptiles recorded were identified using keys and descriptions in Cogger (2000), Swan *et al*. (2004), Weigel (1990) and Wilson and Swan (2008) and the scientific and common name nomenclature of Cogger (2000).

Amphibians recorded were identified using keys and descriptions in Cogger (2000), Robinson (1998), Anstis (2002) and Barker *et al.* (1995) and the scientific and common name nomenclature of Cogger (2000). Mammals recorded were identified using keys and descriptions in Strahan (2002) and Menkhorst and Knight (2004) and the scientific and common name nomenclature of Strahan (2002) for non bat species. Bat species recorded were identified using keys and descriptions in Churchill (1998) and ecological information was obtained from Churchill (2008).

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
BIRDS							
Phasianidae							
Coturnix pectoralis	stubble quail		MAR	✓			✓
Coturnix ypsilophora	brown quail			✓		✓	✓
Anatidae							
Anas castanea	chestnut teal						✓
Anas gracilis	grey teal			✓			✓
Anas rhynchotis	Australasian shoveler						✓
Anas superciliosa	Pacific black duck			✓		✓	✓
Aythya australis	hardhead			✓			✓
Chenonetta jubata	Australian wood duck			✓		✓	✓
Cygnus atratus	black swan			✓			✓
Malacorhynchus membranaceus	pink-eared duck						✓
Podicipedidae							
Podiceps cristatus	great crested grebe						✓
Poliocephalus poliocephalus	hoary-headed grebe			✓			
Tachybaptus novaehollandiae	Australasian grebe			✓			✓
Anhingidae							
Anhinga melanogaster	darter			✓			✓
Phalacrocoracidae							
Phalacrocorax carbo	great cormorant			✓			✓
Phalacrocorax melanoleucos	little pied cormorant			✓			✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Phalacrocorax sulcirostris	little black cormorant			✓			✓
Pelecanidae							
Pelecanus conspicillatus	Australian pelican		MAR			✓	✓
Ardeidae							
Ardea alba	eastern great egret		MAR / MIG		✓		✓
Ardea ibis	cattle egret		MAR / MIG		✓	✓	
Ardea pacifica	white-necked heron			✓			✓
Egretta novaehollandiae	white-faced heron			✓			✓
Nycticorax caledonicus	nankeen night heron						✓
Threskiornithidae							
Platalea flavipes	yellow-billed spoonbill			✓			✓
Threskiornis molucca	Australian white ibis		MAR	✓			
Threskiornis spinicollis	straw-necked ibis		MAR	✓			✓
Accipitridae							
Accipiter cirrhocephalus	collared sparrowhawk						✓
Accipiter fasciatus	brown goshawk		MAR	✓		✓	✓
Aquila audax	wedge-tailed eagle			✓		✓	✓
Aviceda subcristata	Pacific baza			✓			✓
Circus assimilis	spotted harrier	V				✓	
Elanus notatus	black-shouldered kite			✓		✓	✓
Haliaeetus leucogaster	white-bellied sea-eagle		MAR / MIG		✓		✓
Haliastur sphenurus	whistling kite		MAR	✓		✓	✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Hieraaetus morphnoides	little eagle	V		✓			✓
Falconidae							
Falco berigora	brown falcon			✓		✓	✓
Falco cenchroides	nankeen kestrel		MAR	✓		✓	✓
Falco longipennis	Australian hobby					✓	✓
Falco peregrinus	peregrine falcon			✓			✓
Rallidae							
Fulica atra	Eurasian coot			✓		✓	✓
Gallinula tenebrosa	dusky moorhen			✓			✓
Gallirallus philippensis	buff-banded rail						✓
Recurvirostridae							
Himantopus himantopus	black-winged stilt		MAR				✓
Charadriidae							
Elseyornis melanops	black-fronted dotterel			✓			✓
Vanellus miles	masked lapwing			✓		✓	✓
Scolopacidae							
Gallinago hardwickii	Lathams snipe		MAR / MIG		✓		✓
Turnicidae							
Turnix varia	painted button-quail			✓			✓
Laridae							
Chroicocephalus novaehollandiae	silver gull			✓			
Columbidae							

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
**Columba livia*	rock dove						✓
Geopelia cuneata	diamond dove						✓
Geopelia humeralis	bar-shouldered dove			✓			✓
Geopelia placida	peaceful dove			✓			✓
Lopholaimus antarcticus	topknot pigeon			✓			✓
Macrophygia amboinenses	brown cuckoo-dove						✓
Ocyphaps lophotes	crested pigeon			✓		✓	✓
Phaps chalcoptera	common bronzewing			✓		✓	✓
**Streptopelia chinensis*	spotted turtle-dove			✓		✓	✓
Podargidae							
Podargus strigoides	tawny frogmouth			✓		✓	✓
Caprimulgidae							
Eurostopodus mystacalis	white-throated nightjar		MAR	✓			✓
Cacatuidae							
Calyptorhynchus funereus	yellow-tailed black cockatoo						✓
Cacatua galerita	sulphur-crested cockatoo			✓			✓
Cacatua roseicapilla	galah			✓		✓	✓
Cacatua sanguinea	little corella						✓
Psittacidae							
Alisterus scapularis	Australian king-parrot			✓			✓
Glossopsitta concinna	musk lorikeet			✓		✓	✓
Glossopsitta pusilla	little lorikeet	V		✓			✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Lathamus discolor	swift parrot	E	E / MAR	✓	✓		✓
Platycercus elegans	crimson rosella			✓		✓	✓
Platycercus eximius	eastern rosella			✓		✓	✓
Psephotus haematodus	red-rumped parrot						✓
Trichoglossus haematodus	rainbow lorikeet			✓			✓
Cuculidae							
Cacomantis flabelliformis	fan-tailed cuckoo		MAR	✓			✓
Chalcites basalis	Horsfields bronze-cuckoo		MAR	✓			✓
Chalcites lucidus	shining bronze-cuckoo		MAR				✓
Cuculus pallidus	pallid cuckoo		MAR	✓		✓	✓
Scythrops novaehollandiae	channel-billed cuckoo		MAR	✓		✓	✓
Centropodidae							
Centropus phasianinus	pheasant coucal			✓			✓
Strigidae							
Ninox novaeseelandiae	southern boobook		MAR	✓		✓	✓
Ninox strenua	powerful owl	V		✓			✓
Tytonidae							
Tyto alba	barn owl			✓			✓
Tyto novaehollandiae	masked owl	V		✓			✓
Aegothelidae							
Aegotheles cristatus	Australian owlet-nightjar			✓		✓	✓
Apodidae							

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Hirundapus caudacutus	white-throated needletail		MAR / MIG	✓	✓	✓	✓
Halcyonidae							
Alcedo azurea	azure kingfisher			✓			✓
Dacelo novaeguineae	laughing kookaburra			✓			✓
Todiramphus sanctus	sacred kingfisher		MAR	✓		✓	✓
Meropidae							
Merops ornatus	rainbow bee-eater		MAR / MIG	✓	✓		✓
Coraciidae							
Eurystomus orientalis	dollarbird		MAR	✓			✓
Climacteridae							
Climacteris picumnus victoriae	brown treecreeper (eastern subsp.)	V		✓			✓
Corombates leucophaeus	white-throated treecreeper			✓			✓
Ptilonorhynchidae							
Ptilonorhynchus violaceus	satin bowerbird			✓			✓
Maluridae							
Malurus cyaneus	superb fairy-wren			✓		✓	✓
Malurus lamberti	variegated fairy-wren			✓			✓
Pardalotidae							
Pardalotus punctatus	spotted pardalote			✓		✓	✓
Pardalotus striatus	striated pardalote			✓		✓	✓
Acanthizidae							
Acanthiza chrysorrhoa	yellow-rumped thornbill			✓		✓	✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Acanthiza lineata	striated thornbill			✓		✓	✓
Acanthiza nana	yellow thornbill			✓		✓	✓
Acanthiza pusilla	brown thornbill			✓			✓
Acanthiza reguloides	buff-rumped thornbill			✓		✓	✓
Chthonicola sagittata	speckled warbler	V		✓		✓	✓
Gerygone fusca	western gerygone			✓			✓
Gerygone mouki	brown gerygone						✓
Gerygone olivacea	white-throated gerygone			✓		✓	✓
Sericornis citreogularis	yellow-throated scrubwren						✓
Sericornis frontalis	white-browed scrubwren			✓			✓
Smicrornis brevirostris	weebill			✓		✓	✓
Meliphagidae							
Acanthagenys reufogularis	spiny-cheeked honeyeater					✓	
Acanthorhynchus tenuirostris	eastern spinebill			✓			✓
Anthochaera carunculata	red wattlebird			✓			✓
Lichenostomus chrysops	yellow-faced honeyeater			✓		✓	✓
Lichenostomus fuscus	fuscous honeyeater			✓			✓
Lichenostomus leucotis	white-eared honeyeater			✓			✓
Lichenostomus penicillatus	white-plumed honeyeater			✓		✓	✓
Manorina melanocephala	noisy miner			✓		✓	✓
Manorina melanophrys	bell miner			✓			✓
Meliphaga lewinii	Lewins honeyeater			✓			✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Melithreptus brevirostris	brown-headed honeyeater			✓		✓	✓
Melithreptus gularis gularis	black-chinned honeyeater (eastern subsp.)	V		✓			✓
Melithreptus lunatus	white-naped honeyeater			✓			✓
Myzomela sanguinolenta	scarlet honeyeater			✓			✓
Philemon citreogularis	little friarbird			✓			
Philemon corniculatus	noisy friarbird			✓		✓	✓
Phylidonyris nigra	white-cheeked honeyeater			✓			✓
Plectorhyncha lanceolata	striped honeyeater			✓			✓
Petroicidae							
Eopsaltria australis	eastern yellow robin			✓			✓
Melanodryas cucullata cucullata	hooded robin (south-eastern form)	V		✓			✓
Microeca leucophaea	jacky winter			✓			✓
Petroica boodang	scarlet robin	V		✓			✓
Petroica goodenovii	red-capped robin			✓		✓	
Petroica phoenicea	flame robin	V	MAR	✓			✓
Petroica rosea	rose robin			✓		✓	✓
Eupetidae							
Cinclosoma punctatum	spotted quail-thrush			✓			✓
Psophodes olivaceus	eastern whipbird			✓			✓
Pomatostomidae							

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Pomatostomus temporalis temporalis	grey-crowned babbler (eastern subsp.)	V		✓		✓	✓
Neosittidae							
Daphoenositta chrysoptera	varied sittella	V		✓			✓
Pachycephalidae							
Colluricincla harmonica	grey shrike-thrush					✓	✓
Falcunculus frontatus	eastern shrike-tit			✓			✓
Pachycephala pectoralis	golden whistler			✓		✓	✓
Pachycephala rufiventris	rufous whistler			✓			✓
Dicruridae							
Grallina cyanoleuca	magpie-lark		MAR	✓		✓	✓
Myiagra inquieta	restless flycatcher			✓			✓
Myiagra rubecula	leaden flycatcher			✓			✓
Rhipidura fuliginosa	grey fantail			✓		✓	✓
Rhipidura leucophrys	willie wagtail			✓		✓	✓
Rhipidura rufifrons	rufous fantail		MAR / MIG		✓		✓
Campephagidae							
Coracina novaehollandiae	black-faced cuckoo-shrike		MAR	✓		✓	✓
Coracina papuensis	white-bellied cuckoo-shrike						✓
Coracina tenuirostris	cicadabird			✓			
Lalage tricolor	white-winged triller			✓			✓
Oriolidae							

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Oriolus sagittatus	olive-backed oriole			✓		✓	✓
Artamidae							
Artamus cyanopterus	dusky woodswallow			✓			✓
Cracticus nigrogularis	pied butcherbird			✓		✓	✓
Cracticus torquatus	grey butcherbird					✓	✓
Gymnorhina tibicen	Australian magpie			✓		✓	✓
Strepera graculina	pied currawong			✓			✓
Corvidae							
Corvus coronoides	Australian raven			✓		✓	✓
Corcoracidae							
Corcorax melanorhamphos	white-winged chough			✓		✓	✓
Motacilidae							
Anthus novaeseelandiae	Australasian pipit		MAR	✓		✓	✓
Passeridae							
**Passer domesticus*	house sparrow						✓
Estrildidae							
Neochmia temporalis	red-browed finch			✓		✓	✓
Stagonopleura guttata	diamond firetail	V		✓			✓
Taeniopygia bichenovii	double-barred finch			✓		✓	✓
Taeniopygia guttata	zebra finch						✓
Dicaeidae							
Dicaeum hirundinaceum	mistletoebird			✓		✓	✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Hirundinidae							
Hirundo neoxena	welcome swallow		MAR	✓		✓	✓
Petrochelidon ariel	fairy martin			✓		✓	✓
Petrochelidon nigricans	tree martin			✓			✓
Sylviidae							
Acrocephalus australis	Australian reed-warbler		MAR	✓			✓
Cincloramphus mathewsi	rufous songlark						✓
Cisticolidae							
Cisticola exilis	golden-headed cisticola						✓
Zosteropidae							
Zosterops lateralis	silvereye		MAR	✓			✓
Sturnidae							
**Acridotheres tristis*	common myna			✓			✓
**Sturnus vulgaris*	common starling			✓			✓
REPTILES							
Cheloniidae							
Chelodina longicollis	snake-necked turtle			✓		✓	✓
Gekkonidae							
Diplodactylus vittatus	stone gecko			✓			✓
Oedura robusta	robust velvet gecko						✓
Underwoodisaurus milii	thick-tailed gecko						✓
Varanidae							

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Varanus varius	lace monitor			✓		✓	✓
Agamidae							
Amphibolurus muricatus	jacky lizard			✓			✓
Physignathus lesueurii	eastern water dragon						✓
Pogona barbata	eastern bearded dragon			✓			✓
Scincidae							
Carlia tetradactyla	southern rainbow skink			✓			✓
Cryptoblepharus virgatus	cream-striped shinning-skink			✓			✓
Ctenotus robustus	striped skink			✓			✓
Egernia modesta	skink						✓
Egernia striolata	tree skink			✓		✓	✓
Eulamprus tenuis	barred-sided skink						✓
Lampropholis delicata	grass skink			✓		✓	✓
Lampropholis guichenoti	garden skink						✓
Lygisaurus foliorum	tree-base litter-skink			✓			✓
Morethia boulengeri				✓			✓
Tiliqua scincoides	eastern blue-tongue			✓			✓
Pygopodidae							
Delma plebeia	leaden delma						✓
Typhlopidae							
Ramphotyphlops proximus	blind or worm snake						✓
Elapidae							

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Demansia psammophis	yellow-faced whip snake						✓
Furina diadema	red-naped snake			✓			✓
Pseudechis guttatus	blue-bellied black snake						✓
Pseudechis porphyriacus	red-bellied black snake			✓			✓
Pseudonaja textilis	eastern brown snake			✓			✓
Vermicella annulata	bandy bandy					✓	✓
AMPHIBIANS							
Myobatrachidae							
Crinia signifera	common eastern froglet			✓		✓	✓
Limnodynastes dumerilii	banjo frog, eastern pobblebonk						✓
Limnodynastes ornatus	ornate burrowing frog			✓			✓
Limnodynastes peronii	striped marsh frog			✓			✓
Limnodynastes tasmaniensis	spotted marsh frog			✓		✓	✓
Uperoleia fusca	dusky toadlet						✓
Uperoleia laevigata	smooth toadlet			✓		✓	✓
Uperoleia rugosa	rugose toadlet						✓
Hylidae							
Litoria aurea	green and golden bell frog	E	V	✓	✓		✓
Litoria caerulea	green tree frog			✓		✓	✓
Litoria dentata	bleating tree frog						✓
Litoria fallax	green reed frog, dwarf tree frog			✓		✓	✓
Litoria latopalmata	broad-palmed frog			✓		✓	✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Litoria lesueuri	Lesueurs frog			✓			
Litoria peronii	Peron's tree frog			✓		✓	✓
Litoria verreauxii	Verreauxs tree frog					✓	✓
Litoria wilcoxi	Stoney Creek frog						✓
MAMMALS							
Tachyglossidae							
Tachyglossus aculeatus	short-beaked echidna			✓			✓
Dasyuridae							
Antechinus flavipes	yellow-footed antechinus			✓		✓	✓
Antechinus stuartii	brown antechinus			✓			✓^
Dasyurus maculatus	spotted-tailed quoll	V	E	✓	✓	✓	✓
Phascogale tapoatafa	brush-tailed phascogale	V				✓	✓
Planigale tenuirostris	narrow-nosed planigale			✓			✓
Sminthopsis murina	common dunnart			✓		✓	✓
Peramelidae							
Isodon macrourus	northern brown bandicoot						✓
Phascolarctidae							
Phascolarctos cinereus	koala	V	V	✓	✓		✓^
Vombatidae							
Vombatus ursinus	common wombat			✓			✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Petauridae							
Petaurus breviceps	sugar glider			✓			✓^
Petaurus norfolcensis	squirrel glider	V		✓			✓
Phalangeridae							
Trichosurus vulpecula	common brushtail possum			✓		✓	✓
Pseudocheiridae							
Pseudocheirus peregrinus	common ringtail possum			✓			✓
Macropodidae							
Macropus giganteus	eastern grey kangaroo			✓		✓	✓
Macropus robustus	common wallaroo			✓			✓
Macropus rufogriseus	red-necked wallaby			✓		✓	✓
Wallabia bicolor	swamp wallaby			✓		✓	✓
Pteropodidae							
Pteropus poliocephalus	grey-headed flying-fox	V	V	✓	✓		✓
Pteropus scapulatus	little red flying-fox						✓
Emballonuridae							
Saccolaimus flaviventris	yellow-bellied sheathtail-bat	V		✓			✓
Rhinolophidae							
Rhinolophus megaphyllus	eastern horseshoe-bat						✓
Molossidae							
Mormopterus norfolkensis	east coast freetail-bat	V		✓		✓	✓
Mormopterus planiceps	southern freetail-bat			✓		✓	✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Nyctinomus australis	white-striped freetail-bat			✓		✓	✓
Vespertilionidae							
Chalinolobus dwyeri	large-eared pied bat	V	V		✓		✓
Chalinolobus gouldii	Gould's wattled bat			✓		✓	✓
Chalinolobus morio	chocolate wattled bat			✓		✓	✓
Miniopterus australis	little bentwing-bat	V					✓
Miniopterus schreibersii oceanensis	eastern bentwing-bat	V		✓		✓	✓
Myotis macropus	southern myotis	V				✓	✓
Nyctophilus geoffroyi	lesser long-eared bat			✓			✓
Nyctophilus gouldi	Gould's long-eared bat			✓			✓
Scoteanax rueppellii	greater broad-nosed bat	V				✓	✓
Scotorepens balstoni	inland broad-nosed bat			✓		✓	✓
Scotorepens orion	eastern broad-nosed bat			✓			
Vespadelus darlingtoni	large forest bat			✓			✓
Vespadelus pumilus	eastern forest bat			✓			✓
Vespadelus regulus	southern forest bat			✓			✓
Vespadelus vulturnus	little forest bat			✓		✓	✓
Muridae							
**Mus musculus*	house mouse			✓		✓	✓
Pseudomys novaehollandiae	New Holland mouse		V	✓	✓		✓
Rattus lutreolus	swamp rat			✓			✓
**Rattus rattus*	black rat			✓			✓

Scientific Name	Common Name	Conservation Status		Source			
		TSC Act	EPBC Act	OEH Wildlife Atlas Searches	Department of Environment Protected Matters Search Tool	Umwelt Surveys (2011- 2014)	Mount Owen Complex Annual Fauna Monitoring Surveys (1994-2013)
Canidae							
Canis lupus dingo	dingo			✓			✓
**Canis familiaris*	dog			✓		✓	✓
**Vulpes vulpes*	fox			✓		✓	✓
Cervidae							
**Dama dama*	fallow deer						✓
Equidae							
**Equus caballus*	horse			✓			✓
Felidae							
**Felis catus*	cat			✓		✓	✓
Leporidae							
**Lepus capensis*	brown hare			✓			✓
**Oryctolagus cuniculus*	rabbit			✓			✓
Cervidae							
**Bos taurus*	cattle			✓		✓	✓

APPENDIX D

Aquatic Survey Results

Appendix D - Aquatic Survey Results

The following list was developed from surveys of the Project Area, including the proposed disturbance area detailed in Section 3.7 of the main report. It details the results of the AUSRIVAS habitat assessment that was undertaken for the Mount Owen Continued Operations Project.

Table 1 - AUSRIVAS Habitat Assessment

Attribute		Bowmans Creek	
		Site 1	Site 2
Easting		0317683	0317754
Northing		6409251	6409164
Water temperature		18	19
pH		7.61	8.09
Bank height (m)		0.5	1.5
Bank full width (m)		10	20
Length of reach (m)		100	100
Stream width (m)	minimum	1	2
	maximum	6	7
	mode	4	5
Riffle %		<5	10
Pool %		<5	15
Run %		90	75
Edge %		100/100	100/100
Macrophyte %		0/100	0/100
Riparian zone width (m)	left	0.5	7
	right	2	5
% cover of riparian zone	trees (>10 m)	<5	50
	trees (<10 m)	<5	20
	shrubs	5	5
	grasses/ferns/ sedges	90	35
Vegetation description		*Casuarina cunninghamiana, Juncus acutus, Juncus kraussi, Typha* sp. and drain flat sedges	*Casuarina cunninghamiana, Glochidion ferdinandi, Lomandra longifolia, Lantana camara*
Shading of river		<5	>76
Vegetation %	native	25	30
	exotic	60	70
Water odour		normal	normal
Water oils (natural or man-made)		none	none
Turbidity		slight	turbid
Plume		some	Some, lots
Sediment oils		absent	absent
Sediment odours		normal	anaerobic
Flow level		low	low
Bare ground above water mark (%)	left	10	30
	right	<5	20

Table 1 - AUSRIVAS Habitat Assessment (cont.)

Attribute		Bowmans Creek	
		Site 1	Site 2
Are the undersides of stones that are not deeply embedded black?		yes	yes
Sediment deposits		sand, silt	rock
Local catchment erosion		moderate	heavy
Local Point Source pollution		potential – catchment used	obvious – catchment used
Local Non Point Source pollution		obvious – agricultural cattle	potential – agricultural
Dams/barriers		absent	absent
River braiding		yes	no
Site classification		broad valley	broad valley
Land use Left bank		grazing	grazing
Land use Right bank		Industrial, grazing, tree felling	grazing
Bars		0	0
Reach: Substratum description (% cover)	bedrock	0	0
	boulder	0	0
	cobble	10	20
	pebble	50	60
	gravel	40	10
	sand	10	10
	silt	5	<5
	clay	0	0
Organic substratum	Detritus sticks, wood	<5	5
	Muck/Mud	10	5
Percent of reach covered by	Periphyton	1	1
	Moss	1	1
	Filamentous algae	4	3
	Macrophytes	1	1
Macrophytes	Submerged/ floating	0	0
	Emergent	*Juncus kraussii, Typha* sp.	*Juncus acutus, Typha* sp., *Polygonum* sp.

Table 2 - AUSRIVAS Categorisation (Scores) of Habitat Attributes

Habitat variable	Bowman Creek	
	Site 1	**Site 2**
Bottom substrate/available cover	10 (fair)	10 (fair)
Embeddedness	10 (fair)	10 (fair)
Velocity/depth category	6 (fair)	7 (fair)
Channel alteration	5 (fair)	4 (fair)
Bottom scouring and deposition	7 (fair)	3 (poor)
Pool/riffle, run/bend ratio	3 (poor)	6 (fair)
Bank stability	5 (fair)	3 (fair)
Bank vegetative stability	5 (fair)	6 (good)
Streamside vegetation cover	4 (fair)	9 (excellent)
Total Score	**55**	**58**

APPENDIX E

EP&A Act Assessment of Significance

Appendix E – Seven Part Tests under the *Environmental Planning and Assessment Act 1979*

Seven part tests are provided below for those threatened species, endangered populations (EPs) and threatened ecological communities (TECs) considered (refer to **Appendix A**) to have the potential to be impacted by the Project. The following species, EPs and TECs are assessed:

Threatened Ecological Communities

- Central Hunter Grey Box– Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions; and
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions.

Endangered Populations

- Darling River hardyhead (*Craterocephalus amniculus*) population in the Hunter River Catchment.

Critically Endangered Species

- regent honeyeater (*Anthochaera phrygia*).

Endangered Species

- swift parrot (*Lathamus discolor*); and
- green and golden bell frog (*Litoria aurea*).

Vulnerable Species

- *Ozothamnus tesselatus*;
- little eagle (*Heiraaetus morphnoides*);
- spotted harrier (*Circus assimilis*);
- little lorikeet (*Glossopsitta pusilla*);
- powerful owl (*Ninox strenua*);
- masked owl (*Tyto novaehollandiae*);
- brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- speckled warbler (*Chthonicola sagittata*);
- black-chinned honeyeater (eastern subspecies) (*Melithreptus gularis gularis*);
- grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- varied sittella (*Daphoenositta chrysoptera*);

- hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- scarlet robin (*Petroica boodang*);
- flame robin (*Petroica phoenicea*);
- diamond firetail (*Stagonopleura guttata*);
- spotted-tailed quoll (*Dasyurus maculatus*);
- brush-tailed phascogale (*Phascogale tapoatafa*);
- koala (*Phascolarctos cinereus*);
- squirrel glider (*Petaurus norfolcensis*);
- grey-headed flying-fox (*Pteropus poliocephalus*);
- yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*);
- east coast freetail-bat (*Mormopterus norfolkensis*);
- little bentwing-bat (*Miniopterus australis*);
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*);
- southern myotis (*Myotis macropus*);
- greater broad-nosed bat (*Scoteanax rueppellii*), and
- large-eared pied bat (*Chalinolobus dwyeri*).

All assessments are undertaken without any consideration of impact mitigation or offsetting opportunities or commitments. Impact mitigation and biodiversity offsetting commitments are addressed in Sections 6.0 and 7.0 of the main report. Species descriptions are referenced from the Office of Environment and Heritage (OEH 2014) and Department of the Environment (2014) online species profiles, unless otherwise noted.

Threatened Ecological Communities

Central Hunter Grey Box– Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions – Endangered Ecological Community

The Project will result in the removal of approximately 4.4 hectares of Central Hunter Grey Box – Ironbark Woodland EEC. Interrogation of the Hunter Remnant Vegetation Project (HRVP) shows that the mapped extent of this community across its distribution prior to 2006 was approximately 14,800 hectares (Peake 2006).

While the previous extent of TECs can be determined from previous studies, the current extent of communities is difficult to determine. Peake (2006) estimated the extent of TECs within the Central Hunter Valley in 2006. However the current extent of TECs in the Central Hunter Valley is likely less than that listed in Peake (2006), due to a number of major development approvals since 2006. In addition to reductions due to major development approvals, the extent of TECs may have also increased due to natural regeneration of derived native grassland communities into TEC woodland communities. The current extents of TECs in the Central Hunter Valley are unknown.

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;

Not applicable.

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;

Not applicable.

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; and

The removal of approximately 4.4 hectares is not likely to have a significant impact on the community in a regional context. Approximately 78.2 hectares of the community will be retained in the broader Project Area and therefore the loss of 4.4 hectares represents approximately 5 per cent of the extent of the community in the wider Project Area and approximately 0.03 per cent of the mapped (Peake 2006) regional distribution of the community. The removal of approximately 4.4 hectares of the community is not likely to have an adverse effect on the extent of the community such that its local occurrence would be placed at the risk of extinction.

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;

The local occurrence of the community occurring outside of the Proposed Disturbance Area is characterised by small and fragmented remnants. The removal of approximately 4.4 hectares of the community as a result of the Project is unlikely to result in the loss of

species diversity that would adversely modify the composition of the community such that its local occurrence may place it at risk of extinction.

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

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

Approximately 4.4 hectares of the community would be removed for the Project.

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

Fragmentation of remaining remnants of the community within the Project Area, and adjoining the Project Area, is likely to increase as a result of the Project. However, this community largely occurs as small fragmented remnants (Peake 2006) and the increase in fragmentation is not considered significant.

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 for this community within the Project Area is not likely to be important to its long-term survival in the locality.

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

The Project Area is not located in proximity to any areas of declared or recommended critical habitat. The Project will not have an adverse effect on any critical habitat.

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

A recovery plan has not been prepared for this community. There are no threat abatement plans of relevance to the proposed action.

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 Project will contribute to the operation of the following key threatening processes relevant to the EEC:

- bushrock removal (TSC Act);
- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, and considering the application of the precautionary principle, the Project is unlikely to result in a significant impact on the Central Hunter Grey Box – Ironbark Woodland EEC due to the small area of the community that will be impacted by the Project.

Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions – Endangered Ecological Community

The Project will result in the removal of approximately 131.9 hectares of Central Hunter Ironbark– Spotted Gum – Grey Box Forest EEC and 27.4 hectares of Planted Central Hunter Ironbark– Spotted Gum – Grey Box Forest EEC. The Planted Ironbark – Spotted Gum – Grey Box Forest community comprised an area of derived native grassland situated adjacent to intact woodland vegetation that was revegetated with the canopy species grey box (*Eucalyptus moluccana*), broad-leaved ironbark (*Eucalyptus fibrosa*), spotted gum (*Corymbia maculata*) and narrow-leaved ironbark (*Eucalyptus crebra*) approximately 15 years ago. The Planted Ironbark – Spotted Gum – Grey Box Forest was noticeably different to Central Hunter Ironbark – Spotted Gum – Grey Box Forest in that canopy species were planted in rows and the proportion of introduced flora species was also slightly higher than the surrounding remnant woodland. Although this community was planted, natural recruitment of canopy species was evident with eucalypt saplings occurring on the edges of the community and into adjacent grasslands and it is considered to conform to the Scientific Committee determination that describes Central Hunter Ironbark– Spotted Gum – Grey Box Forest EEC.

The Hunter Remnant Vegetation Project (HRVP) indicates that the mapped extent of this community across its distribution prior to 2006 was approximately 18,300 hectares (NSW Scientific Committee 2010). The current extent of the community is not expected to be significantly different to this estimate, as significant areas of this community have not been cleared, or approved for clearing, as part of recent large-scale developments in the central Hunter Valley. The Central Hunter Ironbark– Spotted Gum – Grey Box Forest EEC is mostly located in the central portion of the Project Area. Based on the Peake (2006) estimate of the community extent, impacts as a result of the Project represents a loss of less than 0.9 per cent of the distribution of this community.

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;

Not applicable.

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;

Not applicable.

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; and

The Project would result in the loss of approximately 159.3 hectares of the extent of this community which represents an approximately 23 per cent reduction in the remnant size within the Project Area. The largest remaining remnant of this community is located approximately 20 kilometres to the south of the Project Area in the Singleton Military Training Area, based on mapping of Peake (2006). The loss of approximately 159.3 hectares of this community may potentially result in an adverse effect on the extent of the community such that its local occurrence is likely to be placed at risk of extinction.

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;

The Project would result in the loss of 159.3 hectares of the community which occurs as part of a 699 hectare remnant within the Project Area, most of which is conserved within Ravensworth State Forest, New Forest Area and existing Mount Owen Biodiversity Offset Areas. The ecological impacts of the Project on this community may result in the community being adversely modified such that the composition of the ecological community is placed at risk of extinction.

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

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

The Project would result in the loss of approximately 159.3 hectares of this community. The area of the community to be removed for the Project is considered to constitute an important area of the community in the local area.

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

Fragmentation of the community is likely to occur as a result of the Project.

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 159.3 hectares of the community to be removed from the Proposed Disturbance Area is considered to be important to the long-term survival of the community in the locality and the region due to the presence of the large contiguous remnant occurring in the Project Area.

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

The Proposed Disturbance Area is not located in proximity to any areas of declared or recommended critical habitat areas. The Project is not likely to have an adverse effect on any critical habitat.

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

A recovery plan has not been prepared for this community. There are no threat abatement plans of relevance to the proposed action.

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 Project will contribute to the operation of the following key threatening processes relevant to the EEC:

- bushrock removal (TSC Act);

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, and considering the application of the precautionary principle, the Project is likely to result in a potentially significant impact on the Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC due the extent of the community to be removed in the Proposed Disturbance Area and the 23 per cent reduction in the extent of the community in the Project Area

Endangered Populations

Darling River hardyhead (*Craterocephalus amniculus*) population in the Hunter River Catchment

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;

Not applicable.

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;

The Darling River hardyhead (*Craterocephalus amniculus*) has been recorded in Bowmans Creek, downstream of the Project Area during aquatic monitoring for the Ashton Coal Project (Annick 2011). The species was not recorded during Umwelt surveys of the Project Area during 2012 and similarly has not been recorded in other aquatic assessments within Bowmans Creek (EcoLogical 2013; Roberts and Murray 2005). The species was collected from upper Bowmans Creek in 1976 and 1980, (Eco Logical 2012). The closest record of the species from Bowmans Creek occurs approximately 35 kilometres northwest of the Project Area in Dartbrook, NSW (DPI 2014b). The species is most commonly found in the north-east part of the Murray-Darling Basin, especially in the MacIntyre, Namoi and Border rivers. The Hunter River population is the only known occurrence of the species in an eastward flowing river (DPI 2014c).

The population of this species has presumably always been uncommon in the Hunter catchment as it has only ever been reported from nine widely dispersed sites. The next and most recent records of the species in the Hunter catchment were from the Krui River to the west of the Project area in September 2002 and from the Hunter River at Dartbrook in September 2003 (DPI 2014b). Records are known from slow flowing, clear, shallow waters or in aquatic vegetation at the edge of such waters (DPI 2014c). The species has also been recorded from the edge of fast flowing habitats such as the runs at the head of pools (DPI 2014c). The Darling River hardyhead has potential to make use of the aquatic habitat associated with Bowmans Creek.

The Project will result in the disturbance of ephemeral aquatic habitat within Bettys Creek, and short term, indirect impacts to aquatic habitat in bowmans Creek, associated with the duplication of Hebden Road Bridge. Bettys Creek is ephemeral with short periods of flow common after heavy rain. Minor pools are evident along the creek, however aquatic microhabitats such as pool/riffle sequences that would provided habitat for the species do not occur and potential habitat has not been identified. While the species has been recorded within Bowmans Creek, downstream of the Project Area (Annick 2011), short term indirect impacts to aquatic habitat associated with the duplication of Hebden Road Bridge over Bowmans Creek are not considered likely to result in an adverse effect on the species. The construciton of the Bowmans Creek Bridge has been designed to avoid impacts to the low flow channel. Simiarly negligiable changes to base flows in Bowmans Creek have been predicted in the surface water assessment and the groundwater assessment indicating that there will be no adverse impacts on the aquaitic habitats of Bowmans Creek as a result of the Project. The Project is not considered likely to affect the life cycle of the species such that a local viable population of this species is placed at risk of extinction.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in disturbance of aquatic habitat within Bettys Creek which provides marginal, habitat for the population. The ephemeral habitats of Bettys Creek lack a wide range of aquatic vertebrate and invertebrate species due to an absence of suitable habitat structures and habitat variability. Based on the known distribution of the species and the poor quality of habitat in Bettys Creek it is not likely that the species depends on these habitats.

Bowmans Creek provides potential habitat for the species, however the species was not recorded during aquatic surveys. There will be no direct impacts to the aquatic habitats of Bowmans Creek as the proposed bridge duplication does not include piers within the low flow channel of the Creek. Temporary disturbance to the aquatic habitats of Bowmans Creek resulting from sedimentation runoff and erosion from the duplication of the Hebden Road Bridge will not result in a substantial modification to the area of potential habitat for the 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

The Project will not introduce significant barriers for this species or result in the species being fragmented or isolated from areas of known habitat.

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 Project will result in the removal of ephemeral aquatic habitat within Bettys Creek and the temporary disturbance to the aquatic habitats of Bowmans Creek which provides potential habitat for the population. The aquatic habitats of Bettys Creek do not provide suitable habitat for the species due to lack of flows and previous disturbances associated with diversion impacts. The larger Bowmans Creek does provide potential habitat for this population however it will not be adversely impacted by the Project. There will be no direct impacts to the aquatic habitats of Bowmans Creek as the proposed bridge duplication does not include piers within the low flow channel of the Creek. The aquatic habitats of the Proposed Disturbance Area are not important to the long-term survival of the population in the locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans has been prepared 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.

The action proposed will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (TSC Act); and
- degradation of native riparian vegetation along New South Wales water courses (FM Act).

Conclusion

Based on the information provided above the Project is considered unlikely to result in a significant impact on the Darling River hardyhead (*Craterocephalus amniculus*) endangered population in the Hunter River Catchment.

Critically Endangered Species

Regent honeyeater (*Anthochaera phrygia*)

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;

The regent honeyeater (*Anthochaera phrygia*) has not been recorded within the Project Area or surrounds despite extensive seasonal surveys and 18 years of annual monitoring of the Project Area. The species was not recorded during Umwelt surveys of the Project Area during 2011, 2012 and 2014. The closest record of the species occurs at Warkworth, approximately 17 kilometres south-west of the Project Area. The species is known to occur in a patchy distribution in the temperate woodlands and open forests of the inland slopes of south-east Australia.

The species is mainly known from three key sites from the Bundarra-Barraba area of NSW, the Capertee Valley in NSW, and north-eastern Victoria. The direction and extent of movements, including evidence of movement between breeding sites, and a lack of discernible genetic differences between the sites suggest that the regent honeyeater occurs as a single, contiguous population (Garnett and Crowley 2000). Breeding has been recorded within the Hunter Valley, with the species recorded breeding in open forest close to Kurri Kurri in the Lower Hunter region in 2007. Nests have also been recorded at Quorrobolong, north of the Watagan range in the Lower Hunter region, in lowland forest habitat. Low-lying forests and woodlands of the Hunter Valley are important habitat for the species being used as winter foraging habitat and potential breeding sites.

The regent honeyeater has potential to make use of the box-gum forest and woodland habitats of the Proposed Disturbance Area, particularly when there are prolific flowering eucalypts and this migratory species is likely to move throughout the Hunter Valley in response to mass flowering events. The wider Project Area contains approximately 1117 hectares of eucalypt forest and woodland that provides potential foraging and breeding habitat for the species, however it has not been recorded.

The Project will result in the loss of approximately 163.7 hectares of potential eucalypt foraging habitat for the species within the Proposed Disturbance Area. Given that the species has not been recorded within the Proposed Disturbance Area and in excess of 1000 hectares of suitable foraging habitat is known to occur in the Project Area, including within Ravensworth State Forest, it is not considered that the loss of potential habitat within the proposed dsiturbance area will result in a significant reduction in potential foraging habitat for the local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 163.7 hectares of potential eucalypt foraging habitat for the species. Based on the analysis of annual fauna monitoring records, this species does not depend exclusively on the habitats within the disturbance area for foraging. The wider Project Area provides in excess of 1,000 hectares of eucalypt forests and woodlands that provide potential foraging 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

The Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. Given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation is unlikely to significantly impact on 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;

The Project will result in the loss of approximately 163.7 hectares of potential box-gum foraging habitat for the species in the Central Hunter Region however it will not impact breeding habitat which is centred on the Bundarra-Barraba area and Capertee Valley in NSW, and north-eastern Victoria. The closest record of the species occurs approximately 17 kilometres to the south-west of the Project Area in Warkworth. The species has not been recorded utilising the habitats within the Project Area despite extensive seasonal surveys and over 18 years of annual monitoring and while box-gum woodlands have become increasingly important resources for this species due to ongoing habitat loss, the Proposed Disturbance Area is not important to the long-term survival of the species.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species at the State level. A National Recovery Plan for the regent honeyeater has been prepared (Menkhorst *et al.* 1999) and the 2011 Action Plan for Australian Birds (Garnett *et al*. 2011) outlines conservation objectives for the species. The Project is unlikely to contravene the recovery plan as the species has not been recorded within the Project Area and the Project will remove potential habitat only.

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 proposed will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above the Project is considered unlikely to result in a significant impact on the regent honeyeater (*Anthochaera phrygia*).

Endangered Species

Swift parrot (*Lathamus discolor*)

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;

The swift parrot (*Lathamus discolor*) has been recorded on three occasions near the Proposed Disturbance Area within Ravensworth State Forest and the Southeast Offset Area during annual monitoring surveys of the site. The species was first recorded in May 2005 with more than 20 individuals recorded feeding on prolific flowering in spotted gums; and within the northern section of Ravensworth State Forest in September 2007 when approximately five individuals were recorded, again during a prolific eucalypt flowering event (Forest Fauna Surveys and Newcastle Innovation 2014). Two swift parrots were recorded in June 2014 foraging in a flowering *Eucalyptus tereticornis* in the Southeast Offset. The species was not recorded during Umwelt targeted winter surveys of the Proposed Disturbance Area, however it was noted that winter flowering gums occurring in the Proposed Disturbance Area did not flower in abundance during 2011 to 2014. There have been few records of the species within the central Hunter Valley in the past few years, however recent sightings were reported in the winter 2012 season in the Muswellbrook and Bulga (Birdline 2013 and 2014; Umwelt 2013) areas.

The swift parrot occurs as a single population within Australia and migrates annually from breeding grounds in Tasmania to the winter foraging grounds on the coastal plains and slope woodlands of mainland eastern Australia (Saunders 2002). Approximately 200 mature birds (approximately 10 per cent of the total estimated population) are known to over-winter in the Lower Hunter Region of New South Wales (Saunders 2002). The wider Project Area is considered to form part of a regional dispersal route close to important winter foraging areas in the Lower Hunter Valley.

This species has potential to make use of the box-gum forest and woodland habitats of the Proposed Disturbance Area, particularly where there are prolific flowering eucalypts and this migratory species is likely to move throughout the area in response to mass flowering events. The wider Project Area contains in excess of 1000 hectares of eucalypt forest and woodland that provides known and potential foraging habitat for the species.

The Project will result in the loss of approximately 163.7 hectares of eucalypt foraging habitat for the species within the Proposed Disturbance Area. Given that the species is not commonly recorded within the area and the availability and retention of suitable foraging habitat in the wider Project Area, including within Ravensworth State Forest, it is not considered that the loss of this area will result in a significant reduction in foraging habitat for the population, and the species will not be placed at risk of extinction as a result of the Project.

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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 163.7 hectares of potential eucalypt foraging habitat for the species. This highly mobile species would not depend exclusively on the habitats within the Proposed Disturbance Area for foraging, as the species is rarely recorded within the Project Area. Additionally, the Project Area does not provide breeding habitat for the species. The wider Project Area provides in excess of 1000 hectares of eucalypt forests and woodlands that provide known and potential foraging 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

The Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some foraging habitat will be removed as part of the Project, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact 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;

The Project will result in the loss of approximately 163.7 hectares of potential box-gum foraging habitat for the species in the Central Hunter Region however it will not impact breeding habitat which is restricted to Tasmania. The species has been recorded utilising the habitats within the Project Area in 2005, 2007 and 2014, however has not been recorded using the habitats of the Proposed Disturbance Area despite extensive seasonal surveys and 18 years of annual monitoring. While box-gum woodlands have become increasingly important resources for this species due to ongoing habitat loss, the Proposed Disturbance Area is not important to the long-term survival of the species.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species at the State level. A National Recovery Plan for the swift parrot has been prepared (Saunders and Tzaros 2011). The Project is likely to contravene the recovery plan by removing potential habitat for the species in the Hunter Region, which is a target area of recovery for 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above, the Project is considered unlikely to result in a significant impact on the swift parrot (*Lathamus discolor*).

Green and golden bell frog (*Litoria aurea*)

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;

The green and golden bell frog was formerly distributed from the NSW North Coast near Brunswick Heads southwards along the NSW coast to Victoria, where it extends into East Gippsland, and west to Bathurst, Tumut and the ACT. In the 1960s, the species was considered widespread, abundant and commonly encountered (DECC 2007). In the Hunter, the species is now only known from three key populations. The Upper Hunter Green and Golden Bell Frog Key Population is located between Singleton and Muswellbrook.

The Proposed Disturbance Area forms part of the Upper Hunter Green and Golden Bell Frog Key Population consisting of one main diffuse population at, or in the vicinity of, the Ravensworth and Liddell area and bordering areas of the Singleton and Muswellbrook local government areas (DECC 2007). The Upper Hunter Key Population is one of two inland populations of the species and is known from eight verified locations. The population is assumed to have a diffuse distribution across lands encompassed by these locations and has been recorded sporadically, probably caused by climatic circumstances and/or seasonal life cycle changes of the species (DECC 2007). It is considered highly likely that the precipitous state of the Upper Hunter population is directly due to the impact of disease rather than habitat or other ecological factors (Forest Fauna Surveys and Newcastle Innovation 2014).

The green and golden bell frog was 'rediscovered' in the upper Hunter in 1994 at Mount Owen mine where it was subsequently recorded 1996, 1997 and 1999 (Forest Fauna Surveys and Newcastle Innovation 2014). An unconfirmed report of a single calling male during August 2005 was made (J. Rennie, Earthtech, pers. comm.) at a small pond on a drainage line that enters Main Creek. However, intensive monitoring of this pond over the summer of 2005/2006 did not produce further evidence of the species; that is, no tadpoles, juveniles or adults were located, or calls heard in response to call playback surveys. The record has remained unconfirmed by physical identification. Nevertheless, it is possible that a transient male was present at this pond, but there is no evidence of the pond being utilised for breeding (Fly by Night Surveys *et al.* 2006). No more than three individuals were recorded at any one time at Mount Owen. All confirmed records in recent times for the Upper Hunter population detail only low numbers of adult individuals (DECC 2007).

An additional unconfirmed record of the species exists from the north-west shore of Lake Liddell in 2006 (DECC 2007) and the species was recently recorded during surveys of the Ravensworth North Offset Area for the Ravensworth North Project in 2009 and previously in that locality in 1998 and 2000 (Umwelt 2010).

The green and golden bell frog population within the Project Area has been monitored annually since its discovery in Bettys Creek in 1994 by well recognised frog researchers from the University of Newcastle. Despite extensive surveys, the species has not been positively recorded in the Project Area since 1999.

The absence of individuals at historical sites, or the intermittent observation of single individuals, or very small numbers of green and golden bell frogs, fits with the pattern of observation of bell frogs in the Upper Hunter over a period of more than a decade. The Upper Hunter, which is at the inland edge of the current, contracted distribution of the bell frog, appears to support only a precarious regional population that cannot be regarded as secure (DECC 2007) with few known habitat areas likely to support the species.

The Project will remove dams and associated terrestrial potential habitat for the species. The present occurrence of the species in the Project Area is unknown as the species has not been positively identified in 12 years, despite targeted monitoring. The Project does not propose the disturbance of historical known habitat of the species, only potential habitat. As the species is not known to be extant within the Project Area and the persistence of the species in the Project Area is expected to be limited due to infection of Chytrid fungus, the loss of habitats from the Project Area is not considered likely have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

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

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will remove dams and associated terrestrial habitat that provides potential habitat for the species and is likely to contribute to the ongoing fragmentation of remaining potential habitat areas within the Project Area. The species is not considered to be limited in its extent in the Project Area by factors relating to habitat suitability; rather infection by Chytrid virus is likely to limit the persistence of the species (Forest Fauna Surveys and Newcastle Innovation 2014).

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 green and golden bell frog uses terrestrial habitat for dispersal, foraging and shelter. Potential routes of dispersal are not known within the Project Area, and it is assumed that any potentially occurring frogs would move on wet nights to avoid desiccation, and that they would move along moisture gradients in the environment. These would include along the edge of large waterbodies such as dams and creeklines.

The Upper Hunter key population occurs within a highly fragmented landscape that is dominated by agricultural and mining land uses. The Project is therefore considered unlikely to further fragment habitat for 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;

The Upper Hunter key population of the green and golden bell frog is considered to contain only a few adult individuals and is therefore more susceptible to stochastic impacts than many other populations of the species. The upper Hunter population is considered disjunct

from the larger more secure populations of green and golden bell frog on the coast of NSW at locations such as Kooragang Island, Sydney and Nowra. Therefore, the loss of dams and associated terrestrial habitat in this declining and small population of the species is unlikely to be critical for the survival of the species throughout its range.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

The 'Draft Recovery Plan for the Green and Golden Bell Frog *Litoria aurea*' (DEC 2005) is relevant to this species. The Project contravenes this recovery plan by removing potential habitat for the species in an area where the species is historically known.

The 'Threat Abatement Plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis' (AGDEH 2006) is pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (TSC Act);
- degradation of native riparian vegetation (FM Act); and
- the installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of rivers and streams (TSC and FM Act).

Conclusion

It is considered unlikely that an extant population of the green and golden bell frog occurs within the Project Area due to the ongoing impact of disease, rather than the availability of suitable habitat. The green and golden bell frog is unlikely to be significantly impacted by the Project.

Vulnerable Species

Ozothamnus tesselatus

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;

Ozothamnus tesselatus has not been recorded within the Proposed Disturbance Area for the Project; however it has been previously recorded during surveys undertaken within Ravensworth State Forest in the north-east of the Project Area (Cole *et al*. 2004). The species is known to occur in dry sclerophyll forest and woodlands and is generally restricted around an area north of Rylstone in NSW.

The Proposed Disturbance Area is considered to provide potential habitat for this species, however there is a low likelihood of occurrence due to past disturbances and current grazing pressures. Substantial targeted flora survey was undertaken in the Proposed Disturbance Area and this species was not identified during surveys. The Project will involve the disturbance of approximately 163.7 hectares of eucalypt woodland that provides potential habitat for the species. Only one occurrence of the species has been recorded within the Project Area and its immediate surrounds despite many years of surveys. It is considered unlikely that there is a viable local population of the species occurring in the Proposed Disturbance Area. Additionally, the one known occurrence of the species in the Project Area in Ravensworth State Forest will not be impacted by the Project. Therefore it is considered unlikely that the Project would disrupt the life cycle of this species and a viable population would not 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;

Not applicable.

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; and

Not applicable.

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;

Not applicable.

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;

The Project would result in the loss of approximately 163.7 hectares of potential eucalypt woodland habitat for this species. The habitat to be disturbed as a result of the Project is potential habitat only and the one known occurrence of the species in the Project Area in Ravensworth State Forest will not be impacted.

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 proposed development will not result in further isolation or fragmentation of Ravensworth State Forest which provides known habitat for this species. The known record of *Ozothamnus tesselatus* will not be impacted by the Project.

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 Project would result in the loss of approximately 163.7 hectares of potential eucalypt woodland habitat for this species. The habitat to be disturbed as a result of the Project is potential habitat only for the species and the one known occurrence of the species in the Project Area in Ravensworth State Forest will not be impacted. The potential habitat to be disturbed is not considered to be important to the long-term survival of this species in the locality and the region.

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

The Project Area is not located in proximity to any areas of declared or recommended critical habitat areas. The Project will not have an adverse effect on any critical habitat.

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

A recovery plan has not been prepared for this species. There are no threat abatement plans of relevance to the Project.

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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act).

Conclusion

Based on the information provided above, and considering the application of the precautionary principle, the Project is unlikely to result in a significant impact on *Ozothamnus tesselatus*.

Little eagle (*Heiraaetus morphnoides*)

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;

The little eagle has been recorded in the Project Area during the annual monitoring surveys in the years 1996, 1997, 1999 and 2001 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area, although potential habitat was identified. The species is known to occur throughout the Australian mainland and occurs as a single population in NSW. It is likely the Project Area, and specifically the Proposed Disturbance Area for the Project, provides suitable foraging habitat for the species. Potential nesting habitat occurs within the Proposed Disturbance Area with some appropriately tall trees in the area; however nesting has not been previously recorded in the Project Area.

The Project will result in the loss of approximately 451.5 hectares of known woodland and derived native grassland foraging habitat for the species which represents 16 per cent of the wider Project Area. It is not considered that the loss of this area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the little eagle will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of potential foraging habitat for the species. The little eagle occupy large home ranges and generally forage in open areas while they typically nest in open woodland (usually on hillsides) and along tree-lined watercourses, with the nest typically placed in a mature, living tree. The derived native grassland habitats of the Proposed Disturbance Area are expected to provide the highest quality habitat for the species and based on typical habitat requirements the species is unlikely to nest in the Proposed Disturbance Area. The wider Project Area provides known and potential foraging habitat for this species, including in excess of 1400 hectares of derived native grassland habitat. Areas of native woodland and grassland within the Project Area provide suitable foraging habitat for this species and substantial foraging, nesting and roosting habitat for this species occurs in the surrounding area.

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 Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As likely habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

This species is likely to utilise the Project Area for foraging only. The removal of potential foraging habitat for this species from the Proposed Disturbance Area is unlikely to significantly impact the long-term survival of this species.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. There are no threat abatement plans pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the little eagle (*Hieraaetus morphnoides*).

Spotted Harrier – *Circus assimilis*

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;

The spotted harrier has been recorded in the Project Area on one occasion by Umwelt during surveys of the Proposed Disturbance Area near the Bowmans Creek rail bridge. The species has not been recorded during annual monitoring surveys of the Project Area; however a record of the species from 2000 occurs near Liddell approximately 1 kilometre from the Project Area The species was recorded flying over farmland within the Project Area during the Umwelt UHSA surveys in 2014 (Umwelt 2014, in prep). The Proposed Disturbance Area is considered to comprise potential foraging habitat for this species as part of a wider foraging range in surrounding habitats. The species is known to occur throughout the Australian mainland except in densely forested or wooded habitats of the coast, escarpment and ranges. Individuals disperse widely in NSW and comprise a single population. It is likely the Project Area, and specifically the proposed Disturbance Area for the Project, provides suitable foraging habitat for the species. Potential nesting habitat occurs within the Proposed Disturbance Area with some appropriately tall trees in the area; however nesting has not been previously recorded.

The Project will result in the loss of approximately 451.5 hectares of known foraging habitat for the species which represents 16 per cent of the Project Area. It is not considered that the loss of this area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the little eagle will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of potential foraging habitat for the species. The spotted harrier occupies a large home range and generally forage in open low cover vegetation areas while they typically nest in open or remnant woodland on a horizontal branch in outer foliage or dense regrowth. The derived native grassland habitats of the Proposed Disturbance Area are expected to provide the highest quality habitat for the species and based on typical habitat requirements the species is unlikely to nest in the Proposed Disturbance Area. The wider Project Area provides known and potential foraging habitat for this species, including in excess of 1400 hectares of derived native grassland habitat. Areas of native woodland and grassland within the Project Area provide suitable

foraging habitat for this species and substantial foraging, nesting and roosting habitat for this species occurs in the surrounding area.

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 Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As likely habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

This species is likely to utilise the Project Area for foraging only. The removal of potential foraging habitat for this species from the Proposed Disturbance Area is unlikely to significantly impact the long-term survival of this species.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. There are no threat abatement plans pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the spotted harrier (*Circus assimilis*).

Little lorikeet (*Glossopsitta pusilla*)

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;

The little lorikeet (*Glossopsitta pusilla*) has been regularly recorded at the Project Area during annual monitoring surveys from 1996 to 2009 (Forest Fauna Surveys and Newcastle Innovation 2014). The species' absence from the Project Area in 2010 and 2013 suggests that the species utilised other foraging habitat in the region as no significant flowering event occurred at the Project Area in that year. It was recorded during annual monitoring in 2011 (Forest Fauna Surveys and Newcastle Innovation 2014) and during Umwelt surveys of the Proposed Disturbance Area in 2012. It is typically observed foraging in flowering eucalypt trees across the Project Area and is usually identified in small groups of approximately 10 birds. The species is known to occur across the coastal and Great Dividing Range regions of eastern Australia from Cape York to South Australia. The Project Area contains in excess of 1000 hectares of eucalypt forest and woodland that provides known foraging habitat for the species.

The Project will result in the loss of approximately 163.7 hectares of eucalypt foraging habitat and potential breeding habitat for the species. The Project will result in a 15 per cent loss of eucalypt habitats across the remnant within the Project Area. Given the incremental loss of suitable foraging and breeding habitat in the region and the wider Project Area, it is considered that the loss of 163.7 hectares of known eucalupt habitat has the potential to result in a substantial reduction in foraging habitat for the local population, however a local viable population of the 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 163.7 hectares of known eucalypt foraging habitat and potential breeding habitat for the species, which represents a loss of 15 per cent of eucalypt habitat within the wider Project Area. The little lorikeet is highly mobile and is known to be locally nomadic; recorded regularly in open woodland and forest habitats across the Proposed Disturbance Area and the Project Area. The wider Project Area provides in excess of 1000 hectares of eucalypt forests and woodlands that provide known and potential foraging 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

The Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some known foraging habitat will be removed as part of the Project, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species is known to utilise the flowering eucalypt forests and woodlands within the Project Area and the Proposed Disturbance Area for foraging habitat and potentially breeding habitat. The little lorikeet has been regularly recorded in open woodland and forest habitats throughout the year during annual fauna monitoring of the Project Area and Umwelt surveys of the Proposed Disturbance Area. It is likely that suitable habitat in the Proposed Disturbance Area comprises part of a much larger foraging range for the species, and this is not expected to affect the long-term survival of the species as substantial foraging and breeding habitat for this species occurs in the surrounding area including within the adjacent Ravensworth State Forest.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. There are no threat abatement plans pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the little lorikeet (*Glossopsitta pusilla*).

Powerful owl (*Ninox strenua*)

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;

The powerful owl (*Ninox strenua*) has been recorded at the Project Area during annual monitoring surveys. The species was initially recorded in 2004, and was subsequently recorded in 2005, 2006 and 2007 (Forest Fauna Surveys and Newcastle Innovation 2014). On all occasions the species was recorded in the north of the Project Area, near Ravensworth State Forest and the New Forest Area. The species was not recorded during Umwelt surveys of the Proposed Disturbance Area and no suitable roosting habitat was recorded. The species is known to occur in NSW throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the western slopes and plains. The Project Area contains approximately 1355 hectares of woodland and forest communities that would provide foraging habitat for the species. The species is likely to be restricted to the dense forests and footslopes in the north of the Project Area where suitable roosting habitat in the form of dense cover occurs and the more open areas of woodland and derived native grassland habitats that predominantly occur in the Proposed Disturbance Area are not expected to provide core habitat for the species.

The Project will result in the loss of approximately 223.7 hectares of potential foraging habitat for the species. Given the availability of suitable foraging and breeding habitat in the region and the wider Project Area, including within Ravensworth State Forest, it is not considered that the loss of this area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species. The Project Area provides approximately 1355 hectares of known and potential foraging habitat for this species however the open woodland habitats of the Proposed Disturbance Area are expected to comprise marginal habitat within the home range of the species occurring in the Project Area. Areas of native woodland and grassland within the Proposed Disturbance Area provide suitable foraging habitat for this species and substantial foraging, nesting and roosting habitat for this species occurs in the surrounding area.

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 Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some potential habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact 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;

The habitats within the Proposed Disturbance Area considered marginal habitat only, whereas forested habitats in Ravensworth State Forest and the northern footslopes are likely to contain core habitat for the species in the area. These habitat features are uncommon in the Proposed Disturbance Area and are concentrated in the north of the Project Area, which will not be disturbed as a result of the Project. This species is likely to utilise the sparse woodlands, open grasslands and disturbed areas of the Proposed Disturbance Area as fly-over and foraging habitat only. The removal of potential, marginal foraging habitat for this species from the Proposed Disturbance Area is unlikely to significantly impact 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);

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

The 'NSW Recovery Plan for the Large Forest Owls' (DEC 2006) is applicable to this species. The Project is not consistent with this recovery plan as it contravenes the following objective: 'Manage and protect habitat off reserves and state forest'. The Project will increase the level of fragmentation of potential habitat for this species in the Central Hunter Valley. However, the species has not been recorded within the Proposed Disturbance Area, which provides potential habitat only, and the area of known habitat within and near Ravensworth State Forest will not be disturbed as part of the Project.

No threat abatement plans are applicable to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act);

- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above the Project is unlikely to result in a significant impact on the powerful owl (*Ninox strenua*).

Masked owl (*Tyto novaehollandiae*)

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;

The masked owl (*Tyto novaehollandiae*) has been recorded at the Project Area during annual monitoring surveys and evidence of the species presence was identified during Project specific surveys in the Proposed Disturbance Area. The species was initially recorded in 1997, and was subsequently recorded in 1999, 2002, 2005, 2006, 2009, 2011 and 2013 (Forest Fauna Surveys and Newcastle Innovation 2014). Regurgitated pellets attributed to the species by Barbara Triggs (a recognised expert in the analysis of regurgitate owl pellets) were identified at two locations in the Proposed Disturbance Area however the two potential roost trees present at these locations were investigated but not considered likely to provide suitable roosting habitat for the species due to the unsuitability of potential tree hollows at these two locations. Some roosting habitat for this species potentially occurs in the Proposed Disturbance Area and wider Project Area, in suitable mature eucalypts. The species is known to occur in NSW in forests along the coastline, with scattered records in the western plains. The Project Area contains approximately 2794 hectares of woodland and open areas that would provide known foraging habitat for the species. The species is likely to be utilising the Proposed Disturbance Area as core habitat in wider foraging range of generally between 500 and 1,000 hectares.

The species has been recorded widely in Ravensworth State Forest and it is likely that Proposed Disturbance Area forms part of a large home range for the species that may include roosting and nesting habitat; however roost sites have not been identified.

The Project will result in the loss of approximately 223.7 hectares of woodland habitat and 223.1 hectares of derived native grassland habitat for the species and the identification of the species in the Proposed Disturbance Area indicates that the loss of foraging and likely roosting/nesting habitat may result in the loss of the local population of the masked owl occurring in the Project Area.

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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of woodland habitat and 223.1 hectares of derived native grassland habitat and likely roosting/nesting habitat for the species. The species is likely to be utilising the Proposed Disturbance Area as core habitat in wider foraging range of generally between 500 and 1000 hectares.

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 Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some known and potential habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The Proposed Disturbance Area contains some large, hollow-bearing trees which may be utilised by the species as nesting and roosting sites. These habitat features are not common in the Proposed Disturbance Area however two perch sites of the species, as evidenced by the identification of many regurgitated pellets of the species, indicate that roosting habitat is likely to be proximate. This species is likely to utilise the sparse woodlands, open grasslands and disturbed areas of the Proposed Disturbance Area as foraging habitat as part of a wider home range. The removal of known and potential foraging habitat for this species from the Proposed Disturbance Area may potentially impact the long-term survival of this species in the Project Area.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

The 'NSW Recovery Plan for the Large Forest Owls' (DEC 2006) is applicable to this species. The Project is not consistent with this recovery plan as it contravenes the following objective: 'Manage and protect habitat off reserves and state forest'. The Project will increase the level of fragmentation of habitat for this species in the Central Hunter Valley. The Project will result in the removal of known habitat for the species.

No threat abatement plans are applicable to this threatened 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 proposed will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project is considered to potentially result in a significant impact on the masked owl (*Tyto novaehollandiae*).

Brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)

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;

The brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) has been regularly recorded in the Project Area during annual monitoring surveys from 1994 to 2013 (Forest Fauna Surveys and Newcastle Innovation 2014). It is typically observed in the northern portion of Ravensworth State Forest which supports large mature ironbark trees (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area however it has previously been recorded in proximity to Betty Creek during surveys undertaken for Glendell Mine (Umwelt 2008). The species is known to occur in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is considered to be a resident of the Project Area which contains approximately 1355 hectares of woodland and forest that provides known foraging and known breeding habitat for the species.

The Project will result in the loss of approximately 223.7 hectares of known and potential woodland foraging and likely breeding habitat (tree hollows) for the species. The Project will result in a 17 per cent loss of woodland and forest habitats across the remnant within the Project Area. Given the incremental loss of suitable foraging and breeding habitat in the region and the wider Project Area, it is considered that the loss of 223.7 hectares of known woodland habitat has the potential to result in a significant reduction in foraging and breeding habitat for the local population, and a local viable population of the species may 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of known and potential foraging habitat for the species. The wider Project Area provides approximately 1355 hectares of known and potential foraging habitat for this species and the open woodland habitats of the Proposed Disturbance Area are expected to comprise suitable and important habitat for the 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

The Project will result in the fragmentation of areas of known and potential habitat for this species. The Proposed Disturbance Area provides a north/south linkage between in-tact remnant vegetation associated with Ravensworth State Forest where the species is regularly recorded, to areas of potential habitat to the south of the Project Area that are currently fragmented and generally comprise small remnants.

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 woodland habitats within the Proposed Disturbance Area provide known habitat for the species and likely dispersal and movement pathways for the species between the habitats occurring in Ravensworth State Forest and remnant vegetation within and east of the Proposed Disturbance Area. The Project will result in a 17 per cent reduction of woodland and forest habitats across the remnant within the Project Area and this may affect the long-term survival of the species in the locality. Known foraging and breeding habitat (tree hollows) for this species occurs in the surrounding area including within the broader Project Area.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above, the Project has the potential to result in a significant impact on the brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*).

Speckled warbler (*Chthonicola sagittata*)

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;

The speckled warbler (*Chthonicola sagittata*) has been regularly recorded in the Project Area during annual monitoring surveys from 1994 to 2013, with the exception of 2009 and 2012 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded widely during Umwelt surveys of the Proposed Disturbance Area. It has been observed in many different habitat types including remnant forest, regeneration and planted areas and within rehabilitation sites (Forest Fauna Surveys and Newcastle Innovation 2014). Additionally, it inhabits woodlands with grassy understoreys often on ridges and gullies (Forest Fauna Surveys and Newcastle Innovation 2014). The species has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. It is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. The Project Area contains approximately 1,355 hectares of woodlands, forests and shrublands that provides known and potential habitat for the species.

The Project will result in the loss of approximately 223.7 hectares of known and potential woodland, forest and shrubland habitat for the species. The Project will result in a 17 per cent reduction in woodland and forest habitats across the remnant within the Project Area. Given the incremental loss of suitable foraging and breeding habitat in the region and the wider Project Area, it is considered that the loss of 223.7 hectares of known woodland and shrubland habitat has the potential to result in a significant reduction in foraging habitat for the local population, and a local viable population of the species may 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of known and potential foraging habitat for the species. The Project Area provides approximately 1355 hectares of known and potential foraging habitat for this species. Areas of native woodland forests and shrubland within the Proposed Disturbance Area provide suitable foraging 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

The Project will result in the fragmentation of areas of known and potential habitat for this species. The Proposed Disturbance Area provides a north/south linkage between in-tact remnant vegetation associated with Ravensworth State Forest where the species is regularly recorded, to areas of potential habitat to the south of the Project Area that are currently fragmented and generally comprise small remnants.

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 woodland, forest and shrubland habitats within the Proposed Disturbance Area provide likely dispersal pathways for the species between the habitats occurring in Ravensworth State Forest and remnant vegetation within and east of the Project Area. The Project will result in a 17 per cent reduction in woodland and forest habitats across the remnant within the Project Area and this may affect the long-term survival of the species in the locality. Speckled warbler pairs are known to occupy home ranges of up to 10 hectares when breeding and larger areas outside the breeding season. Known foraging, roosting and breeding habitat for this species occurs in the surrounding area including within the adjacent Ravensworth State Forest.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above, and the Project has the potential to result in a significant impact on the speckled warbler (*Chthonicola sagittata*).

Black-chinned honeyeater (eastern subspecies) (*Melithreptus gularis gularis*)

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;

The black-chinned honeyeater (eastern subspecies) (*Melithreptus gularis gularis*) has been infrequently recorded in the Project Area during annual monitoring surveys in 1994, 1995, 1996 and 2004 (Forest Fauna Surveys and Newcastle Innovation 2014). They are typically observed foraging in flowering eucalypt trees within Ravensworth State Forest. T he species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The eastern subspecies occurs in the eastern states of Australia and in NSW is known from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. The Project Area contains approximately 1355 hectares of forest and woodland that provides known and potential foraging habitat for the species.

The Project will result in the loss of approximately 223.7 hectares of likely woodland foraging habitat for the species during suitable eucalypt flowering conditions. The Project will result in a 17 per cent reduction in woodland and forest habitats across the remnant within the Project Area, however given the availability of suitable foraging and breeding habitat in the region and the wider Project Area, including known habitat within Ravensworth State Forest, it is not considered that the loss of this area will result in a significant reduction in foraging habitat for the highly nomadic local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of potential eucalypt foraging habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or breeding, as the species is only occasionally recorded in selected areas of Ravensworth State Forest. The wider Project Area provides approximately 1355 hectares of eucalypt forests and woodlands that provide known and potential foraging 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

The Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some known foraging habitat will be removed as part of the Project, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact 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;

The species is known to utilise flowering eucalypt forests and woodlands within the Project Area, particularly in Ravensworth State Forest, for foraging habitat. The species is known to have large feeding territories and is likely to be locally nomadic. It is likely that potential habitat in the Proposed Disturbance Area comprises part of a much larger foraging range for the species into surrounding habitats, and the loss of 223.7 hectares of eucalypt habitats is not expected to affect the long-term survival of the species as substantial foraging, roosting and breeding habitat for this species occurs in the surrounding area including within the adjacent Ravensworth State Forest.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species. There are no threat abatement plans pertinent to this threatened species. The Project will not have an adverse effect on any critical habitat.

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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (PD TSC Act).

Conclusion

Based on the information provided above the Project is unlikely to result in a significant impact on the black-chinned honeyeater (eastern subspecies) (*Melithreptus gularis gularis*).

Grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)

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;

The grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) has been regularly recorded in the Project Area during annual monitoring surveys from 1994 to 2013 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded on many occasions during Umwelt surveys of the Proposed Disturbance Area. They have been observed in most woodland habitats within the Project Area including foraging, breeding and nest sites. The eastern subspecies occurs from Cape York south through Queensland, NSW and Victoria and formerly to the south east of South Australia. In NSW, they occur on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. They also occur in woodlands in the Hunter Valley and in several locations on the north coast of NSW. The Project Area contains approximately 1355 hectares of woodland and forest that provides known foraging and nesting habitat for the species.

The Project will result in the loss of approximately 223.7 hectares of known woodland habitat for the species, including breeding and nesting sites. Although suitable foraging and breeding habitat occurs in the wider Project Area, the species tends to utilise the sparse dry woodland habitats dominating the Proposed Disturbance Area for nesting habitat. Additionally, the Project will result in a 17 per cent reduction in woodland and forest habitats across the remnant within the Project Area. Given this incremental loss of suitable foraging and breeding habitat in the region and the wider Project Area, it is considered that the loss of 223.7 hectares of known eucalupt habitat has the potential to result in a significant reduction in foraging habitat for the local population, and a local viable population of the species may 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of known foraging, breeding and nesting habitat for the species. Although the Proposed Disturbance Area is likely to form part of a wider distribution of the species within the Project Area, the species is known to breed and nest in sparse wooded habitats that occur throughout the Proposed Disturbance Area.

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 Project has the potential to introduce some barriers for this species. Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. As a result, individuals are generally unlikely to cross large open areas. The removal of 223.7 hectares of known foraging and nesting habitat may prevent movement of individuals between proximate areas of habitat. The level of fragmentation and isolation will increase for this species as a result of the Project.

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 species is known to utilise the woodland habitats within the Proposed Disturbance Area as foraging, breeding and nesting habitat. Individuals live in family groups and territories range from one to 50 hectares, but are usually around 10 hectares. Grey-crowned babblers are generally unlikely to disperse across large areas of cleared land. Although the species also occurs in adjacent habitats that will be unaffected by the Project, the loss of 223.7 hectares of known foraging, breeding and nesting habitat, that represents a 17 per cent loss of habitat across the Project Area, may affect the long-term survival of the population in the locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 proposed will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above, the Project has the potential to result in a significant impact on the grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*).

Varied sittella (*Daphoenositta chrysoptera*)

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;

The varied sittella (*Daphoenositta chrysoptera*) has been regularly recorded in the Project Area during annual monitoring surveys in 1994, 1997 to 2000 and 2002 to 2009 (Forest Fauna Surveys and Newcastle Innovation 2014). It is typically observed in eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The species distribution in NSW is nearly continuous from the coast to the far west. The Project Area contains approximately 1355 hectares of eucalypt forest and woodland that provides known and potential foraging habitat for the species.

The decline of the varied sittella has been attributed to declining habitat cover and quality. The sedentary nature of the species makes cleared agricultural land a potential barrier to movement. Survival and population viability are sensitive to habitat isolation, reduced patch size and habitat simplification, including reductions in tree species diversity, tree canopy cover, shrub cover, ground cover, logs, fallen branches and litter (NSW Scientific Committee 2010). The varied sittella is also adversely affected by the dominance of noisy miners in woodland patches (NSW Scientific Committee 2010).

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species. The Project will result in a 17 per cent reduction in woodland and forest habitats across the remnant within the Project Area. Given the incremental loss of suitable foraging and breeding habitat in the region and the wider Project Area, it is considered that the loss of 223.7 hectares of known eucalupt habitat has the potential to result in a significant reduction in foraging habitat for the sedentary local population, and a local viable population of the species may 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species, which represents a 17 per cent reduction in woodland habitats across the remnant within the Project Area. Although the Proposed Disturbance Area is likely to form part of a wider distribution of the species within the Project Area, the

species is sedentary and the habitats that occur throughout the Proposed Disturbance Area are likely to provide important habitat for the species in the locality.

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 Project will result in the fragmentation of areas of known and potential habitat for this species. The Proposed Disturbance Area provides a north/south linkage between intact remnant vegetation associated with Ravensworth State Forest where the species is regularly recorded, to areas of potential habitat to the south of the Project Area that are currently fragmented and generally comprised of small remnants.

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 species is known to utilise the woodland within the Project Area for foraging habitat. It is likely that potential habitat in the Proposed Disturbance Area is not expected to be important for the long-term survival of the species as substantial core foraging and breeding habitat for this species occurs in the surrounding area including within the adjacent Ravensworth State Forest.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 proposed will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (PD TSC Act).

Conclusion

Based on the information provided above, the Project has potential to result in a significant impact on the varied sittella (*Daphoenositta chrysoptera*).

Hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*)

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;

The hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*) has been regularly recorded in the Project Area during annual monitoring surveys in 1994 to 2013, with the exception of 2006 and 2010 (Forest Fauna Surveys and Newcastle Innovation 2014). The species is typically recorded in the northern part of Ravensworth State Forest, and has also been observed foraging in the rehabilitation area immediately adjacent to the remnant forest, although it is generally recorded in low abundance, being limited to one or two pairs of birds (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The south-eastern form of the species is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west. The Project Area contains approximately 1355 hectares of eucalypt forest and woodland that provides known and potential foraging habitat for the species.

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species. The Project will result in a 17 per cent reduction in woodland and forest habitats across the remnant within the Project Area. Given the incremental loss of suitable foraging and breeding habitat in the region and the wider Project Area, it is considered that the loss of 223.7 hectares of known woodland and forest habitat has the potential to result in a significant reduction in foraging habitat for the sedentary local population, and a local viable population of the species may 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species, which represents a 17 per cent reduction in woodland habitats across the remnant within the Project Area. Although the Proposed Disturbance Area is likely to form part of a wider distribution of the species within the Project Area, the species is sedentary and the habitats that occur throughout the Proposed Disturbance Area are likely to provide important habitat for the species in the locality.

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 Project will result in the fragmentation of areas of known and potential habitat for this species. The Proposed Disturbance Area provides a north/south linkage between intact remnant vegetation associated with Ravensworth State Forest where the species is regularly recorded, to areas of potential habitat to the south of the Project Area that are currently fragmented and generally comprise small remnants.

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 species is known to utilise the woodland within the Project Area for foraging habitat. It is likely that potential habitat in the Proposed Disturbance Area is not expected to be important for the long-term survival of the species as substantial core foraging and breeding habitat for this species occurs in the surrounding area including within the adjacent Ravensworth State Forest.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. There are no threat abatement plans pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above, the Project has potential to result in a significant impact on the hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*).

Scarlet robin (*Petroica boodang*)

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;

The scarlet robin (*Petroica boodang*) has been infrequently recorded in the Project Area during annual monitoring surveys, only being recorded in 1994, 1997 and 2011 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The species is found from south-east Queensland to south-east South Australia and also in Tasmania and south-west Western Australia. In NSW, it occurs from the coast to the inland slopes. The Project Area contains approximately 1355 hectares of eucalypt forest and woodland that provides known and potential foraging habitat for the species.

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species, which represents a 17 per cent reduction in potential woodland habitats across the Project Area. Given the availability of suitable foraging and breeding habitat in the Project Area, it is not considered that the loss of habitat win the Proposed Disturbance Area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or breeding, as the species is only rarely recorded in selected areas of Ravensworth State Forest. The Project Area provides approximately 1355 hectares of eucalypt forests and woodlands that provide known and potential foraging 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

The Project will result in the fragmentation of areas of known and potential habitat for this species. The Proposed Disturbance Area provides a north/south linkage between in-tact remnant vegetation associated with Ravensworth State Forest where the species is regularly

recorded, to areas of potential habitat to the south of the Project Area that are currently fragmented and generally comprised of small remnants.

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 species is known to utilise the woodland within the Project Area for foraging habitat, particularly within Ravensworth State Forest and its surrounds. Potential habitat in the Proposed Disturbance Area may comprise part of a much larger foraging range for the species, and the loss of habitat from the Proposed Disturbance Area is not expected to affect the long-term survival of the species as substantial areas of potential foraging, roosting and breeding habitat for this species occurs in the surrounding area including within the adjacent Ravensworth State Forest.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the scarlet robin (*Petroica boodang*).

Flame robin (*Petroica phoenicea*)

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;

The flame robin (*Petroica phoenicea*) has been infrequently recorded in the Project Area during annual monitoring surveys, only being recorded in 1994, 1999 and 2000 (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The species is endemic to south-eastern Australia, and ranges from near the Queensland border to south-east 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. The Project Area contains approximately 1355 hectares of eucalypt forest and woodland that provides known and potential foraging habitat for the species.

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species. Given the availability of suitable foraging and breeding habitat in the region and the wider Project Area, including within Ravensworth State Forest, it is not considered that the loss of this area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of potential woodland foraging habitat for the species. It is unlikely that this species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or breeding, as the species is only rarely recorded in selected areas of Ravensworth State Forest. The Project Area provides approximately 1355 hectares of eucalypt forests and woodlands that provide known and potential foraging 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

The Project will result in the fragmentation of areas of known and potential habitat for this species. The Proposed Disturbance Area provides a north/south linkage between in-tact remnant vegetation associated with Ravensworth State Forest where the species is regularly

recorded, to areas of potential habitat to the south of the Project Area that are currently fragmented and generally comprised of small remnants.

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 species is known to utilise the woodland within the Project Area, particularly within Ravensworth State Forest and its surrounds. It is likely that potential habitat in the Proposed Disturbance Area comprises part of a much larger foraging range for the species, and this is not expected to affect the long-term survival of the species as substantial foraging, roosting and breeding habitat for this species occurs in the surrounding area including within the adjacent Ravensworth State Forest.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. There are no threat abatement plans pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- removal of dead wood and dead trees (TSC Act); and
- aggressive exclusion by abundant noisy miners (PD TSC Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the flame robin (*Petroica phoenicea*).

Diamond firetail (*Stagonopleura guttata*)

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;

The diamond firetail (*Stagonopleura guttata*) has been regularly recorded in the Project Area during annual monitoring surveys, being recorded in every year between 1994 and 2012, with the exception of 1999 (Forest Fauna Surveys and Newcastle Innovation 2014). The species is often recorded in the northern portion of Ravensworth State Forest, but has also been observed in woodland habitat in the Proposed Disturbance Area. The species appears to frequent the edges of remnant forested areas and forages in the open grassland areas, particularly when abundant grass seeds are present (Forest Fauna Surveys and Newcastle Innovation 2014). The species is endemic to south-eastern Australia, extending from central Queensland to the Eyre Peninsula in South Australia. It is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina. The Project Area contains approximately 1355 hectares of woodland and forest communities that provides known and potential foraging habitat for the species.

The diamond firetail is threatened by clearance and fragmentation of habitat. Isolation and reductions in remnant area inhibit dispersal and increase their vulnerability to local extinction via stochastic events. Small, isolated populations also lose their long term genetic viability (Barrett *et al.* 1994). Further, diamond firetail populations appear unable to persist in areas which lack remnants of native vegetation larger than 200 hectares (NSW Scientific Committee 2001).

The Project will result in the loss of approximately 223.7 hectares of known woodland foraging habitat for the species. The Project will result in a 17 per cent reduction in woodland and forest habitats across the Project Area. Given the incremental loss of known foraging and breeding habitat in the region and the wider Project Area, it is considered that the loss of 223.7 hectares of known woodland, forest and derived native grassland habitat has the potential to result in a significant reduction in foraging habitat for the local population, and a local viable population of the species may 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of known woodland foraging habitat for the species, which represents a 17 per cent reduction in woodland and

forest habitats across the remnant within the Project Area. The Proposed Disturbance Area is likely to form part of a wider distribution of the species within the Project Area and the species is known to breed and nest in sparse wooded habitats that occur throughout the Proposed Disturbance Area.

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 Project will result in the fragmentation of areas of known and potential habitat for this species. The Proposed Disturbance Area provides a north/south linkage between in-tact remnant vegetation associated with Ravensworth State Forest where the species is regularly recorded, to areas of potential habitat to the south of the Project Area that are currently fragmented and generally comprised of small remnants.

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 species is known to utilise the woodland within the Project Area for foraging and breeding, particularly within Ravensworth State Forest, but also in the woodland habitats of the Proposed Disturbance Area. Although the species also occurs in adjacent habitats that will be unaffected by the Project, the loss of 223.7 hectares of known foraging and breeding habitat, representing a 17 per cent reduction in habitat across the Project Area, may affect the long-term survival of the population in the locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. There are no threat abatement plans pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act); and
- aggressive exclusion by abundant noisy miners (TSC Act).

Conclusion

Based on the information provided above, the Project has potential to result in a significant impact on the diamond firetail (*Stagonopleura guttata*).

Spotted-tailed quoll (*Dasyurus maculatus*)

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;

The spotted-tailed quoll (*Dasyurus maculatus*) has been recorded regularly over the period 1995 to 2013 in the Project Area, particularly within Ravensworth State Forest by hair tube sampling, predator scat searches, cage trapping and remote camera survey. There have also been a number of unconfirmed sightings within the Mount Owen active mine area and the species has also been recorded at Bowmans Creek to the west of the Project Area during fauna monitoring and surveys undertaken as part of ecological impact assessment process undertaken at Liddell (Umwelt 2008; Umwelt 2013; Eco Logical 2012; Umwelt in prep) and in the Xstrata Ravensworth Surface Operations Hillcrest Offset Area approximately 6 kilometres to the north-west of the Project Area (Umwelt 2010).

Recent surveys (2012) undertaken on lands to the west of the Project Area along Bowmans Creek have identified a den site, latrines and have verified a recent breeding event through the deployment of infra-red cameras. Following these surveys, potential den sites in the northern portion of the Project Area have also been identified through the analysis of radio tracking that has been undertaken on behalf of Mount Owen. One male spotted-tailed quoll was fitted with a radio tracking collar and monitored between October 2012 and March 2013. The results indicated that the individual was not recorded in the Referral Area, rather that the core habitat for the individual was centred on Ravensworth State Forest, with ancillary habitat in pastures and woodland remnants to the east and mine rehabilitation to the west. A second male was collared and tracked between April and July 2013. Radio-tracking data indicates that habitat for this individual is also centred on Ravensworth State Forest along with riparian and woodland habitats associated with Main Creek, to the east of the Proposed Disturbance Area. This individual was also recorded using woodland habitats at five locations within the Proposed Disturbance Area during July 2013. The species was not recorded during Umwelt surveys of the Proposed Disturbance Area however it is known to occur there. The results of the detailed surveys indicate that the Mount Owen Complex and surrounding habitat areas, including Bowmans Creek, contain at least one female, two joeys and two males that form part of a breeding population that has persisted in the Mount Owen Complex since at least 1994 when the species was first identified on site.

All of the natural and derived vegetation communities in the Proposed Disturbance Area will provide foraging habitat for the spotted-tailed quoll and the Project Area is considered to comprise a portion of the species' home range occurring in the local area. Woodland and forest communities provide higher quality habitat than derived grassland habitats due to increased habitat complexity and the presence of increased prey resources. Grassland habitats are expected to provide dispersal habitat and connectivity between disjunct woodland remnants, as well as poorer quality hunting areas. Intact woodland and rehabilitation/regeneration communities in the north of the Project Area provide likely core habitat for the species while the Proposed Disturbance Area provides potential foraging habitat, dispersal habitat and connectivity to potential habitats to the south of the Project Area. Although the species has been recorded in the exotic grassland-dominated mine rehabilitation, these area are not considered to provide suitable foraging or denning habitat features and are not considered to provide habitat value for the species. Dens for the species were not recorded in the Proposed Disturbance Area and suitable denning habitat that can include hollow logs and log piles, rocky outcrops and large tree hollows have been recorded in the intact habitats of Ravensworth State Forest and in stockpiled logs salvaged during tree felling operations associated with ongoing mining operations. The Proposed Disturbance Area is considered to provide marginal habitat for the species to establish den sites. Dens may occur in the Proposed Disturbance Area, particularly in suitable tree hollows, however none were identified during fauna surveys.

There are few woodland areas within the central Hunter Valley lowlands (the main Hunter Valley) that are of sufficient size to provide core habitat, without surrounding derived grassland habitat, to support the home range of this species.

The Project will result in the loss of approximately 223.7 hectares of woodland and forest foraging and denning habitat for the species within the Proposed Disturbance Area and 223.1 hectares of derived native grassland habitat. This loss represents approximately 17 per cent of the remnant woodland vegetation located within the Project Area. Given that the species is known to traverse large expanses of land in the Project Area and surrounds, including within Ravensworth State Forest, there is potential that the loss of this area will result in a significant reduction in foraging habitat, including potential den locations for the local population, and a local viable population of the species will 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of known woodland and riparian habitat for the species and 223.1 hectares of derived native grassland habitat. Although, it is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or breeding, as the species is often recorded in areas of Ravensworth State Forest, the Proposed Disturbance Area is likely to provide dispersal corridors into adjoining 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

A small local population of the species occurs in the Mount Owen locality and has been primarily recorded in Ravensworth State Forest, Bettys Creek diversion and nearby along Bowmans Creek and at Liddell Mine. Additionally, the species has been recently radio-tracked in the Proposed Disturbance Area. Important habitat for the individuals occurring in the Project Area, including den sites, known breeding habitat and high quality foraging habitat associated with Ravensworth State Forest and Bowmans Creek will not be impacted by the Project. However, the Project components such as the proposed rail line and expansion of the North Pit has the potential to create a substantial barrier for the species in accessing habitat areas in the southern portion of the Project Area within the Proposed Disturbance Area.

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 species has been recorded within the Project Area and Proposed Disturbance Area as well as at Liddell Mine and latrines along Bowmans Creek. It is likely that a small local population of the species occurs within the Project Area traversing into neighbouring habitats. All of the vegetation communities in the Proposed Disturbance Area will provide foraging habitat for the spotted-tailed quoll and the species is considered to be resident in the Project Area. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares and often traverse their ranges along densely vegetated creek lines. The Project will result in the loss of approximately 223.7 hectares of woodland and forest habitat for the species, including a small area of poor quality riparian vegetation along Bettys Creek and approximately 223.1 hectares of derived native grassland habitat. The species has been regularly recorded in the Project Area over many years and the habitats in the Proposed Disturbance Area are part of a wider foraging range for the species. The Project is likely to result in a reduction in the area of habitat required by the species to persist in the local area due to a reduction in potential habitat availability in the local area and could result in a reduction in the home range of the individuals occurring in the Project Area.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

The 'Recovery plan for *Dasyurus maculatus* (Spotted-tailed Quoll) 2005 – 2009' (Long and Nelson 2004) is applicable to this species. The Project contravenes with the following objective of the recovery plan: 'Reduce the rate of loss and fragmentation of Spotted-tailed Quoll habitat'. The Project will contribute to both the loss of spotted-tailed quoll habitat and slightly increase the level of fragmentation of habitat for this species.

The NSW 'Threat abatement plan for predation by the red fox (*Vulpes vulpes*)' (OEH 2011) is relevant to this threatened species. The Project does not contravene any of the objectives or actions of this plan.

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

The Project will contribute to the operation of the following key threatening processes relevant to the species:

- bushrock removal (TSC Act);
- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act;
- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project is likely to result in a significant impact on the local population of the spotted-tailed quoll (*Dasyurus maculatus*).

Brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*)

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;

The brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*) has been only recently recorded in the Project Area during fauna monitoring in 2011 (Forest Fauna Surveys and Newcastle Innovation 2014). Two adults were observed utilising glider nest boxes in the regeneration area north of Ravensworth State Forest in May 2011. This is the first documented record of the species occurring within the Project Area, despite a number of records of the species in the locality including near Glennies Creek to the south-west of the Project Area (Forest Fauna Surveys and Newcastle Innovation 2014). A brush-tailed phascogale was recorded via remote camera in scattered woodland habitat to the west of Hebden Road, outside the Project Area, in March 2014 (Umwelt, in prep). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. This species has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are isolated occurrences west of the divide. All of the woodland and forest communities in the proposed distance area are likely to provide foraging habitat and potential nesting and shelter habitat for the species. The wider Project Area contains approximately 1355 hectares of woodland and forest that provides known and potential habitat for the species.

The females inhabit territories of approximately 20 to 60 hectares, while the males maintain territories of up to 100 hectares. The territory of a female is exclusive; however, the territory of a male may overlap with other females and males (Strahan 2002). The brush-tailed phascogale nests and shelters in tree hollows, utilising many different hollows over a short time span with suitable hollows between 25 and 40 millimetres wide.

The Project will result in the loss of approximately 223.7 hectares of potential woodland habitat for the species. This loss represents an approximately 17 per cent reduction in the remnant vegetation located within the Project Area. Given that the species is known to require a large home range and taking into account the unknown status of the species' distribution across the Project Area, there is potential that the loss of this area, particularly the loss of hollow bearing trees, will result in a significant reduction in habitat for the local population, and a local viable population of the species may 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of potential woodland habitat that provides potential foraging and nesting habitat for the species. It is unlikely that this species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or breeding, as the species has only been recorded north of Ravensworth State Forest, however the extent of this cryptic species distribution across the Project Area is unknown. The wider Project Area provides approximately 1355 hectares of forests and woodlands that provide known and potential foraging 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

A small local population of the species has been recorded north of Ravensworth State Forest, but has not been recorded elsewhere within the Project Area, despite many surveys of extensive survey and monitoring. If the species traverses through the wider habitats into the Proposed Disturbance Area, Project components such as the proposed rail line and proposed Mount Owen continuation has the potential to create a substantial barrier for the species in accessing other habitat areas within the Project Area and in neighbouring lands.

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

Females of this species occupy home ranges up to about 20 to 60 hectares and males up to 100 hectares. This species has only been recently recorded in the Project Area using a nest box in regenerating forest north of Ravensworth State Forest. The species has not been recorded in other areas of the Project Area despite suitable habitat occurring. The Project Area contains hollow-bearing trees which may be utilised by the species as nesting and shelter sites. These habitat features are common in the Proposed Disturbance Area and wider Project Area; however are generally poorly represented in the wider central Hunter Valley due to previous land clearing. The removal of potential habitat for this species in the Proposed Disturbance Area has the potential to significantly impact the long-term survival of this species in the Mount Owen locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);

- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project has the potential to result in a significant impact on the brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*).

Koala (*Phascolarctos cinereus*)

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;

The koala (*Phascolarctos cinereus*) was tentatively recorded during the fauna monitoring in 1995 through the collection of scats that were attributed to the species (Forest Fauna Surveys and Newcastle Innovation 2014) and a historic record of the species from 1980 in the east of the Project Area. The koala was also recorded in 2012, in grassland adjacent to the corner of Hebden Road and the New England Highway. The description of the individual on the OEH Atlas of NSW Wildlife indicates that it was large and apparently healthy and therefore it is inferred that the individual is likely to be a dispersing male that was occupying grassland between suitable woodland remnants. The koala has been recently recorded approximately 6 kilometres to the north-west of the Project Area in the Hillcrest Offset Area that was established as part of the Ravensworth Continued Operations Project (Umwelt 2010). The species 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. All of the eucalypt woodland and forest communities in the Proposed Disturbance Area are likely to provide marginal foraging habitat for the species with low levels of preferred food trees recorded during surveys. The wider Project Area contains approximately 1,117 hectares of eucalypt dominated woodland and forest that provides marginal habitat for the species.

The Project will result in the loss of approximately 163.7 hectares of potential eucalypt woodland habitat for the species that has low levels of preferred koala food trees, namely forest red gum (*Eucalyptus tereticornis*) which is an uncommon canopy species in woodland communities in the Proposed Disturbance Area. As the habitats in the Proposed Disturbance Area do not contain suitable preferred koala food trees it is considered unlikely that the species would be resident in the Proposed Disturbance Area or wider Project Area. It is considered that the loss of woodland and derived native grassland communitites within the Proposed Disturbance Area is unlikely to result in a significant reduction in foraging habitat for the species, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 163.7 hectares of potential eucalypt woodland habitat for the species. It is unlikely that this species utilises the habitats within the Proposed Disturbance Area for foraging or breeding, as the species has not been recorded in the Proposed Disturbance Area. The wider Project Area provides approximately 1,117 hectares of forests and woodlands that provide marginal habitat only 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

The Project Area has two historic records of the species, from 1980 and a record of a scat attributed to the species in 1995. The species has not been recorded in the Project Area since that time despite many surveys of extensive survey and monitoring. The 2012 record of the species adjacent to the New England Highway and Hebden Road is considered likely to represent a transient male, moving between areas of preferred habitat. If the species traverses the Project Area into the Proposed Disturbance Area, Project components such as the proposed rail line and expansion of the North Pit may create a barrier for the species in accessing other habitat areas within the Project Area and in neighbouring lands.

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

As the habitats in the Proposed Disturbance Area do not contain suitable preferred koala food trees it is considered unlikely that the species would be resident in the Proposed Disturbance Area or wider Project Area. It is considered that the loss of woodland and derived native grassland communitites within the Proposed Disturbance Area is unlikely to result in a significant reduction in foraging habitat. The removal of potential, marginal habitat for this species in the Proposed Disturbance Area is unlikely to significantly impact 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);

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

The 'Recovery plan for the koala (*Phascolarctos cinereus*)' (DECC 2008) is relevant to this species. The proposed action does not contravene with any of the objective or actions listed within this recovery plan.

No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act); and
- human-caused climate change (TSC and FM Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the koala (*Phascolarctos cinereus*).

Squirrel glider (*Petaurus norfolcensis*)

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;

The squirrel glider (*Petaurus norfolcensis*) has been regularly recorded within the Project Area during fauna monitoring from 1994 to 2013 (Forest Fauna Surveys and Newcastle Innovation 2014). The species is often recorded in Ravensworth State Forest, but has also been observed in woodland habitat in the Proposed Disturbance Area in 2009. The species previously occurred in the area now occupied by the Mount Owen North Pit. Since 1996, glider-specific nest boxes and salvaged hollows have been installed in Ravensworth State Forest and adjoining rehabilitated areas have provided habitat for this species in many areas in the Project Area. The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. All of the woodland and forest communities in the Project Proposed Disturbance Area are likely to provide foraging and potentially nesting habitat for the species. The wider Project Area contains approximately 1355 hectares of woodland and forest that provides known and potential habitat for the species.

Assessment of the average estimated density of squirrel gliders in Project Area was determined by home range calculations derived from radio-tracking results. The mean home range of the squirrel glider (n = 4 gliders) is 33 hectares, with an average density of 0.09 gliders per hectare (Forest Fauna Surveys *et al*. 2004). This compares to an average home range in coastal Lake Macquarie and Wyong of 6 hectares, and 0.39 gliders per hectare (Smith and Murray 2003). The lower density of gliders occurring in Project Area and almost a fivefold increase in home range of the population, compared to the coastal populations, is considered due to absence of understorey foraging resources (e.g. *Acacia* species) (Forest Fauna Surveys *et al.* 2004).

The population of the squirrel glider in the Project Area prior to approval of existing mining was estimated to be 40 to 50 individuals. The extent of forest/woodland remaining following clearing of approved mining is expected to have reduced the population to around 20 to 25 individuals. Previous approvals are likely to have resulted in the removal of at least two known sub-populations, one occurring in the Southern Remnant and one population in the approved West Dump location. (Forest Fauna Surveys *et al*. 2004). The reduced size of the squirrel glider population size in the Project Area makes the species susceptible to stochastic events and further reductions in remnant size.

The Project will result in the loss of approximately 223.7 hectares of known woodland habitat for the species. This loss represents an approximately 17 per cent reduction in the size of the remnant vegetation located within the Project Area. As the species is known to occur in the Proposed Disturbance Area, there is potential that the loss of this area of habtiat will result in a significant reduction in habitat for the local population, and a local viable population of the species will 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 223.7 hectares of known woodland habitat for the species. The wider Project Area provides approximately 1355 hectares of forests and woodlands that provide known and potential foraging 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

A local population of the species has been recorded in and around Ravensworth State Forest and within the Proposed Disturbance Area. As the species is known to traverse through the habitats of the Proposed Disturbance Area, Project components such as the proposed rail line and the expansion of the North Pit is likely to create a substantial barrier for the species in accessing other habitat areas within the Project Area and in neighbouring lands.

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

Home ranges for the squirrel glider at Mount Owen have been estimated to be between 30 and 40 hectares. The species is known to move up to 500 metres in a night. Although this species is primarily recorded in the Project Area in Ravensworth State Forest, a record of the species does occur within the woodland habitats of the Proposed Disturbance Area (Forest Fauna Surveys and Newcastle Innovation 2014). The Proposed Disturbance Area contains hollow-bearing trees which may be utilised by the species as nesting and refuge sites. These habitat features are common in the Proposed Disturbance Area, however are more concentrated in and around Ravensworth State Forest which will not be disturbed as a result of the Project. The removal of foraging and potential nesting habitat for this species in the Proposed Disturbance Area may significantly affect 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);

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project is likely to result in a significant impact on the local population of the squirrel glider (*Petaurus norfolcensis*).

Grey-headed flying-fox (*Pteropus poliocephalus*)

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;

The grey-headed flying-fox (*Pteropus poliocephalus*) has been regularly recorded in the Project Area during annual monitoring surveys in 1994, 1996, 1997, 2000, 2004, 2006, 2007 and 2010 when eucalypt species are flowering (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The species is generally found within 200 kilometres of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. The species roosts in 'camps' of many individuals (up to tens of thousands) in vegetation. A known grey-headed flying-fox camp occurs in an urban park in Singleton approximately 17 kilometres south of the Project Area. Camp sites have not been identified and are not expected to occur in the Proposed Disturbance Area due to a lack of preferred habitat. The Proposed Disturbance Area is considered to comprise an area of potential foraging habitat for this species and is unlikely to contain significant breeding and roosting habitat. The wider Project Area contains approximately 1,355 hectares of woodland and forest habitat that is likely to provide further foraging habitat for the species.

The Project will result in the loss of approximately 163.7 hectares of potential eucalypt woodland foraging habitat for the species. Given the species does not utilise the Proposed Disturbance Area for roosting or breeding and the habitats provide only limited foraging habitat, it is not considered that the loss of this area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 163.7 hectares of eucalypt foraging habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or roosting, however the species is often recorded throughout all woodland habitats within the Project Area. The Project Area provides approximately 1355 hectares of forests and woodlands that provide other foraging 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

The Project is unlikely to introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some foraging habitat will be removed, the level of fragmentation and isolation of habitats may increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species is known to utilise the eucalypt woodlands within the Project Area and the Proposed Disturbance Area as foraging habitat. As the suitable habitat in the Proposed Disturbance Area comprises part of a much larger range for the species, the Project will result in a reduction in the area of habitat available to the species in the local area. It is unlikely that the Project will affect the long-term survival of the species in the locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

The 'Draft National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus*' (DECCW 2009) is relevant to this species. The Project does not contravene any of the objectives or actions of this recovery plan.

No threat abatement plans are pertinent to this threatened 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 proposed will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act); and
- human-caused climate change (TSC and FM Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the grey-headed flying-fox (*Pteropus poliocephalus*).

Yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*)

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;

The yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*) has been recorded in the Project Area during annual monitoring surveys in the years 2007, 2009, 2010, 2011, 2012 and 2013 using call echolocation recording, however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The species is wide-ranging and found across northern and eastern Australia, roosting in tree hollows and buildings. The woodland and open habitats of the Proposed Disturbance Area provide likely foraging and potential roosting habitat for the species. The Project Area contains approximately 2,794 hectares of woodland and open derived native grassland areas that would provide foraging and, where trees are present, potential roosting habitat for the species.

The Project will result in the loss of approximately 451.5 hectares of potential foraging and where trees are present, potential roosting habitat for the species. Given that the species is known to utilise woodland and forested habitats across the Project Area for foraging and potentially for roosting, there is potential that the loss of this area will result in a significant reduction in habitat for the local population, and a local viable population of the species will 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of known and potential woodland habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or roosting, as the species is primarily been recorded north of Ravensworth State Forest although a record occurs near the proposed rail loop. The wider Project Area provides approximately 2794 hectares of forest and woodland vegetation and derived native grasslands that provide known and potential foraging 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

The Project will not introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some known and potential habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species is known to utilise the forests and woodlands within the Project Area and the Proposed Disturbance Area for foraging roosting and breeding habitat. Although it is likely that suitable habitat in the Proposed Disturbance Area comprises part of a much larger range for the species, the Project will result in a 16 per cent reduction in the area of habitat available to the species in the Project Area and may affect the long-term survival of the species in the locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 proposed will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project has the potential to result in a significant impact on the yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*).

East coast freetail-bat (*Mormopterus norfolkensis*)

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;

The east coast freetail-bat (*Mormopterus norfolkensis*) has been regularly recorded throughout the woodland and forest habitats of the Project Area, including within the Proposed Disturbance Area, during annual monitoring surveys between the years 1994 to 2013, with the exception of 2006 using call echolocation recording and confirming its presence with capture methods (Forest Fauna Surveys and Newcastle Innovation 2014). The species is also the most abundant of the micro-bat species to utilise bat roost boxes in 2011 monitoring year (Forest Fauna Surveys and Newcastle Innovation 2014) and lactating females have also been recorded during tree felling (Xstrata Coal and Thiess 2006). The species was also recorded during Umwelt surveys of the Proposed Disturbance Area. The species is found along the east coast from south Queensland to southern NSW and roosts mainly in tree hollows and bark. The woodland and open habitats of the Proposed Disturbance Area provide foraging and roosting habitat for the species. The Project Area contains approximately 2,794 hectares of native woodland and open areas that would provide foraging and, where trees are present, potential roosting habitat for the species.

The Project will result in the loss of approximately 451.5 hectares of known foraging, roosting and likely breeding habitat for the species, which represents a 16 per cent reduction in foraging and roosting habitat available in the remnant vegetation in the Project Area. Given that the species is known to utilise woodland and forested habitats across the Project Area for roosting and breeding, and it occurs regularly in the Proposed Disturbance Area, there is potential that the loss of this area will result in a significant reduction in habitat for the local population, and a local viable population of the species will 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of known woodland and forest habitat for the species. The wider Project Area provides approximately 2794 hectares of forests, woodlands and open habitat that provides known and potential foraging 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

The Project is unlikely to introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some known and potential habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species is known to utilise the forests and woodlands within the Project Area and the Proposed Disturbance Area for foraging, roosting and breeding habitat. Although it is likely that suitable habitat in the Proposed Disturbance Area comprises part of a much larger range for the species, the Project will result in a 16 per cent reduction in the area of habitat available to the species in the Project Area and may affect the long-term survival of the species in the locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project has the potential to result in a significant impact on the east coast freetail-bat (*Mormopterus norfolkensis*).

Little bentwing-bat (*Miniopterus australis*)

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;

The little bentwing-bat (*Miniopterus australis*) has been tentatively recorded in Project Area during annual monitoring surveys in 2001 using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The species is found along the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW and roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and occasionally buildings. The Proposed Disturbance Area provides potential foraging habitat for the species. Suitable cave roosting habitat for this species does not occur in the Proposed Disturbance Area and is unlikely to occur in the wider Project Area. The Project Area contains approximately 2794 hectares of native woodland and open areas that would provide potential foraging habitat for the species.

The Project will result in the loss of approximately 451.5 hectares of potential foraging habitat for the species. Given the availability of suitable foraging and breeding habitat in the region and the wider Project Area, including within Ravensworth State Forest, it is not considered that the loss of this area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of potential foraging habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging and it is expected that the species is an uncommon visitor to the Project Area. The species is only tentatively recorded throughout the habitats within the Project Area. The wider Project Area provides approximately 2794 hectares of forest and woodland habitat and derived native grasslands that provide potential foraging 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

The Project is unlikely to introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some potential habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species may utilise the forests and woodlands within Project Area and the Proposed Disturbance Area for foraging, although the species has not been positively recorded in the Project Area, despite substantial fauna monitoring surveys that specifically target micro-bats. It is likely that potentially suitable habitat in the Proposed Disturbance Area comprises part of a much larger range for the species. The Proposed Disturbance Area does not provide potential roosting and breeding habitat for the species. The Project will result in a reduction in the area of foraging habitat available to the species in the local area however is unlikely to affect the long-term survival of the species in the locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species. The Project will not have an adverse effect on any critical habitat.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act); and
- human-caused climate change (TSC and FM Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the little bentwing-bat (*Miniopterus australis*).

Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)

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;

The eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) has been recorded in the Project Area every year during annual monitoring surveys (except in 2003 and 2006) using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species is expected to use the habitats of the Project Area primarily as foraging habitat with an offsite roosting site. The species was known to roost in an underground mine at Cumnock, immediately west of the Project Area although this roosting site no longer provides a roost site (Umwelt 2008). The species was also recorded during Umwelt surveys of the Proposed Disturbance Area. The species is found along the east and north-west coasts of Australia and roost in caves, tunnels, buildings and other man-made structures. The habitats of the Proposed Disturbance Area provides known foraging habitat for the species, however it is unlikely to provide suitable roosting habitat. The Project Area contains approximately 2794 hectares of woodland and open areas that would provide potential foraging habitat for the species.

The Project will result in the loss of approximately 451.5 hectares of known foraging habitat for the species, which represents a 16 per cent reduction in foraging habitat across the wider Project Area. However, given the availability of suitable foraging and breeding habitat in the region and within Ravensworth State Forest and the lack of roosting and breeding habitat within the Proposed Disturbance Area, it is not considered that the loss of this area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of foraging habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging, and the species is occasionally recorded throughout the woodland habitats within Project Area. The wider Project Area provides approximately 2794 hectares of forests, woodlands and open areas that provide known foraging 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

The Project is unlikely to introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some known foraging habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species is known to utilise the woodland and forest habitats within Project Area and the Proposed Disturbance Area for foraging. It is unlikely that the Proposed Disturbance Area provides suitable roosting or breeding habitat for the species due to an absence of caves or similar structures. The Project will result in a reduction in the area of foraging habitat available to the species in the local area however is unlikely to affect the long-term survival of the species in the locality.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act); and
- human-caused climate change (TSC and FM Act).

Conclusion

Based on the information provided above, the Project is unlikely to result in a significant impact on the eastern bentwing-bat (*Miniopterus schreibersii oceanensis*).

Southern myotis (*Myotis macropus*)

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;

The southern myotis (*Myotis macropus*) has been occasionally recorded throughout the habitats of the Project Area, including within the Proposed Disturbance Area, during annual monitoring surveys in the years 1999, 2000, 2005, 2007, 2009 and 2011 using call echolocation recording and confirming its presence with capture methods (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded during Umwelt surveys of the Proposed Disturbance Area. The species is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria and roost close to water in caves mine shafts, hollow-bearing trees, under bridges and in dense foliage. The Proposed Disturbance Area provides known and potential foraging and roosting habitat for the species and the expansion of mine water management structures is expected to have increased the area of habitat for the species in the local area. The Project Area contains approximately 2,794 hectares of woodland and open areas that would provide foraging and roosting habitat for the species and an abundance of aquatic habitat by way of mine water dams and smaller farm dams and ephemeral drainage lines.

The Project will result in the loss of approximately 451.5 hectares of known foraging and likely roosting habitat for the species, which represents a 16 per cent reduction in foraging and roosting habitat available in the remnant vegetation at the Project Area. Given that the species is known to utilise woodland and forested habitats across the Project Area and it is known to occur in the Proposed Disturbance Area, there is potential that the loss of this area will result in a significant reduction in habitat for the local population, and a local viable population of the species will 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of known foraging and roosting habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or roosting, however the species is often recorded throughout the woodland habitats within the Project Area. The wider Project Area provides approximately 2794 hectares of forests, woodlands and open areas that provide known and potential foraging habitat for this species and an abundance of aquatic habitat by way of mine water dams and smaller farm dams and ephemeral drainage lines.

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 Project is unlikely to introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some known and potential habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species is known to utilise the forests and woodlands within the Project Area and the Proposed Disturbance Area for roosting and aquatic habitats including farm and mine water dams and ephemeral drainage lines. As it is likely that suitable habitat in the Proposed Disturbance Area comprises part of a much larger range for the species, the Project may result in a reduction in the area of habitat available to the species in the local area and may affect the long-term survival of the species due to a reduction in potential roosting habitat.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act);
- alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (TSC Act);
- degradation of native riparian vegetation (FM Act);
- the installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of rivers and streams (TSC and FM Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above the Project has the potential to result in a significant impact on southern myotis (*Myotis macropus*).

Greater broad-nosed bat (*Scoteanax rueppellii*)

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;

The greater broad-nosed bat (*Scoteanax rueppellii*) has been occasionally recorded throughout the habitats of the Project Area, including within the Proposed Disturbance Area, during annual monitoring surveys in the years 2000, 2001, 2002, 2007, 2004, 2009, 2010, 2011, 2012 and 2013 using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species was also recorded during Umwelt surveys of the Proposed Disturbance Area. The species is mainly found in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland and extends to the coast over much of its range. The species mainly roosts in tree hollows, but also in buildings. The Proposed Disturbance Area provides known foraging and potentially roosting habitat for the species. The Project Area contains approximately 2794 hectares of woodland and open areas that would provide foraging and roosting habitat for the species.

The Project will result in the loss of approximately 451.5 hectares of known foraging and likely roosting habitat for the species, which represents a 16 per cent reduction in foraging and roosting habitat available in the remnant vegetation at the Project Area. Given that the species is known to utilise woodland and forested habitats across the Project Area and is known to occur in the Proposed Disturbance Area, there is potential that the loss of this area of habitat will result in a significant reduction in habitat for the local population, and a local viable population of the species may 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of known foraging and potential roosting habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or roosting, however the species is occasionally recorded throughout the woodland habitats within the Project Area. The wider Project Area provides approximately 2794 hectares of forests, woodlands and open areas that provide known foraging and potential roosting 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

The Project is unlikely to introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some known and potential habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species is known to utilise the forests and woodlands within the Project Area and the Proposed Disturbance Area for foraging and potentially roosting habitat. It is likely that suitable habitat in the Proposed Disturbance Area comprises part of a much larger range for the species. The Project will result in a reduction in the area of habitat available to the species in the local area and may affect the long-term survival of the species.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act);
- human-caused climate change (TSC and FM Act);
- loss of hollow-bearing trees (TSC Act); and
- removal of dead wood and dead trees (TSC Act).

Conclusion

Based on the information provided above, the Project has the potential to result in a significant impact on greater broad-nosed bat (*Scoteanax rueppellii*).

Large-eared pied bat (*Chalinolobus dwyeri*)

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;

The large-eared pied bat (*Chalinolobus dwyeri*) has been tentatively recorded in the Project Area during annual monitoring surveys in 1999, 2001, 2006 and 2008 using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2014). The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The species is mainly found 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. The species mainly roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*). The Proposed Disturbance Area provides potential foraging habitat for the species. The Project Area contains approximately 2794 hectares of woodland and open areas that would provide potential foraging habitat for the species.

The Project will result in the loss of approximately 451.5 hectares of potential foraging habitat for the species. Given the species has not been confirmed at the site and is more often recorded in the southwest of the Project Area with availability of suitable foraging and breeding habitat in the wider region, it is not considered that the loss of this area will result in a significant reduction in foraging habitat for the local population, and a local viable population of the species will not 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;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed;

Not applicable.

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;

The Project will result in the loss of approximately 451.5 hectares of potential foraging habitat for the species. It is unlikely that this highly mobile species depends exclusively on the habitats within the Proposed Disturbance Area for foraging or roosting and the species is rarely recorded within the woodland habitats within the Project Area. The wider Project Area provides approximately 2794 hectares of forests, woodlands and open areas that provide known foraging and potential roosting 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

The Project is unlikely to introduce significant barriers for this highly mobile species such that it will prevent movement of individuals between proximate areas of habitat. As some potential habitat will be removed, the level of fragmentation and isolation will increase for this species. However, given the extensive area of suitable habitat in the surrounding area and the high mobility of this species, the level of fragmentation and isolation increase is unlikely to significantly impact on 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;

The species may utilise the forests and woodlands within the Project Area and the Proposed Disturbance Area for foraging habitat. As it is likely that suitable habitat in the Proposed Disturbance Area comprises part of a much larger range for the species, the Project will result in a reduction in the area of habitat available to the species in the local area however is unlikely to affect the long-term survival of the species.

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

No critical habitat has been listed within or adjacent to the Project Area for this threatened species.

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

No recovery plans have been prepared for this species. No threat abatement plans are pertinent to this threatened 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 Project will contribute to the operation of the following key threatening processes relevant to the species:

- clearing of native vegetation (TSC Act); and
- human-caused climate change (TSC and FM Act).

Conclusion

Based on the information provided above, and considering the application of the precautionary principle, the Project is unlikely to result in a significant impact on large-eared pied bat (*Chalinolobus dwyeri*).

Conclusion

The Project will result in the loss of a substantial and important area of habitat for a number of woodland dependent threatened species recorded in the Project Area and, in particular, the Proposed Disturbance Area. The loss of 223.7 hectares of woodland, forest and riparian habitat and 223.1 hectares of derived native grassland is considered likely to result in the reduction in the local population of the threatened species recorded or potentially occurring in the Proposed Disturbance Area. The size of this remnant is considered sufficient to support those woodland dependent species that are known to be threatened by habitat fragmentation. The assessments of significance do not take into account the full range of impact mitigation strategies and biodiversity offsets proposed for the Project, rather they consider the impacts of the Project without any mitigation or offsetting, consistent with the requirements of both state and Commonwealth significant impact assessment guidelines (DECC 2007a; DEHWA 2009a). Based on the threatened species assessment detailed above, the Project is considered likely to result in significant impact on the following threatened species:

- spotted-tailed quoll (*Dasyurus maculatus*); and
- squirrel glider (*Petaurus norfolcensis*).

The Project will potentially result in a significant impact on a number of species. These species have been categorised 'potentially significantly impacted' as there are a range of factors that reduce the certainty as to whether the Project will result in a significant impact. These factors include (but are not limited to) certainty regarding the importance of habitat utilisation in the Proposed Disturbance Area; the cryptic nature of many of these species; and the uncertainty regarding the local population of these species occurring within and beyond the Proposed Disturbance Area. The potential for a significant impact cannot be ruled out based on current knowledge and therefore, following application of the precautionary principle, the following list of species are considered to be potentially significantly impacted (without mitigation):

- masked owl (*Tyto novaehollandiae*);
- brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- speckled warbler (*Chthonicola sagittata*);
- grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- varied sittella (*Daphoenositta chrysoptera*);
- hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- diamond firetail (*Stagonopleura guttata*);
- brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*);
- yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*);
- east coast freetail-bat (*Mormopterus norfolkensis*);
- southern myotis (*Myotis macropus*); and
- greater broad-nosed bat (*Scoteanax rueppellii*).

APPENDIX F

EPBC Act Assessment of Significance

Appendix F - Assessment of Significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires an Assessment of Significance relating to the potential impacts of a Project on listed matters of national environmental significance (MNES).

Under the EPBC Act, the approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on MNES. These matters are:

- listed threatened species and ecological communities;
- migratory species protected under international agreements;
- Ramsar wetlands of international importance;
- the Commonwealth marine environment;
- World Heritage properties;
- National Heritage places;
- Great Barrier Reef Marine Park;
- nuclear actions; and
- a water resource, in relation to coal seam gas development and large coal mining development.

A search of the Department of Environment Protected Matters Search Tool (May 2014) and collated information from literature reviews identified three threatened ecological communities (TECs), 26 threatened species and 12 migratory species known to occur, or considered to have the potential to occur on the basis of habitat modeling, around the Project Area. Each of these has been included in tables in **Appendix A**, together with an indication of those species that warrant further assessment by way of an Assessment of Significance.

As outlined in **Appendix A**, the following EPBC Act listed species and communities are considered to have the potential to occur or be impacted by the Project and are subject to an Assessment of Significance below:

Critically Endangered and Endangered Species:

- regent honeyeater (*Anthochaera phrygia*);
- swift parrot (*Lathamus discolor*);
- spotted-tailed quoll (*Dasyurus maculatus maculatus*) SE mainland population; and
- Australian painted snipe (*Rostratula benghalensis australis*).

Vulnerable Species

- green and golden bell frog (*Litoria aurea*);

- koala (*Phascolarctos cinereus*);
- grey-headed flying-fox (*Pteropus poliocephalus*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- New Holland mouse (*Pseudomys novaehollandiae*); and
- *Ozothamnus tesselatus.*

Migratory Species Listed under International Conventions:

- eastern great egret (*Ardea modesta*);
- cattle egret (*Ardea ibis*);
- Latham's snipe (*Gallinago hardwickii*);
- Australian painted snipe (*Rostratula benghalensis australis*);
- white-bellied sea eagle (*Haliaeetus leucogaster*);
- white-throated needletail (*Hirundapus caudacutus*);
- rainbow bee-eater (*Merops ornatus*); and
- rufous fantail (*Rhipidura rufifrons*).

Critically Endangered and Endangered Species

Four critically endangered or endangered species have the potential to be impacted by the Project:

- regent honeyeater (*Anthochaera phrygia*) – endangered;
- swift parrot (*Lathamus discolor*) – endangered;
- spotted-tailed quoll (*Dasyurus maculatus maculatus*) SE mainland population – endangered; and
- Australian painted snipe (*Rostratula benghalensis australis*).

Species descriptions, in the Assessments of Significance below, are referenced from the Office of Environment and Heritage (OEH 2014) and Department of the Environment (2014) online species profiles, unless otherwise noted.

Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*)

The swift parrot has been recorded on three occasions in the vicinity of the Project Area within Ravensworth State Forest and the Southeast Offset Area. The species was first recorded in the Project Area in May 2005 and within the northern section of Ravensworth State Forest in September 2007 (Forest Fauna Surveys and Newcastle Innovation 2013). Two birds were also recorded in a flowering *Eucalyptus tereticornis* in June 2014. There have been few records of the species within the central Hunter Valley in the past few years, with the species generally occupying coastal habitats (Birdline 2013, 2014; Umwelt 2013). This species may make use of the open forest and woodland habitats of the Proposed Disturbance Area, particularly where there are prolific flowering eucalypts and this migratory species is likely to move throughout the area in response to mass flowering events. This species does not breed on mainland Australia, and as such the Proposed Disturbance Area represents foraging habitat only for this species. The Project will result in the removal of approximately 163.7 hectares of known and potential habitat for the species.

This species breeds in Tasmania and moves to mainland Australia for the non-breeding season (usually arriving between February and March). Most of the population winters in Victoria and New South Wales. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region. However, evidence is gathering that the forests on the coastal plains from southern to northern NSW are also important. They return to Tasmania in spring (September-October). The movements of this species on the mainland are poorly understood, but it is considered to be nomadic and irruptive, moving in response to food supply.

Upon reaching their core non-breeding range there is no known geographical pattern of movement. During the non-breeding season, the home-range varies tremendously between individuals and between years.

This species is likely to utilise box-ironbark vegetation associations within the Hunter catchment, as well as coastal areas dominated by spotted gum and swamp mahogany species. Such habitats are estimated to cover up to 10,000 square kilometres within the Hunter catchment.

The regent honeyeater has not been previously recorded within the Project Area or surrounds. The potential habitat for this species corresponds to that of the swift parrot and therefore the species have been assessed together. Potential habitat for the species comprises box-gum woodlands within the Proposed Disturbance Area and due to the significant decrease in habitat for this species (throughout its range, including within the Hunter Valley) and the importance of potential habitat conservation, the removal of approximately 163.7 hectares of box-gum ironbark woodland within the Proposed Disturbance Area may reduce potential foraging habitat for the species in the local area.

This species is known to undertake a complex series of movements, which are thought to be governed mainly by the flowering of a select number of Eucalyptus species. The species is highly mobile, and capable of travelling large distances. The key trend in the movement patterns that relate to the Hunter catchment is:

> Movement into parts of northern NSW and south-east Queensland…in autumn, followed by the concentration of birds into core breeding areas on the inland slopes of the Great Dividing Range in north-western, central-western and south-western NSW…in late winter. (Garnett and Crowley 2000)

It is thought that these regular movements between regions may also be combined with movements on a local scale.

In the Capertee Valley, regent honeyeaters tend to disperse once breeding is complete. Dispersal begins with short distance movements (up to 30 kilometres) into forests on adjacent talus slopes during November and December. More extensive movements begin to occur in February, but the distances and destinations of these movements have yet to be documented.

Recent records from coastal regions of NSW exhibit no seasonal patterns, and it is thought that at least some coastal areas are used when food is scarce in the core breeding areas, none of which occur in the Hunter catchment, occurring in the Bundarra-Barraba area of NSW, the Capertee Valley in NSW, and north-eastern Victoria.

Estimated potential habitat within the Hunter region is up to 10,000 km^2 (1,000,000 hectares).

In this case, a *population* means:

- a geographically distinct regional population, or collection of local populations; or
- a regional population, or collection of local populations, that occurs within a particular bioregion.

The swift parrot occurs as a single population, although it migrates annually from breeding grounds in Tasmania to the winter foraging grounds on the coastal plains and slope woodlands of mainland eastern Australia (Saunders 2002). Approximately 200 mature birds (10 per cent of the total estimated population) are known to over-winter in the Lower Hunter Region of New South Wales (Saunders 2002). The Project Area is considered to form part of a regional dispersal route close to important winter foraging areas in the lower Hunter Valley.

Although there appears to be minor behavioural differences between regent honeyeaters in the three main areas inhabited by the species (the Bundarra-Barraba area in NSW, the Capertee Valley in NSW, and north-eastern Victoria), the direction and extent of movements, including evidence of movement between breeding sites, and a lack of discernable genetic differences between the sites suggest that the regent honeyeater occurs as a single, contiguous population (Garnett and Crowley 2000).

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- **lead to a long-term decrease in the size of a population; or**

No populations of regent honeyeater have been recorded within the Project Area; however, the swift parrot has been recorded on three occasions within the Project Area and the habitats of the Proposed Disturbance Area are considered to comprise known foraging habitat of the swift parrot. The Project will result in the loss of approximately 163.7 hectares of potential foraging habitat for both species. The Proposed Disturbance Area is not known as a historical or important foraging site for these species, however due to the reduction in habitat integrity elsewhere in the central Hunter Valley and across the species range, other areas of box-gum woodlands may become important resources for the two species. However, it is considered unlikely that the Project will lead to a decrease in the size of a *population* (as defined above) of the swift parrot or regent honeyeater.

- **reduce the area of occupancy of the species; or**

The regent honeyeater has not been recorded within the Project Area; however, the swift parrot has been recorded on two occasions. The Project will result in the loss of approximately 163.7 hectares of potential foraging habitat for both species. While the Project will remove potential habitat for these species, it is not likely to lead to a significant reduction in known habitat in the region. Substantial areas of similar habitats for these species are protected within a large expanse of vegetation in the Central Hunter including within Ravensworth State Forest and the Mount Owen Biodiversity Offset Areas which are located within the Project Area.

The loss of approximately 163.7 hectares of potential box-gum woodland habitat will result in a reduction of the potential area of occupancy for the regent honeyeater and swift parrot; however this is unlikely to substantially reduce the area of known occupancy.

- **fragment an existing population into two or more populations; or**

The regent honeyeater has not been recorded within the Project Area; however, the swift parrot has been recorded on three occasions. Both species are highly dispersive and it is unlikely that the Project will create a significant change to the species' dispersal capacity or create a significant barrier the movement of the species.

It is unlikely that the Project will result in the fragmentation of an existing *population* into two or more *populations*.

- **adversely affect habitat critical to the survival of a species; or**

The loss of approximately 163.7 hectares of potential box-gum ironbark woodland habitat within the Proposed Disturbance Area is unlikely to affect habitat that is critical to the survival of the species due to the presence of known habitat for the species within south-eastern Australia and in the case of the swift parrot, in Tasmania (Marchant and Higgins 1990).

- **disrupt the breeding cycle of a population; or**

The regent honeyeater mainly breeds in three key sites from the Bundarra-Barraba area NSW, the Capertee Valley in NSW, and north-eastern Victoria. Breeding has also been recorded within the Hunter Valley, with the species recorded breeding in open forest close to Kurri Kurri in 2007. Nests have also been recorded at Quorrobolong, north of the Watagan range in the Lower Hunter region, in lowland forest habitat. Low-lying forests and woodlands of the Hunter Valley are important habitat for the species being used as winter foraging habitat and potential breeding sites. The regent honeyeater has not been previously recorded in the Project Area.

The regent honeyeater population is considered to be in decline based on historic declines throughout much of the species' range, a range contraction, a decline in reporting frequency and the reduced size and occurrence of flocks (Garnett *et al*. 2011).

Currently, breeding season survey data suggest that the population of the swift parrot is at best stable, with an estimated 2000 breeding birds, or 1000 pairs (Garnett and Crowley 2000).

The swift parrot breeds and nests exclusively in Tasmania and migrates to mainland Australia during the non-breeding season. There is no potential for breeding habitat to occur in the Proposed Disturbance Area.

The Project is not expected to disrupt the breeding cycle of the regent honeyeater or the swift parrot.

- **modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline; or**

The Project will involve the removal of approximately 163.7 hectares of box-gum ironbark woodland that provides potential foraging habitat for these species. The Central Hunter supports other areas of habitat that contain box-gum woodland vegetation that would also provide potential habitat for these species; however the regent honeyeater and swift parrot have not been recorded in many of these areas. Additionally, extensive habitat occurs for the species in adjacent areas including Ravensworth State Forest and the Mount Owen Biodiversity Offset Areas.

It is considered unlikely that the Project will modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the regent honeyeater and swift parrot decline.

- **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;**

The Project is not expected to result in invasive species that are harmful to the regent honeyeater or swift parrot becoming established in the species' habitat.

- **introduce disease that may cause the species to decline; or**

Psittacine beak and feather disease (BFD) is a common and potentially deadly disease of parrots caused by a circovirus named beak and feather disease virus. The disease appears to have originated in Australia and is widespread and continuously present in wild populations of Australian parrots. BFD affecting endangered psittacine species (parrots and related species) was listed in April 2001 as a key threatening process under the EPBC Act.

It is considered unlikely that the Project will introduce BFD or any other disease that may cause the regent honeyeater or swift parrot to decline.

- **interfere with the recovery of the species.**

It is considered unlikely that the Project will interfere with the recovery of the regent honeyeater and swift parrot throughout Australia.

Conclusion

The Project is unlikely to result in a significant impact on the populations of the regent honeyeater or swift parrot. Although the Proposed Disturbance Area provides potential foraging habitat for these species and the swift parrot has been recorded in conserved habitats within the Project Area, they have not been recorded utilising the box-gum woodland within the Proposed Disturbance Area despite many years of extensive surveys and monitoring.

Although a significant impact on these species is unlikely, impact avoidance, mitigation and offsetting initiatives will be developed as part of the Project to reduce the impact on the swift parrot and the potentially occurring regent honeyeater. It is considered likely that the Project will result in residual significant impacts on vegetation communities and fauna habitats at the State level that cannot be avoided or mitigated. The selection of biodiversity offset sites as part of the State approval for the Project will consider habitat for the regent honeyeater and swift parrot.

Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)

The spotted-tail quoll has been recorded regularly at the Mount Owen Complex during fauna monitoring, with the species recorded annually between 1994 and 2013 (except 1998, 1999 and 2005) in Ravensworth State Forest and surrounding woodland and forest communities, including mine rehabilitation. The species has been recorded through a variety of methods, including hair tube sampling, spotlighting, predator scat searches and cage trapping. There have also been a number of sightings within the Mount Owen active mine area and the species has also been recorded at Bowmans Creek during fauna monitoring undertaken at the nearby Liddell Mine (Umwelt 2008) and in 2010 in the Ravensworth Operations Hillcrest Offset Area approximately 6 kilometres to the north-west of the Mount Owen Complex (Umwelt 2010). Additionally, recent radio-tracking undertaken on behalf of Mount Owen in the Mount Owen Complex has shown a resident male spotted-tailed quoll occurring predominantly in Ravensworth State Forest and also in mine rehabilitation to the north and east of North Pit, in remnant vegetation associated with Main Creek to the east of Mount Owen Complex and at five locations within the Proposed Disturbance Area. Remote camera monitoring has also identified an additional individual (i.e. not the individual that is being tracked) occurring at a den site in the north of the Mount Owen Complex.

All of the native and derived vegetation communities in the Proposed Disturbance Area are likely to provide foraging habitat for the spotted-tailed quoll and habitats in the Proposed Disturbance Area are considered to form part of the home range of the species. Although the species has been recorded in the exotic grassland-dominated mine rehabilitation, these areas are not considered to provide suitable foraging or denning habitat features and are not considered to provide habitat value for the species. The Proposed Disturbance Area does not include known den or breeding sites for the species. Den sites have been identified to the north of the Proposed Disturbance Area within Mount Owen Complex mine rehabilitation, in the Ravensworth State Forest and in habitats along Bowmans Creek to the west of the Proposed Disturbance Area. In late 2012 the spotted-tailed quoll was recorded to have successfully bred in a den on Bowmans Creek approximately 6 kilometres to the west of the Proposed Disturbance Area. The presence of the spotted-tailed quoll in the Mount Owen Complex is of importance as there are few areas within the central Hunter Valley lowlands (the main Hunter Valley) that are of sufficient size to support the home range of this species.

In this case, a *population* means:

- a geographically distinct regional population, or collection of local populations; or
- a regional population, or collection of local populations, that occurs within a particular bioregion.

There is very little research-based literature that allows confident definition of population size or population boundaries of the spotted-tailed quoll. Spotted-tailed quoll records are generally confined to within 200 kilometres of the NSW coast and ranges from the Queensland border to Kosciuszko National Park. The species is known to occur in the Hunter Valley. According to the National Recovery Plan for the species (Long and Nelson 2008) it is considered likely that the total number of mature adult spotted-tailed quolls is probably greater than 2000 but fewer than 10,000 individuals in Australia. Home range estimates vary considerably according to location and habitat quality, however females can occupy home ranges up to 750 hectares and males up to 3500 hectares and both sexes usually traverse their ranges along densely vegetated creeklines. Extant populations are highly fragmented and declining. The geographic distribution of the species is contracting and its subpopulations are becoming increasingly fragmented.

There are few recent records of this species occurring from the floor of the Hunter Valley. There are, however more frequent records of this species from the habitats of the southern

footslopes of the Barrington Tops and associated areas. It is likely that the fragmented habitats of the Hunter Valley floor (as well as major road, rail and other infrastructure networks crossing it) would limit genetic exchange from the Barrington area in a southerly direction, thus providing a likely genetic barrier to records of this species from the Wollemi/Yengo National Parks areas. The Barrington Tops and Mount Royal Range areas provide reasonable geographic features with which to bound the population to the north, although there is likely to be no firm discontinuity in species records between the subject area and habitats to the north of Barrington Tops. For the purpose of this assessment, it is considered that a regional population of this species is focused on the Barrington Tops southern and western footslopes and that this is genetically distinct and fragmented from those on the southern side of the Hunter Valley. This area comprises some 1800 km^2 of land, of which approximately 48 per cent is wooded, with about 52 per cent comprising agricultural lands. This includes an area centred on middle Foy Brook, to the west of the Mount Owen Complex, which is regarded for the purposes of this assessment as supporting a local population of the species.

There are regular records of the spotted-tailed quoll in the Mount Owen Complex between 1995 and 2013 in Ravensworth State Forest and surrounding woodland, forest and rehabilitation communities. Radio-tracking at Mount Owen has identified a male spotted-tailed quoll occurring in Ravensworth State Forest and mine rehabilitation and regeneration communities in the north of the Mount Owen Complex, in remnant vegetation associated with Main Creek to the east of Mount Owen Complex and at five locations within the Proposed Disturbance Area. Other non-tagged individuals have also been recorded during remote camera surveys. Other known local occurrences include a breeding record from a den on Bowmans Creek in 2012 (Umwelt 2008 and 2013) and in the Ravensworth Operations Hillcrest Offset Area (Umwelt 2010) (at least three recorded latrine sites), however records are generally concentrated on Bowmans Creek and Ravensworth State Forest, with extension into the more disturbed operational areas surrounding these core areas.

It is likely that the records within the Mount Owen Complex indicate a small population of the species in the locality and records from the northern portion of the Hunter Valley are likely to comprise part of a regional population centred on the Barrington Tops southern and western footslopes.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- **lead to a long-term decrease in the size of a population; or**

The spotted-tailed quoll is frequently recorded across the Mount Owen Complex and has mainly been recorded in Ravensworth State Forest. It is likely that these records indicate a small local population of the species. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares and usually traverse their ranges along densely vegetated creeklines. Radio-tracking of an individual male at the Mount Owen Complex indicates a small but distinct home range within Ravensworth State Forest and the mine rehabilitation area in the north of the site, in remnant vegetation associated with Main Creek to the east of Mount Owen Complex and at five locations within the Proposed Disturbance Area (Peter York pers. comm.). Records of the species in combination with the known location of den sites, latrines and breeding records indicate that intact vegetation associated within Ravensworth State Forest and riparian vegetation on Bowmans Creek and Main Creek provide the most important habitat for the species in the locality. Habitats associated with the Proposed Disturbance Area provide foraging habitat for the species as part of a wider home range.

All of the native and derived vegetation communities in the Proposed Disturbance Area will provide foraging habitat for the spotted-tailed quoll and the species is considered to be resident in the Mount Owen Complex. The Project will result in the loss of approximately 223.7 hectares of woodland, forest and riparian habitat for the species and 223.1 hectares of native grassland habitat which is considered to be of lesser importance to the species than woodland/forest habitats, including riparian vegetation along Bettys Creek. The Project is likely to result in a reduction in the area of habitat available to the species in the local area and is likely to result in a reduction in the home range of the individuals occurring in the Mount Owen Complex however this is not considered likely to lead to a long-term decrease in the size of the Barrington Tops (southern and western footslopes) regional population of the spotted-tailed quoll.

- **reduce the area of occupancy of the species; or**

The spotted-tail quoll occurs in the Mount Owen locality and has been mainly recorded in Ravensworth State Forest. The Project will result in the loss of approximately 223.7 hectares of woodland, forest and riparian habitat for the species and 223.1 hectares of native grassland habitat which is considered to be of lesser importance to the species than woodland/forest habitats, in southern portion of the Mount Owen Complex. This leads to a reduction in the area of occupancy of the species by approximately 447 hectares, which is not important, notable, or of consequence to the area of occupancy for the species, in accordance with the significant impact guidelines (Department of the Environment 2013).

- **fragment an existing population into two or more populations; or**

A small local population of spotted-tail quoll occurs in the Mount Owen locality and has mainly been recorded in Ravensworth State Forest and along Bowmans Creek to the west of the Proposed Disturbance Area and Main Creek to the east of the Proposed Disturbance Area. The Project components such as the proposed rail line and North Pit continuation may create a substantial barrier for the species in accessing habitat areas in the southern portion of the Mount Owen Complex within the Proposed Disturbance Area.

Important habitat for the individuals occurring in the Mount Owen Complex, including den sites, known breeding habitat and high quality foraging habitat associated with Ravensworth State Forest and Bowmans Creek will not be impacted by the Project. It is considered unlikely that the Project will result in the fragmentation of the Barrington (southern and western footslopes) *population* of the spotted-tailed quoll into two or more *populations*.

- **adversely affect habitat critical to the survival of a species; or**

The loss of approximately 223.7 hectares of woodland, forest and riparian habitat and 223.1 hectares of native grassland habitat which is considered to be of lesser importance to the species than woodland/forest habitats within the Proposed Disturbance Area is unlikely to affect habitat that is critical to the survival of the species due to the presence of known habitat for the species along the east coast of NSW and Victoria, including southern Queensland and south-eastern South Australia. Similarly, important habitat for the individuals occurring in the Mount Owen Complex, including den sites, known breeding habitat and high quality foraging habitat associated with Ravensworth State Forest and Bowmans and Main Creeks will not be impacted by the Project.

- **disrupt the breeding cycle of a population; or**

The spotted-tailed quoll generally dens in rock shelters, small caves, hollow logs or tree hollows and utilises numerous dens within its home range. In the Mount Owen Complex, dens have been located in stockpiled timber associated with mine rehabilitation. It is a highly

mobile species and there are numerous records of overnight movements of several kilometres. Known den sites occur in Ravensworth State Forest and in the north of the Mount Owen Complex in mine rehabilitation. Additionally, a known breeding den occurs on the western side of Bowmans Creek approximately 6 kilometres from the Proposed Disturbance Area. The species has not been recorded breeding within the Proposed Disturbance Area, and potential den sites have not been recorded during surveys, however their potential presence cannot be ruled out at this stage. There is no evidence to suggest that breeding has occurred within the Proposed Disturbance Area. Project components such as the proposed rail line and the North Pit continuation may create a significant barrier for the species in accessing current portions of its home range and potentially den sites. Known breeding habitat for the species will not be impacted by the Project.

While the Project is likely to result in local impacts to the species in proximity to the Proposed Disturbance Area, the breeding cycle of the Barrington (southern and western footslopes) population of the spotted-tailed quoll is unlikely to be adversely affected.

- **modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline; or**

It is considered likely that the total number of mature adult spotted-tailed quolls is probably greater than 2000 but fewer than 10,000 individuals in Australia (Long and Nelson 2008). Extant populations are highly fragmented and declining. The Project will involve the removal of approximately 223.7 hectares of woodland, forest and riparian habitat for the species and 223.1 hectares of native grassland habitat which is considered to be of lesser importance to the species than woodland/forest habitats. The Central Hunter supports other areas of habitat that contain suitable habitat for the species; however the species has not been recorded in many of these areas. The area of habitat to be removed is not important, notable, or of consequence, in accordance with the significant impact guidelines (DEWHA 2009). The Project will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species as a whole is likely to decline.

- **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;**

The Project will not result in invasive species that are harmful to the spotted-tailed quoll becoming established in the species' habitat.

- **introduce disease that may cause the species to decline; or**

The spotted-tailed quoll is not known to be affected by diseases that are causing the species to decline. Therefore, the Project is not likely to result in the introduction of disease.

- **interfere with the recovery of the species.**

It is considered unlikely that the Project will interfere with the recovery of the spotted-tailed quoll throughout its range.

Conclusion

Based on the information provided above, and taking into account the application of the precautionary principle, the Project is unlikely to result in a significant impact on the Barrington (southern and western footslopes) population of the spotted-tailed quoll or on the species as a whole. Known breeding habitat, den sites and latrines will not be impacted the Project.

Although a significant impact on this species is unlikely, the Biodiversity Offset Strategy that is being developed as part of the State approval process will include measures to compensate for the loss of habitat of the spotted-tailed quoll and will provide long term conservation of alternate areas of habitat for the species. The existing and proposed biodiversity offset areas and other potential on-site impact mitigation measures will be developed as part of the on-going development of the Project.

Australian Painted Snipe (*Rostratula benghalensis australis*)

The preferred habitat of the Australian painted snipe includes fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. The species has been recently recorded in dense ground cover within the riparian corridor of Bowmans Creek, however the species has not been recorded in the Project Area during annual fauna monitoring surveys or Project specific surveys and habitat for the species within the Proposed Disturbance Area is considered to be marginal and limited to farm dams and a small area of Bowmans Creek that is highly modified and in poor condition. The species is considered unlikely to occur in the Proposed Disturbance Area.

In this case, a *population* means:

- a geographically distinct regional population, or collection of local populations; or
- a regional population, or collection of local populations, that occurs within a particular bioregion.

Potential habitat within the Proposed Disturbance Area for the Australian painted snipe is not expected to provide habitat for population of the species, based on the criteria listed above. The Proposed Disturbance Area includes a highly modified and degraded section of Bowmans Creek that comprises approximately 0.6 hectares and 1.8 hectares of farm dams that are scattered across the Proposed Disturbance Area. The species is considered unlikely to occur in the Proposed Disturbance Area despite being recorded in high quality, dense groundcover vegetation of Bowmans Creek to the north west of the Proposed Disturbance Area.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- **lead to a long-term decrease in the size of a population; or**

The Australian painted snipe recently recorded along Bowmans Creek are not considered to comprise a ‘population’ of the species and therefore the Project is not expected to result in the long-term decrease in the size of a population of the species.

- **reduce the area of occupancy of the species; or**

The Proposed Disturbance Area does not provide habitat for a population of the Australian painted snipe. The Project will result in the loss of 0.6 hectares of highly disturbed potential habitat for the species as a result of the Hebden Bridge duplication.

- **fragment an existing population into two or more populations; or**

The Proposed Disturbance Area does not provide habitat for a population of the Australian painted snipe. The Project will not result in the fragmentation of a population of the Australian painted snipe into two or more populations.

- **adversely affect habitat critical to the survival of a species; or**

The Proposed Disturbance Area does not provide habitat for a population of the Australian painted snipe and the habitat recorded in the Proposed Disturbance Area is considered to be marginal and highly degraded, limited to scattered farms dams and approximately 0.6 hectares of Bowmans Creek. The Project is not likely to adversely affect habitat that is critical to the survival of the species.

- **disrupt the breeding cycle of a population; or**

The Proposed Disturbance Area does not provide habitat for a population of the Australian painted snipe. The Project will result in the loss of 0.6 hectare of highly disturbed potential habitat for the species as a result of the Bowmans Creek Bridge duplication. The species is not considered likely to breed in the Proposed Disturbance Area and therefore the Project is not likely to disrupt the breeding cycle of the Australian painted snipe.

- **modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline; or**

The Project will result in the loss of 0.6 hectares of highly disturbed potential habitat for the species as a result of the Bowmans Creek Bridge duplication. The loss of 0.6 hectares of poor quality potential habitat is not expected to adversely affect habitat for the species such that the species is likely to decline.

- **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;**

The Project will not result in invasive species that are harmful to the Australian painted snipe becoming established in the species' habitat.

- **introduce disease that may cause the species to decline; or**

The Australian painted snipe is not known to be affected by diseases that are causing the species to decline. Therefore, the Project is not likely to result in the introduction of disease.

- **interfere with the recovery of the species.**

It is considered unlikely that the Project will interfere with the recovery of the Australian painted snipe throughout its range.

Conclusion

The Project is not expected to adversely impact the Australian painted snipe.

Vulnerable Species

Six vulnerable species have been recorded in the Project Area and therefore have the potential to be impacted by the Project:

- green and golden bell frog (*Litoria aurea*);
- *Ozothamnus tesselatus*;
- grey-headed flying-fox (*Pteropus poliocephalus*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- New Holland mouse (*Pseudomys novaehollandiae*); and
- Koala (*Phascolarctos cinereus*).

Green and Golden Bell Frog (*Litoria aurea*)

The green and golden bell frog has been recorded in the Project Area on four occasions over a 15 year period, with the last confirmed record from 1999 (Forest Fauna Surveys and Newcastle Innovation 2013). The Project Area forms part of the Upper Hunter Green and Golden Bell Frog Key Population consisting of one main diffuse population at, or in the vicinity of, the Ravensworth and Liddell area and bordering areas of the Singleton and Muswellbrook local government areas (DECC 2007). The Upper Hunter Key Population is one of two inland populations of the species and is known from eight verified locations. The population is assumed to have a diffuse distribution across lands encompassed by these locations and has been recorded sporadically, probably caused by climatic circumstances and/or seasonal life cycle changes of the species (DECC 2007). It is considered highly likely that the precipitous state of the Upper Hunter population is directly due to the impact of disease rather than habitat or other ecological factors (Forest Fauna Surveys and Newcastle Innovation 2013).

An additional unconfirmed record of the species exists from the north-west shore of Lake Liddell in 2006 (DECC 2007) and the species was recently recorded during surveys for the Ravensworth Operations in 2009 in the Ravensworth North Offset Area.

In this case, an *important population* is a population that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal; or
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

The green and golden bell frog was formerly distributed from the NSW North Coast near Brunswick Heads southwards along the NSW coast to Victoria, where it extends into East Gippsland, and west to Bathurst, Tumut and the ACT. In the 1960s, the species was considered widespread, abundant and commonly encountered (DECC 2007). In the Hunter, the species is now only known from three key populations. The Upper Hunter Green and Golden Bell Frog Key Population is located between the settlements of Singleton and Muswellbrook.

The green and golden bell frog was 'rediscovered' in the upper Hunter in 1994 at the Project Area where it was subsequently recorded 1996, 1997 and 1999 (Forest Fauna Surveys and Newcastle Innovation 2013). An unconfirmed report of a single calling male during August 2005 was reported (J Rennie, Earthtech, personal communication) at a small pond on a drainage line that enters Main Creek. However, intensive monitoring of this pond over the summer of 2005/2006 did not produce further evidence of the species; that is, no tadpoles, juveniles or adults were located, or calls heard in response to call playback surveys. The record has remained unconfirmed by physical identification. Nevertheless, it is possible that a transient male was present at this pond, but there is no evidence of the pond being utilised for breeding (Fly by Night Surveys *et al.* 2006). No more than three individuals were recorded at any one time at Mount Owen. All confirmed records for the Upper Hunter population detail only low numbers of adult individuals (DECC 2007).

In the case of the green and golden bell frog, all current populations of the species, where individuals have been detected on at least one occasion since 1995, are considered to be an 'important population' due to the species tendency towards local extinction and recolonisation cycles (DEWHA 2009).

As such, this population is one of high importance for the species being at the western limit of the species distribution along the east coast of NSW and being one of only two inland populations persisting. Therefore, the potential habitat for the species in the Proposed Disturbance Area occurs within the limits of an *important population* of the species, as described above.

An action has, will have, or is likely to have a significant impact on threatened species if it does, will, or is likely to:

- **lead to a long-term decrease in the size of an important population of a species;**

The green and golden bell frog population within the Project Area has been monitored annually since its discovery in Bettys Creek in 1994 by well recognised frog researchers from the University of Newcastle. Despite extensive surveys, the species has not been recorded in the Project Area since 1999, although an unconfirmed report of a single calling male during August 2005 was reported (J Rennie, Earthtech, personal communication) at a small pond on a drainage line that enters Main Creek (Fly by Night Surveys *et al*. 2006).

The absence of individuals at historical sites, or the intermittent observation of single individuals, or very small numbers of green and golden bell frogs, fits with the pattern of observation of bell frogs in the Upper Hunter over a period of more than a decade. The Upper Hunter, which is at the inland edge of the current, contracted distribution of the bell frog, appears to support only a precarious regional population that cannot be regarded as secure (DECC 2007).

The Project will remove dams and associated terrestrial habitat for the species. The present occurrence of the species in the Project Area is unknown as the species has not been positively identified at the site in 12 years, despite extensive monitoring. The Project does not propose the disturbance of historical known habitat of the species, only potential habitat. As the species is not known to be extant within the Project Area and the persistence of the species in the Project Area is expected to be limited due to infection by Chytrid virus, the loss of habitats from the Proposed Disturbance Area is not considered likely to lead to a long term decrease in the size of this important population.

- **reduce the area of occupancy of an important population, or;**

The Project will remove dams and associated terrestrial habitat that provide potential habitat for the species and is likely to contribute to the ongoing fragmentation of remaining potential habitat areas within the Project Area. The species is not considered to be limited in its extent in the Proposed Disturbance Area by factors relating to habitat suitability; rather infection by Chytrid virus limits the potential persistence of the species (Forest Fauna Surveys and Newcastle Innovation 2013). The Project is therefore unlikely to result in a reduction in the potential area of occupancy of an important population of the species.

- **fragment an existing important population into two or more populations, or;**

The green and golden bell frog uses terrestrial habitat for dispersal, foraging and shelter. Routes of dispersal are not known within the Project Area, and it is assumed that any potentially occurring frogs would move on wet nights to avoid desiccation, and that they would move along moisture gradients in the environment. These would include along the edge of large waterbodies such as dams and creeklines.

The Upper Hunter important population occurs within a highly fragmented landscape that is dominated by agricultural and mining land uses. The Project is therefore considered unlikely to further fragment the potentially occurring important population.

- **adversely affect habitat critical to the survival of a species, or;**

The Upper Hunter important population is considered to contain only a few adult individuals and is therefore more susceptible to stochastic impacts. The upper Hunter population is considered disjunct from the larger more secure populations of green and golden bell frog on the coast of NSW at locations such as Kooragang Island, Sydney and Nowra. Therefore, the loss of dams and associated terrestrial habitat in this declining and small population of the species is unlikely to be critical for the survival of the species in throughout its range.

- **disrupt the breeding cycle of an important population, or;**

The loss of dams and associated terrestrial habitat within the bounds of the Upper Hunter Important Population is not likely to substantially disrupt the breeding cycle of the important population as known breeding habitat will not be impacted.

- **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or;**

The loss of dams and associated terrestrial habitat within the bounds of the Upper Hunter Important Population is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Substantial potential habitat in the way of farm dams, mine water dams and constructed habitats specifically designed for the species occurs within and in proximity to the Project Area.

- **result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;**

The plague minnow (*Gambusia holbrooki*) is an invasive species that has been associated with the decline of the green and golden bell frog. The presence of the plague minnow has been identified as a major threatening process for the green and golden bell frog and the presence of the plague minnow has been demonstrated to reduce the breeding success of the species (Goldingay 2008). However, the absence of the plague minnow from the Bettys

Creek catchment indicates that predation by this species is not a factor in its ecology at the Project Area (Forest Fauna Surveys *et al.* 2006). Other local catchments in the Project Area, such as Main Creek, do contain the plague minnow.

The potential presence of the plague minnow within the habitat of the important population of the green and golden bell frog is unlikely to become exacerbated as a result of the Project.

- **introduce disease that may cause the species to decline; or**

Green and golden bell frog populations are commonly affected by the amphibian chytrid fungus *Batrachochytrium dendrobatidis.* The 'infection of amphibians with chytrid fungus resulting in chytridiomycosis*'* is listed under the EPBC Act as a key threatening process for amphibian species. Chytrid fungus infection is likely to occur within the important population and the effect of the Project on the rate of infection by *Batrachochytrium dendrobatidis* is not known. However, the chytrid fungus is considered likely to be contributing to the decline of the green and golden bell frog across NSW (Professor M. Mahony pers comm.). Lowered population numbers as a result of habitat reduction may increase the susceptibility of the population to the disease.

The Project will not result in the introduction of a disease that may cause the species to decline, but may increase the susceptibility of a potentially occurring important population to the disease due to habitat loss.

- **interfere substantially with the recovery of the species.**

The Project will remove dams and associated terrestrial habitat that provides potential habitat for the green and golden bell frog. The Upper Hunter important population is likely in decline and has not been positively recorded within the Project Area since 1999. If persisting, the population likely consists of only a few adult individuals across a broad area in the Ravensworth and Liddell locality, which includes Mount Owen mine. The habitat loss and impacts associated with the Project are not likely to interfere substantially with the recovery of this species across its range.

Conclusion

The loss of dams and associated terrestrial habitat that may be utilised by individuals occurring within the Upper Hunter Important Population of green and golden bell frog is not considered likely to result in a significant impact on the species due to the species not being positively recorded in the Proposed Disturbance Area despite annual monitoring undertaken by recognised experts in the identification and ecology of the species and since it is considered highly likely that the precipitous state of the Upper Hunter population is directly due to the impact of disease rather than habitat or other ecological factors (Forest Fauna Surveys and Newcastle Innovation 2013).

New Holland Mouse (*Pseudomys novaehollandiae*)

The New Holland mouse has been recorded during five of the last 18 years of fauna monitoring in the Project Area, with all captures of the species occurring between 2003 and 2007 (Forest Fauna Surveys and Newcastle Innovation 2013). The species has been recorded in areas of rehabilitation in the North Pit in the Project Area and to the east of Ravensworth State Forest. The species selectively prefers habitats which have been disturbed by events in which it rapidly colonises following the event (Forest Fauna Surveys and TUNDRA 2007). Populations of the species remain high for a period following disturbance and decline in abundance in areas not subjected to disturbance.

Habitat preferences across the species range include open heathland; open woodland with a heathland understorey; and vegetated sand dunes. The species is usually found to peak in abundance during the early to mid stages of vegetation succession three to five years after fire or other disturbances. Due to the largely granivorous nature of the species, sites where the New Holland mouse is found are often high in floristic diversity, especially leguminous perennials. Established woodland and grassland habitats in the Proposed Disturbance Area do not conform to the preferred habitat types in which the species is typically located.

It is considered likely that this successional species will utilise the habitats within the Proposed Disturbance Area when conditions are optimal, followed by the decline of the species once rehabilitated habitats improve in habitat complexity, thereby reducing the area of habitat that can be successfully occupied by the species. The presence of the New Holland mouse at Mount Owen has been determined through the systematic, annual monitoring of rehabilitated habitats within former mining areas using survey techniques conducive to the identification of the species, namely pit fall trapping and Elliot A trapping. It is considered likely that post-mining rehabilitation occurring on mine sites throughout the Hunter Valley provides areas of habitat conducive to the occupation of the New Holland mouse.

In this case, an *important population* is a population that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal; or
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species' range.

The presence of the species within the Mount Owen is considered to comprise part of an important population as the majority of records of the species occur within coastal areas and habitats. Atlas of NSW Wildlife identifies five records of the species at Mount Owen and one near Jerrys Plains in the upper Hunter Valley and a number of records in the Kurri Kurri/Cessnock area. Non-coastal habitats in the Hunter Valley are expected to provide a diffuse area of habitat for the species where habitat conditions are appropriate. Therefore, the record of the New Holland mouse in the Proposed Disturbance Area represents part of an important population occurring within the upper Hunter Valley.

The New Holland mouse has not been recorded in the Project Area since 2007, despite annual targeted surveys. Habitats are likely to have reached a condition where they no longer provide suitable habitat for this successional species. Ongoing mine rehabilitation works at the Project Area are considered to provide potential habitat resources for the species.

An action has, will have, or is likely to have a significant impact on threatened species if it does, will, or is likely to:

- **lead to a long-term decrease in the size of an important population of a species;**

The New Holland mouse has not been recorded in the Proposed Disturbance Area and the established woodland and forest habitats are not considered likely to provide habitat for the species. The Project is not expected to lead to a long-term decrease in the size of the upper Hunter important population of the species as approximately 24.7 hectares of Planted Ironbark – Spotted Gum – Grey Box Forest and 4.7 hectares of shrubland that may provide potential habitat for the species will be impacted. Known habitat for the species will not be impacted.

- **reduce the area of occupancy of an important population, or;**

The Project is not expected to reduce the area of occupancy of an important population New Holland mouse which is expected to have a diffuse distribution across the upper Hunter in rehabilitated and disturbed habitats suitable for the species.

- **fragment an existing important population into two or more populations, or;**

The Proposed Disturbance Area is considered to provide an area of potential habitat for the species in rehabilitated and disturbed areas. It is expected that the species has a diffuse distribution across the upper Hunter where habitats and conditions are favourable. The Project is not expected to result in the fragmentation of the important population, which is currently occurring in a highly fragmented landscape, into two or more populations.

- **adversely affect habitat critical to the survival of a species, or;**

Habitats occurring in the Proposed Disturbance Area and more widely across the upper Hunter Valley do not comprise preferred habitat for the species, which generally occurs in heath and coastal dune habitats. The Project will not impact preferred habitat locations and therefore is unlikely to adversely affect habitat critical to the survival of the species.

- **disrupt the breeding cycle of an important population, or;**

The New Holland mouse has not been recorded in the Proposed Disturbance Area and the woodland and forest habitats are not considered likely to provide habitat for the species. The Project is not expected to disrupt the breeding cycle of an important population of the species. Breeding success is considered to be related to the availability and quality of food, which in turn is related to rainfall and fire succession.

- **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or;**

The loss of potential habitat within the bounds of the upper Hunter Important Population is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Substantial potential habitat in the way of rehabilitated and disturbed lands occurs within and in proximity to the Project Area.

- **result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;**

There are not any invasive species that are likely to become established as a result of the Project that may have an impact upon any habitat relevant to the New Holland mouse.

- **introduce disease that may cause the species to decline; or**

There are no diseases implicated in the decline of the New Holland mouse. The Project is not expected to introduce any diseases that may cause this species to decline.

- **interfere substantially with the recovery of the species.**

No significant effect on the recovery of the New Holland mouse is expected to occur as a result of the Project.

Conclusion

The Project is unlikely to result in a significant impact upon an *important population* of New Holland mouse as the Proposed Disturbance Area is not considered likely to impact habitats currently occupied by the species and substantial areas of potential, non-preferred habitat occurs within the limits of the important population occurring in the upper Hunter Valley.

Vulnerable Species for Which the Proposed Disturbance Area does Not Provide Important Habitat

Grey-headed Flying-fox *(Pteropus poliocephalus)*

The grey-headed flying-fox has been previously recorded on six occasions during monitoring of the Project Area (Forest Fauna Surveys and Newcastle Innovation 2013). All woodland vegetation within the Proposed Disturbance Area is expected to provide potential foraging habitat for this species. Camp sites (breeding habitat) have not been identified and are not expected to occur due to a lack of preferred habitat.

According to the draft National Recovery Plan for the grey-headed flying-fox (DECC 2009), foraging habitat that meets one of the following criteria is considered critical to the survival of the species:

- productive during winter and spring, when food bottlenecks have been identified;
- known to support populations of >30,000 individuals within an area of 50 kilometre radius (the maximum foraging distance of an adult);
- productive during the final weeks of gestation, and during the weeks of birth, lactation and conception;
- productive during the final stages of fruit development and ripening in commercial crops affected by grey-headed flying-foxes; and/or
- known to support a continuously occupied camp.

The two nearest substantial roost camp sites of the grey-headed flying-fox to the proposed Disturbance Area are at Burdekin Park, Singleton (approximately 17 kilometres from the Project Area) and in Blackbutt Reserve, Newcastle (approximately 80 kilometres from the Project Area). The population estimate for the grey-headed flying-fox population at Burdekin Park is estimated at approximately 3170 individuals and the population of the Blackbutt Reserve population is estimated at 40,000 individuals (Bionet 2012). As the Proposed Disturbance Area is not located within 50 kilometres of a population of the grey-headed flying-fox that supports more than 30,000 individuals it is not considered that it is habitat critical or essential to the survival of this species.

Two smaller roost camp sites of the grey-headed flying-fox occur at East Cessnock (approximately 60 kilometres south-east the Proposed Disturbance Area) and Lorn (approximately 65 kilometres south-east of the Proposed Disturbance Area). In 1990 the East Cessnock population was estimated at 50,000 individuals; however all counts since 1990 have recorded less than 100 individuals (Bionet 2012). However, it is believed that the East Cessnock populations may currently be in the order of 500 to 2,000 individuals. At Lorn population estimates range between 7000 in 1999, 1000 in 2011 and 170 in 2012 (Bionet 2012).

The species is infrequently recorded and when recorded it is in low numbers within the Project Area, which appears to be associated with the flowering of eucalypt tree species. The Proposed Disturbance Area does not support a population greater than 30,000 individuals, does not support an occupied camp and is not consistently productive during breeding events or during winter and spring. Flowering events in the Mount Owen Complex are sporadic and only a few individuals of the species have been recorded utilising these habitats over the last 18 years of annual fauna monitoring surveys. The Proposed Disturbance Area is considered to comprise an area of potential foraging habitat for this species but is unlikely

to contain significant breeding and roosting habitat and therefore not considered to contain important habitat for the species.

Large-eared Pied Bat (*Chalinolobus dwyeri)*

The large-eared pied bat has been tentatively recorded in the Project Area during annual fauna monitoring surveys in 1999, 2001, 2006 and 2008 using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2013). All woodland vegetation within the Proposed Disturbance Area is expected to provide potential foraging habitat for this species, however no roosting habitat for this cave roosting species has been identified. The Proposed Disturbance Area is considered to comprise an area of potential foraging habitat for this species however is unlikely to contain significant breeding and roosting habitat.

The National Recovery Plan for the large-eared pied bat (DERM 2011) states that habitat critical for the survival of the species requires the presence of diurnal roosts and shelter habitat, usually in the form of sandstone cliffs and adjacent fertile woodland valley foraging habitat. The majority of records of the species occur within several kilometres of clifflines or caves. Records within the Hunter Valley generally occur near the escarpment habitat associated with Yengo and Wollemi National Parks approximately 20 kilometres from the Proposed Disturbance Area. No evidence exits of the large-eared pied bat roosting in tree hollows (DERM 2011). Due to the absence of suitable cliffline or cave roosting habitat near the Proposed Disturbance Area and the infrequency of unconfirmed records of the species within the wider Project Area, the Proposed Disturbance Area is not considered to contain important habitat for the species.

Koala (*Phascolarctos cinereus*)

The koala was tentatively recorded during monitoring in 1995 in Ravensworth State Forest through the collection of scats resembling those of the koala (Forest Fauna Surveys and Newcastle Innovation 2013) and the species was recorded in grassland adjacent to the corner of Hebden Road and the New England Highway in June 2012. A historic record of the species from 1980 is also known in the east of the Project Area, outside the Proposed Disturbance Area. The koala has also been recorded approximately 6 kilometres to the north-west of the Project Area in the Hillcrest Offset Area that was established as part of the Ravensworth Continued Operations Project (Umwelt 2010).

Koala habitat is defined in the Draft EPBC Act Referral Guidelines for the Vulnerable Koala (DoE 2013) as any forest or woodland containing species that are known koala feed trees or shrubland with emergent food trees. It is generally considered that the most important factor influencing koala occurrence is the presence of primary or secondary feed trees, floristic diversity and the availability of shelter trees (DECC 2008). The woodland habitat of the Proposed Disturbance Area has low occurrences of koala feed trees, with only forest red gym (*Eucalyptus tereticornis*) occurring in low numbers. As the habitats in the Proposed Disturbance Area do not contain suitable preferred koala food trees, it is not considered to contain important habitat for the species.

Ozothamnus tesselatus

Until recently, this species had been restricted to a few locations north of Rylstone. However in 2003 it was recorded in Ravensworth State Forest (Cole *et al.* 2003), which occurs within the Project Area. *Ozothamnus tesselatus* has not been recorded within the Proposed Disturbance Area and is not expected to be impacted by the Project. The Proposed Disturbance Area is considered to provide an area of potential habitat for the species.

An assessment of significance has been prepared for these species below.

In the case of a vulnerable species, an *important population* is a population that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal; or
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

The identification of habitat or potential habitat for these vulnerable species within the Project Area does not constitute the presence of an 'important population' as defined by the criteria listed above, as the records of the species in the Project Area do not represent a key source population either for breeding or dispersal; the Project Area is not important for the maintenance of genetic diversity of the species; and the species are not at the limits of their ranges in the Project Area. Therefore, the Project Area does not contain an important population of the grey-headed flying-fox, large-eared pied bat, koala or *Ozothamnus tesselatus.*

An action has, will have, or is likely to have a significant impact on threatened species if it does, will, or is likely to:

- **lead to a long-term decrease in the size of an important population of a species;**

Given that there is not considered to be an *important population* of the grey-headed flying-fox, large-eared pied bat, koala or *Ozothamnus tesselatus* present within the Project Area, the Project will not lead to a long-term decrease in the size of an *important population* of these species.

- **reduce the area of occupancy of an important population, or;**

The Project Area does not contain an *important population* of the grey-headed flying-fox, large-eared pied, koala or *Ozothamnus tesselatus* and therefore will not reduce the area of occupancy of an *important population* of these species.

- **fragment an existing important population into two or more populations, or;**

The Project Area does not contain an *important population* of the grey-headed flying-fox, large-eared pied bat, koala or *Ozothamnus tesselatus* and therefore the Project will not result in the fragmentation of an *important population* of these species

- **adversely affect habitat critical to the survival of a species, or;**

The grey-headed flying-fox, large-eared pied bat and koala are distributed across the east coast of Australia. *Ozothamnus tesselatus* is restricted to a few locations in an east-west zone south of Bunnan and between Bylong in the west and east to Ravensworth. The habitat in the Project Area is not known to provide core habitat for any of these species and the Project is not expected to interfere with any dispersal pathways for these species. Given the above, the Project Area is not considered to be critical habitat for the grey-headed flying-fox, large-eared pied bat, koala or *Ozothamnus tesselatus* and consequently the Project is not expected to adversely affect habitat critical to the survival of these species.

- **disrupt the breeding cycle of an important population, or;**

No important populations of the grey-headed flying-fox, large-eared pied bat or koala have been identified in the Project Area, nor have any breeding populations or habitat of these species been recorded. *Ozothamnus tesselatus* is not known to occur in the Proposed Disturbance Area and consequently, the Project is not expected to disrupt the breeding cycle of an important population of these species.

- **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or;**

Given the lack of core habitat in the Project Area for the grey-headed flying-fox, large-eared pied bat, koala or *Ozothamnus tesselatus* the Project will not modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that these species are likely to decline.

- **result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;**

There are not any invasive species that are likely to become established as a result of the Project that may have an impact upon any habitat relevant to the grey-headed flying-fox, large-eared pied bat, koala or *Ozothamnus tesselatus.*

- **introduce disease that may cause the species to decline; or**

There are no diseases associated with the decline of the grey-headed flying-fox, large-eared pied bat or *Ozothamnus tesselatus*.

The koala is known to be affected by chlamydia and while many koalas carry chlamydia, they do not always show clinical symptoms (known as chlamydiosis). The symptoms include eye, urinary tract, respiratory tract and reproductive tract infections, and the latter can lead to infertility in female koalas. Koala Retrovirus (KoRV) has been identified and is thought to be responsible for a range of conditions, including leukaemia (Tarlinton *et al*. 2005) and an immunodeficiency syndrome. Up to 100 per cent of koalas in Queensland and NSW have KoRV. The effects of this disease on the koala is of growing concern.

The Project is not expected to introduce or exacerbate any diseases that may cause these species to decline.

- **interfere substantially with the recovery of the species.**

No significant effect on the recovery of the grey-headed flying-fox, large-eared pied bat, koala or *Ozothamnus tesselatus* is expected to occur as a result of the Project as the known and potential areas of habitat that will be impacted as a result of the Project are not expected to impact an important population of these species.

Conclusion

The Project is unlikely to result in a significant impact upon an *important population* of grey-headed flying-fox, large-eared pied bat, koala or *Ozothamnus tesselatus* as the Project Area is not considered to support an important population of these species.

Migratory Species

The following 11 migratory species were identified on the Protected Matters Search Tool as known, may or are likely to occur within the Project Area:

- eastern great egret (*Ardea modesta*);
- cattle egret (*Ardea ibis*);
- Lathams snipe (*Gallinago hardwickii*);
- Australian painted snipe (*Rostratula benghalensis australis*);
- white-bellied sea eagle (*Haliaeetus leucogaster*);
- white-throated needletail (*Hirundapus caudacutus*);
- fork-tailed swift (*Apus pacificus*);
- rainbow bee-eater (*Merops ornatus*);
- black-faced monarch (*Monarcha melanopsis*);
- spectacled monarch (*Monarcha trivirgatus*); and
- rufous fantail (*Rhipidura rufifrons*).

Analysis of fauna monitoring results indicate that a total of seven migratory species listed under international conventions have been recorded in the Project Area, including:

- eastern great egret (*Ardea modesta*);
- cattle egret (*Ardea ibis*);
- white-bellied sea eagle (*Haliaeetus leucogaster*);
- Lathams snipe (*Gallinago hardwickii*);
- white-throated needletail (*Hirundapus caudacutus*);
- rufous fantail (*Rhipidura rufifrons*); and
- rainbow bee-eater (*Merops ornatus*).

Additionally, potential habitat for the Australian painted snipe (*Rostratula benghalensis australis*) has been identified within the Project Area.

The malleefowl (*Leipoa ocellata*), fork-tailed swift (*Apus pacificus*), black-faced monarch (*Monarcha melanopsis*), spectacled monarch (*Monarcha trivirgatus*) and satin flycatcher (*Myiagra cyanoleuca*) are considered unlikely to occur in the Project Area as they have not been recorded during greater than 15 years of detailed fauna monitoring and preferred habitats have not been recorded. These species are therefore not considered further in this assessment.

Each of the remaining migratory species listed above that have been previously recorded in the Project Area or are considered to have the potential to occur are assessed in the assessment of significance below.

An area of *important habitat* is:

- **habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; or**
- **habitat utilised by a migratory species which is at the limit of the species range; or**
- **habitat within an area where the species is declining.**

The habitats within the Project Area for migratory species listed under international conventions is not considered to meet the criteria listed above, and important habitat is not likely to occur. The EPBC Act lists additional criteria that are used to determine whether an action is likely to have a significant impact on migratory species. The proposed Project is considered likely to result in a significant impact on migratory species if there is a real chance or possibility that it will:

- substantially modify and/or destroy an area of important habitat for a migratory species;
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species; and/or
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

The Project Area is not considered to comprise *important habitat* for any of the identified migratory species listed above, and therefore the Project is not likely to substantially modify or destroy important migratory species habitat. Similarly, the Project will not seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species; or result in an invasive species that is harmful to migratory species becoming established within the Project Area.

Conclusion

The Project is not likely to result in a significant impact on any migratory species listed under the EPBC Act or international conventions.

APPENDIX G

Biodiversity Offset Site Survey
Methodology and Species Lists

Appendix G – Biodiversity Offset Site Survey Methodology and Species Lists

This appendix provides the biodiversity survey methodology undertaken on the Esparanga Offset Site, Cross Creek Offset Site and Stringybark Creek Habitat Corridor proposed as part of the Project. The location of biodiversity survey sites are shown on Figures 7.3 and 7.5 of the Ecological Assessment.

1.0 Survey Methodology

A detailed survey methodology was designed and undertaken to gain a thorough understanding of the ecological features of the Cross Creek and Esparanga Offset Sites. The methods included a detailed literature review of relevant reports and vegetation mapping, as well as searches of relevant ecological databases. Information gathered from the literature reviews and database searches was then used to assist in the design of the field survey program, targeting potential threatened flora and fauna species, endangered populations, TECs, and their habitats.

A one day targeted site inspection was undertaken at the Stringybark Creek Habitat Corridor to gain an understanding of the ecological features of the site. A comprehensive survey methodology was not employed at this site, but is referred to in the sections below, where relevant.

Details on each of the methods used in this assessment are provided in the following sections.

1.1 Literature Review

A review of all relevant and available literature was undertaken in order to gain a greater understanding of the known and potential ecological values of the Cross Creek and Esparanga Offset Sites and the broader locality. Documents reviewed included previous ecological studies relating to the two offset sites, regional vegetation mapping and ecological studies completed in the local area. The literature review also included a search of relevant ecological databases to identify threatened flora and fauna species, endangered populations and TECs that have been previously recorded or have potential to occur in, or with proximity to the Cross Creek Offset Site, Esparanga Offset Site and Stringybark Creek Habitat Corridor.

A summary of the ecological findings of the key literature is provided below.

1.1.1 Ecological Assessment of the Richards Property, Cross Creek, NSW, Prepared by Umwelt (2011) for Xstrata Coal NSW

Umwelt was engaged by Xstrata Coal NSW (XCN) to conduct a baseline biodiversity study for the Richards property (now referred to as the Cross Creek Offset Site), south-east of Muswellbrook, NSW. The purpose of the study was to document the biodiversity values of the property to aid in its establishment as a biodiversity offset for XCN.

Flora and fauna surveys of the Richards property were undertaken on 15 September and between 28 and 30 September 2010 by two ecologists and included systematic plot-based vegetation surveys, rapid vegetation assessments, bird searches, diurnal and nocturnal reptile and amphibian searches, spotlighting searches, call playback sessions, micro-bat

echolocation recordings, hair funnel surveys and habitat assessments. The surveys recorded a total of 112 flora species and 41 fauna species. One threatened ecological community, *Central Hunter Ironbark - Spotted Gum - Grey Box Forest EEC*, was recorded in the woodland areas within the site. Three threatened fauna species listed as vulnerable under the TSC Act were recorded including the grey-crowned babbler (*Pomatostomus temporalis temporalis*), eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) and east coast freetail-bat (*Mormopterus norfolkensis*).

The property was considered to have high value offsetting potential, as the property adjoins existing offset areas established at Mount Owen Mine. The property provides good opportunities for environmental gain through natural regeneration of derived native grassland communities.

1.1.2 Baseline Ecological Studies of Potential Biodiversity Offset Site – Esparanga, near Manobalai NSW, Prepared by Umwelt (2012) for Xstrata Coal NSW

Umwelt was commissioned by XCN to undertake baseline ecological studies of a rural property known as 'Esparanga', in order to assess its potential to act as a biodiversity offset for current and future Xstrata operations.

Flora and fauna surveys of the Esparanga property were undertaken between 16 and 18 April and 23 May 2012 by two ecologists and included systematic plot-based vegetation surveys, rapid vegetation assessments, bird searches, diurnal and nocturnal reptile and amphibian searches, spotlighting searches, call playback sessions, micro-bat echolocation recordings, hair funnel surveys, targeted winter bird surveys and habitat assessments. The surveys recorded a total of 196 flora species, 9 vegetation communities and 91 fauna species. One threatened ecological community, *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands*, listed as a CEEC under the Commonwealth EPBC Act, was recorded within the Esparanga site. Six threatened fauna species listed as vulnerable under the TSC Act were also recorded including, little lorikeet (*Glossopsitta pusilla*), brown treecreeper (eastern subspecies (*Climacteris picumnus victoriae*)), speckled warbler (*Chthonicola sagittata*), varied sittella (*Daphoenositta chrysoptera*), scarlet robin (*Petroica boodang*) and eastern cave bat (*Vespadelus troughtoni*).

This preliminary assessment considered that the site provided value as a potential biodiversity offset for a number of mine operations owned by Xstrata Coal NSW.

1.1.3 Biodiversity and Land Management Strategy Stage 2 – Ecological Characteristics of Xstrata Non-operational Land. Prepared by Umwelt (2009) for Xstrata Coal NSW

This report included a description of all the ecological attributes of the 14 XCN (now Glencore) managed land resources in NSW. The closest Glencore managed site to the Esparanga Offset Site is Mangoola Mine, which is located approximately 25 kilometres to the south-east.

The section of this report relating to the Mangoola Mine identified the presence of seven threatened flora species, 19 threatened fauna species, three endangered flora populations, one endangered ecological community, and seven vegetation communities that were considered to be of regional significance (three of which are now listed as TECs).

Threatened flora species recorded in the Mangoola Coal landholdings were:

- *Commersonia rosea*;
- painted diuris (*Diuris tricolor*);
- *Lasiopetalum longistamineum*;
- *Pomaderris queenslandica*;
- *Pomaderris reperta*; and
- austral toadflax (*Thesium australe*).

Endangered populations recorded were:

- painted diuris (*Diuris tricolor*) in the Muswellbrook LGA;
- tiger orchid (*Cymbidium canaliculatum*); and
- weeping myall (*Acacia pendula*).

Threatened fauna species recorded were:

- brown treecreeper (*Climacteris picumnus victoriae*);
- brush-tailed rock-wallaby (*Petrogale penicillata*);
- diamond firetail (*Stagonopleura guttata*);
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*);
- eastern cave bat (*Vespadelus troughtoni*);
- eastern false pipistrelle (*Falsistrellus tasmaniensis*);
- eastern freetail-bat (*Mormopterus norfolkensis*);
- glossy black-cockatoo (*Calyptorhynchus lathami*);
- greater broad-nosed bat (*Scoteanax rueppellii*);
- grey-crowned babbler (*Pomatostomus temporalis temporalis*);
- hooded robin (*Melanodryas cucullata cucullata*);
- koala (*Phascolarctos cinereus*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- large-footed myotis (*Myotis adversus*);
- masked owl (*Tyto novaehollandiae*);
- powerful owl (*Ninox strenua*);
- speckled warbler (*Chthonicola sagittata*);

- squirrel glider (*Petaurus norfolcensis*); and
- turquoise parrot (*Neophema pulchella*).

Threatened ecological communities recorded were:

- Weeping Myall Woodland EEC;
- Hunter Floodplain Red Gum Woodland EEC;
- Central Hunter Grey Box – Ironbark Woodland; and
- Slaty Box Woodland vulnerable ecological community (VEC).

1.1.4 The Great Eastern Ranges – Connecting People, Connecting Nature (A Continental Scale Conservation Vision for Australia) (Great Eastern Ranges Organisation 2009).

The Great Eastern Ranges Initiative aims to maintain and improve the 'corridor' connectivity of mountain ecosystems running the length of eastern Australia. The focal area of the Initiative includes the Great Dividing Range and the Great Escarpment of Eastern Australia which extend along the majority of Australia's east coast. The corridor includes un-fragmented natural ecosystems along extensive sections of these two major geomorphic structures. The current area of focus for this Initiative is the 1200 kilometres section of the Great Eastern Ranges that falls within NSW.

The Initiative aims to strengthen the resilience of natural ecosystems, of native plant and animal species, to help protect water supplies for over 93 per cent of eastern Australia's population and to support the regions significant nature-based tourism assets. The Initiative focuses on bringing together the various stakeholders including the government, non-government groups, industry and the community to achieve its purposes.

The Esparanga Offset Site occurs within the Hunter Valley section of the Great Eastern Ranges Initiative. The Hunter Valley has been identified as one of the five priority areas along the ranges and is considered to be the most diverse and complex with regard to its biodiversity and connectivity and its social and economic factors. The Hunter Valley represents a significant east-west linkage of natural vegetation in the Great Eastern Ranges, with the potential for north-south 'stepping stones' of vegetation to allow species movement.

The location of the Esparanga Offset Site in relation to the Great Eastern Ranges Initiative is shown in Figure 7.2 of the Ecological Assessment. The position of the Esparanga Offset Site within this proposed corridor is highly strategic, when considering current gaps in remnant vegetation in the Hunter Region section of the initiative. In addition to its individual value, the Esparanga Offset Site lies adjacent to the Manobalai Nature Reserve. The Glencore-owned 'Reedy Valley' property lies to the north-east of the Esparanga Offset Site and when combined, these areas provide a substantial benefit to the consolidation of part of this corridor.

1.1.5 Ecological Assessment for Anvil Hill Project (Umwelt 2006)

Umwelt was commissioned to undertake an Ecological Assessment for the then proposed Anvil Hill Coal Mine and coal preparation plant located in Wybong, NSW. The Anvil Hill Project Area (now renamed to Mangoola Mine) is located to the south of the Esparanga Offset Site. Ecological surveys undertaken as part of this project consisted of 44, 10 hour person days of flora surveys and 10 separate fauna survey periods consisting of a total of 38.5 survey days.

At the time studies were undertaken, six threatened flora species, two endangered populations, one EEC and 19 threatened fauna species were recorded in the Anvil Hill Project Area (refer to Section 1.1.3 above).

Although the Mangoola Mine is located approximately 25 kilometres south-east of the Esparanga Offset Site, it is indicative of the presence of numerous threatened species in the locality as well the importance of connectivity for the long term survival of many of these species.

The detailed Biodiversity Offset Strategy provided as part of the Anvil Hill Project included the protection and enhancement of over 3,000 hectares of land. This will include large areas of unmined land to be revegetated or enhanced to form large regional corridors extending from the site to the north towards the Esparanga Offset Site and west to existing large conservation reserves. On a broader scale, such works will assist in enhancing landscape connectivity and providing for its long-term protection and management.

1.1.6 The Vegetation of the Central Hunter Valley, New South Wales. A Report on the Findings of the Hunter Remnant Vegetation Project (Peake 2006)

As part of the study of remnant vegetation in the 315,000 hectare central Hunter Valley, Peake sampled 13 plots and undertook extensive ground-truthing of vegetation community boundaries in the vicinity of the Esparanga Offset Site between 2 September 1999 and 17 July 2001. As part of the broader survey, representative plots were sampled from broad vegetation communities to assess mapped vegetation boundaries in the locality referred to as the Wybong Uplands, which occur to the east of the Esparanga Offset Site.

The flora sampling methods used in the Esparanga Offset Site were consistent with those reported in this study, and the results have been used as part of this assessment. In total, 218 plant species, of which 19 (9 per cent) were weeds, were recorded. Thirty-six vegetation communities were mapped across the entirety of the Central Hunter Valley. Those considered most relevant to the Esparanga Offset Site include:

- MU 6 - Upper Hunter Hills Exposed Ironbark Woodland;
- MU 10 - Central Hunter Box – Ironbark Woodland;
- MU 11 - Upper Hunter White Box – Ironbark Grassy Woodland;
- MU 13 - Hunter Floodplain Red Gum Woodland Complex;
- MU 15 – Western Hunter Narrabeen Exposed Grey Gum – Stringybark Woodland; and
- MU 29 – Upper Hunter Hills Sheltered Moist Forest.

Several significant species were identified as occurring near to the Esparanga Offset Site in Manobalai Nature Reserve. The report considered that the central Hunter Valley was an important area to investigate in terms of corridors and connectivity given the large extent of fragmentation between areas of remnant vegetation in the central Hunter Valley.

1.1.7 The Vertebrate Fauna of Manobalai Nature Reserve and Adjacent Crown Lands (DEC 2005)

This report was funded by the Central Branch Parks and Wildlife Division Biodiversity Survey Priorities Program by NSW Department of Environment and Conservation (DEC). This report compiled and examined Atlas of NSW Wildlife data and documents the results of extensive fauna surveys undertaken by DEC from 1997 through to 2005 across the Manobalai Nature Reserve and adjoining Crown Land. A total of 214 native vertebrate fauna were documented as occurring within the study area and included 128 species of birds, 32 mammals, 30 reptiles and 14 frogs. At the time of reporting, 14 species listed as threatened under the TSC Act were documented as occurring within the Manobalai Nature Reserve with a further six species occurring in the adjoining Crown Lands.

1.1.8 Manobalai Vacant Crown Land and Manobalai Nature Reserve Studies:

- **Bell 1997 – Vegetation Survey and Mapping of Crown Land, South of Manobalai Nature Reserve, Upper Hunter Valley. East Coast Flora Survey – unpublished Report to Department of Land and Water Conservation and NSW National Parks and Wildlife Service; and**

- **Peake T (1999) - The Vegetation of Manobalai Nature Reserve. Unpublished Report prepared for NSW National Parks and Wildlife Service, Muswellbrook.**

Vegetation surveys and mapping were commissioned by the Department of Land and Water Conservation and National Parks and Wildlife Service (NPWS) of vacant crown land at Manobalai. The project area for these purposes was approximately 4500 hectares in size. Bell (1997) mapped 10 vegetation communities and recorded 246 flora species (including several significant flora species) as part of this project. Peake (1999) undertook surveys of the adjoining Manobalai Nature Reserve and described an additional five vegetation communities to those identified by Bell 1997.

1.2 Ecological Database Searches

In order to identify all threatened species, EPs and TECs with the potential to occur in the local area, a detailed assessment of relevant ecological databases was completed. These database sources comprised:

- a 10 kilometre radius search from the centre of the Cross Creek Offset Site, Esparanga Offset Site and Stringybark Creek Habitat Corridor from the Office of Environment and Heritage (OEH) Atlas of NSW Wildlife Muswellbrook and Merriwa 1:100,000 Map Sheet (October 2013); and

- Department of the Environment EPBC Act Protected Matters Search Tool Results for a 10 kilometre radius search from the centre of the Cross Creek Offset Site, Esparanga Offset Site and Stringybark Creek Habitat Corridor (October 2013).

Records from these database searches were combined with records from a number of other sources (including literature reviews and professional opinion) to develop a list of potentially occurring threatened species. Furthermore, a number of additional species that are not listed under the TSC Act were included, such as species listed under the EPBC Act and rare or threatened Australian plant (ROTAP) species considered likely to have potential habitat within the Esparanga and Cross Creek Offset Sites. The information sourced from these records was then used to assist in survey design, as particular attention was paid to targeting potentially occurring threatened species, EPs and TECs during field surveys.

1.3 Flora Survey Methods

Vegetation survey and mapping was carried out to describe and map flora species and vegetation communities present in the Cross Creek Offset Site, Esparanga Offset Site and Stringybark Creek Habitat Corridor. The steps involved in the flora survey methodology included:

- aerial photograph interpretation (API);
- field survey site selection using stratification;
- field survey and associated plant identification; and
- vegetation community description and delineation.

The flora survey and vegetation mapping techniques used to describe and map vegetation communities occurring at the Esparanga and Cross Creek Offset Sites is consistent with the methodology described in Section 3.3 of the Ecological Assessment.

1.3.1 Flora Survey Timing

Flora field surveys were carried out during multiple survey periods across the offset sites. **Table 1** identifies the timing and type of survey conducted at each of the sites.

Table 1 – Field Survey Timing and Locations

Date of Surveys	Description & Names of Survey Locations	Survey Type
15/09/2010	Cross Creek Offset Site	Quadrat Sampling Rapid Sampling Walking Transects (Preliminary Vegetation Assessment)
28/09/2010 to 30/09/2010	Cross Creek Offset Site	Quadrat Sampling Rapid Sampling Meandering Transects
16/04/2012 to 18/04/2012 and 22/05/2012	Esparanga Offset Site	Quadrat sampling Walking Transects (Preliminary Vegetation Assessment)
24/10/2012 26/10/2012	Cross Creek Offset Site	BioBanking sampling Meandering Transects
13/05/2013 to 15/05/2013	Esparanga Offset Site	Quadrat sampling BioBanking sampling Rapid sampling Meandering Transects
25/10/2013	Stringybark Creek Habitat Corridor	Quadrat sampling BioBanking sampling Rapid sampling

1.3.1.1 Summary and Adequacy of Flora Field Survey Effort

Table 2 summarises the adequacy of flora surveys undertaken in the proposed offset sites in accordance with the *Draft Threatened Species Survey and Assessment: Guidelines for Developments and Activities* (DEC 2004).

Table 2 – Adequacy of Vegetation Surveys at the Esparanga and Cross Creek Offset Sites

Stratification Unit[1]	Area (ha) in Offset Area	No. of Quadrats and Transects Sampled and No. of each required (x)[2]
Esparanga Offset Site		
Upper Hunter White Box - Ironbark Grassy Woodland	41.5	Quadrats: 2 (**2**) Transects: 2 (0)
Spotted Gum Open Forest Complex on Sandstone	7.3	Quadrats: 1 (**1**) Transects: 1 (**0**)
Shrubby White Box Woodland	14.3	Quadrats: 2 (**1**) Transects: 2 (**0**)
Red Gum Open Forest on Alluvium/Colluvium	2.7	Quadrats: 1 (**1**) Transects: 1 (**0**)
Narrabeen Sheltered Dry Forest	56.8	Quadrats: 3 (**3**) Transects: 3 (**0**)
Narrabeen Ironbark Woodland	89.4	Quadrats: 3 (**3**) Transects: 3 (**0**)
Derived Native Grassland (White Box Woodland)	84.5	Quadrats: 3 (**2**) Transects: 3 (**0**)
Derived Native Grassland (Red Gum Open Forest on Alluvium/Colluvium)	5.9	Quadrats: 2 (**1**) Transects: 2 (**0**)
Derived Native Grassland (Narrabeen Ironbark Woodland)	0.4	Quadrats: 1 (**0**) Transects: 1 (**0**)
Cross Creek Offset Site		
Central Hunter Ironbark – Spotted Gum – Grey Box Forest	37.2	Quadrats: 2 (**5**) Transects: 2 (**0**)
Central Hunter Ironbark – Spotted Gum – Grey Box Forest Red Gum variant	14.5	Quadrats: 2 (**3**) Transects: 2 (**0**)
Native Grassland	315.7	Quadrats: 5 (**3**) Transects: 5 (**0**)

1. See **Table 3.2** of the Ecological Assessment for details about biophysical attributes used in stratification units
2. Number of quadrats and transects (100 m traverses) recommended in accordance with Draft Threatened Species Survey and Assessment: Guidelines for Developments and Activities (DEC 2004)

Two vegetation quadrats and five rapid vegetation assessment sites were sampled during the site inspection in order to describe and delineate vegetation communities and EECs.

Surveys undertaken in the proposed offset sites are considered to be adequate to accurately describe and map the extent of vegetation communities occurring.

1.4 Fauna Survey Methods

Comprehensive fauna surveys were undertaken to identify the fauna species and their habitats occurring, or considered to have the potential to occur in the Esparanga and Cross Creek Offset Sites. Surveys included specific methodologies to target potentially occurring threatened species, migratory species, EPs and species of local or regional significance, particularly those that were identified as being impacted by the Project.

Reference was made to the relevant Office of Environment and Heritage (OEH) fauna survey guidelines (DEC 2004) when designing the field survey, with appropriate survey methods selected that maximised the opportunities of identifying the full suite of fauna species that occur within the Offset Sites.

Fauna surveys were undertaken within the Esparanga and Cross Creek Offset Sites during 2010, 2011, 2012 and 2013. A summary of the survey timing for each Offset Site is provided in **Table 3**.

Table 3 – Timing of Fauna Survey within Each Proposed Offset Site

Survey Technique		**Esparanga Offset Site**	**Cross Creek Offset Site**	**Stringybark Creek Habitat Corridor**
Targeted Threatened Fauna Survey	**Green and Golden Bell Frog Survey Sites**			
	Nocturnal call-playback	-	Summer 2013	-
	Targeted nocturnal area search	-	Summer 2013	-
	Threatened Micro-bat Survey Sites			
	Anabat detector	Autumn 2012, Winter 2013	Spring 2010	-
	Harp traps	-	-	-
	Threatened Migratory Bird Survey Sites			
	Winter bird survey	Winter 2012 and 2013	Winter 2012	-
General Fauna Survey	Hair funnel transects	Autumn 2012, Winter 2013	Spring 2010	-
	Diurnal bird survey	Autumn 2012, Winter 2012 and 2013	Spring 2010	-
	Diurnal herpetofauna survey	Autumn 2012, Winter 2013	Spring 2010	-
	Spotlighting survey	Autumn 2012, Winter 2013	Spring 2010	-
	Nocturnal Call-playback	Autumn 2012, Winter 2013	Spring 2010	-
	Remote sensing cameras	Winter 2013	-	-
	Habitat assessment	Autumn 2012, Autumn 2013	Spring 2010, Spring 2012	Spring 2013
	Opportunistic survey	Autumn 2012, Winter 2012 and 2013	Spring 2010, Spring 2012, Summer 2013	Spring 2013

Baseline fauna surveys at the Cross Creek Offset Site were undertaken from 28 to 30 September 2010. Additional targeted winter bird surveys were undertaken over 19 and 20 July 2012. Habitat assessments were completed in conjunction with flora surveys on 24 and 25 October 2012 and targeted green and golden bell frog surveys were undertaken on 11 and 12 February 2013. The locations of fauna survey sites are included in Figure 7.3 of the Ecological Assessment.

Temperature during the 2010 survey ranged between 23 to 29 degrees Celsius during the day. No rain fell during surveys undertaken in 2010, recorded at Scone Airport weather station approximately 45 kilometres from the Cross Creek Offset Site (BOM 2013).

Temperature during the 2012 winter bird surveys ranged between 0 and 15 degrees Celsius, and 0.2 millimetres of rain fell on 19 July. Temperature during the 2013 green and golden bell frog surveys ranged between 17 and 27 degrees Celsius, and 24 millimetres of rain fell on 11 February.

Baseline fauna surveys on the Esparanga Offset Site were undertaken from 16 to 18 April, 22 May and 28 June 2012. Temperature during the autumn survey period ranged from maximums of 22 to 26 degrees Celsius during the day and minimums of 4 to 17 degrees Celsius overnight. A total of 1.3 millimetres of rain fell during the autumn surveys with a total of 24 millimetres in April.

Detailed fauna surveys of the Esparanga Offset Site were conducted from 29 April to 3 May 2013. The locations of fauna survey sites at the Esparanga Offset Site are provided in Figure 7.3 of the main report. A summary of the fauna survey effort undertaken at each offset site is provided below.

Opportunistic fauna surveys and habitat assessments were undertaken at the Stringybark Creek Habitat Corridor during the one day site inspection on 25 October 2013.

1.4.1 Trapping Surveys

1.4.1.1 Hair Funnel Surveys

Hair funnel sampling was used at two sites within each offset site during fauna surveys targeting terrestrial and arboreal mammals in lieu of live trapping. The location of hair funnel transect sites is shown as part of the general fauna survey sites identified in on Figures 7.3 and 7.5.

Hair funnels target terrestrial and arboreal mammals by collecting samples of hair on a sticky wafer attached to the roof of a baited funnel. The dimensions of each funnel are 140 millimetres at the entry to the funnel down to 40 millimetres at the baited end. This design allows both large and small mammals to enter the funnels thereby allowing the collection of a range of hair samples on the sticky wafer.

Hair funnel survey sites comprised 20 terrestrial hair funnels and 10 arboreal hair funnels at the Esparanga Offset Site. Hair funnel survey sites on the Cross Creek Offset Site consisted of 15 terrestrial hair funnels and 10 arboreal hair funnels. Terrestrial hair funnels were placed approximately 20 metres apart while arboreal hair funnels were fastened to tree trunks approximately 40 metres apart.

Half the terrestrial hair funnels were baited with meat and the other half were baited with a mix of oats and peanut-butter. Arboreal hair funnels were baited with a mix of honey, oats and peanut butter. A concentrated honey-water mixture was sprayed on the trunk of the tree that arboreal hair funnels were fastened to a height of approximately 3 metres to further attract animals.

Hair funnels remained on site at the Esparanga Offset Site for 14 days resulting in 420 trap nights per trap site and 840 trap nights across the site. Hair funnels remained on site at Cross Creek for 14 days resulting in 350 trap nights per trap site and 700 trap nights across the site. In total, two lines of 25 funnels were used to survey for a total of 700 trap nights per trap site. Hair samples were sent to Barbara Triggs (Dead Finish) for expert analysis.

1.4.1.2 Remote Sensing Cameras

Remote sensing cameras were included in surveys of the Esparanga Offset Site in May 2013. Baited remote sensing camera stations were placed at five locations in gully vegetation on the eastern portion of the Offset Site (refer to Figure 7.5). ScoutGuard 550V cameras were fastened to tree trunks approximately 30 centimetres above the ground and 1.5 metres from a PVC tube baited with chicken necks and pegged to the ground. As an additional attractant, tuna oil was soaked into the soil in front of the bait tube. Cameras were programmed to operate continuously and to take 3 exposures every 60 seconds when the trigger was activated.

1.4.2 Area Searches

A variety of area searches were undertaken as part of the fauna surveys. The area searches employed across the Offset Sites are detailed below and the locations of each area search method are provided in Figures 7.3 and 7.5.

1.4.2.1 Diurnal Bird Survey

Diurnal bird surveys consisted of one or two ecologists undertaking a slow walking transect within a 2 hectare area of each survey site. Surveys were undertaken for a total of one person-hour on each survey occasion. Bird surveys were undertaken at various times of the day, primarily in early to mid morning and mid to late afternoon. Each survey consisted of a slow walking transect within a 2 hectare area of the survey site. Bird species were identified from characteristic calls and by observation using binoculars with magnification up to 10x. Opportunistic observations were recorded during all other aspects of the field survey.

1.4.2.2 Diurnal Herpetological Survey

Diurnal herpetological (reptile and amphibian) surveys were conducted for a total of one person-hour on each survey occasion. Herpetological surveys were generally undertaken during the warmest parts of the day. Surveys targeted areas of likely habitat in proximity to each fauna survey site. During the search likely micro-habitats were examined including around waterbodies, beneath rocks and logs, in tree bark and in ground litter.

Amphibians not identifiable from their calls and non-venomous reptiles were captured for visual identification. All amphibians were handled according to the hygiene protocol for the control of disease in frogs (DECC 2008).

1.4.2.3 Spotlighting Surveys

Nocturnal spotlighting surveys were conducted for a total of one person-hour on each survey occasion. Spotlighting surveys targeted nocturnal birds, mammals and herpetofauna. Spotlighting was conducted on foot within a 2 hectare area of the survey site using 30 watt Lightforce hand-held spotlights and head torches. Spotlighting was undertaken generally between 8.00 pm and 12.00 am, commencing 1 hour after dusk.

1.4.2.4 Nocturnal Call-playback

Nocturnal call-playback sessions were undertaken at each Offset Site using a 15 watt directional loud hailer. Call-playback sessions commenced with a quiet listening period of approximately five minutes. Each species' call was played for a minimum of 4 minutes followed by a listening period of 2 minutes before the beginning of the next species' call. Call-playback sessions were tailored to suit species with the potential to occur within each Offset Site, and are listed in **Table 4**.

Table 4 – Species Recordings Broadcast at Each Offset Site

Species Played	Esparanga Offset Site	Cross Creek Offset Site
green and golden bell frog *Litoria aurea*		X
squirrel glider *Petaurus norfolcensis*	X	X
koala *Phascolarctos cinereus*	X	X
powerful owl *Ninox strenua*	X	X
barking owl *Ninox connivens*	X	X
masked owl *Tyto novaehollandiae*	X	X

1.4.2.5 Signs of Presence Searches

Searches for signs of animal presence were conducted opportunistically during all survey activities, particularly during habitat searches and reptile and amphibian searches. Due to the opportunistic nature of signs of presence surveys, the level of survey effort was not recorded. Evidence of presence included scats, feathers, nests, burrows, footprints, bones, tufts of hair and scratch marks on trees. All hair, scat and bone samples were sent to Barbara Triggs (Dead Finish) for expert analysis.

1.4.3 Targeted Threatened Fauna Survey Methods

Throughout the fauna surveys of the Esparanga and Cross Creek Offset Sites, targeted searches were carried out for threatened fauna species that are known to occur or were considered likely to occur based on the species' known distribution and the presence of suitable habitat.

Of these species, the following were considered to require targeted surveys as outlined in the sections below:

- green and golden bell frog (*Litoria aurea*);
- migratory bird species; and
- threatened micro-bat species.

1.4.3.1 Green and Golden Bell Frog Surveys

Targeted green and golden bell frog (*Litoria aurea*) surveys were undertaken in areas of potential habitat within Cross Creek Offset Site (refer to Figure 7.3) in February 2013.

Nocturnal searches for the green and golden bell frog targeted existing water bodies within the Cross Creek Offset Site and involved broadcasting recorded calls of the species for a period of one minute followed by a quiet listening period of one minute to detect any response calls at each location, repeated twice. Two ecologists then searched an area surrounding the water body for a minimum of half a person-hour traversing areas of suitable habitat. The number of individuals sighted or heard calling at each site was recorded. Searches were conducted on foot using 30 watt Lightforce hand-held spotlights and head

torches. Searches were undertaken generally between 8.00 pm and 12.00 am, commencing 1 hour after dusk. Opportunistic observations were made during all aspects of the survey effort.

1.4.3.2 Migratory Bird Surveys

Additional bird surveys were undertaken to target threatened winter migratory bird species known to occur in the vicinity, primarily the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*). Diurnal call playback sessions were undertaken at each site, using a 15 watt directional loud hailer. The sessions began with a period of quiet listening for approximately five minutes. Each species' call was played for a minimum of four minutes followed by a listening period of five minutes before the beginning of the next species. If a potential call of a target species was heard the method was repeated. Targeted winter bird surveys were undertaken from early morning until late afternoon by two surveyors for a minimum of 30 minutes at each site.

Bird species were identified by characteristic calls or observation using 10 × 42 binoculars.

1.4.3.3 Micro-bat Echolocation Recording

Echolocation calls were detected using an Anabat II Bat Detector and recorded digitally onto memory cards using Anabat CF storage ZCAIM at the Esparanga and Cross Creek Offset Sites. The combination of detector and recording device is collectively referred to as the 'Anabat detector'. Anabat echolocation recorders used at Esparanga were positioned at a 45 degree angle approximately 1 metre off the ground in a purpose built PVC pipe that protects the detector from rain. Anabat echolocation recorders used at Cross Creek were positioned horizontally, with a small roof protecting the detector from rain. This enabled the Anabat detectors to capture calls regardless of weather conditions.

All night Anabat detectors were positioned with a clear view of potential micro-bat flyways. The recorders were automated and programmed to start recording one hour before dusk and to stop recording one hour after sunrise the following morning. All night recordings were collected at each Anabat survey site.

All Anabat detector recordings were analysed by Glenn Hoye (a recognised expert in the field) of Fly by Night. The echolocation calls of species were identified to one of three levels of confidence:

- confident;
- probable; and
- possible.

All three levels of identification confidence were treated as positive identifications.

1.4.4 Habitat Assessments

Habitat assessments were undertaken across each of the Esparanga and Cross Creek Offset Sites. Habitat assessments were undertaken at a total of 27 sites across the Esparanga Offset Site (refer to Figure 7.3 of the main text) and 11 sites across the Cross Creek Offset Site (refer to Figure 7.5 of the main text). The assessment targeted potential habitat and resources for fauna species, particularly for threatened fauna species and included an assessment of SEPP 44 potential habitat. Records of a number of habitat features were made at each site which are listed in Section 3.6 of the Ecological Assessment.

1.4.5 Summary of Fauna Survey Effort

Table 5 below provides a summary of all of the fauna survey techniques employed at each of the Biodiversity Offset Sites. Fauna survey methods employed were consistent with the methodology described in Section 3.5 of the Ecological Assessment, unless otherwise specified.

Opportunistic fauna identification was undertaken during all other surveys completed within each offset area; however the effort from such survey is not quantifiable.

Table 5 – Summary of Fauna Survey Trapping Effort (Trapping and Non-trapping)

Survey Method	**Total Effort**	
	Esparanga Offset Site	**Cross Creek Offset Site**
Trapping Method[1]		
Terrestrial hair funnel	560	420
Arboreal hair funnel	280	280
Remote sensing camera	180	-
General Fauna Survey		
Bird surveys	13 person hours	3 person hours
Diurnal reptile and amphibian surveys	13 person hours	1 person hour
Walking spotlight surveys	5 person hours	2 person hours
Driving spotlight surveys	7 kilometres	-
Nocturnal call playback	11 sessions	2 sessions
Habitat assessment	27 sites	11 sites
Targeted Threatened Fauna Survey		
Green and golden bell frog surveys	-	7 person hours
Winter bird surveys	19 person hours	6 person hours
Anabat echolocation	8 nights	4 nights

1 = number of trap nights. One trap night equals one trap set for one night.

2.0 Flora Species Lists

The following lists were developed from surveys of the Esparanga and Cross Creek Offset Sites as detailed in **Section 1.3** above and in Section 7.4 of the Ecological Assessment. It includes all species of vascular plants observed during fieldwork completed by Umwelt between 2010 and 2013. Although substantial, the list will not be comprehensive because not all species are readily detected at any one time of the year. Many species flower only during restricted periods of the year, and some flower only once in several years. In the absence of flowering material, many of these species cannot be identified, or even detected.

Names of classes and families follow a modified Cronquist (1981) System.

Any species that could not be identified to the lowest taxonomic level are denoted in the following manner:

sp. specimens that are identified to genus level only.

The following abbreviations or symbols are used in the list:

1 to 6 modified Braun-Blanquet cover-abundance score;

X species recorded in proximity to, but outside of quantitative floristic quadrats, or recorded opportunistically during the survey effort;

asterisk (*) denotes species not native to Mount Owen Complex or relevant offset sites;

subsp. subspecies;

var. variety; and

Bold font denotes threatened plant species or populations.

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 & 2002) and Wheeler *et al*. (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2013), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 and 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

Table 6 lists the flora species recorded across the Esparanga Offset Site in quadrats, rapid assessment sites and transect sites.

Table 7 lists the flora species recorded across the Cross Creek Offset Site in quadrats, rapid assessment sites and transect sites.

Table 8 lists the flora species recorded across the Stringybark Creek Habitat Corridor in quadrats, rapid assessment sites and transect sites.

Table 6 – Flora Species Recorded During Surveys of Esparanga Offset Site

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Coniferopsida																										
Cupressaceae	*Callitris endlicheri*	black cypress pine	3										3					1			3					
Cycadopsida																										
Zamiaceae	*Macrozamia* sp.												1													
Filicopsida																										
Adiantaceae	*Cheilanthes distans*	bristly cloak fern	1			3															2				2	
Adiantaceae	*Cheilanthes sieberi*									1																
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*		2			2	3	1	2			1	2	2	2							2	1	1		
Aspleniaceae	*Asplenium flabellifolium*	necklace fern	1						2													1	1		1	
Magnoliopsida (Flowering Plants) - Liliidae																										
Anthericaceae	*Arthropodium minus*	small vanilla lily				1																				
Anthericaceae	*Arthropodium* sp.				1																					
Anthericaceae	*Dichopogon fimbriatus*	nodding chocolate lily																		1						
Anthericaceae	*Laxmannia gracilis*	slender wire lily					2																			
Cyperaceae	*Cyperus enervis*												1			1										
Cyperaceae	*Cyperus gracilis*			1		2																				
Cyperaceae	*Cyperus* sp.							1																		
Cyperaceae	*Gahnia aspera*	rough saw-sedge	1	2	1	2	4	1			3	3	2	3	3	2		1		2			1	2	3	
Cyperaceae	*Lepidosperma laterale*		2				3		3		2		2								2		2		3	
Cyperaceae	*Scleria mackaviensis*					2																				
Juncaceae	*Juncus* sp.											2														1
Lomandraceae	*Lomandra confertifolia* subsp. *rubiginosa*						2																1			
Lomandraceae	*Lomandra filiformis*												2													
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*					3																				
Lomandraceae	*Lomandra glauca*	pale mat-rush												2	2											
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	many-flowered mat-rush	1			1	1		4	5				3							1	1		1		
Lomandraceae	*Lomandra* sp.																				1					
Luzuriagaceae	*Eustrephus latifolius*	wombat berry						1			2									1						
Orchidaceae	*Acianthus fornicatus*	pixie caps								2				2												
Orchidaceae	*Acianthus* sp.		1				2		1												1	2				
Orchidaceae	***Cymbidium canaliculatum***	**tiger orchid**																	**1**							
Orchidaceae	*Pterostylis* sp.							1	2	2											1				1	
Phormiaceae	*Dianella caerulea* var. *caerulea*							1																		

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Phormiaceae	*Dianella revoluta* var. *revoluta*								3	2	1		2							1		2				
Phormiaceae	*Dianella* sp.		2			1	2		2	3	1		3		2					2		2	2		2	
Poaceae	*Aristida ramosa*	purple wiregrass									2		2			2										
Poaceae	*Aristida* sp.			1																						
Poaceae	*Aristida vagans*	threeawn speargrass	2				1		3					3	3									2		
Poaceae	*Austrostipa scabra*	speargrass																		2						
Poaceae	*Austrostipa scabra* subsp. *falcata*													2												
Poaceae	*Austrostipa scabra* subsp. *scabra*								3	3																
Poaceae	*Austrostipa* sp.					3																				
Poaceae	*Austrostipa verticillata*	slender bamboo grass		2																						
Poaceae	*Bothriochloa biloba*															2										
Poaceae	*Bothriochloa decipiens*	red grass			1			1			2					4										
Poaceae	*Bothriochloa macra*	red grass		3		1					3					3										
Poaceae	**Bromus cartharticus*	prairie grass										2														
Poaceae	**Bromus rubens*	red brome		1																						
Poaceae	*Chloris truncata*	windmill grass														2										
Poaceae	*Chloris ventricosa*	tall chloris		3	2	3					3					3								2		
Poaceae	*Cleistochloa rigida*												3	3			1	1				3				
Poaceae	*Cymbopogon refractus*	barbed wire grass	1	1	2	2	1				2	2	2			2				2	2			1		
Poaceae	*Cynodon dactylon*	common couch								2																
Poaceae	*Dichanthium sericeum*	Queensland bluegrass		3		4		1																2		
Poaceae	*Dichanthium sericeum* subsp. *sericeum*	Queensland bluegrass			5																					
Poaceae	*Dichelachne micrantha*	shorthair plumegrass									2	2			2	1										
Poaceae	*Digitaria ramularis*		1						2				2	2	2						2				2	
Poaceae	*Echinopogon caespitosus*	bushy hedgehog-grass					3																			
Poaceae	*Echinopogon ovatus*	forest hedgehog grass										3			3											
Poaceae	*Echinopogon* sp.		1				1																		1	
Poaceae	*Entolasia stricta*	wiry panic					1																		2	
Poaceae	*Eragrostis brownii*	Browns lovegrass													2						1					
Poaceae	*Eragrostis leptostachya*	paddock lovegrass						2				2														
Poaceae	*Eriochloa pseudoacrotricha*	early spring grass														2										
Poaceae	*Imperata cylindrica*											2														
Poaceae	*Lachnagrostis filiformis*											3														

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Poaceae	*Microlaena stipoides* var. *stipoides*		2	2		3	1	2	4		3	4	3	3	3								2		2	
Poaceae	*Panicum effusum*	poison or hairy panic									2			2	2	2										
Poaceae	*Panicum queenslandicum* var. *queenslandicum*				3		4																			
Poaceae	*Panicum* sp.			1																	2					
Poaceae	*Paspalidium gracile*	slender panic		1																						
Poaceae	**Paspalum dilatatum*	paspalum			1			2			2	3												2		
Poaceae	*Poa* sp.							1																		
Poaceae	*Rytidosperma bipartitum*				2	1							2	3	3	4				2	2			2		
Poaceae	*Rytidosperma fulvum*	wallaby grass	3	2																						
Poaceae	*Rytidosperma monticola*		3								3												2			2
Poaceae	*Rytidosperma pilosum*	smooth-flowered wallaby grass						1																		
Poaceae	*Rytidosperma* sp.															2										
Poaceae	*Sporobolus creber*	slender rats tail grass		1				2			2	3				3										
Poaceae	*Themeda australis*	kangaroo grass				2																				
Xanthorrhoeaceae	*Xanthorrhoea* sp.								3													2				
Magnoliopsida (Flowering Plants) - Magnoliidae																										
Acanthaceae	*Brunoniella australis*	blue trumpet		2		3			2				1	2	2					2			1			
Acanthaceae	*Rostellularia adscendens*					2																				
Acanthaceae	*Rostellularia* sp.			1																						
Apiaceae	**Cyclospermum leptophyllum*	slender celery		1																						
Apiaceae	*Hydrocotyle laxiflora*	stinking pennywort		2		4																				
Apiaceae	*Hydrocotyle* sp.							1																		
Apocynaceae	*Parsonsia eucalyptophylla*	gargaloo											1													
Asclepiadaceae	**Gomphocarpus fruticosus*	narrow-leaved cotton bush		1	2			2			2	2				3										2
Asteraceae	**Arctotheca calendula*	Capeweed										3				2										
Asteraceae	**Bidens pilosa*	cobblers pegs		3		2		3			3	2							1							2
Asteraceae	*Brachycome multifida* var. *multifida*														3											
Asteraceae	*Brachyscome multifida* var. *multifida*		2																		1					
Asteraceae	*Calotis lappulacea*	yellow burr-daisy	1	2		2																				

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Asteraceae	**Carthamus lanatus*	saffron thistle			2														1							
Asteraceae	*Cassinia arcuata*	sifton bush					2							1	2						2				2	
Asteraceae	*Cassinia* sp.								2	1				1												
Asteraceae	*Chrysocephalum apiculatum*	common everlasting, yellow but		1			1	1			2				2	2								2		
Asteraceae	*Chrysocephalum semipapposum*	clustered everlasting			3																					
Asteraceae	*Chrysocephalum* sp.		1																							
Asteraceae	**Cirsium vulgare*	spear thistle		3				2			2	2														2
Asteraceae	**Conyza bonariensis*	flaxleaf fleabane			2			4						1					1							2
Asteraceae	**Conyza* sp.			2																						
Asteraceae	*Cymbonotus* sp.				1	2	2																			
Asteraceae	*Euchiton gymnocephalus*	creeping cudweed									1															
Asteraceae	*Glossocardia bidens*	cobblers tack			2																					
Asteraceae	**Hypochaeris radicata*	catsear						2			2	3				2								2		
Asteraceae	*Lagenifera gracilis*	slender lagenophora											2													
Asteraceae	*Olearia elliptica*	sticky daisy bush													1											
Asteraceae	*Ozothamnus diosmifolius*	white dogwood													1											
Asteraceae	*Pseudognaphalium luteoalbum*	jersey cudweed						1																		
Asteraceae	**Senecio madagascariensis*	fireweed	1	2	3	3	2	3			2	2		2	1	2				2			2			2
Asteraceae	*Senecio quadridentatus*	cotton fireweed									1															
Asteraceae	*Senecio queenslandicus*			1		1																				
Asteraceae	*Sigesbeckia orientalis*		1	3				2												2						
Asteraceae	**Sonchus oleraceus*	common sowthistle		1		1																				
Asteraceae	**Taraxacum officinale*	dandelion		1	2	1										1										
Asteraceae	*Vernonia cinerea*		1																							
Asteraceae	*Vernonia cinerea* var. *cinerea*						1														1					
Asteraceae	*Vittadinia pterochaeta*	rough fuzzweed		2							2															
Asteraceae	*Vittadinia* sp.		1		1	1														2						
Asteraceae	*Vittadinia sulcata*										1			2	2	2										
Bignoniaceae	*Pandorea pandorana* subsp. *pandorana*																							1		
Boraginaceae	*Cynoglossum suaveolens*																							1		
Brassicaceae	**Brassica napus*											3														

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Brassicaceae	**Lepidium africanum*							1																		
Brassicaceae	*Lepidium* sp.			1																						
Cactaceae	**Opuntia aurantiaca*	tiger pear									1															
Cactaceae	**Opuntia stricta*					3																				
Cactaceae	**Opuntia stricta* var. *stricta*	common prickly pear	1	2	2				2		1		1			1				2			2	1	2	
Campanulaceae	*Wahlenbergia communis*	tufted bluebell					1																			
Campanulaceae	*Wahlenbergia luteola*					1					2															
Campanulaceae	*Wahlenbergia* sp.		2	1			2															2			1	
Campanulaceae	*Wahlenbergia stricta*	tall bluebell							2				2		2											
Campanulaceae	*Wahlenbergia stricta* subsp. *stricta*																				2		2			
Caryophyllaceae	**Silene gallica*											1														
Caryophyllaceae	**Stellaria media*	common chickweed										2														
Casuarinaceae	*Allocasuarina torulosa*	forest oak								2															3	
Celastraceae	*Maytenus silvestris*	narrow-leaved orangebark	1			3			1																	
Chenopodiaceae	*Atriplex* sp.			1																						
Chenopodiaceae	*Einadia hastata*	berry saltbush																		1					1	
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*										1															
Chenopodiaceae	*Einadia nutans* subsp. *nutans*												2													
Chenopodiaceae	*Einadia polygonoides*			2																						
Chenopodiaceae	*Einadia trigonos*	fishweed						1				2														
Chenopodiaceae	*Sclerolaena muricata*	black rolypoly			2											2										
Clusiaceae	*Hypericum gramineum*	small St John's wort	1				2																			
Convolvulaceae	*Dichondra repens*	kidney weed	2	3	5	4	5			2	2	2	2		2	2								2		
Convolvulaceae	*Dichondra species A*							2												2			2			1
Dilleniaceae	*Hibbertia acicularis*								2				2		2							1				
Dilleniaceae	*Hibbertia* sp.					1																				
Epacridaceae	*Leucopogon muticus*	blunt beard-heath	1				3		3	2			3	3	3		1	1			2	2				
Epacridaceae	*Lissanthe strigosa*	peach heath	1				3														2					
Epacridaceae	*Melichrus urceolatus*	urn heath								2			1	3												
Epacridaceae	*Styphelia triflora*	pink five-corners					2															1				
Euphorbiaceae	*Breynia oblongifolia*	coffee bush	1	1				2			1		2						1						2	
Euphorbiaceae	*Chamaesyce drummondii*	caustic weed		1		2					1															

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Euphorbiaceae	*Phyllanthus hirtellus*													2												
Euphorbiaceae	*Phyllanthus hirtellus* forma A						2																			
Fabaceae (Caesalpinioideae)	*Senna clavigera*																									2
Fabaceae (Faboideae)	*Daviesia acicularis*					2																				
Fabaceae (Faboideae)	*Daviesia genistifolia*	broom bitter pea		1							1															
Fabaceae (Faboideae)	*Daviesia ulicifolia*	gorse bitter pea					1			1				2												
Fabaceae (Faboideae)	*Desmodium brachypodum*	large tick-trefoil		1		3																				
Fabaceae (Faboideae)	*Desmodium gunnii*										1												1			
Fabaceae (Faboideae)	*Desmodium* sp.					4																				
Fabaceae (Faboideae)	*Desmodium varians*	slender tick-trefoil		1											2											
Fabaceae (Faboideae)	*Glycine clandestina*						2	1				1														
Fabaceae (Faboideae)	*Glycine microphylla*		2	2					2						2											
Fabaceae (Faboideae)	*Glycine* sp.					1																				
Fabaceae (Faboideae)	*Glycine tabacina*				2	1		1			2			2	2	2				1				1		2
Fabaceae (Faboideae)	*Hardenbergia violacea*	false sarsaparilla		1																						
Fabaceae (Faboideae)	*Hovea apiculata*																								2	
Fabaceae (Faboideae)	*Hovea lanceolata*												2													
Fabaceae (Faboideae)	*Indigofera australis*	Australian indigo	1																							
Fabaceae (Faboideae)	**Medicago* sp.					3																				
Fabaceae (Faboideae)	**Medicago truncatula*	barrel medic		1																						
Fabaceae (Faboideae)	*Podolobium ilicifolium*	prickly shaggy pea							2													1			2	
Fabaceae (Faboideae)	*Pultenaea* sp.								2																	
Fabaceae (Faboideae)	*Swainsona galegifolia*	smooth darling pea		2		3																				
Fabaceae (Faboideae)	**Trifolium campestre*	hop clover						2																		
Fabaceae (Faboideae)	**Trifolium* sp.					2																				
Fabaceae (Mimosoideae)	*Acacia piligera*												1													
Fabaceae (Mimosoideae)	*Acacia salicina*	cooba									3															
Fabaceae (Mimosoideae)	*Acacia* sp.			1				1			3					2										2

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Fabaceae (Mimosoideae)	*Acacia verniciflua*	varnish wattle	3				3	2						3	3						2			3		
Gentianaceae	*Centaurium spicatum*	spike centaury			2			1			2															
Gentianaceae	*Centaurium* sp.						2																			
Gentianaceae	**Centaurium tenuiflorum*					1																				
Geraniaceae	*Geranium homeanum*							1																		
Geraniaceae	*Geranium solanderi*	native geranium				3					2	2														
Geraniaceae	*Geranium* sp.			2																						
Goodeniaceae	*Brunonia australis*	blue pincushion																						1		
Goodeniaceae	*Goodenia glabra*						1																			
Goodeniaceae	*Goodenia ovata*	hop goodenia																					2			
Haloragaceae	*Gonocarpus teucrioides*	raspwort					3																			
Lamiaceae	**Marrubium vulgare*	horehound		2																2						
Lamiaceae	*Mentha satureioides*	native pennyroyal		2	2			1			2					3										
Lamiaceae	**Salvia verbenaca*	wild sage		2	1																					
Lauraceae	*Cassytha glabella*						2																			
Lobeliaceae	*Pratia purpurascens*	whiteroot																								2
Loranthaceae	*Amyema miquelii*										2			1	2											
Loranthaceae	*Amyema* sp.			1																						
Malvaceae	*Sida corrugata*				2	1																				
Malvaceae	**Sida rhombifolia*	Paddys lucerne		1		1		2																		2
Malvaceae	*Sida* sp.																						1			
Moraceae	*Ficus rubiginosa*	Port Jackson fig, rusty fig						1																		
Myoporaceae	*Eremophila debilis*	amulla	1	1		1					2				1	1				2				2	2	
Myoporaceae	*Myoporum montanum*	western boobialla									1															
Myrtaceae	*Angophora floribunda*	rough-barked apple		1				3											1							4
Myrtaceae	*Corymbia gummifera*	red bloodwood											9	1												
Myrtaceae	*Corymbia maculata*	spotted gum								4							1					4				
Myrtaceae	*Eucalyptus albens* x *moluccana*			4		4					4									4				4		3
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark	3				5	3	4				4	4	3		1	1			4		3			
Myrtaceae	*Eucalyptus fibrosa*	red ironbark					1						3	4	3											
Myrtaceae	*Eucalyptus punctata*	grey gum	3						3									1					3		4	
Myrtaceae	*Eucalyptus sparsifolia*	narrow-leaved stringybark								2												3				
Oleaceae	*Notelaea microcarpa* var. *microcarpa*		1	2		3	2		3		1		1						1	4			2	3	2	4

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Oleaceae	**Olea europaea* subsp. *cuspidata*	African olive												1	2											
Oxalidaceae	*Oxalis perennans*			1	3						2	2														
Oxalidaceae	*Oxalis* sp.		1		2		2	1																		
Pittosporaceae	*Billardiera scandens*	appleberry					1																			
Pittosporaceae	*Bursaria spinosa*	native blackthorn	3				3															1	2		3	
Pittosporaceae	*Bursaria spinosa* subsp. *spinosa*								4	2			1	2	2											
Plantaginaceae	*Plantago debilis*		2		4						2					1							1			
Plantaginaceae	**Plantago lanceolata*	lambs tongues										2														
Plantaginaceae	*Plantago* sp.										1															
Polygonaceae	**Acetosella vulgaris*	sorrel, sheep sorrel										2														
Polygonaceae	*Rumex brownii*	swamp dock						1																		
Polygonaceae	*Rumex* sp.															1										
Primulaceae	**Anagallis arvensis*	scarlet/blue pimpernel		1	2	2		1			1	2			1					1						
Proteaceae	*Persoonia linearis*	narrow-leaved geebung	1				1		3	2			2		1		1	1				2	1			
Ranunculaceae	*Clematis glycinoides*	headache vine		2																			1			
Rhamnaceae	*Cryptandra spinescens*						2														1					
Rosaceae	*Acaena agnipila*				1	1					2													2		2
Rosaceae	*Acaena* sp.			1																						
Rosaceae	*Rubus* sp.																									3
Rubiaceae	*Asperula conferta*	common woodruff		2	3	2					2					3										
Rubiaceae	*Psydrax odorata*	shiny-leaved canthium		1							2			1	1											
Rubiaceae	*Galium binifolium*																						1			
Rubiaceae	*Galium gaudichaudii*	rough bedstraw				3																				
Rubiaceae	*Galium propinquum*	Maori bedstraw		2																						
Rubiaceae	*Pomax umbellata*		2				3						2	2	2							1	1		1	
Rutaceae	*Correa reflexa*	native fuschia							3						1											
Rutaceae	*Correa reflexa* var. *reflexa*	native fuschia																					1			
Santalaceae	*Choretrum species* A		3	1		1	2		3		3		3		3					4	3	2	2	2	3	
Sapindaceae	*Dodonaea triangularis*		3										4		3			1			2	1				
Sapindaceae	*Dodonaea viscosa*								2																	
Scrophulariaceae	*Veronica plebeia*	trailing speedwell	2	2			4				2	1	2		1										2	
Solanaceae	*Solanum brownii*	violet nightshade													1											
Solanaceae	*Solanum campanulatum*												1													

Family	Scientific Name	Common Name	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	ER9	ER10
Solanaceae	**Solanum nigrum*	black-berry nightshade		1		1		1																		
Solanaceae	*Solanum* sp.		1	1		1	2																			
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*		1	1		1	2	1			2		2											1		
Urticaceae	*Urtica incisa*	stinging nettle		2																						
Verbenaceae	**Verbena bonariensis*	purpletop		1							2	2														2
Verbenaceae	**Verbena officinalis*	common verbena									1															
Verbenaceae	**Verbena rigida*	veined verbena						1																		
Vitaceae	*Cayratia clematidea*	slender grape				2		1			2									1						

Table 7 – Flora Species Recorded During Surveys of Cross Creek Offset Site

Family	Scientific Name	Common Name	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	R01	R02	R03
Filicopsida																
Adiantaceae	*Cheilanthes distans*	bristly cloak fern	1	2	1			2	1			2			2	
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*			1	2	1		3	3		2	2	2		2	2
Magnoliopsida (Flowering Plants) - Liliidae																
Anthericaceae	*Arthropodium milleflorum*	vanilla lily		1												
Anthericaceae	*Dichopogon fimbriatus*	nodding chocolate lily			1	1	1	1	2					1		
Colchicaceae	*Wurmbea biglandulosa*			1												
Iridaceae	**Romulea rosea*										2	2	2			
Juncaceae	*Juncus kraussii*										2		2			
Juncaceae	*Juncus* sp.			1		2	2									
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*			1			1									
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	many-flowered mat-rush	1	1	1	1	1	1	1				1		2	
Phormiaceae	*Dianella caerulea* var. *caerulea*			1						1						
Phormiaceae	*Dianella revoluta* var. *revoluta*												1			
Phormiaceae	*Stypandra glauca*	nodding blue lily						1								
Poaceae	*Aristida ramosa*	purple wiregrass		3												
Poaceae	*Aristida* sp.		2			1	2		1	1		2		1	1	
Poaceae	*Aristida vagans*	threeawn speargrass														
Poaceae	*Austrostipa scabra*	speargrass		1	2											
Poaceae	*Austrostipa scabra* subsp. *falcata*												2			
Poaceae	*Austrostipa verticillata*	slender bamboo grass									3	3	3			

Family	Scientific Name	Common Name	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	R01	R02	R03
Poaceae	**Axonopus fissifolius*	narrow-leafed carpet grass										3				
Poaceae	*Bothriochloa* sp.										2		2			
Poaceae	**Briza minor*	shivery grass				1					2	2				1
Poaceae	**Bromus cartharticus*	prairie grass			1					1						
Poaceae	**Bromus molliformis*										2					
Poaceae	*Chloris* sp.												3			
Poaceae	*Chloris ventricosa*	tall chloris	2	3	2		3			1	1			3	3	
Poaceae	*Cymbopogon refractus*	barbed wire grass	1	1		2	1	2	3	3		3	3		1	2
Poaceae	*Cynodon dactylon*	common couch								2	3					
Poaceae	*Dichelachne micrantha*	shorthair plumegrass									2	3	2			1
Poaceae	*Elymus scaber*						1									
Poaceae	*Eragrostis brownii*	Browns lovegrass									3	2	3			
Poaceae	*Eragrostis* sp.			1												
Poaceae	*Microlaena stipoides*		3				2									
Poaceae	*Microlaena stipoides* var. *stipoides*			2	3			3	3	2				2	3	
Poaceae	*Oplismenus* sp.		2													
Poaceae	*Rytidosperma bipartitum*						2	1								
Poaceae	*Rytidosperma pilosum*	smooth-flowered wallaby grass										3				
Poaceae	*Rytidosperma* sp.		2								1					
Poaceae	*Sporobolus creber*	slender rat's tail grass	1		2	2			3		3	2	3			2
Poaceae	*Themeda australis*	kangaroo grass		1		1	1	3	3	1			3			1
Poaceae	**Vulpia bromoides*	squirrel tail fesque									2					

Family	Scientific Name	Common Name	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	R01	R02	R03
Magnoliopsida (Flowering Plants) - Magnoliidae																
Asclepiadaceae	**Gomphocarpus fruticosus*	narrow-leaved cotton bush										1	2			
Asteraceae	**Bidens pilosa*	cobbler's pegs	1	1												
Asteraceae	*Calotis lappulacea*	yellow burr-daisy		1		1		1	1	1						3
Asteraceae	*Cassinia aculeata*	dolly bush						1								
Asteraceae	*Cassinia* sp.			1												
Asteraceae	*Chrysocephalum apiculatum*	common everlasting, yellow but						1	2				2			1
Asteraceae	**Cirsium vulgare*	spear thistle	1							1	2		2	2		
Asteraceae	*Cotula australis*	common cotula	2		2	2	1	1						1		1
Asteraceae	**Gamochaeta* sp.		1								3					
Asteraceae	**Hypochaeris radicata*	catsear									3	2	3			
Asteraceae	**Senecio madagascariensis*	fireweed	1	2	2	3	3	1		3	2	2	2	3	2	3
Asteraceae	**Sonchus oleraceus*	common sowthistle	1													
Asteraceae	*Senecio* sp.		1													
Asteraceae	**Taraxacum officinale*	dandelion	1													
Asteraceae	*Vittadinia muelleri*											2				
Asteraceae	*Vittadinia* sp.		1	1												
Brassicaceae	**Lepidium africanum*		1													
Brassicaceae	*Lepidium pseudohyssopifolium*	peppercress			1											
Cactaceae	**Opuntia aurantiaca*	tiger pear										2				
Cactaceae	**Opuntia stricta* var. *stricta*	prickly pear	1	1	1	1	1	1	1							
Campanulaceae	*Wahlenbergia communis*	tufted bluebell	1		1	2	2			1						
Campanulaceae	*Wahlenbergia gracilis*	sprawling or Australian bluebell						2	2							1

Family	Scientific Name	Common Name	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	R01	R02	R03
Campanulaceae	*Wahlenbergia* sp.			1											3	
Caryophyllaceae	**Cerastium glomeratum*	mouse-ear chickweed	2		1					1						1
Caryophyllaceae	**Paronychia brasiliana*	chilean whitlow wort	1				1									
Caryophyllaceae	**Petrorhagia nanteuilii*				1	1	1		1		2	2			1	2
Caryophyllaceae	**Stellaria media*	common chickweed										2				
Celastraceae	*Maytenus silvestris*	narrow-leaved orangebark					1									
Chenopodiaceae	*Einadia nutans*	climbing saltbush	2	1	1		2			1						
Clusiaceae	*Hypericum gramineum*	small St Johns wort							1			2	2			
Convolvulaceae	*Convolvulus* sp.		1													
Convolvulaceae	*Dichondra repens*	kidney weed	3	2	4	1	3	2	2	3			2	3	3	
Crassulaceae	*Crassula sieberiana*	Australian stonecrop					1				2		2			
Dilleniaceae	*Hibbertia aspera*	rough guinea flower			1				1	1						
Dilleniaceae	*Hibbertia* sp.			1												
Epacridaceae	*Leucopogon virgatus*						1									
Epacridaceae	*Lissanthe strigosa*	peach heath					1	1	1		9		2			
Epacridaceae	*Melichrus urceolatus*	urn heath						1								
Euphorbiaceae	*Breynia oblongifolia*	coffee bush	1													
Fabaceae (Faboideae)	*Bossiaea rhombifolia*							1								
Fabaceae (Faboideae)	*Daviesia genistifolia*	broom bitter pea				1										
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*			1				1		1						

Family	Scientific Name	Common Name	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	R01	R02	R03
Fabaceae (Faboideae)	*Glycine tabacina*		1	2	3	1	1	3	2	2		1		1	2	
Fabaceae (Faboideae)	*Hardenbergia violacea*	false sarsaparilla	1		1											
Fabaceae (Faboideae)	**Medicago* sp.				1					2				1		1
Fabaceae (Faboideae)	*Pultenaea spinosa*					1										
Fabaceae (Faboideae)	**Trifolium campestre*	hop clover			1											
Fabaceae (Mimosoideae)	*Acacia decora*	western golden wattle		1												
Fabaceae (Mimosoideae)	*Acacia irrorata*	green wattle				1										
Gentianaceae	**Centaurium erythraea*	common centaury									3	2	2			
Geraniaceae	*Geranium solanderi*	native geranium	2	1	2					2				2		
Geraniaceae	*Geranium* sp.												1			
Haloragaceae	*Haloragis heterophylla*											2				
Lamiaceae	**Lamium amplexicaule*	dead nettle														1
Lamiaceae	*Ajuga australis*	Austral bugle	1	1	1			1		1						
Linaceae	**Linum trigynum*	french flax										2				
Lobeliaceae	*Pratia purpurascens*	whiteroot	1	3	1	2	1	2	1	1					2	
Malvaceae	**Modiola caroliniana*	red-flowered mallow			1											
Malvaceae	**Sida rhombifolia*	Paddys lucerne	1		1					1		2	2			
Malvaceae	*Sida corrugata*				1					1						
Myrtaceae	*Angophora floribunda*	rough-barked apple			2	1										
Myrtaceae	*Corymbia maculata*	spotted gum	4		2	2	3	2	3					2	4	

Family	Scientific Name	Common Name	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	R01	R02	R03
Myrtaceae	*Eucalyptus blakelyi*	Blakelys red gum			2	2				3						
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark	3	3			2	3	4						2	
Myrtaceae	*Eucalyptus fibrosa*	red ironbark				1										
Myrtaceae	*Eucalyptus moluccana*	grey box			2		1									
Myrtaceae	*Eucalyptus punctata*	grey gum												3		
Oleaceae	*Jasminum volubile*		2		1									1	2	
Oleaceae	*Notelaea longifolia*	large mock-olive		1												
Oleaceae	*Notelaea longifolia* forma *intermedia*		1													
Oleaceae	*Notelaea microcarpa*	native olive							1							
Oleaceae	**Olea europaea* subsp. *cuspidata*	African olive	1	1					1						1	
Oxalidaceae	**Oxalis pes-caprae*	soursob						1	2							
Oxalidaceae	*Oxalis exilis*		1	2												
Oxalidaceae	*Oxalis* sp.									1					1	
Phytolaccaceae	**Phytolacca octandra*	inkweed	1													
Pittosporaceae	*Billardiera scandens*	appleberry	1													
Plantaginaceae	**Plantago lanceolata*	lamb's tongues	2	2	3	3	1		1	3	2	2	3	3	3	4
Plantaginaceae	**Plantago myosuros*										2					
Plantaginaceae	*Plantago* sp.		1													
Polygonaceae	*Rumex brownii*	swamp dock											2			
Polygonaceae	*Rumex* sp.		1													
Primulaceae	**Anagallis arvensis*	scarlet/blue pimpernel	2	1	1	2			1	2	2			2		
Rosaceae	*Rubus* sp.		1													
Rubiaceae	*Asperula conferta*	common woodruff	3		2				1	2				1		
Rubiaceae	*Galium gaudichaudii*	rough bedstraw			1			1	1							

Family	Scientific Name	Common Name	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	R01	R02	R03
Rubiaceae	*Opercularia diphylla*					1			1							
Scrophulariaceae	**Veronica arvensis*	wall speedwell			1											
Scrophulariaceae	*Veronica plebeia*	trailing speedwell	1	1				1								
Solanaceae	*Solanum pungetium*	eastern nightshade	1		1		1	1	1	1				1	1	
Solanaceae	*Solanum* sp.		1													
Solanaceae	*Solanum stelligerum*	devils needles	1													
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*		1													
Verbenaceae	**Verbena bonariensis*	purpletop			1				1	1	1					2
Verbenaceae	**Verbena rigida*	veined verbena		2							2	2	2			

Table 8 – Flora Species Recorded During Site Inspection of Stringybark Creek Habitat Corridor

Family	Scientific Name	Common Name	P1	P2	OPS
Coniferopsida					
Cupressaceae	*Callitris endlicheri*	black cypress pine		X	
Filicopsida					
Adiantaceae	*Adiantum aethiopicum*	common maidenhair	1		
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*		2		
Magnoliopsida (Flowering Plants) - Liliidae					
Lomandraceae	*Lomandra longifolia* var. *longifolia*		2	2	
Luzuriagaceae	*Eustrephus latifolius*	wombat berry	2	1	
Phormiaceae	*Dianella revoluta* var. *revoluta*		1	2	
Poaceae	*Aristida ramosa*	purple wiregrass	3	3	X
Poaceae	*Austrostipa scabra*	speargrass	3		
Poaceae	*Chloris ventricosa*	tall chloris	3		
Poaceae	*Cymbopogon refractus*	barbed wire grass	3	4	X
Poaceae	*Echinopogon ovatus*	forest hedgehog grass	2		
Poaceae	*Imperata cylindrica*		2	2	X
Poaceae	*Themeda australis*	kangaroo grass	3	3	X
Magnoliopsida (Flowering Plants) - Magnoliidae					
Aizoaceae	**Galenia pubescens*	galenia	1		
Anacardiaceae	**Schinus areira*	pepper tree			X
Asclepiadaceae	**Araujia sericifera*	moth vine		1	
Asclepiadaceae	**Gomphocarpus fruticosus*	narrow-leaved cotton bush	2		
Asteraceae	*Cassinia aculeata*	dolly bush	2	2	
Asteraceae	*Chrysocephalum apiculatum*	common everlasting, yellow but	2		
Asteraceae	*Ozothamnus diosmifolius*	white dogwood		1	
Cactaceae	**Opuntia stricta* var. *stricta*	common prickly pear	2		
Casuarinaceae	*Allocasuarina luehmannii*	bulloak		3	
Casuarinaceae	*Casuarina glauca*	swamp oak			X

Family	Scientific Name	Common Name	P1	P2	OPS
Epacridaceae	*Brachyloma daphnoides*	daphne heath	1		
Euphorbiaceae	*Breynia oblongifolia*	coffee bush	3		X
Euphorbiaceae	*Phyllanthus virgatus*		1		
Fabaceae (Mimosoideae)	*Acacia falcata*		1	2	
Fabaceae (Mimosoideae)	*Acacia parvipinnula*	silver-stemmed wattle		3	
Moraceae	*Ficus rubiginosa*	Port Jackson fig	2		
Myrtaceae	*Angophora floribunda*	rough-barked apple			X
Myrtaceae	*Backhousia myrtifolia*	grey myrtle			X
Myrtaceae	*Corymbia maculata*	spotted gum	3		X
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark	3	3	X
Myrtaceae	*Eucalyptus fibrosa*	red ironbark	4		X
Myrtaceae	*Eucalyptus punctata*	grey gum	3		X
Myrtaceae	*Eucalyptus sparsifolia*	narrow-leaved stringybark			X
Myrtaceae	*Eucalyptus tereticornis*	forest red gum			X
Oleaceae	*Notelaea longifolia*	large mock-olive	1		
Oleaceae	*Notelaea microcarpa* var. *microcarpa*			2	X
Oleaceae	**Olea europaea* subsp. *cuspidata*		3	4	X
Pittosporaceae	*Bursaria spinosa* subsp. *spinosa*			2	X
Pittosporaceae	*Pittosporum undulatum*	sweet pittosporum			X
Proteaceae	*Grevillea robusta*	silky oak			X
Rhamnaceae	*Pomaderris ferruginea*		3		
Santalaceae	*Exocarpos cupressiformis*	native cherry		2	
Solanaceae	*Solanum cinereum*	Narrawa burr	1		
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*		1		
Ulmaceae	*Trema tomentosa*				X
Verbenaceae	**Verbena rigida* var. *rigida*	veined verbena		2	X

3.0 Fauna Species List

Table 9 below was developed from surveys of the Esparanga and Cross Creek Offset Sites, detailed in Section 7.4 of the Ecological Assessment and opportunistic recording of fauna species during the one-day site inspection at the Stringybark Creek Corridor. It includes all species of vertebrate fauna observed during fieldwork.

The following abbreviations or symbols are used in the list:

asterisk (*)	denotes species not indigenous to Australia;
subsp.	subspecies;
MAR	Listed marine species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
MIG	Listed migratory species under the EPBC Act;
V	Vulnerable under Schedule 2 of the *Threatened Species Conservation Act 1995* (TSC Act); and
E	Endangered under Schedule 1 of the TSC Act.

Birds recorded were identified using descriptions in Slater *et al.* (2003) and the scientific and common name nomenclature of BirdLife International Taxonomic Checklist (2013) (formerly Birds Australia). Reptiles recorded were identified using keys and descriptions in Cogger (2000), Swan *et al*. (2004), Weigel (1990) and Wilson and Swan (2008) and the scientific and common name nomenclature of Cogger (2000).

Amphibians recorded were identified using keys and descriptions in Cogger (2000), Robinson (1998), Anstis (2002) and Barker *et al.* (1995) and the scientific and common name nomenclature of Cogger (2000). Mammals recorded were identified using keys and descriptions in Strahan (2002) and Menkhorst and Knight (2004) and the scientific and common name nomenclature of Strahan (2002) for non bat species. Bat species recorded were identified using keys and descriptions in Churchill (1998) and ecological information was obtained from Churchill (2008).

Table 9 – Fauna Species List

FAMILY/Scientific Name	Common Name	Conservation Status		Offset Site		
		TSC Act	EPBC Act	Esparanga	Cross Creek	Stringybark Creek
AMPHIBIANS						
MYOBATRACHIDAE						
Crinia signifera	common froglet				x	
Limnodynastes dumerilii	eastern banjo frog			x	x	
Limnodynastes ornatus	ornate burrowing frog				x	
Limnodynastes tasmaniensis	spotted grass frog			x	x	
Pseudophryne bibronii	brown toadlet			x		
Pseudophryne coriacea	red-backed toadlet			x		
Uperoleia laevigata	smooth toadlet				x	
HYLIDAE						
Litoria dentata	bleating tree frog				x	
Litoria fallax	eastern dwarf tree frog				x	
Litoria latopalmata	Gunthers frog			x	x	
Litoria peronii	Perons Tree frog				x	
Litoria tyleri	Tylers tree frog				x	
Litoria verreauxii	Verreauxs frog				x	
REPTILES						
CHELIDAE						
Chelodina longicollis	snake-necked turtle			x	x	
GEKKONIDAE						
Diplodactylus vittatus	stone gecko			x		
Oedura lesueurii	Lesueurs velvet gecko			x		
Phyllurus platurus	southern leaf-tailed gecko			x		
Underwoodisaurus milii	thick-tailed gecko			x		
VARANIDAE						

FAMILY/Scientific Name	Common Name	Conservation Status		Offset Site		
		TSC Act	EPBC Act	Esparanga	Cross Creek	Stringybark Creek
Varanus varius	lace monitor					x
AGAMIDAE						
Pogona barbata	eastern bearded dragon				x	
SCINCIDAE						
Anomalopus leuckartii	two-clawed worm-skink			x		
Anomalopus swansoni	punctate worm-skink			x		
Ctenotus taeniolatus	copper-tailed skink			x		
Lampropholis delicata	dark-flecked darden sunskink				x	
Lerista bougainvillii	south-eastern slider			x		
BIRDS						
PHASIANIDAE						
Coturnix ypsilophora	brown quail			x		
ANATIDAE						
Chenonetta jubata	wood duck			x	x	
Anas castanea	chestnut teal					x
Aythya australis	hardhead					x
PODICIPEDIDAE						
Tachybaptus novaehollandiae	Australasian grebe			x		
COLUMBIDAE						
Ocyphaps lophotes	crested pigeon			x		
Phaps chalcoptera	common bronzewing			x		
AEGOTHELIDAE						
Aegotheles cristatus	Australian owlet-nightjar			x		
ARDEIDAE						
Egretta novaehollandiae	white-faced heron					
THRESKIORNITHIDAE						
Platelea flavipes	yellow-billed spoonbill					**x**

FAMILY/Scientific Name	Common Name	Conservation Status		Offset Site		
		TSC Act	EPBC Act	Esparanga	Cross Creek	Stringybark Creek
ACCIPITRIDAE						
Accipiter novaehollandiae	grey goshawk			x		
Aquila audax	wedge-tailed eagle			x	x	
Elanus axillaris	black-shouldered kite			x	x	
Haliastur sphenurus	whistling kite				x	
FALCONIDAE						
Falco berigora	brown falcon			x	x	
Falco cenchroides	nankeen kestrel			x	x	x
Falco longipennis	Australian hobby			x		
CHARADRIIDAE						
Vanellus miles	masked lapwing				x	x
CACATUIDAE						
Cacatua galerita	sulphur-crested cockatoo			x	x	
Calyptorhynchus funereus	yellow-tailed black-cockatoo			x		
Eolophus roseicapillus	galah			x	x	
PSITTACIDAE						
Alisterus scapularis	Australian king-parrot			x		
Glossopsitta concinna	musk lorikeet			x	x	
Glossopsitta pusilla	little lorikeet	V		x		
Platycercus elegans	crimson rosella				x	x
Platycercus eximius	eastern rosella			x	x	
Trichoglossus haematodus	rainbow lorikeet			x		
CUCULIDAE						
Eudynamis orientalis	eastern koel				x	
Scythrops novaehollandiae	channel-billed cuckoo		MAR		x	
Cacomantis flabelliformis	fan-tailed cuckoo			x		
STRIGIDAE						

FAMILY/Scientific Name	Common Name	Conservation Status		Offset Site		
		TSC Act	EPBC Act	Esparanga	Cross Creek	Stringybark Creek
Ninox novaeseelandiae	southern boobook			x		
TYTONIDAE						
Tyto alba	eastern barn owl			x		
Tyto sp.				x		
HALCYONIDAE						
Dacelo novaeguineae	laughing kookaburra			x	x	
CLIMACTERIDAE						
Climacteris picumnus victoriae	brown treecreeper (eastern subsp.)	V		x		
Cormobates leucophaea	white-throated treecreeper			x	x	
MALURIDAE						
Malurus cyaneus	superb fairy-wren			x	x	x
ACANTHIZIDAE						
Acanthiza chrysorrhoa	yellow-rumped thornbill			x	x	
Acanthiza lineata	striated thornbill			x		
Acanthiza nana	yellow thornbill			x	x	
Acanthiza pusilla	brown thornbill			x		
Acanthiza reguloides	buff-rumped thornbill			x		
Chthonicola sagittata	speckled warbler	V		x		x
Gerygone albogularis	white-throated gerygone			x	x	
Origma solitaria	rock warbler			x		
Sericornis frontalis	white-browed scrubwren				x	
Smicrornis brevirostris	weebill			x	x	
PARDALOTIDAE						
Pardalotus punctatus	spotted pardalote			x	x	
Pardalotus striatus	striated pardalote			x	x	x
MELIPHAGIDAE						

FAMILY/Scientific Name	Common Name	Conservation Status		Offset Site		
		TSC Act	EPBC Act	Esparanga	Cross Creek	Stringybark Creek
Meliphaga lewinii	Lewins honeyeater				x	
Anthochaera carunculata	red wattlebird			x	x	
Lichenostomus chrysops	yellow-faced honeyeater			x	x	
Lichenostomus fuscus	fuscous honeyeater			x		
Lichenostomus leucotis	white-eared honeyeater			x		
Lichenostomus melanops	yellow-tufted honeyeater			x		
Lichenostomus ornatus	yellow-plumed honeyeater			x	x	
Manorina melanocephala	noisy miner			x	x	x
Melithreptus brevirostris	brown-headed honeyeater					
Melithreptus lunatus	white-naped honeyeater			x	x	
Philemon corniculatus	noisy friarbird			x	x	x
POMATOSTOMIDAE						
Pomatostomus temporalis temporalis	grey-crowned babbler (eastern subsp.)	V			x	
NEOSITTIDAE						
Daphoenositta chrysoptera	varied sittella	V		x		
CAMPEPHAGIDAE						
Coracina novaehollandiae	black-faced cuckoo-shrike			x	x	
PACHYCEPHALIDAE						
Colluricincla harmonica	grey shrike-thrush			x	x	
Pachycephala pectoralis	golden whistler			x	x	
Pachycephala rufiventris	rufous whistler			x		x
ORIOLIDAE						
Oriolus sagittatus	olive-backed oriole			x		
ARTAMIDAE						
Cracticus nigrogularis	pied butcherbird			x	x	
Cracticus tibicen	Australian magpie			x	x	x

FAMILY/Scientific Name	Common Name	Conservation Status		Offset Site		
		TSC Act	EPBC Act	Esparanga	Cross Creek	Stringybark Creek
Cracticus torquatus	grey butcherbird			x	x	
Strepera graculina	pied currawong			x	x	
RHIPIDURIDAE						
Rhipidura albiscapa	grey fantail			x	x	x
Rhipidura leucophrys	willie wagtail			x		
CORVIDAE						
Corvus coronoides	Australian raven			x	x	x
MONARCHIDAE						
Grallina cyanoleuca	magpie-lark			x	x	
Myiagra inquieta	restless flycatcher			x		
CORCORACIDAE						
Corcorax melanorhamphos	white-winged chough			x	x	
PETROICIDAE						
Eopsaltria australis	eastern yellow robin			x		
Microeca fascinans	jacky winter			x	x	
Petroica boodang	scarlet robin	V		x		
Petroica rosea	rose robin			x		
TIMALIIDAE						
Zosterops lateralis	silvereye			x	x	x
HIRUNDINIDAE						
Hirundo ariel	fairy martin			x	x	
Hirundo neoxena	welcome swallow			x		
STURNIDAE						
Sturnus vulgaris	common starling			x		
NECTARINIIDAE						
Dicaeum hirundinaceum	mistletoebird			x		
ESTRILDIDAE						

FAMILY/Scientific Name	Common Name	Conservation Status		Offset Site		
		TSC Act	EPBC Act	Esparanga	Cross Creek	Stringybark Creek
Neochmia temporalis	red-browed finch			x	x	x
Taeniopygia bichenovii	double-barred finch				x	
MOTACILLIDAE						
Anthus novaeseelandiae	Australian pipit			x		x
MAMMALS						
DASYURIDAE						
Antechinus flavipes	yellow-footed antechinus			x		
Dasyurus maculatus maculatus	spotted-tailed quoll (eastern subspecies)	V	E	x		
VOMBATIDAE						
Vombatus ursinus	common wombat			x		
PETAURIDAE						
Petaurus breviceps	sugar glider			x		
Petaurus norfolcensis	squirrel glider	V		x		
PSEUDOCHEIRIDAE						
Pseudocheirus peregrinus	common ringtail possum			x		
PHALANGERIDAE						
Trichosurus vulpecula	common brushtail possum			x	x	
MACROPODIDAE						
Macropus giganteus	eastern grey kangaroo			x	x	x
Macropus robustus	common wallaroo			x	x	x
Macropus rufogriseus	red-necked wallaby			x	x	x
Wallabia bicolor	swamp wallaby			x		x
RHINOLOPHIDAE						
Rhinolophus megaphyllus	eastern horseshoe-bat			x		
EMBALLONURIDAE						
Saccolaimus flaviventris	yellow-bellied sheathtail-bat	V		x		

FAMILY/Scientific Name	Common Name	Conservation Status		Offset Site		
		TSC Act	EPBC Act	Esparanga	Cross Creek	Stringybark Creek
MOLOSSIDAE						
Mormopterus norfolkensis	east coast freetail-bat	V			x	
Mormopterus planiceps	southern freetail-bat			x		
Mormopterus sp. 3	eastern freetail-bat			x		
Tadarida australis	white-striped freetail-bat			x		
VESPERTILIONIDAE						
Chalinolobus dwyeri	large-eared pied bat	V	V	x		
Chalinolobus gouldii	Goulds wattled bat			x	x	
Chalinolobus morio	chocolate wattled bat			x	x	
Miniopterus schreibersii oceanensis	eastern bentwing-bat	V		x	x	
Nyctophilus sp.				x		
Scotorepens balstoni	inland broad-nosed bat			x	x	
Scotorepens orion	south-eastern broad-nosed bat			x		
Vespadelus sp.				x		
Vespadelus troughtoni	eastern cave bat	V		x		
Vespadelus vulturnus	little forest bat			x	x	
MURIDAE						
**Rattus rattus*	black rat				x	
CANIDAE						
**Vulpes vulpes*	red fox			x		
LEPORIDAE						
**Oryctolagus cuniculus*	European rabbit			x	x	

APPENDIX H

EPBC Offset Calculator Assessment of the
Mount Owen Continued Operations
Project Biodiversity Offset Strategy

Appendix H – EPBC Offset Calculator Assessment of the Mount Owen Continued Operations Project Biodiversity Offset Strategy

An assessment of the offsetting value of the proposed Biodiversity Offset Sites for the Matters of National Environmental Significance (MNES) identified in the Supplement to the Director-General's Requirements (DGRs) has been undertaken. This was completed using the Offsets Assessment Guide in the form of a function-embedded excel spreadsheet. The MNES identified in the Supplement to the DGRs are:

- spotted-tailed quoll (*Dasyurus maculatus maculatus*);
- swift parrot (*Lathamus discolor*);
- regent honeyeater (*Anthochaera phrygia*);
- koala (*Phascolarctos cinereus*);
- green and golden bell frog (*Litoria aurea*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- New Holland mouse (*Pseudomys novaehollandiae*); and
- grey-headed flying-fox (*Pteropus poliocephalus*).

Following are the individual assessments for each of the above MNES. For each MNES the key inputs and results of the Offset Assessment Guide are summarised. An assessment for the green and golden bell frog *(Litoria aurea*) has not been undertaken as the Project is not expected to have a significant impact on the species and therefore no direct offsets are proposed.

A summary of the presence and quality of habitat for the relevant MNES has been assessed in a manner consistent with the approach in How to Use the Offset Assessment Guide (DSEWPC 2012b).

1.1 Habitat Quality

1.1.1 Spotted-tailed Quoll Habitat Quality

The spotted-tailed quoll has been recorded annually in the Project Area, with the species recorded annually between 1994 and 2013 (except 1998, 1999 and 2005) in Ravensworth State Forest and surrounding woodland and forest communities, including mine rehabilitation. Radio-tracking data has recorded an individual using the woodland habitats at five locations within the proposed disturbance area during the period April to July 2013. All natural and derived vegetation communities in the disturbance area are likely to provide habitat for the spotted-tailed quoll and the proposed disturbance area comprises a portion of the home range of at least one individual. While the species will forage and move through Derived Native Grassland (DNG) habitat, woodland and forest communities provide the most important foraging habitat for the species due to the greater habitat complexity and increased prey opportunities.

Woodland Habitat Quality

Spotted-tailed quoll woodland habitat quality was assessed as 5 out of 10 for the proposed disturbance area with moderate scores across the range of habitat quality parameters (site condition, site context, species stocking rate).

Spotted-tailed quoll woodland habitat quality is currently 6 out of 10 at the Esparanga Offset Site with known presence of the species established during targeted surveys and the identification of well connected habitat. Habitat quality at Esparanga Offset Site will remain at 6 without the offset. Woodland habitat quality at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor is currently low at 3 due to the isolated and disturbed nature of the woodland habitat. Without the offset, the quality of habitat will decrease to 2 due to the threat of African olive (*Olea europaea* subsp. *cuspidata*) invasion and establishment which can result in the suppression of native species growth and regeneration, limiting biodiversity and the availability of prey resources for the species. The Cross Creek and Stringybark Creek Habitat Corridor Offset sites are expected to increase from a quality score of 3 to 6 with the establishment of the offset sites that will include specific management measures to control African olive. The Esparanga Offset Site will increase from 6 to 7 as an offset site with an increase in quality and connected habitat areas. At each of the three offset sites the habitat quality with the establishment of the offset site will be of equal or higher value with the habitat quality of the proposed disturbance area.

Derived Native Grassland Habitat Quality

Spotted-tailed quoll DNG habitat quality was assessed as 3 out of 10 for the proposed disturbance area with lower scores for site condition and low to moderate scores for species stocking rate and site context. Areas of DNG at the offset sites will be managed back to woodland form and will provide potential habitat areas for the spotted-tailed quoll once established that is well connected within the offset sites and to existing Mount Owen offset sites.

Spotted-tailed quoll grassland habitat quality is currently 4 out of 10 at the Esparanga Offset Site with known presence of the species and few threats and disturbances across the site. Habitat quality for grassland at Esparanga Offset Site will remain at 4 without the offset with few current threats identified. The grassland at the Esparanga Offset Site will increase from 4 to 7 with active regeneration to quality woodland with similar habitat value to the existing woodland on the site. Grassland habitat quality at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor is currently 2 due to the isolated and disturbed nature of the habitat for the spotted-tailed quoll. Without the offset, habitat quality will decrease to 1 due to the threat of African olive invasion and establishment which can result in the suppression of native species growth and regeneration, limiting biodiversity and the availability of prey resources for the spotted-tailed quoll. The Cross Creek and Stringybark Creek Habitat Corridor Offset will increase from a quality score of 2 to 6 with the establishment of active management strategies for African olive and regeneration of DNG areas to high quality woodland habitat at these offset sites. At each of the three offset sites the habitat quality with the establishment of the offset site will be of equal or higher value with the habitat quality of the proposed disturbance area.

1.1.2 Swift Parrot Habitat Quality

The swift parrot was recorded in 2005, 2007 and 2014 in the Project Area within Ravensworth State Forest and the Southeast Forest Area, during annual monitoring surveys. The species has not been recorded during monitoring or targeted Project-specific surveys in the proposed disturbance area. The species was recorded foraging during a mass eucalypt flowering event, with approximately 20 individuals recorded in 2005 and approximately five in 2007. Two birds were recorded in June 2014 in the Southeast Offset Area feeding on a flowering *E. tereticornis* (M. Murray pers comm.). All eucalypt dominated woodland areas

within the proposed disturbance area are considered to provide potential foraging habitat for the species. Small groups of flowering eucalypt trees and mass eucalypt flowering events provide potential habitat when flowering occurs during the winter months.

Woodland Habitat Quality

Swift parrot woodland habitat quality was assessed as 6 out of 10 for the proposed disturbance area with high scores for site condition and species stocking rate and a moderate score for site context.

Swift parrot woodland habitat quality at each of the three offset sites is currently 4 out of 10, however without the offset, it will decrease to 3 at the Cross Creek and Stringybark Creek Habitat Corridor Offset sites due to the threat of African olive invasion and establishment which can result in the suppression of native species growth and regeneration, reducing biodiversity and the availability of resources for target fauna species. Few specific threats to eucalypt woodland are known at the Esparanga Offset Site and therefore habitat quality will remain at 4 without the offset. Sites will increase from a quality score of 4 to 6 with the establishment of the three offset sites with an increase in quality, connection of habitat areas and reduction in threats. At each of the three offset sites the habitat quality with the establishment of the offset site will be equivalent with the current habitat quality of the proposed disturbance area.

Derived Native Grassland Habitat Quality

Areas of DNG will be managed back to woodland form and will provide potential foraging habitat areas for the swift parrot once eucalypt species begin flowering. The habitat quality of DNG for the swift parrot was assessed against the habitat quality of woodland areas in the proposed disturbance area.

As DNG does not provide any habitat features for the swift parrot, the start quality and quality without offset is zero across all three offset sites. The habitat quality with the offset for each of the proposed offset sites is 6 after 20 years of regeneration. The increase of habitat quality in these grassland habitats includes the active management and regeneration to woodland habitat, providing high quality foraging habitat and reduction of disturbances and threats in these areas. At each of the three offset sites the DNG returned to woodland will achieve an equivalent habitat quality score to woodland areas of the proposed disturbance area.

1.1.3 Regent Honeyeater Habitat Quality

The regent honeyeater has not been recorded within the Project Area or surrounds despite extensive seasonal surveys and 18 years of annual monitoring of the Project Area. The species was not recorded during Umwelt surveys of the Project Area during 2011 and 2012. The closest record of the species occurs at Warkworth, approximately 17 kilometres south-west of the Project Area. However, the species has potential to make use of the box-gum forest and woodland habitats of the proposed disturbance area, particularly when there are prolific flowering eucalypts and this migratory species is likely to move throughout the Hunter Valley in response to mass flowering events.

Woodland Habitat Quality

Regent honeyeater woodland habitat quality was assessed as 5 out of 10 for the proposed disturbance area with high scores for site condition, moderate scores for site context and low scores for species stocking rate.

Regent honeyeater woodland habitat quality is currently 4 out of 10 at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor and 5 out of 10 at the Esparanga Offset Site. These scores are due to a lack of known records of the species, despite potential foraging

habitat available. Quality at the Esparanga Offset Site is slightly higher due to better connected habitats and proximate records of the species. Habitat quality at Esparanga Offset Site will remain at 4 without the offset due to low levels of disturbance and limited threats, whereas quality at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor will decrease to 3 due to the threat of African olive invasion and establishment which can result in the suppression of native species growth and regeneration, limiting biodiversity and the availability of resources for the species. The Cross Creek and Stringybark Creek Habitat Corridor Offset sites will increase from a quality score of 4 to 5 with the establishment of the offset sites with decreased threats and improved connectivity to surrounding habitats. The Esparanga Offset Site will increase from 5 to 6 as an offset site with an increase in quality and connected habitat areas. At each of the three offset sites the habitat quality with the establishment of the offset site will be of equal or higher value with the habitat quality of the proposed disturbance area.

Derived Native Grassland Habitat Quality

Areas of DNG will be managed back to woodland form and will provide potential habitat areas for the regent honeyeater once eucalypt species begin flowering. The habitat quality of DNG for the regent honeyeater was assessed against the habitat quality of woodland areas in the proposed disturbance area.

As DNG does not provide any habitat features for the regent honeyeater, the start quality and quality without offset is zero across all three offset sites. The Cross Creek and Stringybark Creek Habitat Corridor Offset will increase from a quality score of zero to 5 with the establishment of active management and regeneration from grassland to quality woodland habitat. The grassland at the Esparanga Offset Site will increase from zero to 5 with the active regeneration to quality woodland and well connected habitats. At each of the three offset sites the habitat quality with the establishment of the offset site will be of equal or higher value with the habitat quality of the proposed disturbance area.

1.1.4 Koala Habitat Quality

The koala was tentatively recorded during the Mount Owen Complex monitoring in 1995 through the collection of scats resembling those of the koala (Forest Fauna Surveys and Newcastle Innovation 2012). A historic database record of the species (1980) is located in the south-east of the Project Area. A recent database record occurs near the intersection of the New England Highway and Hebden Road near Bowmans Creek (OEH 2013). The species was not recorded during Umwelt surveys and few preferred feed trees were recorded within the proposed disturbance area. A resident population of the koala has not been identified in the proposed disturbance area and the area is considered to comprise potential foraging and dispersal habitat for this species although it has not been confirmed in the area.

Woodland Habitat Quality

Koala woodland habitat quality was assessed as 4 out of 10 for the proposed disturbance area with moderate scores across the range of habitat quality parameters (site condition, site context, species stocking rate).

Koala woodland habitat quality is currently 4 out of 10 at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor and 6 out of 10 at the Esparanga Offset Site. These scores are due to lack of confirmed presence of the species, despite some potential foraging habitat being identified. Quality at the Esparanga Offset Site is slightly higher due to increased habitat connectivity compared to surrounding areas and closer records of the species. Habitat quality at Esparanga Offset Site will remain at 6 without the offset due to low disturbances, whereas quality at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor will decrease to 3 due to the threat of African olive invasion and establishment which

can result in the suppression of native species growth and regeneration, limiting biodiversity and the availability of resources for the species. The Cross Creek and Stringybark Creek Habitat Corridor Offset sites will increase from a quality score of 4 to 5 with the establishment of the offset sites, with fewer threats and improved connectivity to surrounding habitats. The Esparanga Offset Site will increase from 6 to 7 as an offset site. At each of the three offset sites the habitat quality with the establishment of the offset site will be of equal or higher value with the habitat quality of the proposed disturbance area.

Derived Native Grassland Habitat Quality

Areas of DNG will be managed back to woodland form and will provide potential habitat areas for the koala. The habitat quality of DNG for the koala was assessed against the habitat quality of woodland areas in the proposed disturbance area.

As DNG do not provide any habitat features for the koala, the start quality and quality without offset was zero across all three offset sites. The Cross Creek and Stringybark Creek Habitat Corridor Offset sites will increase from a quality score of zero to 5 with the establishment of active management and regeneration to quality woodland habitat to the habitat quality of the surrounding existing woodland. The grassland at the Esparanga Offset Site will increase from zero to 5 with the active regeneration to quality woodland and well connected habitats. At each of the three offset sites the habitat quality with the establishment of the offset site will be of equal or higher value with the habitat quality of the proposed disturbance area.

1.1.5 Large-eared Pied Bat Habitat Quality

The large-eared pied bat has been tentatively recorded through Anabat call analysis in the Project Area during annual fauna monitoring surveys in 1999, 2001, 2006 and 2008 using call echolocation recording however no individuals have been captured to confirm its presence (Forest Fauna Surveys and Newcastle Innovation 2012). The species was not recorded during Umwelt surveys of the proposed disturbance area. All woodland vegetation within the proposed Disturbance Area is expected to provide potential foraging habitat for this species, however no roosting habitat for this cave-roosting species has been identified. The proposed disturbance area is considered to comprise an area of foraging habitat for this species however is unlikely to contain breeding and roosting habitat.

Woodland Habitat Quality

Large-eared pied bat woodland habitat quality was assessed as 3 out of 10 for the proposed disturbance area with low to moderate scores across the range of habitat quality parameters (site condition, site context, species stocking rate).

Large-eared pied bat woodland habitat quality is currently 3 out of 10 at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor and 6 out of 10 at the Esparanga Offset Site. These scores are due to lack of confirmed presence of the species, despite some potential foraging habitat available. Quality at the Esparanga Offset Site is slightly higher due to increased habitat connectivity and known records of the species occurring on the site. Habitat quality at Esparanga Offset Site will remain at 6 without the offset due to low levels of threat and disturbance, whereas quality at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor will decrease to 2 due to the threat of African olive invasion and establishment which can result in the suppression of native species growth and regeneration, limiting biodiversity and the availability of resources for the species. The Cross Creek and Stringybark Creek Habitat Corridor Offset will increase from a quality score of 3 to 4 with the establishment of the offset sites with fewer threats and improved connectivity to surrounding habitats. The Esparanga Offset Site will increase from 6 to 7 as an offset site. At each of the three offset sites the habitat quality with the establishment of the offset site will be of equal or higher value with the habitat quality of the proposed disturbance area.

Derived Native Grassland Habitat Quality

Areas of DNG will be managed back to woodland form and will provide potential habitat areas for the large-eared pied bat. The habitat quality of DNG for the large-eared pied bat was assessed against the habitat quality of woodland areas in the proposed disturbance area.

As DNG does not provide any habitat features for the large-eared pied bat, the start quality and quality without offset was zero across all three offset sites. The Cross Creek and Stringybark Creek Habitat Corridor Offset sites increased from a quality score of 0 to 4 with the establishment of active management and regeneration to quality woodland habitat equivalent to the surrounding existing woodland in quality. The grassland at the Esparanga Offset Site is expected to increase from 0 to 7 with the active regeneration to quality woodland and well connected habitats, with known records of the species currently utilising the existing woodland habitats of the site. At each of the three offset sites the habitat quality with the establishment of the offset site was of equal or higher value with the habitat quality of the proposed disturbance area.

1.1.6 New Holland Mouse Habitat Quality

This species has been recorded during five of the last 18 years of fauna monitoring, with all captures of the species occurring between 2003 and 2007 (Forest Fauna Surveys and Newcastle Innovation 2012). The species has been recorded in areas of rehabilitation in the North Pit and to the east of Ravensworth State Forest in regenerating habitats however not within the Proposed Disturbance Area. The species selectively prefers habitats which have been disturbed by events in which it rapidly colonises following the event (Fly By Night *et al.* 2007). The New Holland mouse has not been recorded in the Project Area since 2007, despite annual targeted surveys. The species was not recorded during Umwelt surveys of the Proposed Disturbance Area. The Proposed Disturbance Area is considered to comprise potential foraging habitat for this species as part of a wider foraging range in surrounding habitats.

Woodland Habitat Quality

New Holland mouse woodland habitat quality was assessed as 2 out of 10 for the proposed disturbance area with low scores across the range of habitat quality parameters (site condition, site context, species stocking rate). The proposed disturbance area contains some areas of mature rehabilitation that may provide marginal habitat for the species; however it has not been recorded despite annual targeted monitoring surveys.

New Holland mouse woodland habitat quality is currently 2 out of 10 at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor and 3 out of 10 at the Esparanga Offset Site. These scores are due to lack of confirmed presence of the species and lack of regenerating, fire-affected or heathland habitat that is favoured by the species. Quality at the Esparanga Offset Site is slightly higher due to a known record of the species occurring immediately adjacent the site in Manobalai Nature Reserve in steep slope, dense shrub layer and exposed soil habitat. Habitat quality at Esparanga Offset Site will remain at 3 with and without the offset due to low levels of threat and disturbance and only marginal improvements as a result of establishing the offset. Quality at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor will remain at 2 with and without the offset due to the ongoing maturity of the vegetation resulting in the species less likely to occupy the site.

Derived Native Grassland Habitat Quality

Areas of DNG will be managed back to woodland form and will provide potential habitat areas for the New Holland mouse in the early rehabilitation and regeneration phases. The

habitat quality of DNG for the New Holland mouse was assessed against the habitat quality of woodland areas in the Proposed Disturbance Area.

As DNG does not provide any habitat features for the New Holland mouse, the start quality and quality without offset was zero across all three offset sites. The Cross Creek and Stringybark Creek Habitat Corridor Offset sites increased from a quality score of 0 to 2 with the establishment of active management and regeneration within the first 10 years of rehabilitation works. The grassland at the Esparanga Offset Site is expected to increase from 0 to 4 with the active regeneration to quality woodland and well connected habitats, with a known record of the species occurring in the adjacent woodland habitats of Manobalai Nature Reserve. At each of the three offset sites the habitat quality with the establishment of the offset site was of equal or higher value to the habitat quality of the Proposed Disturbance Area.

1.1.7 Grey-headed Flying-fox Habitat Quality

The grey-headed flying-fox has been occasionally recorded in the Project Area during annual monitoring surveys in 1994, 1996, 1997, 2000, 2004, 2006, 2007 and 2010 (Forest Fauna Surveys and Newcastle Innovation 2013). The species is infrequently recorded in low numbers within the Project Area, and is associated with periods when flowering of eucalypt tree species occur. Flowering events in the Project Area are sporadic and only a few individuals of the species have been recorded utilising these habitats over the last 18 years of annual fauna monitoring surveys. The Proposed Disturbance Area is considered to comprise an area of potential foraging habitat for this species however breeding and roosting habitat has not been recorded. The Project Area is located approximately 17 kilometres from a known roost site at Burdekin Park, Singleton, which comprises approximately 3170 individuals.

Woodland Habitat Quality

Grey-headed flying-fox woodland habitat quality was assessed as 4 out of 10 for the proposed disturbance area with low to moderate scores across the range of habitat quality parameters (site condition, site context, species stocking rate).

Grey-headed flying-fox woodland habitat quality is currently 3 out of 10 at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor and 5 out of 10 at the Esparanga Offset Site. These scores are due to lack of confirmed presence of the species, despite some potential foraging habitat available. Quality at the Esparanga Offset Site is slightly higher due to increased habitat connectivity and fewer threats associated with the site. Habitat quality at Esparanga Offset Site will remain at 5 with and without the offset due to low levels of threat and disturbance, and major improvements to woodland quality occurring over the life of the offset. Quality at the Cross Creek Offset Site and Stringybark Creek Habitat Corridor will remain at 3 with only minor changes in habitat quality over the life of the offset. The Cross Creek and Stringybark Creek Habitat Corridor Offset will increase from a quality score of 3 to 4 with the establishment of the offset sites with fewer threats and improved connectivity to surrounding habitats.

Derived Native Grassland Habitat Quality

Areas of DNG will be managed back to woodland form and will provide potential foraging habitat areas for the grey-headed flying-fox. The habitat quality of DNG for grey-headed flying-fox was assessed against the habitat quality of woodland areas in the proposed disturbance area.

As DNG does not provide any habitat features for the grey-headed flying-fox, the start quality and quality without offset was zero across all three offset sites. The Cross Creek and Stringybark Creek Habitat Corridor Offset sites are predicted to increase from a quality score of 0 to 3 with the establishment and active management of woodland regeneration. The grassland at the Esparanga Offset Site is expected to increase from 0 to 5 with the active regeneration to quality woodland and well connected habitats. At each of the three offset sites the habitat quality with the establishment of the offset site was of equal or higher value with the habitat quality of the proposed disturbance area.

1.2 Outcomes of Offset Assessment Guide

1.2.1 Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)

The Offset Assessment Guide indicated that:

- 49 per cent of the impacts on woodland habitat areas for the spotted-tailed quoll in the proposed disturbance area are offset by woodland areas for the species at the proposed Cross Creek Offset Site (15.55 per cent), Stringybark Creek Habitat Corridor Offset Site (11.51 per cent) and Esparanga Offset Site (21.99 per cent);

- 106 per cent of the impacts on grassland habitat areas for the spotted-tailed quoll in the proposed disturbance area can be offset by DNG areas to be regenerated to woodland habitat areas for the species at the proposed Cross Creek Offset Site (41.84 per cent), Stringybark Creek Habitat Corridor Offset Site (33.22 per cent) and Esparanga Offset Site (30.51 per cent); and

- 58 per cent of the impacts on woodland habitat areas for the spotted-tailed quoll in the proposed disturbance area are offset by the excess DNG areas to be regenerated to woodland areas for the species at the proposed Cross Creek Offset Site (57.80 per cent).

Woodland impacts for the spotted-tailed quoll are offset with a combination of existing woodland (49 per cent of the offset) and using the excess grassland habitat calculations (220 hectares at Cross Creek) by regenerating grassland to comparable woodland habitat (58 per cent of the offset) for a total of 107 percent offset for woodland impacts.

Grassland impacts for the spotted-tailed quoll are offset with existing grassland areas to be regenerated into eucalypt woodland comprising 95.3 hectares at the Cross Creek Offset Site, 61 hectares at the Stringybark Creek Corridor Site and 91 hectares at the Esparanga Offset Site for a total of 106 per cent offset for grassland impacts.

The Offset Assessment Guide input values used in the assessment are listed in **Table 1**.

Table 1 – Spotted-tailed Quoll Offset Assessment Guide Values

	Woodland Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Grassland
CROSS CREEK OFFSET SITE			
Impact Area	223.7 ha	223.7 ha	223.1 ha
Impact Quality	5	5	3
Offset Area	51.7 ha	220 ha	95.3 ha
Offset Site Start Quality	3	2	2
Without Offset Quality	2	2	2
With Offset Quality	6	6	6
Risk of Loss Without Offset	20%	20%	20%
Risk of Loss With Offset	1%	1%	1%
Time Over Which Loss is Adverted	20 years	20 years	20 years
Time Until Ecological Benefit	10 years	10 years	10 years
Confidence in Loss	90%	90%	90%
Confidence in Quality Change	90%	75%	75%
% of Impact Offset	**15.55%**	**57.80%**	**41.84%**
STRINGYBARK CREEK HABITAT CORRIDOR			
Impact Area	223.7 ha	-	223.1 ha
Impact Quality	5	-	3
Offset Area	36 ha	-	61 ha
Offset Site Start Quality	3	-	2
Without Offset Quality	2	-	1
With Offset Quality	6	-	6
Risk of Loss Without Offset	40%	-	40%
Risk of Loss With Offset	1%	-	1%
Time Over Which Loss is Adverted	20 years	-	20 years
Time Until Ecological Benefit	10 years	-	10 years
Confidence in Loss	90%	-	90%
Confidence in Quality Change	90%	-	75%
% of Impact Offset	**11.51%**	-	**33.32%**
ESPARANGA OFFSET SITE			
Impact Area	223.7 ha	-	223.1 ha
Impact Quality	5	-	3
Offset Area	211 ha	-	91 ha
Offset Site Start Quality	6	-	4
Without Offset Quality	6	-	4
With Offset Quality	7	-	7
Risk of Loss Without Offset	10%	-	10%
Risk of Loss With Offset	1%	-	1%
Time Over Which Loss is Adverted	20 years	-	20 years
Time Until Ecological Benefit	10 years	-	10 years
Confidence in Loss	90%	-	90%

Table 1 – Spotted-tailed Quoll Offset Assessment Guide Values (cont.)

	Woodland Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Grassland
Confidence in Quality Change	90%	-	75%
% of Impact Offset	**21.99%**	-	**30.51%**
TOTAL IMPACT OFFSET	**Woodland Impacts**		**Grassland Impacts**
	106.85%		**105.67%**

1.2.2 Swift Parrot (*Lathamus discolor*)

The Offset Assessment Guide indicated that:

- 57 per cent of the impacts on eucalypt woodland habitat areas for the swift parrot in the proposed disturbance area are offset by existing eucalypt woodland areas for the species at the proposed Cross Creek Offset Site (13.21 per cent), Stringybark Creek Habitat Corridor Offset Site (8.07 per cent) and Esparanga Offset Site (35.64 per cent); and

- 173 per cent of the impacts on eucalypt woodland habitat areas for the swift parrot in the proposed disturbance area were offset by DNG areas to be regenerated to eucalypt woodland habitat areas for the species at the proposed Cross Creek Offset Site (116.98 per cent), Stringybark Creek Habitat Corridor Offset Site (22.74 per cent) and Esparanga Offset Site (33.11 per cent).

The combination of offsetting existing eucalypt woodland with areas to be regenerated into eucalypt woodland provides a 230 per cent offset for the swift parrot.

The Offset Assessment Guide input values used in the assessment are listed in **Table 2**.

Table 2 – Swift Parrot Offset Assessment Guide Values

	Eucalypt Woodland Areas to Offset Impacts on Eucalypt Woodland	Regenerated Areas to Offset Impacts on Eucalypt Woodland
CROSS CREEK OFFSET SITE		
Impact Area	163.7 ha	163.7 ha
Impact Quality	6	6
Offset Area	51.7 ha	315.3 ha
Offset Site Start Quality	4	0
Without Offset Quality	3	0
With Offset Quality	6	6
Risk of Loss Without Offset	20%	20%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**13.21%**	**116.98%**

Table 2 – Swift Parrot Offset Assessment Guide Values (cont.)

	Eucalypt Woodland Areas to Offset Impacts on Eucalypt Woodland	Regenerated Areas to Offset Impacts on Eucalypt Woodland
STRINGYBARK CREEK HABITAT CORRIDOR		
Impact Area	163.7 ha	163.7 ha
Impact Quality	6	6
Offset Area	27 ha	59 ha
Offset Site Start Quality	4	0
Without Offset Quality	3	0
With Offset Quality	6	6
Risk of Loss Without Offset	40%	40%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**8.07%**	**22.74%**
ESPARANGA OFFSET SITE		
Impact Area	163.7 ha	163.7 ha
Impact Quality	6	6
Offset Area	211 ha	91 ha
Offset Site Start Quality	4	0
Without Offset Quality	4	0
With Offset Quality	6	6
Risk of Loss Without Offset	10%	10%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**35.64%**	**33.11%**
TOTAL IMPACT OFFSET	**229.75 %**	

1.2.3 Regent Honeyeater (*Anthochaera phrygia*)

The Offset Assessment Guide indicated that:

- 45 per cent of the impacts on eucalypt woodland habitat areas for the regent honeyeater in the proposed disturbance area are offset by existing eucalypt woodland areas for the species at the proposed Cross Creek Offset Site (11.42 per cent), Stringybark Creek Habitat Corridor Offset Site (7.37 per cent) and Esparanga Offset Site (26.32 per cent); and

- 173 per cent of the impacts on eucalypt woodland habitat areas for the regent honeyeater in the proposed disturbance area are offset by DNG areas to be regenerated to eucalypt woodland habitat areas for the species at the proposed Cross Creek Offset Site (116.98 per cent), Stringybark Creek Habitat Corridor Offset Site (22.74 per cent) and Esparanga Offset Site (33.11 per cent).

The combination of offsetting existing eucalypt woodland with areas to be regenerated into eucalypt woodland provides a 218 per cent offset for the regent honeyeater.

The Offset Assessment Guide input values used in the assessment are listed in **Table 3**.

Table 3 – Regent Honeyeater Offset Assessment Guide Values

	Woodland Areas to Offset Impacts on Woodland	**Regenerated Areas to Offset Impacts on Woodland**
CROSS CREEK OFFSET SITE		
Impact Area	163.7 ha	163.7 ha
Impact Quality	5	5 ha
Offset Area	51.7 ha	315.3
Offset Site Start Quality	4	0
Without Offset Quality	3	0
With Offset Quality	5	5
Risk of Loss Without Offset	20%	20%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**11.42%**	**116.98%**
STRINGYBARK CREEK HABITAT CORRIDOR		
Impact Area	163.7 ha	163.7 ha
Impact Quality	5	5
Offset Area	27 ha	59 ha
Offset Site Start Quality	4	0
Without Offset Quality	3	0
With Offset Quality	5	5
Risk of Loss Without Offset	40%	40%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**7.37%**	**22.74%**
ESPARANGA OFFSET SITE		
Impact Area	163.7 ha	163.7 ha
Impact Quality	5	5
Offset Area	211 ha	91 ha
Offset Site Start Quality	5	0
Without Offset Quality	5	0
With Offset Quality	6	5
Risk of Loss Without Offset	10%	10%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years

Table 3 – Regent Honeyeater Offset Assessment Guide Values (cont.)

	Woodland Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Woodland
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**26.32%**	**33.11%**
TOTAL IMPACT OFFSET	**217.94%**	

1.2.4 Koala (*Phascolarctos cinereus*)

The Offset Assessment Guide indicated that:

- 71 per cent of the impacts on eucalypt woodland habitat areas for the koala in the proposed disturbance area are offset by existing eucalypt woodland areas for the species at the proposed Cross Creek Offset Site (17.41 per cent), Stringybark Creek Habitat Corridor Offset Site (11.23 per cent) and Esparanga Offset Site (42.63 per cent); and

- 264 per cent of the impacts on eucalypt woodland habitat areas for the koala in the proposed disturbance area are offset by DNG areas to be regenerated to eucalypt woodland habitat areas for the species at the proposed Cross Creek Offset Site (178.35 per cent), Stringybark Creek Habitat Corridor Offset Site (34.67 per cent) and Esparanga Offset Site (50.47 per cent).

The combination of offsetting existing eucalypt woodland with areas to be regenerated into eucalypt woodland provides a 335 per cent offset for the koala.

The Offset Assessment Guide input values used in the assessment are listed in **Table 4**.

Table 4 – Koala Offset Assessment Guide Values

	Woodland Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Woodland
CROSS CREEK OFFSET SITE		
Impact Area	163.7 ha	163.7 ha
Impact Quality	4	4
Offset Area	51.7 ha	315.3 ha
Offset Site Start Quality	4	0
Without Offset Quality	3	0
With Offset Quality	5	5
Risk of Loss Without Offset	20%	20%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**17.41%**	**178.35%**
STRINGYBARK CREEK HABITAT CORRIDOR		
Impact Area	163.7 ha	163.7 ha
Impact Quality	4	4

Table 4 – Koala Offset Assessment Guide Values (cont.)

	Woodland Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Woodland
Offset Area	27 ha	59 ha
Offset Site Start Quality	4	0
Without Offset Quality	3	0
With Offset Quality	5	5
Risk of Loss Without Offset	40%	40%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**11.23%**	**34.67%**
ESPARANGA OFFSET SITE		
Impact Area	163.7 ha	163.7 ha
Impact Quality	4	4
Offset Area	211 ha	91 ha
Offset Site Start Quality	6	0
Without Offset Quality	6	0
With Offset Quality	7	5
Risk of Loss Without Offset	10%	10%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**42.63%**	**50.47%**
TOTAL IMPACT OFFSET	**334.76%**	

1.2.5 Large-eared Pied Bat (*Chalinolobus dwyeri*)

The Offset Assessment Guide indicated that:

- 70 per cent of the impacts on woodland habitat areas for the large-eared pied bat in the proposed disturbance area are offset by existing eucalypt woodland areas for the species at the proposed Cross Creek Offset Site (15.72 per cent), Stringybark Creek Habitat Corridor Offset Site (12.80 per cent) and Esparanga Offset Site (41.60 per cent); and

- 235 per cent of the impacts on woodland habitat areas for the large-eared pied bat in the proposed disturbance area are offset by DNG areas to be regenerated to eucalypt woodland habitat areas for the species at the proposed Cross Creek Offset Site (139.22 per cent), Stringybark Creek Habitat Corridor Offset Site (27.06 per cent) and Esparanga Offset Site (68.95 per cent).

The combination of offsetting existing woodland with areas to be regenerated into eucalypt woodland provides a 305 per cent offset for the large-eared pied bat.

The Offset Assessment Guide input values used in the assessment are listed in **Table 5**.

Table 5 – Large-eared Pied Bat Offset Assessment Guide Values

	Woodland Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Woodland
CROSS CREEK OFFSET SITE		
Impact Area	223.7 ha	223.7 ha
Impact Quality	3	3
Offset Area	51.7 ha	315.3 ha
Offset Site Start Quality	3	0
Without Offset Quality	2	0
With Offset Quality	4	4
Risk of Loss Without Offset	20%	20%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**15.72%**	**139.22%**
STRINGYBARK CREEK HABITAT CORRIDOR		
Impact Area	223.7 ha	223.7 ha
Impact Quality	3	3
Offset Area	36 ha	59 ha
Offset Site Start Quality	3	0
Without Offset Quality	2	0
With Offset Quality	4	4
Risk of Loss Without Offset	40%	40%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**12.80%**	**27.06%**
ESPARANGA OFFSET SITE		
Impact Area	223.7 ha	223.7 ha
Impact Quality	3	3
Offset Area	211 ha	91 ha
Offset Site Start Quality	6	0
Without Offset Quality	6	0
With Offset Quality	7	7
Risk of Loss Without Offset	10%	10%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**41.60%**	**68.95%**
TOTAL IMPACT OFFSET	**305.35%**	

1.2.6 New Holland Mouse (*Pseudomys novaehollandiae*)

The Offset Assessment Guide indicated that:

- 61 per cent of the impacts on woodland habitat areas for the New Holland mouse in the Proposed Disturbance Area are offset by existing eucalypt woodland areas for the species at the proposed Cross Creek Offset Site (17.16 per cent), Stringybark Creek Habitat Corridor Offset Site (20.45 per cent) and Esparanga Offset Site (23.50 per cent); and

- 1,268 per cent of the impacts on woodland habitat for the New Holland mouse in the Proposed Disturbance Area are offset by DNG areas to be regenerated to eucalypt woodland habitat for the species at the proposed Cross Creek Offset Site (716.23 per cent), Stringybark Creek Habitat Corridor Offset Site (138.29 per cent) and Esparanga Offset Site (413.43 per cent).

The combination of offsetting existing woodland with areas to be regenerated into eucalypt woodland provides a 1,329 per cent offset for the New Holland mouse.

The Offset Assessment Guide input values used in the assessment are listed in **Table 6**.

Table 6 – New Holland Mouse Offset Assessment Guide Values

	Woodland Areas to Offset Impacts on Woodland	**Regenerated Areas to Offset Impacts on Woodland**
CROSS CREEK OFFSET SITE		
Impact Area	32.1 ha	32.1 ha
Impact Quality	2	2
Offset Area	37.2 ha	315.3 ha
Offset Site Start Quality	2	0
Without Offset Quality	2	0
With Offset Quality	2	2
Risk of Loss Without Offset	20%	20%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	10 years	10 years
Time Until Ecological Benefit	5 years	5 years
Confidence in Loss	80%	75%
Confidence in Quality Change	90%	75%
% of Impact Offset	**17.16%**	**716.23%**
STRINGYBARK CREEK HABITAT CORRIDOR		
Impact Area	32.3 ha	32.3 ha
Impact Quality	2	2
Offset Area	21.6 ha	61 ha
Offset Site Start Quality	2	0
Without Offset Quality	2	0
With Offset Quality	2	2
Risk of Loss Without Offset	40%	40%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	10 years	10 years
Time Until Ecological Benefit	5 years	5 years
Confidence in Loss	80%	75%
Confidence in Quality Change	90%	75%

Table 6 – New Holland Mouse Offset Assessment Guide Values (cont.)

	Woodland Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Woodland
% of Impact Offset	**20.45%**	**138.29%**
ESPARANGA OFFSET SITE		
Impact Area	32.3 ha	32.3 ha
Impact Quality	2	2
Offset Area	71.7 ha	91 ha
Offset Site Start Quality	3	0
Without Offset Quality	3	0
With Offset Quality	3	4
Risk of Loss Without Offset	10%	20%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	10 years	10 years
Time Until Ecological Benefit	5 years	5 years
Confidence in Loss	80%	75%
Confidence in Quality Change	90%	75%
% of Impact Offset	**23.50%**	**413.43%**
TOTAL IMPACT OFFSET	**1,329.06%**	

1.2.7 Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Offset Assessment Guide indicated that:

- 25 per cent of the impacts on woodland habitat areas for the grey-headed fling-fox in the Proposed Disturbance Area are offset by existing eucalypt woodland areas for the species at the proposed Cross Creek Offset Site (7.79 per cent), Stringybark Creek Habitat Corridor Offset Site (7.51 per cent) and Esparanga Offset Site (9.18 per cent); and

- 130 per cent of the impacts on woodland habitat areas for grey-headed flying fox in the Proposed Disturbance Area are offset by DNG areas to be regenerated to eucalypt woodland habitat for the species at the proposed Cross Creek Offset Site (78.31 per cent), Stringybark Creek Habitat Corridor Offset Site (15.22 per cent) and Esparanga Offset Site (36.94 per cent).

The combination of offsetting existing woodland with areas to be regenerated into eucalypt woodland provides a 155 per cent offset for the grey-headed flying-fox.

The Offset Assessment Guide input values used in the assessment are listed in **Table 7**.

Table 7 – Grey-headed Flying-fox Offset Assessment Guide Values

	Woodland Areas to Offset Impacts on Woodland	Regenerated Areas to Offset Impacts on Woodland
CROSS CREEK OFFSET SITE		
Impact Area	223.7 ha	223.7 ha
Impact Quality	4	4
Offset Area	51.7 ha	315.3 ha
Offset Site Start Quality	3	0
Without Offset Quality	3	0
With Offset Quality	4	3
Risk of Loss Without Offset	20%	20%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**7.79%**	**78.31%**
STRINGYBARK CREEK HABITAT CORRIDOR		
Impact Area	223.7 ha	223.7 ha
Impact Quality	4	4
Offset Area	36 ha	59 ha
Offset Site Start Quality	3	0
Without Offset Quality	3	0
With Offset Quality	4	3
Risk of Loss Without Offset	40%	40%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**7.51%**	**15.22%**
ESPARANGA OFFSET SITE		
Impact Area	223.7 ha	223.7 ha
Impact Quality	4	4
Offset Area	211 ha	91 ha
Offset Site Start Quality	5	0
Without Offset Quality	5	0
With Offset Quality	5	5
Risk of Loss Without Offset	10%	10%
Risk of Loss With Offset	1%	1%
Time Over Which Loss is Adverted	20 years	20 years
Time Until Ecological Benefit	20 years	20 years
Confidence in Loss	90%	90%
Confidence in Quality Change	90%	75%
% of Impact Offset	**9.18%**	**36.94%**
TOTAL IMPACT OFFSET	**154.95%**	

1.3 Summary

The high values generated for the grassland areas to be regenerated into eucalypt woodland are a function of a large increase in habitat quality as DNG areas are managed back to woodland form over a 20 year period. For the swift parrot, regent honeyeater, koala, large-eared pied bat, grey-headed flying-fox and New Holland mouse the return of DNG areas to woodland areas would provide in excess of 400 hectares of additional eucalypt-dominated woodland habitat capable of providing suitable foraging habitat in areas within the species' distribution in NSW.

The exception for high offset percentages is the spotted-tailed quoll, which is known to also utilise the DNG habitats of the Proposed Disturbance Area. This additional impact substantially increased the impact numbers applicable in the calculator. Two hundred and thirteen per cent of the grassland impacts for the species are offset by regenerating grassland to high quality woodland habitats at the offset sites. The residual offset percentages for grassland beyond the required 100 per cent were then applied to the shortfall for offsetting woodland impacts, which increased woodland offsets from 22 per cent to 107 per cent.

The improvement of the habitat quality scores across all sites depends on the active regeneration of eucalypt-dominated woodland vegetation, which will substantially increase the area of suitable habitat available for these species as well as improving connectivity between the offset sites and surrounding habitat. The likely reduction of future habitat quality of the Cross Creek Offset Site and Stringybark Creek Habitat Corridor, without the provision of the offset, is derived from the likely ongoing threats at the sites such as mining and associated activities and the invasion and establishment of African olive (*Olea europaea* subsp. *cuspidata*) which can result in the suppression of native species growth and regeneration which limits biodiversity and resources for target fauna species. Active management of this species will be a key management factor in maintaining and improving the habitat on these sites as part of the Biodiversity Offset Strategy.

The above results from the EPBC Offset Assessment Guide indicate that the proposed offset sites for the Project provide in excess of 100 per cent of the offsetting requirements for the predicted impacts of the Project on the spotted-tailed quoll, swift parrot, regent honeyeater, koala, large-eared pied bat, New Holland mouse and grey-headed flying-fox. This exceeds the minimum 90 per cent direct offset requirement for these species as specified by the EPBC Offsets Assessment Guide.

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