Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Report for Offsite Infrastructure Project

BioCondition Assessment Report

31 October 2013

GHD

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Executive summary

In March, 2013 Adani Mining Pty Ltd commissioned an assessment of BioCondition within and adjacent to an area proposed for offsite infrastructure for the Carmichael Coal Mine and Rail Project (the Project). This assessment has been undertaken as part of a Supplementary Environmental Impact Statement to provide information on areas that were not assessed during the original Environmental Impact Statement.

Offsets will be required under Commonwealth and State legislation where impacts to identified environmental values cannot be reasonably avoided or mitigated. Commonwealth environmental values, such as threatened fauna species, will need to be offset according to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) *Environmental Offset Policy*. Native remnant vegetation will be offset under the Queensland *Policy for Vegetation Management Offsets*. An offset strategy is being produced for the broader Project, including the Mine, Rail and Offsite infrastructure.

BioCondition and habitat quality assessments are required to inform the offset process and the development of an offset strategy. This report provides the results of an assessment of the condition and quality of ecological values requiring offsetting for the Project (Offsite). The information from the assessments will be used to support on offset proposal to offset unavoidable impacts to biodiversity values as a result of the broader Project, combining the Mine, Rail and offsite infrastructure.

Environmental values assessed in this report include threatened species and ecological communities under the Commonwealth EPBC Act, and remnant vegetation protected under the Queensland *Vegetation Management Act* (VM Act) *1999*. Values impacted include:

- Six EPBC Act-listed Matters of Environmental Significance confirmed present or are likely to occur within the Study Area
- Assessable vegetation under the VM Act *1999*, including endangered and of concern regional ecosystems, watercourse and wetland vegetation and corridor vegetation.

Habitat quality is defined within the *Offset Assessment Guidelines* which accompanies the *EPBC Act Environmental Offset Policy*. An investigation was undertaken to describe and map the condition of vegetation and habitat quality for threatened species across the Study Area. Potential habitat was ground-truthed and a condition score derived, using a set criterion based on an individual species' particular habitat preferences/requirements.

Potential habitat and the quality of the habitat were mapped for five threatened fauna species:

- Ornamental snake (*Denisonia maculata*), vulnerable:
  - Thirty-six polygons of potential habitat assessed within the Study Area; a total of 313.8 ha mapped within the Project (Offsite) footprint. Habitat is predominantly low quality (≤ 2 out of 10)
- Black –throated finch (southern) (*Poephila cincta cincta*), endangered:
  - Eleven polygons of potential habitat assessed within the Study Area; a total of 2.5 ha mapped within the Project (Offsite) footprint. The quality of habitat is low across the Study Area (≤ 3 out of 10)

- Squatter pigeon (southern) (*Geophaps stricta stricta*), vulnerable:
  - Ten polygons of potential habitat assessed within the Study Area; a total of 2.5 ha mapped within the Project (Offsite) footprint. The quality of potential habitat within the Study Area was moderate (5 – 7 out of 10).
- Yakka skink (*Egernia rugosa*), endangered:
  - Fifteen polygons of potential habitat assessed within the Study Area; a total of 2.5 ha mapped within the Project (Offsite) footprint. The quality of habitat is predominantly low to moderate (4 – 5 out of 10)
- Koala (Phascolarctos cinereus), vulnerable:
  - Seven polygons of potential habitat assessed within the Study Area; a total of 2.7 ha mapped within the Project (Offsite) footprint. The quality of habitat is moderate (4 – 6 out of 10).

The endangered threatened ecological community, brigalow (*Acacia harpophylla* dominant and subdominant), was not assessed as the size of representative remnant patches were not large enough to accommodate assessment methodology.

Habitat mapping for the Study Area was supported by an assessment of the condition of native remnant vegetation across the Study Area. BioCondition assessments were undertaken, in accordance with the Ecological Equivalence Methodology, were undertaken at 10 sites within the Study Area. These sites were chosen as representative sites to establish a condition score for native vegetation types expected to be cleared for the Project. Benchmarks for these REs were derived for five impacted REs and BioCondition scores were calculated. The remaining two assessed REs could not be scored due to their being no available benchmarks at the time of assessment.

The surveys found that the existing environment within the Study Area had been heavily impacted by past land-uses. The landscape has been substantially fragmented by past land clearing and heavily degraded by decades of moderate intensity cattle grazing. Remnants of native vegetation are predominantly small, fragmented and highly degraded, with high densities of buffel grass, erosion and trampling damage. As a result, the condition of remnant vegetation and many of the areas of potential habitat for EPBC listed species have only low – moderate quality scores. The information provided in this report can be incorporated into a combined offsets strategy for the broader Project, combining offset requirements for the Mine, Rail and offsite infrastructure.

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1. Introduction

1.1 Project overview

Adani Mining Pty Ltd (Adani, the Proponent), commenced an Environmental Impact Statement (EIS) process for the Carmichael Coal Mine and Rail Project (the Project) in 2010. On 26 November 2010, the Queensland (Qld) Office of the Coordinator General declared the Project a 'significant project' and the Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (referral No. 2010/5736). The Project was assessed to be a controlled action on 6 January 2011 under section 75 and section 87 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The controlling provisions for the Project include:

- World Heritage properties (sections 12 & 15A)
- National Heritage places (sections 15B & 15C)
- Wetlands (Ramsar) (sections 16 & 17B)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- The Great Barrier Reef Marine Park (GBRMP) (sections 24B & 24C)
- Protection of water resources (sections 24D & 24E)

The Qld Government's EIS process has been accredited for the assessment under Part 8 of the EPBC Act in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland.

The Proponent prepared an EIS in accordance with the Terms of Reference (ToR) issued by the Qld Coordinator-General in May 2011 (Qld Government, 2011). The EIS process is managed under section 26(1) (a) of the *State Development and Public Works Act 1971* (SDPWO Act), which is administered by the Qld Government's Department of State Development, Infrastructure and Planning (DSDIP).

The EIS, submitted in December 2012, assessed the environmental, social and economic impacts associated with developing a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the northern Galilee Basin, approximately 160 kilometres (km) north-west of Clermont, Central Queensland, Australia. Coal from the Project will be transported by rail to the existing Goonyella and Newlands rail systems, operated by Aurizon Operations Limited (Aurizon). The coal will be exported via the Port of Hay Point and the Point of Abbot Point over the 60 year (90 years in the EIS) mine life.

Project components are as follows:

- The Project (Mine): a greenfield coal mine over EPC 1690 and the eastern portion of EPC 1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure

- The Project (Rail): a greenfield rail line connecting the mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively including:
  - Rail (west): a 120 km dual gauge portion running west from the Mine site east to Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah
  - Quarries: five local quarries to extract quarry materials for construction and operational purposes

1.2 Purpose of this report

The purpose of this report is to present an assessment of the condition and quality of ecological values requiring offsetting for the Mine (Offsite) infrastructure. This information will be used to support an offsets proposal to offset unavoidable impacts to biodiversity values as a result of the Project. Where the Project will impact upon important ecological values, such as matters of national environmental significance (NES), high conservation status regional ecosystems (REs), protected fauna and watercourse or corridor vegetation, offsets will be required under relevant Commonwealth and State government offset policies.

This report will identify the Project (Offsite) impacts to terrestrial environmental values and will present the results of habitat quality assessments for threatened species and ecological communities under the EPBC Act and BioCondition assessments for State level environmental values undertaken within the Study Area. This information will be incorporated into a combined offsets strategy that is being undertaken (separate to this report) for the broader Project, including offset obligations from the Mine, Rail and Offsite Infrastructure Area. As such, this report is not intended to represent an independent assessment of BioCondition within the Study Area, rather a summary of BioCondition values that can be incorporated into the offsets strategy for the broader Project.

The study area for this report was defined by the Project (Mine) Offsite footprint. At the time of reporting, the footprint included an offsite bore field and associated pipelines. The bore field is no longer a component of the Carmichael Coal Mine and Rail Project. As such, the study area for this report includes areas where the bore field was to be situated.

1.3 Summary of offsite infrastructure

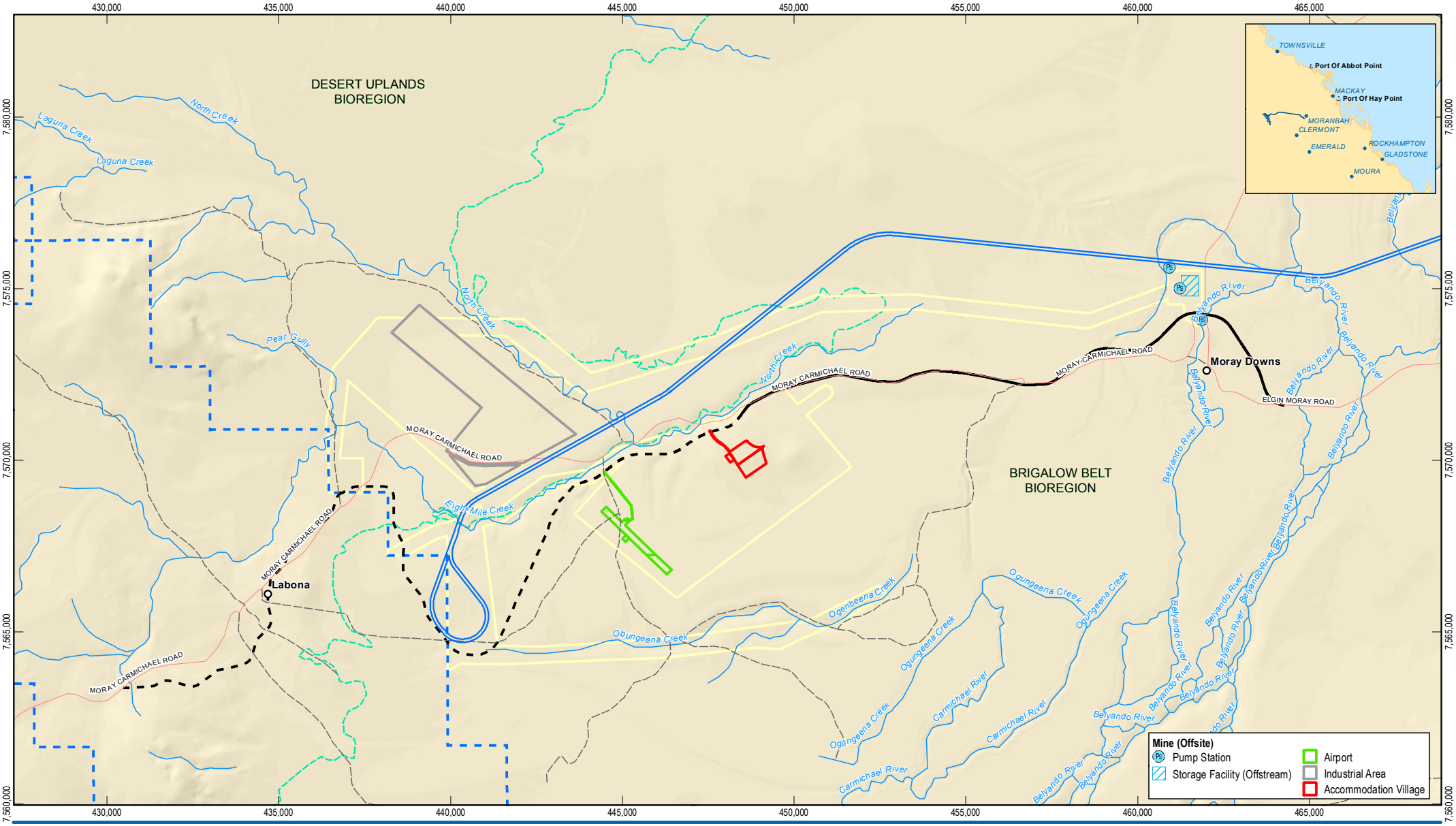
The Study Area for the Mine (Offsite) infrastructure assessed in this report includes:

- Worker accommodation village and airport (126.8 ha).
- Industrial precinct, including rail siding (964.8 ha) to facilitate services such as a fuel farm, rail siding, freight unloading terminal).
- New rail loop (523.5 ha).
- An off-stream storage and pump station near the Belyando River (0.04 ha)
- 5 gigalitres (GL) storage dam (51 ha).

The proposed offsite infrastructure is located immediately east of the Project (Mine). The Study Area for the Mine (Offsite) infrastructure covers an area of 7,187.13 ha, of which the Mine (Offsite) footprint occupies 1,157.7 ha (refer Figure 1).

1.4 Assumptions and limitations

Field BioCondition surveys were undertaken within the Study Area outlined in Figure 1. An additional area of proposed impact (the realignment of the Carmichael Road) was added to the Project (Offsite) footprint after the surveys were completed. The report presents BioCondition data for environmental values within the Study Area shown in Figure 1 and did not include the Carmichael Road. Independent surveys are required to assess the BioCondition of environmental values within that area.



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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Bioregion Boundary
- Study Area
- Rail Corridor
- Project Area
- Road Corridor
- Road Corridor (proposed)

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BioCondition Assessment Report

Job Number 41-26422
Revision 1
Date 31-10-2013

Offsite Infrastructure Study Area

Figure 1

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Data source: DME: EPC1690 (2010)/EPC1080 (2011); DNRM: Bioregion Boundary (2011); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007); Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013). Created by: AJ

2. Legislative context

2.1 Overview

Offsets will be required under Commonwealth and state legislation where impacts to identified ecological values cannot be reasonably avoided or mitigated. Determining the exact interaction between the State and Commonwealth legislation will require liaison with relevant agencies and a final offset package will need to consider a combination of both legislative jurisdictions.

2.2 Commonwealth legislation and policy

Under the *Environmental Protection Biodiversity Conservation Act 1999* (EPBC Act), environmental offsets are considered a mechanism to compensate for the adverse impacts of developments on matters of NES protected by the EPBC Act.

The Commonwealth government's EPBC Act Environmental Offsets Policy (DSEWPaC, 2012) outlines the Australian Government's position on the use of environmental offsets under the EPBC Act. Under the EPBC Act, environmental offsets can be used to maintain or enhance the health, diversity and productivity of the environment as it relates to matters protected by the Act.

The Offsets Assessment Guide, which accompanies the EPBC Act Environmental Offsets Policy, has been developed to measure impacts associated with a project and applies where the impacted protected matter is a threatened species or ecological community. This guide can be used to calculate offset requirements associated with a project.

The EPBC Act Environmental Offsets Policy requires an assessment and consideration of the existing quality of habitats. For impacts on habitat for threatened species, migratory species and threatened ecological communities, any direct offset must meet, as a minimum, the quality of the habitat at the impact site. Where a proposed offset site has a lower habitat quality than that of the impact site, the offset must be managed and resourced over a defined period of time, so that its habitat quality is improved to meet the quality of habitat originally impacted.

2.3 State legislation and policy

2.3.1 Queensland Government Environmental Offset Policy

The QGEOP (Queensland Government, 2008) provides a framework for the use of environmental offsets in Queensland, in order to counterbalance unavoidable, negative environmental impacts that result from an activity or a development. This policy is based on the premise that offsets are used consistently and transparently across the state, and are only considered after all environmental impacts have been avoided and minimised and all other government environmental standards have been met (Queensland Government, 2008).

2.3.2 Queensland Biodiversity Offset Policy

The Queensland Biodiversity Offset policy (QBOP) does not apply to 'development that is a significant project declared under section 26(1) (a) of the SDPWO Act'. The Project was declared a 'significant project' under Section 26 (1) (a) of the SDPWO Act in January 2011. However, the Coordinator-General may use discretionary powers to require compliance with the QBOP as part

of an approval for a significant project. The policy is expected to be applied to the mine and rail components of the project.

2.3.3 Policy for Vegetation Management Offsets

Vegetation clearing in Queensland is regulated through the *Vegetation Management Act 1999* (VM Act), which outlines the rules and regulations that guide what clearing can be done, and how it must be done in order to comply with the legal requirements. The current Policy for Vegetation Management Offsets (Version 3) (DERM, 2011b) (hereafter referred to as the Vegetation Offset Policy) was developed by the chief executive in accordance with the provisions set out in the VM Act. This policy sets the requirements for an offset as a condition of a development approval that the chief executive considers is necessary or desirable for achieving the purpose of the VM Act (DERM, 2011a).

Under this policy, offsets may be proposed for Project (Offsite) activities, as a solution to meet specific performance requirements for maintaining the current remnant vegetation extent of a particular RE.

The Project (Offsite) will require assessment under the Regional Vegetation Management Code for Brigalow Belt and New England Tablelands Bioregions (Version 2.1) (DNRM, 2012a) and the Regional Management Code for Western Bioregions (Version 2.1) (DNRM, 2012b). These management codes regulate the clearing of vegetation in Queensland using a set of performance criteria. Where the performance criteria cannot be met, offsetting can be offered as a solution for meeting the performance requirements.

Areas offered as offsets must meet a variety of criteria outlined in the Vegetation Offset Policy, including ecological quality (determined through BioCondition assessments and the Ecological Equivalence Methodology (EEM) (see Section 4).

3. Summary of project impacts

3.1 Overview

Potential direct and indirect impacts within and adjacent to the proposed Project (Offsite) have been described in Appendix F of the SEIS (Offsite Infrastructure Ecological Assessment Report). These impacts include the direct loss of native vegetation, habitat and resources as a result of vegetation clearing within the Project (Offsite) footprint. The area of direct impact (i.e. the Project (Offsite) footprint) encompasses 11 REs protected under the VM Act and potential habitat for six matters of NES protected under the EPBC Act. The potential impacts on these environmental values are summarised below.

3.2 *Environmental Protection Biodiversity Conservation Act 1999* Environmental Offsets Policy

Six matters of NES have been confirmed present or are considered 'likely to occur' within the Study Area, based on the results of field surveys and subsequent likelihood of occurrence assessments (refer to Appendix F of the SEIS (Offsite Infrastructure Ecological Assessment Report)). Matters of NES identified include one Threatened Ecological Community (TEC) and five threatened fauna species (refer to Table 1).

Potential habitat for these species (and communities) was identified in field surveys of the Study Area and occurs within the Project (Offsite) footprint. These areas may be permanently impacted as a result of vegetation clearing for the Project (Offsite) footprint. Table 1 below presents a summary of the area of potential habitat impacted by clearing. In accordance with the EPBC Environmental Offsets Policy, it is necessary to assess the quality of these areas to accurately calculate the offset obligations.

Table 1 Area of potential habitat within the Project (Offsite) footprint

Matters of NES Feature	EPBC Status	Likelihood of occurrence	Area of Potential Habitat Impacted (ha)
Ornamental snake (*Denisonia maculata*)	V	Confirmed present	313.8
Black-throated finch (southern) (*Poephila cincta cincta*)	E	Confirmed present	2.5
Squatter pigeon (southern) (*Geophaps scripta scripta*)	V	Confirmed present	2.5
Yakka skink (*Egernia rugosa*)	E	Likely to occur	2.5
Koala (*Phascolarctos cinereus*)	V	Likely to occur	2.7

3.3 Policy for Vegetation Management Offsets

The removal of native vegetation will occur within the Project (Offsite) footprint. Offsets will be required to meet the performance requirements that address the conservation of remnant vegetation that are:

- Of concern REs
- Endangered REs
- Watercourse vegetation
- Wetland vegetation
- Corridor vegetation (with respect to habitat connectivity)

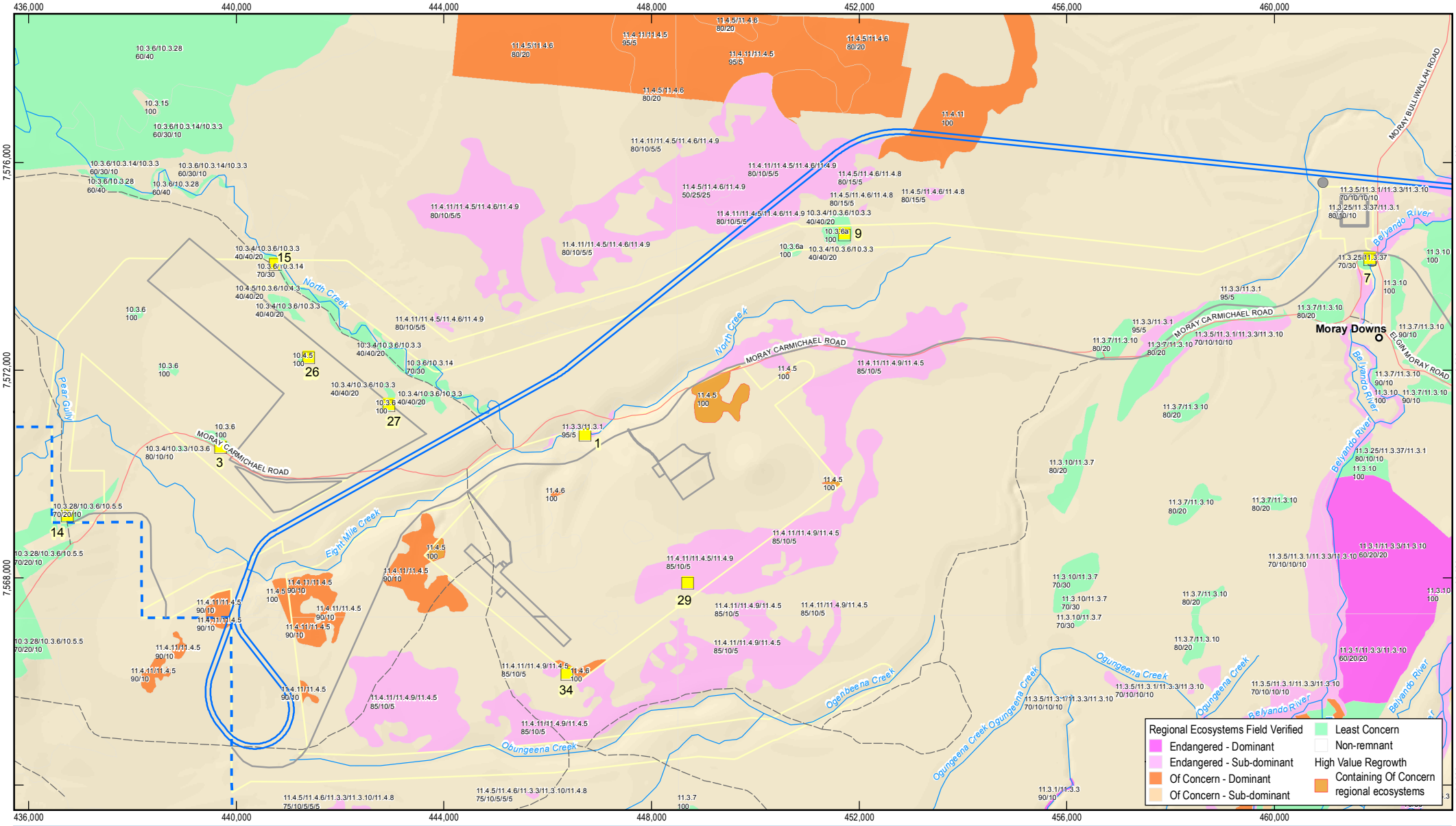
The Project (Offsite) will require clearing of 1,157.7 ha of land (Figure 2). This comprises 7.2 ha of remnant vegetation (least concern REs) and 1,150.7 ha of non-remnant vegetation. Additional areas of officially mapped RE (36.9 ha) and non-remnant vegetation (78.7 ha) are mapped within the Moray-Carmichael Road corridor. These additional areas were not field-verified as they were outside of the original Study Area (see Section 1.4). Where remnant vegetation occurs within watercourses, within wildlife corridors and within wetland areas, offsets will also be required.

Table 2 Area of regional ecosystems within the Project (Offsite) footprint

RE	VM Act Status	Description	Area (ha)
10.3.6a	Least concern	*Eucalyptus brownii* open woodland on alluvial plains	2.9
10.3.28	Least concern	*Eucalyptus melanophloia* or *E. crebra* open woodland on sandy alluvial fans	1.3
10.5.5	Least concern	*Eucalyptus melanophloia* open woodland on sand plains	0.2
10.4.5	Least concern	*Acacia cambagei* low woodland on Cainozoic lake beds	2.5
11.3.1	Endangered	Open-forest dominated by *Acacia harpophylla* and/or *Casuarina cristata,* with or without scattered emergent Eucalyptus sp.	0.0 Not assessed* / outside Study Area
11.3.3	Of concern	*Eucalyptus coolabah* woodland to open-woodland with a grassy understorey	0.0 Not assessed* / outside Study Area
11.3.7	Least concern	*Corymbia clarksoniana, C. tessellaris* and *C. dallachiana* tall woodland to open-woodland.	0.0 Not assessed* / outside Study Area

RE	VM Act Status	Description	Area (ha)
11.3.10	Least concern	*Eucalyptus brownii* grassy woodland	0.0 Not assessed* / outside Study Area
11.3.25	Least concern	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	0.16
11.3.37	Least concern	*Eucalyptus coolabah* fringing woodland on alluvial plains	0.1
11.4.5	Of concern	*Acacia argyrodendron* dominates the very sparse canopy with scattered small trees.	0.0 Not assessed* / outside Study Area
11.4.9	Endangered	Open-forest, occasionally woodland, dominated by *Acacia harpophylla* usually with a low tree mid-storey of *Terminalia oblongata* and *Eremophila mitchellii.*	0.0 Not assessed* / outside Study Area
11.4.11	Of concern	*Dichanthium sericeum* and *Astrebla* spp. grassland with patches of low *Acacia harpophylla* or *Eucalyptus coolabah.*	0.0 Not assessed* / outside Study Area

*Areas not assessed were within the proposed footprint of the Moray-Carmichael Road re-alignment, added to the Project (Offsite) footprint after surveys were completed. These REs have not been field-verified and may be incorrectly mapped in certified RE mapping (See Section 1.4).



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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
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LEGEND

- Homestead
- BioCondition Assessment Sites
- Local Road
- Track
- Watercourse
- Study Area
- Rail Corridor
- Project Area
- Mine (Offsite)
- Mine (Offsite)

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Carmichael Coal Mine and Rail Project SEIS
BioCondition Assessment Report

Field Verified Regional Ecosystems and Biocondition Assessment Sites

Job Number 41-26422
Revision 1
Date 15-10-2013

Figure 2

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Data source: DME: EPC1690 (2010)/EPC1080 (2011); DNRM\GHD: Field Verified Regional Ecosystems (2011); GHD: Flora Survey Sites (2013); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007);
Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013). Created by: AJ

4. Assessment methodology

4.1 Overview

An investigation of vegetation condition and habitat quality within the Study Area was undertaken on-site by four GHD ecologists between 30 April and 6 May 2013. This section discusses the methods used during the investigations within the Study Area.

4.2 *Environmental Protection Biodiversity Conservation Act 1999* habitat quality assessment for protected matters

4.2.1 Introduction

In order to derive offsets that are suitably equivalent to the residual impacts resulting from a given project, the EPBC Act Environmental Offsets Policy requires not only a measure of the area of habitat affected, but also a measure of existing habitat quality.

The Offsets Assessment Guide, which accompanies the EPBC Act Environmental Offsets Policy, provides a number of measurements which help to quantify the impact associated with a project in order to determine the suitability of offset sites. One of these measurements is that of habitat quality for threatened species or ecological communities under the EPBC Act. There are three components that contribute to the calculation of habitat quality, including:

- **Site condition:** the condition of a site in relation to the ecological requirements of a threatened species or ecological community.
- **Site context:** the relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of a threatened species or ecological community.
- **Species stocking rate:** the usage and/or density of a species at a particular site. The principle acknowledges that a particular site may have a high value for a particular threatened species, despite appearing to have poor condition and/or context.

These three criteria contribute to a final score of habitat quality for each polygon impacted. Six matters of NES are potentially impacted by the Project (Offsite) and require calculation of habitat quality scores for all areas of potential habitat within the Study Area. The methods used to derive potential habitat and calculate habitat quality scores are described below.

4.2.2 Overview of approach

Defining potential habitat

For each protected matter of NES confirmed present or considered likely to occur within the Study Area, areas of potential habitat were mapped using the Department of Natural Resources and Mines (DNRM) VM Act RE mapping Version 6.1 as a base. For each species, RE communities known to represent potentially suitable habitat were identified and mapped to provide a map of potential habitat within the Study Area. A summary of the REs used to map potential habitat for each species is provided in Section 4.2.3.

Assessing condition

All areas of potential habitat for matters of NES were then ground-truthed in field surveys to assess their 'condition'. For each polygon of potential habitat occupied by a given species, a condition score (from 1 – 10) was derived based on the presence, absence or relative abundance of a number of specific ecological resources that are required by that species. The specific ecological criteria used to assess condition for each species are summarised in Section 4.2.4.

Assessing context

A desktop GIS approach was then used to derive separate scores for site context and site connectivity for each polygon. For both context and connectivity, each polygon was attributed a score from 1 – 10. These were calculated using the methods for measuring context and connectivity outlined in the EEM Guideline (DERM, 2011).

Assessing stocking rates

An assessment of the density and role of a species population to inform the determination of stocking rate requires detailed surveys and techniques (i.e. mark-recapture) to quantify or reliably estimate local population size and carrying capacity of a site. Given the uncertainty associated with this estimate, it has the potential to incorporate an element of error that could bias the results of the habitat quality assessment. Species stocking rates have therefore not been included in the assessment of quality. Information on 'context' and 'condition' provided in this report can be used to calculate a final score of habitat quality once a consistent approach to species stocking rate is available for the broader project.

4.2.3 Regional ecosystems used to map potential habitat

Regional ecosystems used to map potential habitat for EPBC listed species confirmed or likely to occur within the Study Area are summarised in Table 3 below. These are REs known to represent suitable habitat for each species.

Table 3 Regional ecosystems used to map potential habitat for EPBC species

EPBC species	Regional Ecosystems used to map potential habitat
Ornamental snake (*Denisonia maculata*)	RE 10.4.3, 10.4.5, 11.4.5, 11.4.6, 11.4.8, 11.4.9, 11.4.11 AND Cleared areas of non-remnant vegetation and high value regrowth that coincide with pre-cleared extent of the above REs that contain cracking clay soils
Black-throated finch (*Poephila cincta cincta*)	RE 10.3.6, 10.3.9, 10.3.13, 10.3.28, 10.4.8, 10.5.1, 10.5.5, 10.7.11, 11.3.12, 11.3.25b, 11.3.27, 11.3.30, 11.3.35, 11.11.9
Squatter pigeon (*Geophaps scripta scripta*)	RE 11.3.10, 11.3.12, 11.3.14, 11.3.15, 11.3.16, 11.3.17, 11.3.18, 11.3.19, 11.3.2, 11.3.23, 11.3.25, 11.3.26, 11.3.28, 11.3.29, 11.3.3, 11.3.30, 11.3.35, 11.3.36, 11.3.37, 11.3.38, 11.3.39, 11.3.4, 11.3.6, 11.3.7, 11.3.9, 11.4.10, 11.4.12, 11.4.13, 11.4.2, 11.4.7, 11.4.8, 11.5.1, 11.5.12, 11.5.13, 11.5.17, 11.5.2, 11.5.20, 11.5.21, 11.5.3, 11.5.4, 11.5.5, 11.5.7, 11.5.8, 11.5.9, 11.8.1, 11.8.12, 11.8.14, 11.8.15, 11.8.2, 11.8.4, 11.8.5, 11.8.8, 11.9.1, 11.9.10, 11.9.13, 11.9.14, 11.9.2, 11.9.7, 11.9.9, 11.11.1, 11.11.10, 11.11.11, 11.11.12, 11.11.15, 11.11.16, 11.11.19, 11.11.20, 11.11.3, 11.11.4, 11.11.6, 11.11.7, 11.11.8, 11.11.9, 11.12.1, 11.12.10, 11.12.11, 11.12.13, 11.12.14, 11.12.17,

EPBC species	Regional Ecosystems used to map potential habitat
	11.12.19, 11.12.2, 11.12.20, 11.12.3, 11.12.5, 11.12.6, 11.12.7, 11.12.8, 11.12.9, 10.3.10, 10.3.11, 10.3.12, 10.3.13, 10.3.14, 10.3.15, 10.3.2, 10.3.20, 10.3.27, 10.3.28, 10.3.5, 10.3.6, 10.3.9, 10.4.3, 10.4.9, 10.5.1, 10.5.10, 10.5.11, 10.5.12, 10.5.2, 10.5.4, 10.5.5, 10.5.7, 10.5.8, 10.5.9, 10.9.2, 10.9.3, 10.9.5
Yakka skink (*Egernia rugosa*)	RE 10.4.3, 10.4.5, 11.4.5, 11.4.6, 11.4.11
Koala (*Phascolarctos cinereus*)	RE 10.3.3, 10.3.4, 10.3.6, 11.3.1, 11.3.3

4.2.4 Criteria used to assess site condition

Criteria used to derive condition scores for each EPBC listed species confirmed present or considered likely to occur within the Study Area are summarised for each species below.

The following criteria were used to assess habitat condition in each polygon of potential habitat for EPBC listed species:

- Ornamental snake
  - Remnant vegetation status – remnant / non-remnant
  - Structural complexity of ground level habitats (i.e. woody debris, mixed substrates)
  - Grazing intensity
  - Presence / absence of cracking clay soils
- Black-throated finch (southern)
  - Density of buffel grass (*Cenchrus ciliaris*)
  - Grazing intensity
  - Relative abundance and diversity of native grasses
- Squatter pigeon (southern)
  - Density of buffel grass
  - Grazing intensity
  - Relative abundance and diversity of native grasses
  - Erosion impact
- Yakka skink
  - Structural complexity of ground level habitats (i.e. woody debris, mixed substrates)
  - Relative abundance of large hollow logs
  - Presence / absence of burrows
  - Relative abundance of ground-level vegetation cover
  - Grazing intensity
  - Erosion impact
- Koala
  - Relative abundance of *Eucalyptus tereticornis subsp. tereticornis* and *E. camaldulensis subsp. camaldulensis* (significant koala trees in Isaac Regional Council Area)

– Relative openness of understorey
– Proximity to water/ sources
– Evidence of recent or historic use by koalas (pellets and scratches)

A guide to the condition scores for the habitat of each species is summarised in Appendix A.

4.3 *Vegetation Management Act 1999* ecological equivalency methodology and BioCondition assessment

4.3.1 Ecological equivalency methodology and BioCondition assessments

The EEM Guideline (DEHP 2011c) was developed by the DERM, now the Department of Environment and Heritage Protection (DEHP), to assist in determining ecological equivalence between the areas proposed for clearing and potential offset areas, under the Vegetation Management Offset Policy.

The methodology described within the guideline includes the following criteria:

- Ecological condition
- Special features

Ecological condition is a measure using a number of field-based indicators and is based on the methodology for BioCondition Assessment Methodology Guidelines (Eyre et al., 2011) and the Methodology for the Establishment and Survey of Reference Sites for BioCondition (Eyre et al., 2006).

The special features criterion identifies areas and values which are considered unique and ecologically significant for each of the State's bioregions. There are 14 special features indicators that have been adapted from the spatial layers supporting DEHP's Biodiversity Planning Assessments (BPAs), which are a GIS-based biodiversity decision support tool (DERM, 2011c). These indicators were queried during spatial analyses, which were employed to measure landscape-level attributes and calculate the special feature scores for each assessment site.

For ecological equivalence to be met, potential offset areas must achieve an overall score for ecological condition and special feature that is equal to or greater than the score for the clearing area.

BioCondition assessments were undertaken at 10 RE sites within the Study Area (Figure 2). These sites were chosen as representative sites to establish a condition score for native vegetation types that are expected to be cleared for the Project (Offsite)(refer to Appendix A). Surveys were only undertaken within remnants that were large enough to accommodate the survey method. Assessments of potential cleared areas were undertaken to provide a comparison when determining the ecological equivalence of potential offset areas. The data from these assessments can be used once potential offset sites have been determined for the Project (Offsite). The results of the BioCondition Assessments can be found in Section 5.2.

4.3.2 Comparison with benchmark regional ecosystems

Comparison of condition is based on measurements of specific site-based attributes and a benchmark value for each of these attributes, specific to a particular RE, as well as a BioCondition score obtained from these comparisons.

At the time of the assessments, benchmark values for the impacted REs had not yet been published. Benchmarks can be derived in a number of ways. Table 4 summarises the methods for obtaining benchmark data where published benchmarks were not available.

Additional benchmark data is required to obtain BioCondition scores for the remaining two REs that were assessed within the Study Area. These have been sought from Adani. When these become available, BioCondition scores can be calculated.

The REs that were assessed, and for which benchmarks are not available, can also be used as 'best-on-offer' reference sites to obtain benchmarks for these REs. The benchmarks derived from these sites can in turn be used for comparison with REs impacted in other parts of the broader Project (Mine and Rail) area.

Table 4 Summary of assessments to obtain a BioCondition score

Regional Ecosystem	Method for establishing benchmarks	BioCondition score obtained
10.4.5	Benchmarks were obtained for five of the 13 field-based ecological condition indicators from the published RE technical description (DEHP, 2013). The technical description provides averages for ecological condition indicators (e.g. canopy height, canopy cover, species richness) for REs sampled across their range.	Yes. Scores of 0 were applied where benchmark data was not available. Therefore a low score has been obtained for this RE.
11.3.6a	Benchmarks were obtained from three polygons of RE 10.3.6a located outside of the Project (Offsite) footprint and were assessed during surveys.	Yes
11.3.3	Draft benchmarks for this RE were made available for the purpose of this assessment from the Queensland Herbarium. These benchmarks were used to calculate a BioCondition score for this RE.	Yes
11.3.37	Draft benchmarks for the RE 11.3.3 were used in assessment for RE 11.3.37. These REs are similar in structure and species composition and both fall within the same Broad Vegetation Group (BVG: 16ca). An adjustment to the benchmark canopy height was applied to the RE for a more accurate comparison and calculation of a BioCondition score. These benchmarks were made available for the purpose of this assessment from the Queensland Herbarium.	Yes

Regional Ecosystem	Method for establishing benchmarks	BioCondition score obtained
11.4.5	Benchmarks for the RE 10.3.1 were used in the assessment for RE 11.4.5. These REs are similar in structure and species composition and both fall within the same Broad Vegetation Group (BVG: 26a). An adjustment to the benchmark canopy height was applied to the RE for a more accurate comparison and calculation of a BioCondition score.	Yes

5. Results and discussion

5.1 Overview

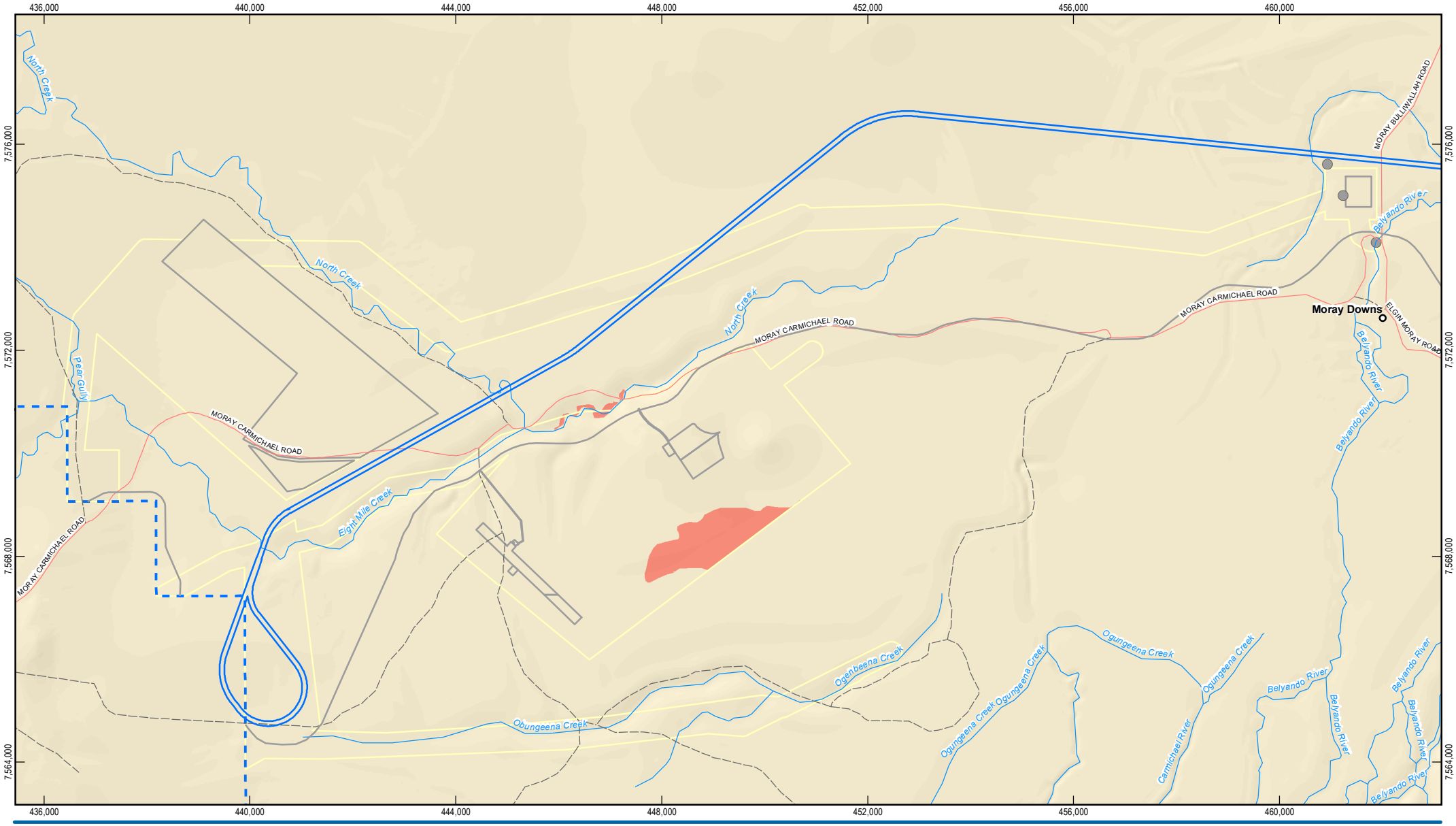
Habitat quality assessments for the single TEC and five threatened fauna species protected under the EPBC Act and BioCondition assessment results for the 11 REs protected under the VM Act are presented respectively in the following sections.

5.2 *Environmental Protection Biodiversity Conservation Act 1999* habitat quality assessment

This section will present the results of the habitat quality assessment for EPBC Act-listed TECs and threatened fauna species confirmed present or likely to occur within the Study Area.

5.2.1 Threatened ecological communities

One TEC was confirmed present within the Study Area, (but outside the Project (Offsite) footprint), Brigalow (*Acacia harpophylla* dominant and sub-dominant) TEC (refer to Figure 3). This RE was represented by the endangered REs 11.3.1 and 11.4.9. The RE 11.3.1 occurred as a narrow heterogeneous RE polygon with 11.3.3 along an ephemeral watercourse. The RE 11.4.9 was observed as patchy open-forest within a larger heterogeneous RE polygon (11.4.11/11.4.5/11.4.9) located at the southern extent of the Study Area. The brigalow RE occurred as minor areas within these heterogeneous polygon, and were too small to sample for BioCondition. As a result, no BioCondition assessment results are presented for these two REs.



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0 2 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- *Acacia harpophylla* - Dominant and Subdominant
- Study Area
- Rail Corridor
- Project Area
- Mine (Offsite)
- Mine (Offsite)

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BioCondition Assessment Report

Threatened Ecological Communities within the Study Area

Job Number 41-26422
Revision 1
Date 15-10-2013

Figure 3

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Data source: DME: EPC1690 (2010)/EPC1080 (2011); DNRM\GHD: Threatened Ecological Communities (2011); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007);
Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013). Created by: AJ

5.2.2 Threatened species listed under the *Environmental Protection Biodiversity Conservation Act 1999*

Overview

A summary of the habitat condition, context and overall quality of potential habitat is presented for each species below.

Ornamental snake

A total of 1,432 ha of potential habitat for the ornamental snake was mapped within the Study Area. 313.8 ha of this are potentially impacted by clearing for the Project (Offsite) (refer to Figure 4). This area of potential habitat includes 2.5 ha of RE vegetation and 311.3 ha of non-remnant that coincides with the pre-clear extent of suitable RE vegetation and retains suitable substrate (i.e. cracking clay soils). Such areas are still considered potential habitat for the ornamental snake, given the species' reliance on refuges within cracking clay soils (DSEWPaC, 2011). However, the condition of these areas of non-remnant vegetation was found to be very low, with high levels of impact from grazing and stick-raking. This should be taken into consideration during the offsetting process.

A total of 36 polygons of potential habitat for the ornamental snake were mapped within the Study Area. These areas were ground-truthed to assess condition and their context/connectivity was assessed using a desktop approach in ArcGIS.

As referenced above, most (66 percent) of the polygons had low condition scores (≤ 2 out of 10). These polygons had no remnant vegetation, immature regrowth, and high grazing impacts, but retained the cracking clay soils and gilgais required by the species (refer to Plate 1). Nevertheless, a number of polygons of remnant vegetation had higher habitat condition scores, due to the presence of remnant vegetation, higher structural complexity of the ground-level habitats and a relative lack of grazing impacts (refer to Plate 2).

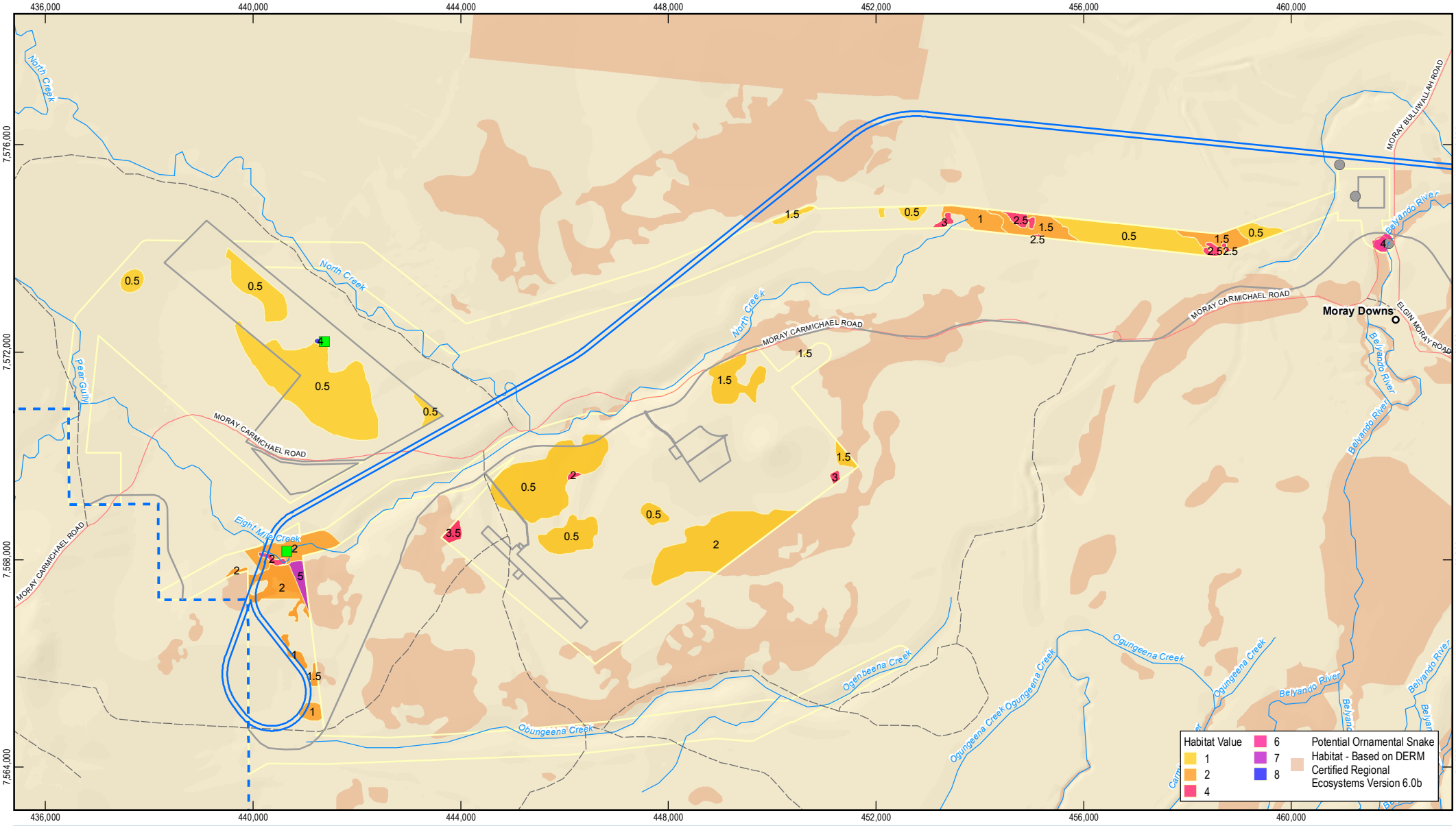
Plate 1 Low condition potential habitat for the ornamental snake

Plate 2 Moderate - high condition potential habitat for the ornamental snake

Table 5 Condition, context and quality scores for ornamental snake habitat

Polygon	Area (ha)	Condition (out of 10)	Context (out of 10)	Quality* (out of 10)
1	16.0	1	0	0.5
2	2.5	8	0	4
3	12.5	1	0	0.5
4	65.8	1	0	0.5
5	294.4	1	0	0.5
6	8.8	1	2	1.5
7	14.0	1	0	0.5
8	11.7	4	1	2.5
9	6.2	4	2	3
10	1.0	4	1	2.5
11	4.4	4	1	2.5
12	6.3	4	1	2.5
13	32.9	2	1	1.5
14	20.2	1	0	0.5
15	110.1	1	0	0.5
16	35.7	2	0	1
17	42.5	2	1	1.5
18	9.8	6	2	4
19	13.7	2	0	1
20	4.0	2	2	2
21	5.0	2	1	1.5
22	10.7	2	0	1
23	59.5	2	2	2
24	6.0	4	0	2
25	63.3	2	2	2
26	15.7	7	3	5
27	16.0	1	0	0.5
28	58.1	1	0	0.5
29	10.0	4	3	3.5
30	65.0	1	2	1.5
31	0.6	1	2	1.5
32	202.3	1	0	0.5
33	189.8	1	3	2
34	2.5	4	0	2
35	3.8	4	2	3
36	11.2	1	2	1.5

*Quality score is yet to include stocking rate estimates



1:100,000 (at A4)

0 2 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- Confirmed Location of Ornamental Snake
- Local Road
- Track
- Watercourse
- Study Area
- Rail Corridor
- Project Area
- Mine (Offsite)
- Mine (Offsite)

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Carmichael Coal Mine and Rail Project SEIS
BioCondition Assessment Report

Potential Habitat for the Ornamental Snake (Colour-coded by Quality Score)

Job Number 41-26422
Revision 1
Date 15-10-2013

Figure 4

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Data source: DME: EPC1690 (2010)/EPC1080 (2011); DNRM: Potential Habitat (2011); GHD: Confirmed Sightings (2013), Habitat Value (2013); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007);
Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013). Created by: AJ.

Black-throated finch (southern)

A total of 94.3 ha (11 polygons) of potential habitat for the black-throated finch (southern) was mapped within the Study Area. A total of 2.5 ha is within the current proposed Project (Offsite) footprint (refer to Figure 5). These areas were ground-truthed to assess condition and their context/connectivity was assessed using a desktop approach in ArcGIS.

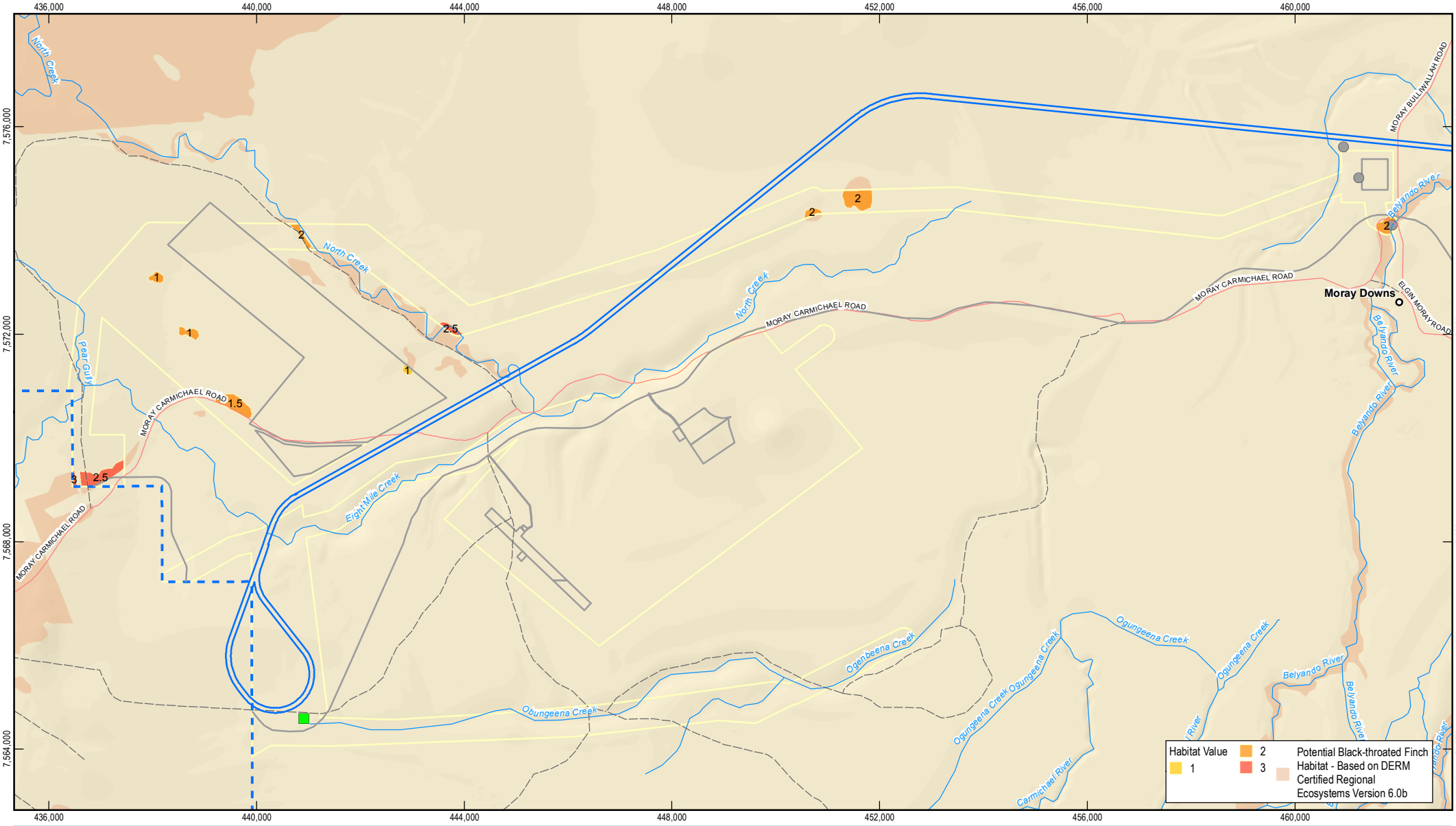
All polygons had low condition scores (≤ 3 out of 10). Despite supporting REs that are potential habitat for the black-throated finch, these areas were generally dominated by buffel grass, contained few (if any) native grasses and were subject to heavy grazing impacts (refer to Plate 3). This is in contrast to the high condition habitats recorded on the Mine, as part of surveys for the EIS (refer to Plate 4).

Table 6 Condition, context and quality scores for black-throated finch habitat

Polygon	Area (ha)	Condition (out of 10)	Context (out of 10)	Quality* (out of 10)
1	17.1	2	1	1.5
2	5.9	2	0	1
3	4.5	2	0	1
4	5.6	2	2	2
5	19.3	2	2	2
6	9.8	2	2	2
7	5.4	3	2	2.5
8	20.2	3	2	2.5
9	2.1	3	3	3
10	2.5	1	1	1
11	1.8	2	2	2
*Quality score is yet to include stocking rate estimates				

Plate 3 Low quality potential habitat for the black-throated finch within the Study Area

Plate 4 High quality potential habitat for the black-throated finch recorded on the Project (Mine) area within the Environmental Impact Statement (April, 2011)



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0 2 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- Confirmed Location of Black-throated Finch
- Local Road
- Track
- Watercourse
- Study Area
- Rail Corridor
- Project Area
- Mine (Offsite)
- Mine (Offsite)

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BioCondition Assessment Report

Potential Habitat for the Black-throated Finch (Colour-coded by Quailty Score)

Job Number	41-26422
Revision	1
Date	15-10-2013

Figure 5

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Squatter pigeon (southern)

A total of 87.1 ha (10 polygons) of potential habitat for the squatter pigeon (southern) was mapped within the Study Area. Approximately 2.5 ha of potential habitat occurs within the current proposed Project (Offsite) footprint (refer to Figure 6). These areas were ground-truthed to assess condition and their context/connectivity was assessed using a desktop approach in ArcGIS.

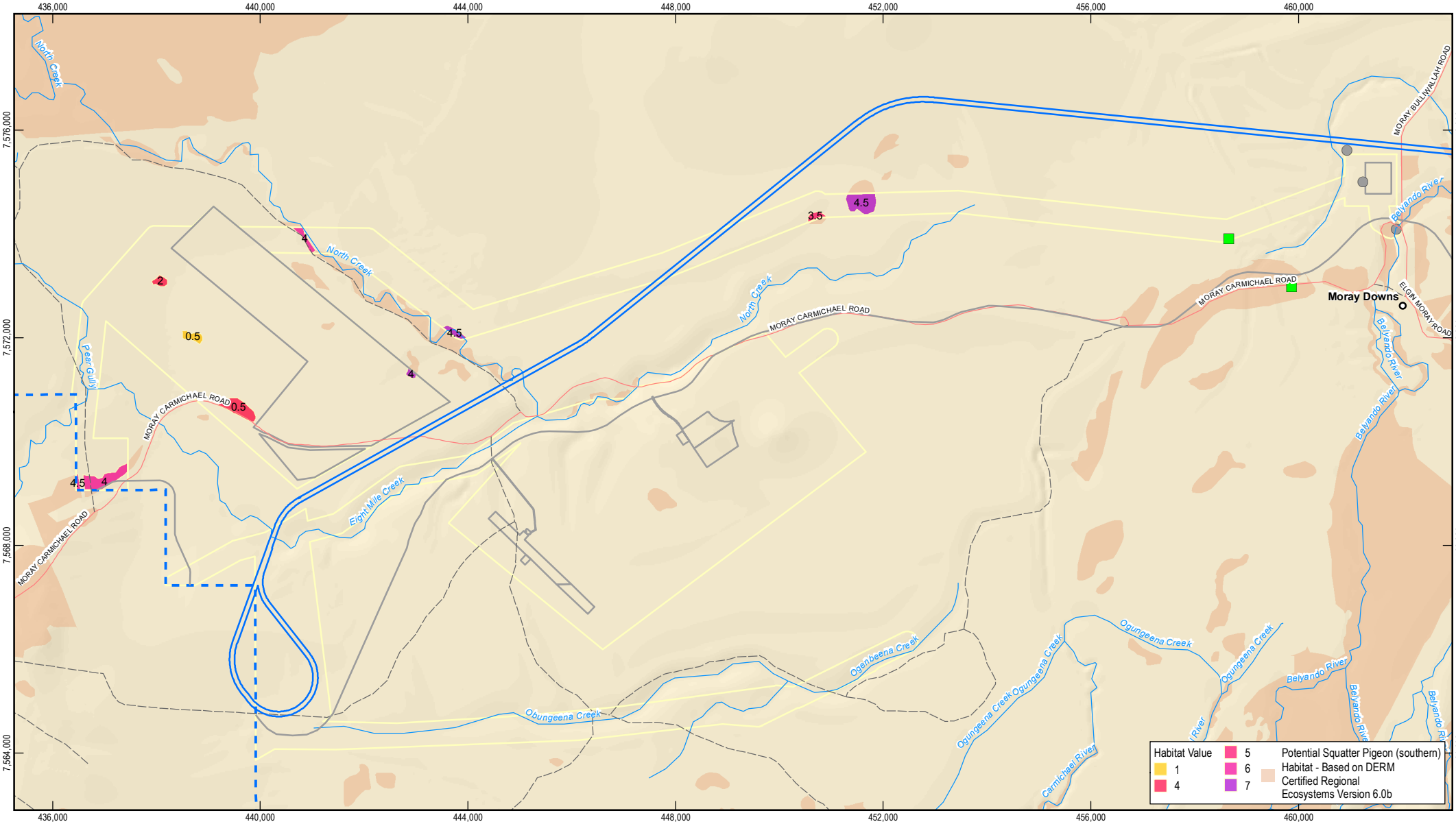
Most polygons (70 percent) had moderate condition scores (5 – 7 out of 10). These areas were characterised by a mix of buffel and native grasses, low-moderate grazing impacts and low-moderate erosion (refer to Plate 5). One polygon of potential habitat had a lower quality score due to heavy grazing pressure and an overall dominance of buffel grass (refer to Plate 6).

Table 7 Condition, context and quality scores for squatter pigeon habitat

Polygon	Area (ha)	Condition (out of 10)	Context (out of 10)	Quality* (out of 10)
1	17.1	4	1	2.5
2	5.9	1	0	0.5
3	4.5	4	0	2
4	5.6	6	2	4
5	20.2	6	2	4
6	2.1	6	3	4.5
7	2.5	7	1	4
8	5.4	7	2	4.5
9	4.4	5	2	3.5
10	19.3	7	2	4.5
*Quality score is yet to include stocking rate estimates				

Plate 5 Moderate condition potential habitat for the squatter pigeon

Plate 6 Low condition potential habitat for the squatter pigeon



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0 2 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- Confirmed Location of Squatter Pigeon (southern)
- Local Road
- Track
- Watercourse
- Study Area
- Rail Corridor
- Project Area
- Mine (Offsite)
- Mine (Offsite)

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Carmichael Coal Mine and Rail Project SEIS
BioCondition Assessment Report

Potential Habitat for the Squatter Pigeon (Colour-coded by Quality Score)

Job Number 41-26422
Revision 1
Date 15-10-2013

Figure 6

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Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013). Created by: AJ.

Yakka skink

A total of 34.5 ha (5 polygons) of potential habitat for the yakka skink was mapped within the Study Area. A total of 2.5 ha is within the Project (Offsite) footprint potentially subject to clearing (refer to Figure 7). These were ground-truthed to assess condition and their context/connectivity was assessed using a desktop approach in ArcGIS.

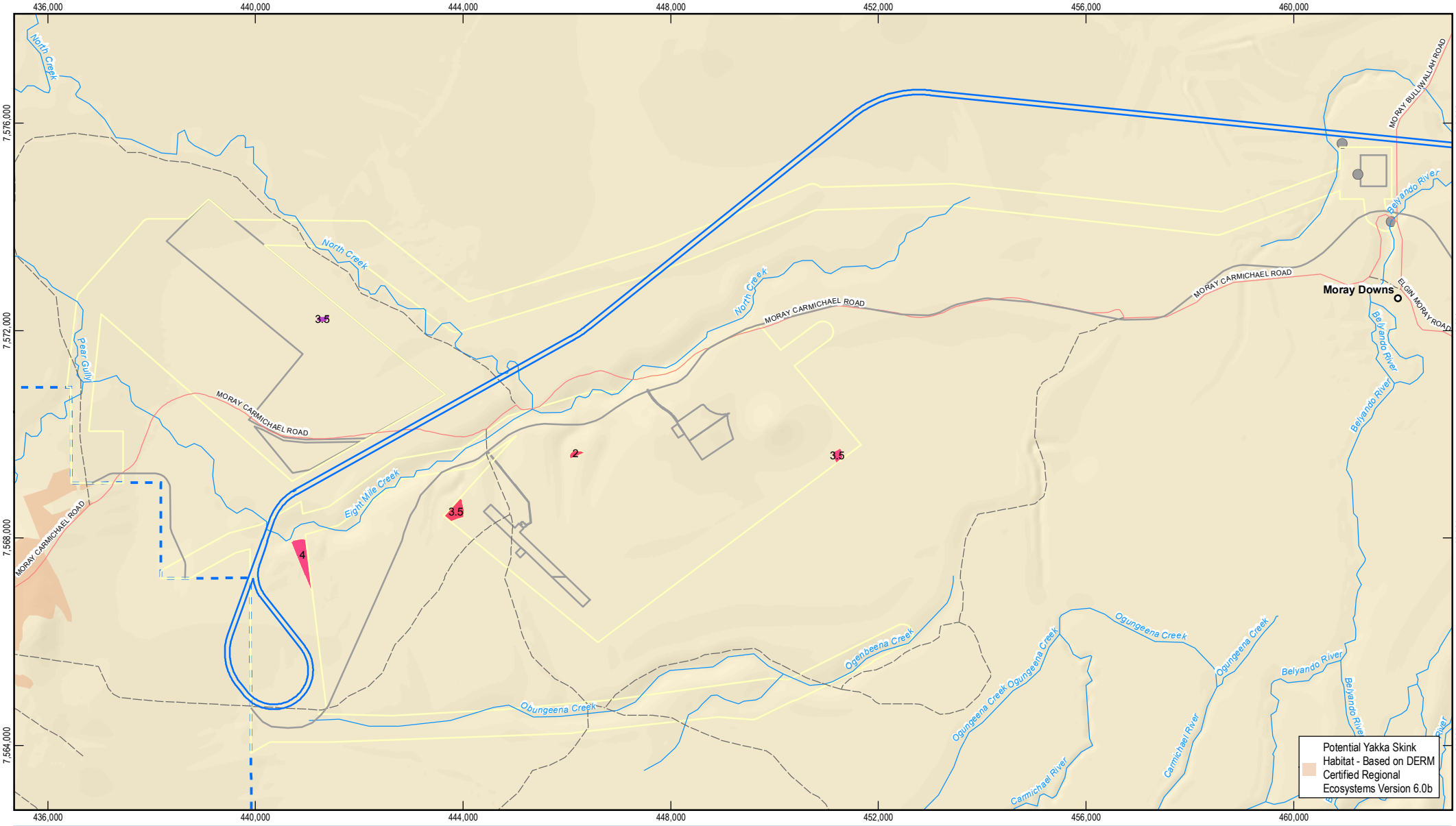
Most polygons (90 percent) had low - moderate condition scores (4 - 5 out of 10). These areas were characterised by moderate structural complexity in the ground-layer, presence of fallen logs and woody debris, but moderate grazing impacts (refer to Plate 7). One polygon of potential habitat had higher quality due to an abundance of fallen logs and relatively low grazing pressure (refer to Plate 8).

Table 8 Condition, context and quality scores for yakka skink habitat

Polygon	Area (ha)	Condition (out of 10)	Context (out of 10)	Quality* (out of 10)
1	2.5	4	0	2
2	2.5	7	0	3.5
3	15.7	5	3	4
4	3.8	5	2	3.5
5	10.0	4	3	3.5
*Quality score is yet to include stocking rate estimates				

Plate 7 Low - moderate condition potential habitat for the yakka skink

Plate 8 Moderate condition potential habitat for the yakka skink



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0 2 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Study Area
- Habitat Value: 4, 5, 7
- Rail Corridor
- Project Area
- Mine (Offsite)
- Mine (Offsite)

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BioCondition Assessment Report

Potential Habitat for the Yakka Skink (Colour-coded by Quality Score)

Job Number 41-26422
Revision 1
Date 15-10-2013

Figure 7

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Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013). Created by: AJ.

Koala

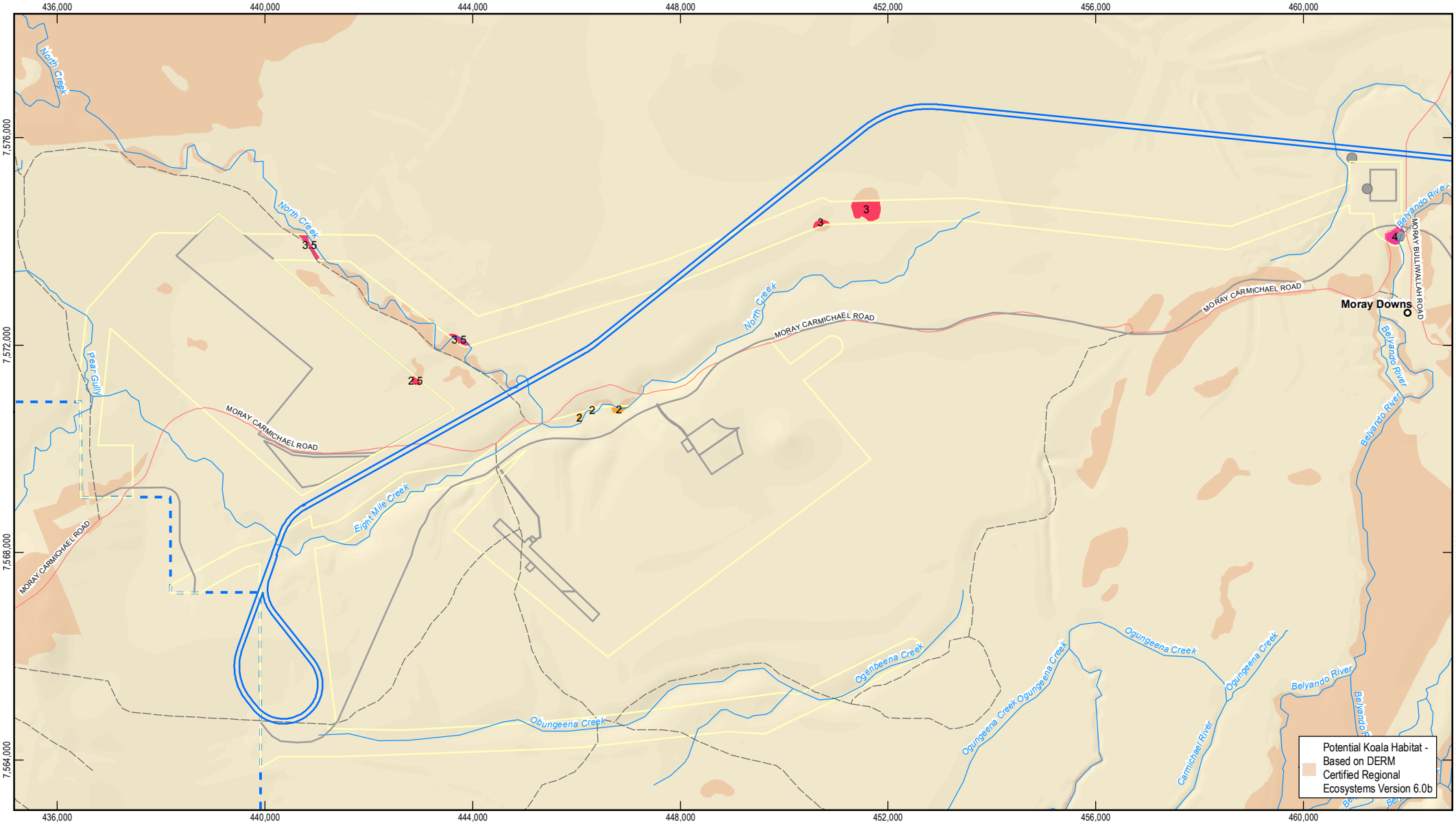
A total of 52.9 ha (7 polygons) of potential habitat for the koala was mapped within the Study Area. A total of 2.7 ha is within the current proposed Project (Offsite) footprint subject to potential clearing (refer to Figure 8). These were ground-truthed to assess condition and their context/connectivity was assessed using a desktop approach in ArcGIS.

All polygons had moderate condition scores (4 – 6 out of 10). These areas were characterised by a sub-dominant canopy of koala food trees (*Eucalyptus tereticornis* and/or *E. camaldulensis*), open understorey, but no pellets or scratches to indicate recent or historic use by koalas (refer to Plate 9).

Table 9 Condition, context and quality scores for koala habitat

Polygon	Area (ha)	Condition (out of 10)	Context (out of 10)	Quality* (out of 10)
1	5.6	5	2	3.5
2	5.4	5	2	3.5
3	2.5	4	1	2.5
4	4.4	4	2	3
5	9.8	6	2	4
6	5.8	4	2	2
7	19.3	4	2	3
*Quality score is yet to include stocking rate estimates				

Plate 9 Moderate condition potential habitat for the koala



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Study Area
- Habitat Value
  - 2
  - 4
  - 5
  - 6
- Rail Corridor
- Project Area
- Mine (Offsite)
- Mine (Offsite)

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BioCondition Assessment Report

Potential Habitat for the Koala (Colour-coded by Quality Score)

Job Number	41-26422
Revision	1
Date	15-10-2013

Figure 8

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Data source: DME: EPC1690 (2010)/EPC1080 (2011); DNRM: Potential Habitat (2011); Habitat Value (2013); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007);
Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013). Created by: AJ.

5.3 *Vegetation Management Act 1999* BioCondition assessment results

BioCondition assessments were undertaken at 10 RE sites within the Study Area. These sites were chosen as representative sites to establish a condition score for native vegetation types that occur within the Study Area. The results of these assessments are presented in Table 3 to Table 6.

The BioCondition assessment methodology provides measure of quality, considering patch size, context and connectivity, as well as a number of generic measures of habitat quality for a broad range of fauna species. Assessment of habitat quality for specific threatened fauna species is discussed further in Section 4.2). The ecological condition of assessment sites is just one criterion used in the EEM. The other criterion is 'special features', for which a score is calculated based on 14 indicators (DERM, 2011c). The results of the special features assessments are presented in Table 3 to Table 6.

The condition of remnant vegetation within the Study Area was generally of moderate condition, with moderate-high levels of disturbance from selective clearing and cattle grazing. Substantial fragmentation of remnant vegetation due to past clearing has isolated many of the remnant patches within the Study Area. Remnant vegetation along watercourses has also been cleared such that the riparian vegetation has been reduced to narrow strips along one or both sides of the watercourses.

The calculation of BioCondition scores requires comparison with benchmarks obtained from reference sites. At the time of the assessments, benchmark values for the impacted REs had not yet been published. However, benchmarks were derived for five of the assessed REs using a number of methods (refer to Section 4.3). BioCondition scores were calculated for five REs. The results of the BioCondition assessments for these five REs, including the BioCondition score are provided in Table 10. All BioCondition assessment results can be found in Appendix C. For the remaining two REs assessed within the Study Area, external BioCondition data is needed to obtain benchmarks for comparison to calculate a score.

An additional six REs were observed within the Study Area but were not assessed for BioCondition. These REs occurred as part of heterogeneous RE polygons and were represented by only small areas within these polygons. The extent of each of these REs was not large enough to accommodate the survey method and these REs were not assessed as a result.

Table 10 BioCondition assessment results and BioCondition score for bioregion 10 regional ecosystems

Regional ecosystem		10.3.6a					10.4.5		
Site			Site 27		Site 24			Site 26	
Attribute	Weighting (%)	Benchmark	Value	Score	Value	Score	Benchmark	Value	Score
Recruitment of woody perennial species (%):	5	100	50	3	66	3	100	100	5
Native plant species richness:									
Tree:	5	5	5	5	6	5	2	3	5
Shrub:	5	5	1	0	2	2.5	2	8	5
Grass:	5	3	8	5	7	2.5	5	1	0
Other species:	5	6	8	5	7	2.5	5	3	2.5
Trees:									
Canopy cover (%):	5	25.4 (canopy) 12.1 (subcanopy)	30.5 -	2.5	16.1 4.8	3.5	10.4 (canopy) 3.0 (subcanopy)	21.4 -	1.5
Median canopy height (m):	5	14.3 (canopy) 7.4 (subcanopy)	12 -	2.5	11 7	5	12 (canopy) 6.7 (subcanopy)	12 -	2.5
Large trees:									
Eucalypts									
Number of trees per hectare*:	7.5	5	6	15	8	7.5	unavailable	0	0
Non eucalypts									
Number of trees per hectare*:	7.5	1	2		0		unavailable	74	0
Shrubs:									
Shrub layer cover (%):	5	5.7	3.1	5	0	0	3.0	40.7	3
Ground cover:									
Native perennial grass cover (%):	5	0.7	20.0	5	6.0	5	unavailable	0.0	0
Organic litter cover (%):	5	32.0	32.0	5	14.4	3	unavailable	33.0	0
Coarse woody debris:									
Total length (m) of logs ≥10 cm diameter:	5	32	82	2	56	5	unavailable	1295	0
Non-native plant cover (%):	10	0	25	5	80	0	unavailable	60	0
Distance from permanent water:	20	N/a	2	2	5	5	N/a	2	2
Total:	100	N/a	N/a	62	N/a	50	N/a	N/a	21.5
BioCondition score:	N/a	N/a	0.62	2	0.50	3	N/a	0.22	4
Special features score:	N/a	N/a	N/a	15.01	N/a	0.10	N/a	N/a	20.88

Table 11 BioCondition assessment results and BioCondition score for bioregion 11 regional ecosystems

Regional ecosystem		11.3.3			11.3.37			11.4.5		
Site		Site 1			Site 7			Site 34		
Attribute	Weighting (%)	Benchmark	Value	Score	Benchmark	Value	Score	Benchmark	Value	Score
Recruitment of woody perennial species (%):	5	100	100	5	100	100	5	100	100	5
Native plant species richness:										
Tree:	5	3	3	5	3	6	5	1-5	6	5
Shrub:	5	5	3	2.5	5	3	2.5	1-5	8	5
Grass:	5	12	5	2.5	12	5	2.5	6-15	0	0
Other species:	5	15	2	0	15	7	2.5	8-17	5	2.5
Trees:										
Canopy cover (%):	5	28 (canopy) 5 (subcanopy)	43.5 38.5	4	28 (canopy) 5 (subcanopy)	3.5 25.2	2.5	12 (canopy) 3 (subcanopy)	12 -	2.5
Median canopy height (m):	5	18 (canopy) 10 (subcanopy)	17 12	5	11 (canopy) 10 (subcanopy)	17 13	5	16 (canopy) 4 (subcanopy)	10 -	1.5
Large trees:										
Eucalypts										
Number of trees per hectare*:	7.5	10	30	15	10	28	15	0	n/a	15
Non eucalypts										
Number of trees per hectare*:	7.5	n/a	2	n/a	n/a	2		6	10	
Shrubs:										
Shrub layer cover (%):	5	4.0	7.0	5	4	0.4	3	5-12	13.0	5
Ground cover:										
Native perennial grass cover (%):	5	45	28.0	3	45	38.0	5	16.0	9.4	3
Organic litter cover (%):	5	30	54.0	5	30	54.6	5	10.0	3.0	3
Coarse woody debris:										
Total length (m) of logs ≥10 cm diameter:	5	285	157	5	285	171	5	347	205	5
Non-native plant cover (%):	10	0	5	5	0	5	5	0	60	0
Size of patch:	10	N/a	2	2	N/a	10	10	N/a	10	10
Context:	5	N/a	2	2	N/a	4	4	N/a	4	4
Connectivity:	5	N/a	0	0	N/a	2	2	N/a	2	2
Total:	100	N/a	N/a	66	N/a		79	N/a	N/a	68.5
BioCondition score:	N/a	N/a	0.66	2	N/a	0.79	2	N/a	0.69	2
Special features score:	N/a	N/a	N/a	0.46	N/a		4.77	N/a	N/a	0.24

6. Summary

BioCondition surveys were undertaken within the Project (Offsite) Study Area in May 2013, to provide information to meet the requirements of the EPBC Act Environmental Offsets policy and the VM Act Vegetation Offsets Policy. BioCondition scores were obtained for five of the sampled REs.

Information on habitat condition and context was used to assess BioCondition under each policy. This information is to be incorporated into, and used in support of, a coordinated offsets strategy for the Project (Mine and Rail).

The surveys confirmed the presence of, and assessed the BioCondition of, the following environmental values within the Study Area:

- One TEC protected under the EPBC Act: *Acacia harpophylla* (dominant and sub-dominant) (9.8 ha), None of this mapped TEC occurs within the Project (Offsite) footprint.
- Potential habitat for five threatened fauna species protected under the EPBC Act
  - Ornamental snake (1432 ha)
  - Black-throated finch (southern) (94.3 ha)
  - Squatter pigeon (southern) (87.1 ha)
  - Yakka skink (34.5 ha)
  - Koala (52.9 ha)
- 11 REs protected under the VM Act

This information has been used to inform the design and layout of the Project (Offsite) footprint. Wherever possible, areas of environmental value have been avoided. The Project (Offsite) footprint directly impacts the following environmental values:

- Potential habitat for four threatened fauna species protected under the EPBC Act
  - 313.8 ha of potential habitat for the ornamental snake
  - 2.5 ha of potential habitat for the black-throated finch
  - 2.5 ha of potential habitat for the squatter pigeon (southern)
  - 2.5 ha of potential habitat for the yakka skink
  - 2.7 ha for the koala
- six least concern REs protected under the VM Act (7.2 ha)

The surveys found that the existing environment within the Study Area has been heavily impacted by past land-uses. The landscape has been substantially fragmented by past land clearing and heavily degraded by decades of moderate intensity cattle grazing. Remnants of native vegetation are predominantly small, fragmented and highly degraded, with high densities of buffel grass, erosion and trampling damage. Habitat remnants and REs within the Study Area generally had lower condition, compared with those observed in the Project Area (Mine).

As a result, many of the areas of potential habitat for EPBC listed species have only low – moderate quality scores under the EPBC Environmental Offsets guideline. The information provided in this report can be incorporated into a combined offsets strategy for the broader

Project (Mine and Rail), combining offset requirements for the Mine, Rail and offsite infrastructure.

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Appendices


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Appendix A – BioCondition assessment locations


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BioCondition Assessment Site	Easting	Northing	RE Assessed	Comments	Photo
Site 1	446709	7570763	11.3.1 (LC)	Occurs as a heterogeneous polygon with endangered RE 11.3.1 RE 11.3.1 occurred in patches too small to assess separately Also contains watercourse and corridor vegetation	
Site 3	439701	7570525	11.3.6a (LC)	Occurs as a heterogeneous polygon with the least concern REs 10.3.4 and 10.3.3. which were absent	

BioCondition Assessment Site	Easting	Northing	RE Assessed	Comments	Photo
Site 7	461831	7574157	11.3.37 (LC)	Occurs as a heterogeneous polygon with 11.3.25 and endangered 11.3.1 11.3.1 was absent Also contains watercourse and corridor vegetation	
Site 9	451712	7574630	10.3.6a (LC)	Occurs as a heterogeneous polygon with the least concern REs 10.3.4 and 10.3.3. which were absent	

BioCondition Assessment Site	Easting	Northing	RE Assessed	Comments	Photo
Site 14	436745	7569203	10.3.6a (LC)	Occurs as a heterogeneous polygon with the least concern REs 10.3.28 and 10.5.5	
Site 15	440748	7574054	10.3.6a (LC)	Occurs as a heterogeneous polygon with the least concern REs 10.3.4 and 10.3.3. which were absent Also contains watercourse and corridor vegetation	

BioCondition Assessment Site	Easting	Northing	RE Assessed	Comments	Photo
Site 26	441389	7572255	10.4.5 (LC)	Occurs as a heterogeneous polygon with the least concern RE 10.4.3, which was absent	
Site 27	442939	7571336	10.3.6a (LC)	Occurs as a heterogeneous polygon with the least concern REs 10.3.4 and 10.3.3. which were absent	

BioCondition Assessment Site	Easting	Northing	RE Assessed	Comments	Photo
Site 29	448695	7567907	11.4.11 (OC)	Occurs as a heterogeneous polygon with the of concern RE 11.4.5 (present) and the endangered RE 11.4.9, which was absent Also contains corridor vegetation	
Site 34	446364	7566156	11.4.5 (OC)	Occurs as a heterogeneous polygon with the of concern RE 11.4.11 and the endangered RE 11.4.9, which were absent Also contains corridor vegetation	


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Appendix B – Habitat condition scores for *Environmental Protection Biodiversity Conservation Act 1999* listed species


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Condition Score	Ecological characteristics used to assess habitat condition for each species
Ornamental snake (Denisonia maculata)	
1 - 2	Remnant status - Non-remnant, regrowth - immature, structural complexity - low, grazing intensity - high (evidence of trampling, dung deposition), cracking clay soils - present
3 - 4	Remnant status - non-remnant, regrowth - advanced, structural complexity - low, grazing intensity - high, cracking clay soils - present
5 - 6	Remnant status - remnant (RE), structural complexity - low-moderate, grazing intensity - moderate - high, cracking clay soils - present
7 - 8	Remnant status - remnant (RE), structural complexity - moderate, grazing intensity - moderate, cracking clay soils - present
9 - 10	Remnant status - remnant (RE),vegetation, structural complexity - moderate-high, grazing intensity - low, cracking clay soils - present
Black-throated finch (southern) (Poephila cincta cincta)	
1 - 2	Buffel grass - dense, native grasses absent, grazing intensity - high
3 - 4	Buffel grass - moderate, native grasses absent, grazing intensity - high
5 - 6	Buffel grass - low - moderate, native grasses - moderate, grazing intensity - moderate
7 - 8	Buffel grass - low, native grasses - moderate, grazing intensity - low-moderate
9 - 10	Buffel grass - absent, native grasses - abundant and diverse, grazing intensity – low
Squatter pigeon (southern) (Geophaps scripta scripta)	
1 - 2	Buffel grass - dense, native grasses absent, grazing intensity - high, erosion - high
3 - 4	Buffel grass - moderate, native grasses absent, grazing intensity - high, erosion - high
5 - 6	Buffel grass - low/moderate, native grasses - moderate, grazing intensity – moderate, erosion - moderate
7 - 8	Buffel grass - low, native grasses - moderate, grazing intensity - low/moderate, erosion - low
9 - 10	Buffel grass - absent, native grasses - abundant and diverse, grazing intensity - low, erosion absent
Yakka skink (Egernia rugosa)	
1 - 2	Structural complexity - low, large logs - absent, ground cover - absent, grazing intensity - high, erosion - high, burrows - absent
3 - 4	Structural complexity - low/moderate, large logs - low abundance, ground cover - low abundance, grazing intensity - moderate/high, erosion - moderate/high, burrows - absent
5 - 6	Structural complexity - moderate, large logs - moderate abundance, ground cover - moderate abundance, grazing intensity – low/moderate, erosion - moderate, burrows - absent
7 - 8	Structural complexity - moderate/high, large logs - moderate/high abundance, ground cover - moderate/high abundance, grazing intensity - low, erosion – low, burrows - present
9 - 10	Structural complexity - high, large logs - high abundance, ground cover - high abundance, grazing intensity - low, erosion - low, burrows - abundant
Koala (Phascolarctos cinereus)	
1 - 2	E. tereticornis, E. camaldulensis - sparse, understorey density - high, scratches/pellets - absent

Condition Score	Ecological characteristics used to assess habitat condition for each species
3 - 4	E. tereticornis, E. camaldulensis - sub-dominant, understorey density - moderate, scratches/pellets - absent
5 - 6	E. tereticornis, E. camaldulensis - sub-dominant, understorey density - low/moderate, scratches/pellets - low abundance/old
7 - 8	E. tereticornis, E. camaldulensis – dominant, understorey density - low, scratches/pellets – moderate abundance/old
9 - 10	E. tereticornis, E. camaldulensis - dominant, understorey density - low, scratches/pellets - high abundance/recent

Appendix C – BioCondition assessment results


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BioCondition assessment results – bioregion 11 (woodland ecosystems)

Regional Ecosystem		11.3.3	11.3.37	11.4.5
Site		Site 1	Site 7	Site 34
Attribute	Weighting (%)	Value	Value	Value
Recruitment of woody perennial species (%):	5	100	100	100
Native plant species richness:				
Tree:	5	3	6	6
Shrub:	5	3	3	8
Grass:	5	5	5	0
Other species:	5	2	7	5
Trees:				
Canopy cover (%):	5	43.5(canopy) 38.5 (subcanopy)	3.5 (canopy) 25.2 (subcanopy)	12.0 (canopy) - (subcanopy)
Median canopy height (m):	5	17 (canopy) 12 (subcanopy)	17 (canopy) 13 (subcanopy)	10 (canopy) - (subcanopy)
Large trees:				
Eucalypts Number of trees per hectare*:	7.5	30	28	n/a
Non eucalypts Number of trees per hectare*:	7.5	2	2	10
Shrubs:				
Shrub layer cover (%):	5	7	0.4	13
Ground cover:				
Native perennial grass cover (%):	5	28.0	38.0	9.4
Organic litter cover (%):	5	54.0	54.6	3.0
Coarse woody debris:				
Total length (m) of logs ≥10 cm diameter:	5	157	171	205
Non-native plant cover (%):	10	5	5	60
Size of patch:	10	2	10	10
Context:	5	2	4	4
Connectivity:	5	0	2	2
Total:	**100**			
Special features score:		**0.46**	**4.77**	**0.24**

BioCondition assessment results - bioregion 11 (grassland ecosystems)

Regional Ecosystem		11.4.11
Site		Site 29
Attribute	Weighting (%)	Value
Recruitment of woody perennial species (%):	**0**	n/a
Native plant species richness: Tree: Shrub: Grass: Other species:	 **0** **0** **5** **5**	 n/a n/a 10 12
Trees: Canopy cover (%): Median canopy height (m):	 **0** **0**	 n/a n/a
Large trees: Eucalypts Number of trees per hectare*: Non eucalypts Number of trees per hectare*:	 **0** **0**	 n/a n/a
Shrubs: Shrub layer cover (%):	 **0**	 n/a
Ground cover: Native perennial grass cover (%): Organic litter cover (%):	 **5** **5**	 70.0 6.0
Coarse woody debris: Total length (m) of logs ≥10 cm diameter:	 **0**	 n/a
Non-native plant cover (%):	**10**	5
Size of patch:	**10**	10
Context:	**5**	4
Connectivity:	**5**	2
Total:	**50**	
Special features score:		0

BioCondition assessment results – bioregion 10 (woodland ecosystems)

Regional Ecosystem		10.3.6a					10.4.5
Site		Site 27	Site 3	Site 9	Site 14	Site 15	Site 26
Attribute	Weighting (%)	Value	Value	Value	Value	Value	Value
Recruitment of woody perennial species (%):	5	50	66	33	66	50	100
Native plant species richness:							
Tree:	5	5	5	4	6	5	3
Shrub:	5	1	7	1	2	8	8
Grass:	5	8	3	3	7	2	1
Other species:	5	8	8	4	7	5	3
Trees:							
Canopy cover (%):	5	30.5 (canopy) - (subcanopy)	54.9 (canopy) - (subcanopy)	14.4 (canopy) 21.0 (subcanopy)	16.1 (canopy) 4.8 (subcanopy)	6.8 (canopy) 15.3 (subcanopy)	21.4 (canopy) - (subcanopy)
Median canopy height (m):	5	12 (canopy) - (subcanopy)	11 (canopy) - (subcanopy)	17 (canopy) 12 (subcanopy)	11 (canopy) 7 (subcanopy)	15 (canopy) 10 (subcanopy)	12 (canopy) - (subcanopy)
Large trees:							
Eucalypts							
Number of trees per hectare*:	7.5	6	4	10	8	2	n/a
Non eucalypts							
Number of trees per hectare*:	7.5	2	0	2	0	2	74
Shrubs:							
Shrub layer cover (%):	5	3.1	4.3	3.7	0	9.1	40.7
Ground cover:							
Native perennial grass cover (%):	5	20.0	0	2.0	6.0	0	0.0
Organic litter cover (%):	5	32.0	46.4	16.0	14.4	33.6	33.0

Regional Ecosystem		10.3.6a					10.4.5
Site		Site 27	Site 3	Site 9	Site 14	Site 15	Site 26
Attribute	Weighting (%)	Value	Value	Value	Value	Value	Value
Coarse woody debris: Total length (m) of logs ≥10 cm diameter:	5	82	204	35	56	125	1295
Non-native plant cover (%):	10	25	60	80	80	75	60
Distance from permanent water:	20	2	5	5	5	0	2
Total:	**100**						
Special features score:		**15.01**	**2.85**	**0.01**	**0.1**	**5.52**	**20.88**

Appendix D – BioCondition benchmarks and regional ecosystem technical descriptions


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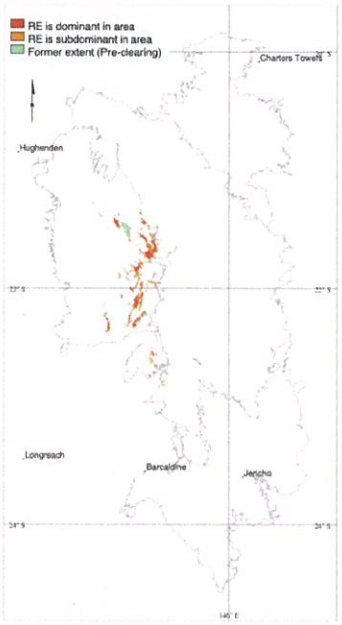
BioCondition benchmark for regional ecosystem condition assessment

Desert Uplands — Regional ecosystem: 10.3.1

Acacia argyrodendron low open-woodland on alluvial plains (western)



Melinda Laidlaw

BioCondition attribute			Benchmark
Recruitment of dominant canopy species (%):			100
Native plant species richness:		Tree:	1-5
		Shrub:	1-5
		Grass:	6-15
		Forbs and other:	8-17
Trees:	Tree canopy	Tree canopy median height (m):	10
		Tree canopy cover (%):	12
	Tree sub-canopy	Tree sub-canopy median height (m):	4
		Tree sub-canopy cover (%):	3
	Large trees	Large eucalypt tree dbh threshold (cm):	30
		Number of large eucalypt trees per hectare:	0
		Large non-eucalypt tree dbh threshold (cm):	25
		Number of large non-eucalypt trees per hectare:	6
	Typical tree species: Acacia argyrodendron (blackwood), Atalaya hemiglauca (western whitewood), Lysiphyllum carronii (ebony tree)		
Shrubs:		Native shrub cover (%):	5-12
	Typical shrub species: Eremophila mitchellii (false sandalwood), Psydrax oleifolia (wild lemon), Carissa lanceolata (conkle berry)		
Ground cover (%):		Native perennial grass cover (%):	16
		Organic litter cover (%):	10
	Typical ground cover species: Sporobolus actinocladus (katoora grass), Astrebla spp., Enteropogon acicularis (curly windmill grass), Evolvulus alsinoides (tropical speedwell), Trianthema triquetra (red spinach)		
Coarse woody debris: Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare:			347
Non-native plant cover			0
None listed			

Selected typical species are those that characterize the ecosystem, community or stratum at reference sites. Up to five frequently occurring species for each stratum are selected. Users should refer to the regional ecosystem description database (REDD) and/or the technical description for more complete lists of characteristic species. Only the most frequently used common name is given. Other common names may be used in other regions. Declared pest species in Queensland are designated (^).

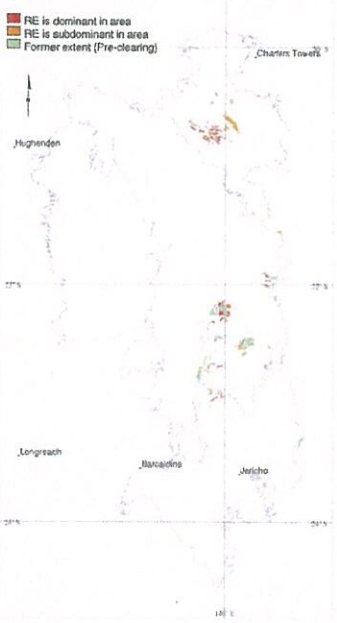
RE: 11.3.3 ***Eucalyptus coolabah*** **woodland on alluvial plains**

BioCondition Attributes	Benchmark	Typical Species
Tree Canopy Cover (%)	28	
Tree Subcanopy Cover (%)	5	
Native Shrub Cover (%)	4	
Large eucalypt tree DBH threshold (cm)	45	
Number of Large Eucalypt Trees (per ha)	10	
Large non-eucalypt tree DBH threshold (cm)	na	
Number of Large non-eucalypt Trees (per ha)	na	
Tree Canopy Height (m)	18	
Tree Subcanopy height (m)	10	
Coarse Woody Debris (m/ha)	285	
Species Richness – Trees	3	*Eucalyptus coolabah, E. populnea, Acacia pendula, Acacia salicina,*
Species Richness – shrubs	5	*Acacia stenophylla, Acacia pendula, Acacia salicina, Casuarina cristata,*

Species Richness – grasses	12	*Aristida leptopoda, Bothriocloa erianthoides, Chloris divaricata,*
Species Richness - forbs and other	15	*Cyperus bifax, Sida hackettiana, Brunoniella australis, Cyperus gracilis,*
Ground cover – native perennial grass cover (%)	45	
Ground cover – organic litter (%)	30	
Non-native plant cover (%)	0	*Malvastrum americanum var. americanum (spiked malvastrum), Parkinsonia aculeata, Megathyrsus maximus (green panic grass), Vachellia farnesiana (mimosa bush), Cenchrus ciliaris (buffel grass), Parthenium hysterophorus, Opuntia stricta (smooth*
Reliability ranking (* = low reliability; ***** highly reliable)	****	
Benchmarks developed by the Queensland Herbarium, based on 14 CorVeg and two Qld Herbarium BioCondition reference sites (MGD0012, MGD0013), two O2 Ecology reference sites and expert opinion. April 2013.		

Technical Description Regional ecosystem: **10.4.5**

Acacia cambagei low woodland on Cainozoic lake beds



E.J. Thompson

Pre-clearing area (ha), remnant area (ha) and per cent remaining:	45,550	17,639	39%

Species recorded: Total: 121; woody: 26; ground: 106; Avg. spp./site: 42.8; std dev.: 8.4, 4 site(s)

Basal area: Avg./site: 6.6 m²/ha, range: 3.8 - 9 m²/ha, std. deviation: 2 m²/ha, 4 site(s)

Structural formation: Woodland: 40%; open-woodland: 40%; low open-woodland: 20%, 5 site(s)

Representative sites: 2436, 19972, 20062, 20086, 20124.

Stratum: **T1**

Height avg. = 12.0m, range 8-16m, 5 sites

Crown cover avg. = 10.4%, range 4.0-20.0%, 5 sites

Stem density/ha avg. = 140, range 40-280, 4 sites

Dominant species (relative cover, frequency): Acacia cambagei (86, 100%), Acacia harpophylla (5, 60%)

Frequent species (cover, frequency): Acacia cambagei (10, 100%), Acacia harpophylla (1, 60%), Acacia argyrodendron (2, 20%), Acacia excelsa (20%), Amyema quandang (20%), Eucalyptus cambageana (20%), Flindersia dissosperma (1, 20%)

Stratum: **T2**

Height avg. = 6.7m, range 5-8m, 3 sites

Crown cover avg. = 3.0%, range 2.0-5.0%, 3 sites

Stem density/ha avg. = 467, range 120-1080, 3 sites

Dominant species (relative cover, frequency): Lysiphyllum carronii (63, 40%), Acacia cambagei (47, 40%)

Frequent species (cover, frequency): Acacia cambagei (2, 40%), Lysiphyllum carronii (2, 40%), Acacia argyrodendron (20%), Acacia harpophylla (1, 20%), Eremophila mitchellii (1, 20%), Terminalia oblongata (1, 20%)

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

Technical Description — Regional ecosystem: **10.4.5**

Stratum: **S1**

Height avg. = 2.0m, range 0.6-4m, 5 sites

Crown cover avg. = 3.0%, range 1.0-6.0%, 5 sites

Stem density/ha avg. = 1250, range 200-2760, 4 sites

Dominant species (relative cover, frequency): Eremophila mitchellii (52, 40%), Acacia cambagei (50, 60%), Eremophila deserti (11, 40%), Santalum lanceolatum (9, 40%), Ehretia membranifolia (8, 60%)

Frequent species (cover, frequency): Acacia cambagei (2, 60%), Ehretia membranifolia (60%), Eremophila deserti (1, 40%), Eremophila mitchellii (3, 40%), Santalum lanceolatum (40%), Acacia harpophylla (20%), Alectryon diversifolius (20%), Apophyllum anomalum (20%), Atalaya hemiglauca (20%), Carissa lanceolata (1, 20%), Carissa ovata (1, 20%), Enchylaena tomentosa (20%), Flindersia dissosperma (20%), Hakea leucoptera (20%), Owenia acidula (20%), Psydrax oleifolia (1, 20%), Senna artemisioides subsp. filifolia (20%)

Stratum: **S2**

Height avg. = 0.6m, range 0.5-0.6m, 2 sites

Crown cover avg. = 0.5%, range 0.0-1.0%, 2 sites

Stem density/ha avg. = 400, 1 site

Frequent species (cover, frequency): Abutilon otocarpum (20%), Acacia cambagei (1, 20%), Atalaya hemiglauca (20%), Carissa lanceolata (20%), Enchylaena tomentosa (20%), Eremophila deserti (20%), Psydrax oleifolia (20%), Salsola kali (20%), Sarcostemma viminale subsp. brunonianum (20%), Senna artemisioides subsp. filifolia (20%)

Stratum: **G**

Height avg. = 0.2m, range 0.1-0.3m, 4 sites

PFC avg. = 7.3%, range 5-11%, 4 sites

Dominant species (relative cover, frequency): Tripogon loliiformis (16, 40%), Paspalidium caespitosum (13, 60%), Enteropogon acicularis (7, 80%), Eragrostis lacunaria (6, 40%), Sporobolus caroli (3, 80%)

Frequent species (cover, frequency): GRAMINOIDS: Enteropogon acicularis (1, 80%), Pennisetum ciliare (80%), Sporobolus caroli (80%), Paspalidium caespitosum (1, 60%), Paspalidium constrictum (60%), Bothriochloa ewartiana (40%), Dactyloctenium radulans (40%), Enneapogon polyphyllus (40%), Enteropogon ramosus (40%), Eragrostis lacunaria (1, 40%), Sporobolus actinocladus (40%), Tripogon loliiformis (1, 40%), Aristida latifolia (20%), Brachyachne convergens (20%), Chloris pectinata (20%), Chrysopogon fallax (20%), Cyperus bifax (20%), Cyperus concinnus (20%), Dichanthium fecundum (20%), Echinochloa colona* (20%), Enneapogon lindleyanus (20%), Enneapogon pallidus (20%), Eragrostis microcarpa (20%), Eragrostis schultzii (20%), Eragrostis setifolia (20%), Eriochloa pseudoacrotricha (20%), Eulalia aurea (2, 20%), Fimbristylis dichotoma (20%), Heteropogon contortus (20%), Iseilema vaginiflorum (20%), Leptochloa decipiens (5, 20%), Leptochloa fusca (1, 20%), Leptochloa fusca subsp. fusca (20%), Oxychloris scariosa (1, 20%), Panicum effusum (20%), Sporobolus coromandelianus* (20%), Sporobolus disjunctus (20%), Tragus australianus (20%), Urochloa gilesii (20%)*
FORBS: Abutilon oxycarpum (60%), Capparis lasiantha (60%), Portulaca oleracea (60%), Sida fibulifera (60%), Sida trichopoda (60%), Alternanthera micrantha (40%), Amyema quandang var. bancroftii (40%), Boerhavia dominii (40%), Chamaesyce drummondii (40%), Commelina lanceolata (40%), Dipteracanthus australasicus (40%), Enchylaena tomentosa (40%), Evolvulus alsinoides (40%), Marsdenia viridiflora (40%), Marsilea hirsuta (40%), Portulaca australis (40%), Salsola kali (40%), Trianthema triquetra (40%), Achyranthes aspera (20%), Alternanthera angustifolia (20%), Alternanthera nana (20%), Atalaya hemiglauca (20%), Centipeda minima (20%), Cheilanthes distans (20%), Einadia hastata (20%), Einadia nutans (20%), Einadia trigonos (20%), Epaltes australis (20%), Galactia tenuiflora (20%), Goodenia lunata (20%), Harrisia martini* (20%), Hibiscus brachysiphonius (20%), Hibiscus krichauffianus (20%), Hybanthus enneaspermus (20%), Hygrophila angustifolia (20%), Indigofera linnaei (20%), Maireana villosa (20%), Malvastrum americanum* (20%), Melhania oblongifolia (20%), Neptunia dimorphantha (20%), Neptunia gracilis (20%), Ocimum tenuiflorum (2, 20%), Parsonsia lanceolata (20%), Phyllanthus maderaspatensis (20%), Portulaca filifolia (20%), Psydrax oleifolia (20%), Rhynchosia minima (20%), Rostellularia adscendens (20%), Sarcostemma brevipedicellatum (20%), Sauropus trachyspermus (20%), Sclerolaena convexula (20%), Sclerolaena diacantha (20%), Sclerolaena everistiana (20%), Sclerolaena ramulosa (20%), Sclerolaena tricuspis (20%), Senna artemisioides (20%), Senna artemisioides subsp. filifolia (20%), Sesbania cannabina (20%), Sida everistiana (20%), Sida spinosa* (20%), Solanum esuriale (20%), Stylosanthes hamata* (20%), Xenostegia tridentata (20%)*

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

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