5. Nature Conservation

This section provides a summary of the nature conservation investigations and the potential impacts identified, in regards to the Project (Mine) during construction and operation. The assessment was undertaken in accordance with the requirements of the Terms of Reference (ToR) and a table cross-referencing these requirements is provided in Volume 4 Appendix C ToR Cross Reference Table. The following detailed reports inform this section:

- *Volume 4 Appendix N Mine Terrestrial Ecology Report*
- *Volume 4 Appendix O Mine Aquatic Ecology Report*

5.1 Introduction

5.1.1 Scope

The study areas for this chapter is defined as EPC1690 (the EPC 1690 Study Area) and EPC1080 and the Project (Mine) airstrip, workers accommodation village and water supply infrastructure (the EPC 1080 Study Area). This Section provides a summary of nature conservation values of both study areas (the Study Area), the potential impacts of the Project (Mine) on those values, measures to manage or mitigation those impacts.

Desktop reviews and field surveys were undertaken to describe and assess the nature conservation values in terms of the integrity of ecological processes and landscapes, conservation of resources, biological diversity, and aquatic and terrestrial ecosystems.

This chapter summarises the more detailed assessment in Volume 4 Appendix N Mine Terrestrial Ecology Report and Volume 4 Appendix O Mine Aquatic Ecology Report.

5.1.2 Methodology

The description of the existing nature conservation values of the Study Area was achieved using a combination of desktop assessments and field studies. The desktop assessment comprised a review of relevant literature and mapping, database searches and existing technical reports. Field studies were conducted to obtain ecological information relevant to the Project (Mine) and to ground-truth results from desktop assessments.

5.1.2.1 Desktop Assessment

Information relating to the terrestrial and aquatic ecological values of the Study Area was obtained from a variety of literature and numerous database sources. Desktop sources undertaken and search extents are summarised in Table 5-1. Further detail on information sources and limitation of the data with respect to this study is provided in Volume 4 Appendix N Mine Terrestrial Ecology Report and Volume 4 Appendix O Mine Aquatic Ecology Report.

Table 5-1 Summary of Desktop Sources

Source/Search Tool	Search Extent	Information Note
DSEWPaC Protected Matters Search Tool and Environmental Reporting Tool.	Point search approximating the centre of the Mine Study Area -22.041, 146.364 with a 50 km buffer	This is a predictive tool identifying species and ecological communities.
DSEWPaC Directory of Important Wetlands	Point search approximating the centre of the Mine Study Area -22.041, 146.364 with a 50 km buffer	This mapping identifies wetlands that satisfy at least one criterion agreed upon by the Australian and New Zealand Environment and Conservation Council (ANZECC) Wetlands Network in 1994
DNRM Regional Ecosystem (RE) and Regrowth Vegetation Mapping.	Geographical Information System (GIS) mapping layer issued by DNRM for within and adjacent to the Study Area	RE mapping is informed by interpretation of landform, substrate, photo/satellite imagery and where available, field data. Regrowth mapping is informed by statewide landcover and tree study (SLATS) foliage protective cover (FPC) and pre-clearing RE mapping. The mapping has undergone little or no ground-truthing in many parts of Queensland
DEHP Environmentally Sensitive Areas Map – Mining Activities	Search based on EPC boundaries	ESAs identified on the map may require field survey and ground-truthing exercises for accuracy
DNRM Essential Habitat and Essential Regrowth Mapping	GIS mapping layer issued by DNRM for within and adjacent to the Study Area	Mapping is underpinned by RE/regrowth mapping, the constraints associated with mapping scale and lack of ground-truthing are applicable to this information source
DEHP Wetland Mapping	GIS mapping layer issued by DEHP for within and adjacent to the Study Area	Wetlands are identified using the DEHP AquaBAMM Methodology. The mapping has undergone little or no ground-truthing in many parts of Queensland
DEHP Biodiversity Planning Assessment (BPA) Mapping and BPA Expert Panel Reports	GIS mapping layer issued by DEHP for within and adjacent to the Study Area	As BPA mapping is underpinned by RE mapping, the constraints associated with mapping scale and lack of ground-truthing is applicable to this information source
DEHP Wildlife Online Database	Point search approximating the centre of the Mine Study Area -22.041, 146.364 with a 50 km buffer	This database catalogues known records of species in a defined area however DEHP recommend that independent verification of records should be undertaken
DEHP HERBRECS Specimen Database, Queensland Museum Data Search, Birds Australia Bird Atlas Data	Rectangular area was searched, such that the diagonal extending from the approximate centre of the Study Area (22.041, 146.364) to each corner was 50 km	These databases catalogue known records of species in a defined area. The age of species records may limit their value for inclusion in current studies in some instances

Source/Search Tool	Search Extent	Information Note
Burdekin Natural Resource Management (NRM) Region Back on Track Actions for Biodiversity report (DERM, 2010a)	The document covers the entire Burdekin NRM region (in which the Study Area occurs)	Some species/impacts listed in this document are not relevant to the Study Area, as the Burdekin NRM region encompasses a large area of central Queensland
Burdekin Dry Tropics & Australian Government Freshwater Fish of Burdekin Dry Tropics NRM Region	The document covers the entire Burdekin Dry Tropics NRM region	Species distributions are described in terms of sub-catchments and distribution maps are useful to identify species with potential to occur.
DEHP Expert Panel Reports: Burdekin Region	These documents assess the riverine and non-riverine wetlands of the Burdekin region	Some species listed in this document are not relevant to the Study Area, as the Burdekin catchment encompasses a large area of central Queensland.
Publically available Environmental Impact Statement (EIS) documents for projects in the wider region surrounding the Study Area.	The description of the existing environmental values of landscapes in which other major development projects are proposed to occur were assessed	The project Study Areas of each of the EIS projects (listed at left) do not always correlate with the Study Area of this project rather provide regional information.

5.1.2.2 Field Surveys

Field surveys were conducted to identify the existing terrestrial and aquatic ecological values of the EPC1690 and EPB1080 Study Area and to supplement and ground-truth the information acquired from the desktop assessment. Desktop information was reviewed to identify areas to be targeted for field studies. Verification was based on direct observations of flora, fauna, fauna traces or suitable habitat for flora and fauna species. Access and conditions (wet/dry) influenced location of field surveys.

Volume 4 Appendix N1 Mine Terrestrial Ecology Report and Volume 4 Appendix O1 Mine Aquatic Ecology Report describe in detail the approaches completed for all terrestrial and aquatic ecology field surveys. Surveys were conducted between November 2010 and August 2012 (refer Table 5-2).

Figure 5-1 depicts the Study Area. For figures representing the distribution of survey effort within the Study Area, refer to Volume 4 Appendix N1 Mine Terrestrial Ecology Report and Volume 4 Appendix O1 Mine Aquatic Ecology Report.

Table 5-2 Temporal Survey Effort on the Mine Site

Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
Terrestrial and surface aquatic flora	60 sites, 19 sites	Spring: November 2010 and November 2011
	168 sites, 17 sites	Autumn: April/May 2011
Terrestrial and surface aquatic fauna	69 sites, 19 sites	Spring: November 2010 and November 2011
	40 sites, 17 sites	Autumn: April/May 2011
Subterranean aquatic fauna	20 groundwater bores	Post-wet: October 2011
	20 groundwater bores	Post-wet: August 2012

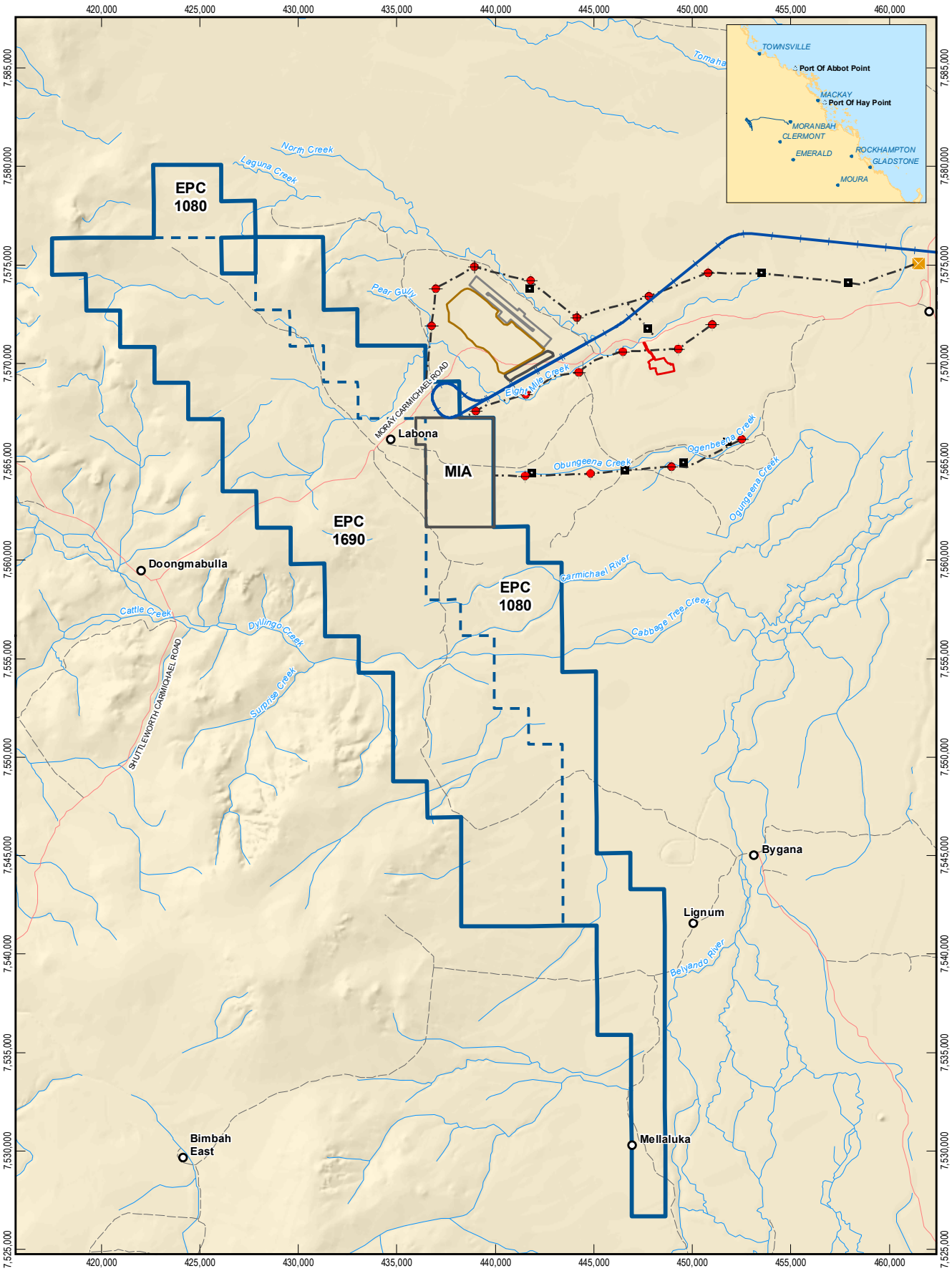
*a combination of rapid and comprehensive survey approaches were used across sites

An aquatic ecology assessment was also undertaken at the nearby Doongmabulla Springs. The details of the assessment and results are documented in Volume 4 Appendix N2 Doongmabulla Springs Existing Environment Report. An assessment of presence and habitat for the black-throated finch in the area adjacent to the mine site was also undertaken in May 2012. The results of this assessment are included Volume 4 Appendix N3 Black Throated Finch Report.

An offsite Water Infrastructure assessment was undertaken by Hyder Consulting on 27 June 2012 in potential locations of water supply options, including existing bores and water storages and potential sites of additional water extraction. A rapid site assessment was undertaken at a number of sites.

Stygofauna sampling was undertaken across two seasons as follows:

- 20 groundwater bores were sampled during the post-wet season 24 - 27 October 2011
- 20 groundwater bores were sampled during the post-wet season 10 - 13 August 2012



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Bioregion Boundary
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

1:275,000 (at A4)

0 1 2 3 4 5

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Study Area

Job Number 41-25215
Revision D
Date 19-11-2012

Figure 5-1

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Bioregion Boundary (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012);. Created by: BW, CA

5.1.2.3 Terrestrial Field Survey Techniques

Terrestrial Flora

Flora surveys employed standardised approaches recognised by regulatory agencies, including CORVEG methodologies defined by the Queensland herbarium (Neldner *et al.*, 2005). The purpose of the flora surveys was to describing the existing floristic environment and to detect the presence of protected species. The employed flora sampling methods were:

- Quadrat sampling
- Plotless sampling
- Site species lists
- Random meander and targeted habitat search techniques where suitable habitat was encountered
- Verification of REs using quaternary site assessment methods
- Brief site descriptions

Terrestrial Fauna

Fauna surveys employed the methods detailed in Table 5-3.

Table 5-3 Summary of terrestrial fauna survey methods

Comprehensive Survey Sites	Rapid Assessment Sites	Additional Areas throughout Study Area
◗ Systematic trapping (comprising Elliott 'A' traps, cage traps, funnel traps, pitfall traps*) ◗ Habitat assessment ◗ Opportunistic search for wildlife traces ◗ Three standardised (20 minute) bird surveys ◗ One hour of active searches for herpetofauna ◗ One night (minimum) of ultrasonic bat detection (Anabat) ◗ Standardised spotlighting for nocturnal fauna ◗ Call-playback for owls	<u>All rapid assessment sites</u> ◗ Habitat assessment ◗ Opportunistic search for wildlife traces ◗ One standardised (20 minute) bird surveys ◗ Half an hour of active searches for herpetofauna <u>Some rapid assessment sites</u> ◗ One night (minimum) of ultrasonic bat detection (Anabat) ◗ Standardised spotlighting for nocturnal fauna ◗ Call-playback for owls	◗ Remote camera ◗ Water body watches ◗ Opportunistic wildlife records

*Pitfall traps only used at some comprehensive survey sites. Where pitfall trapping not undertaken, four additional funnel traps were deployed.

Habitat assessments undertaken at comprehensive and rapid sites recorded the following parameters.

- Landscape context (size, shape, connectivity or relative isolation of habitat remnants)

- Structural and floristic complexity of vegetation (i.e. tree density, canopy cover, vertical structural complexity of vegetation strata – canopy, shrub and understorey layers, ground cover)
- Structural complexity and relative heterogeneity of ground-level microhabitats (i.e. substrate type, vegetation cover, leaf litter, woody debris, presence of rocks, logs or boulders)
- Habitat features (i.e. hollows, fallen logs, rock outcrops, nests, burrows, water bodies, gilgais)
- Relative abundance of hollows and hollow-bearing (habitat) trees
- Sources of disturbance (i.e. adjacent land-uses, feral animals, predation, weed infestation)

Further detail on systematic trapping, opportunistic searches, standardised bird surveys, diurnal active searches for reptiles and amphibians, nocturnal spotlighting and call-playback, anabat bat detectors and remote cameras is provided in Volume 4 Appendix N Mine Terrestrial Ecology Report.

Terrestrial Threatened Species

Targeted surveys for threatened species were incorporated into the sampling methodologies outlined above. Although the surveys generally followed Commonwealth guidelines for detecting threatened species, in some cases the requisite hours and days of survey effort were not met. The survey effort applied to each threatened species with reference to the applicable guideline is detailed in Volume 4 Appendix N Mine Terrestrial Ecology Report.

5.1.2.4 Aquatic Field Survey Techniques

Aquatic Habitat

Aquatic habitat assessments were undertaken to characterise the water bodies with respect to ecological values for aquatic flora and fauna. Seasonal assessment was undertaken at some sites to confirmed the temporal qualities of the aquatic habitats.

Visual habitat assessments of the 100 m reach were used to describe the aquatic ecosystems in terms of habitat diversity and extent, suitability for aquatic fauna groups, sensitivity to change, existing disturbances/modifications or barriers, riparian condition and flow characteristics.

Aquatic Flora

Aquatic flora assessment was undertaken in conjunction with habitat assessments. Species present and relative abundance was recorded.

Riparian assessment was conducted in riparian vegetation communities across the Study Area as part of the terrestrial flora ecology assessment.

Aquatic Fauna

Fauna surveys aimed to supplement the desktop information on fauna species in the region and provide information specific to the Study Area. The sites selected for fauna assessment were environments representative of the aquatic habitats on the site that were expected to be important for fish and crustaceans. Low trapping success in some areas led to the prioritisation for sampling at the riverine and palustrine habitats rather than dams that are considered to have lower habitat values.

Aquatic macroinvertebrate sampling was undertaken in accordance with the AusRivAS Sampling and Processing Manual (NRM, 2001) during the May 2011 and November 2011 surveys.

A survey for fish and crustaceans was undertaken using baited traps during the May 2011 survey and a combination of bait traps and seine netting techniques during the November 2011 survey.

Box and opera house traps were baited and set for a minimum of two hours within suitable habitats. A minimum of eight traps were set at each site. Individual trap placement aimed to sample the variety of microhabitats within the 100 m reach, for example woody debris, root balls and trailing bank vegetation.

Seine netting was conducted using a five metre seine net with a mesh size of 2 mm. The length of the seine transects were determined by the characteristics (depth, length and presence of woody debris) of the water body however they did not exceed 10 m for each trawl.

Subterranean Aquatic Ecosystems

Stygofauna sampling was undertaken using methods outlined in the Western Australia Environmental Protection Agency Guidance Statement No. 54 and 54a. The aim of the surveys was to determine if stygofauna were present in groundwater associated with the Project, and within the constraints of the study design, determine the range of taxa present and their conservation significance.

A 400 m diameter phraetobiological net was used to collect stygofauna samples. Samples were then sorted in the laboratory with individuals identified to Order/Family (or lower taxanomic rank if possible) in accordance with the Project TOR.

Groundwater quality samples were also collected at the time of stygofauna sampling using a hand held water quality meter.

5.1.2.5 Likelihood of Occurrence Assessment

The information acquired through the desktop assessment (refer to Section 5.1.2.1) and field assessments (refer to Section 5.1.2.2) was used to characterise the ecological values of the Study Area. For conservation significant flora and fauna species, a likelihood of occurrence assessment was undertaken to focus the assessment on certain species.

A likelihood of occurrence ranking was attributed to each conservation significant species. Likelihood of occurrence rankings are as follows.

- unlikely to occur
- may occur
- likely to occur
- confirmed present)

The assessment focused predominantly on those species that were ranked as likely to occur or confirmed present. A precautionary method was applied to assigning a likelihood of occurrence ranking to conservation significant flora and fauna (refer to Volume 4 Appendix N Mine Terrestrial Ecology Report). Ranking was assigned based on the following factors.

- Habitat preferences
- Distribution
- Relative abundance
- Previous records from the region

- The occurrence of suitable habitat at the based on field observations
- Confirmed presence at the Study Area

5.1.2.6 Potential Habitat Mapping for Threatened Species and Communities

A methodology was developed to map potential habitat for threatened species and threatened ecological communities (TECs) within the Study Area and adjacent landscape. Potential habitat was mapped for threatened species and TECs that were 'likely to occur' or 'confirmed present' (refer to 5.1.2.5). The methodology incorporated the known distribution, ecology and preferred habitat characteristics of the following threatened species and TECs.

- Black-throated finch
- Squatter pigeon
- Koala
- Ornamental snake and yakka skink
- Brigalow (Acacia harpophylla dominant and co-dominant) TEC

5.1.3 Relevant Legislation

A detailed description of policy and legislation relevant to the nature conservation assessment of the Project (Mine) is included within Volume 4 Appendix N Mine Terrestrial Ecology Report and Volume 4 Appendix O Mine Aquatic Ecology Report. In summary, the relevant policies and legislation are:

- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)
- Commonwealth EPBC Act Environmental Offsets Policy (Consultation Draft)
- Queensland Government Environmental Offsets Policy (QGEOP)
- State Development and Public Works Organisation Act 1974 (SDPWO Act)
- Queensland Nature Conservation Act 1992 (NC Act) and Nature Conservation (Wildlife) Regulation 2006
- Queensland Vegetation Management Act 1999 (VM Act)
- Queensland Sustainable Planning Act 2009
- Queensland Land protection (Pest and Stock Route Management) Act 2002
- Queensland Environmental Protection Act 1994 (EP Act)
- Queensland Environmental Protection (Water) Policy 2009
- State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments (Wetlands SPP)
- Western Australian Environmental Protection Agency Guidance Statements 54 and 54a

5.2 Description of Environmental Values

5.2.1 Study Area

The Study Area occurs in central Queensland within the Carmichael River sub catchment of the Burdekin Catchment (refer to Figure 5-2), at the boundary of the Brigalow Belt and Desert Uplands bioregions. Land use in the catchment is dominated by grazing and natural pasture, where widespread clearing has resulted in a decline in riparian habitat condition (Dight, 2009). Cattle grazing occurs across the Study Area though the intensity of grazing varies with some areas retaining remnant vegetation status. The Bygana West Nature Refuge occurs over part of the southern extent of the Study Area, south of the Carmichael River, and covers an area of approximately 1,487 ha. A number of improvements exist within the Study Area, such as homesteads, an air strip, cattle yards, farm dams and bores.

The main riverine feature of the Study Area is the Carmichael River, which joins the Belyando River almost 20 km downstream of the eastern boundary of the Study Area. Connectivity of remnant vegetation is maintained by vegetation including mature river red gum (Eucalyptus camaldulensis) and Paper Bark (Melaleuca leucadendra) associated with the Carmichael and Belyando rivers. The Study Area drains into a number of ephemeral creeks that become undefined before draining into the Belyando River. The elevated location of the Study Area in the Burdekin Catchment in combination with seasonality of rainfall means stream flows are generally restricted to the wetter months (November to March). During the dryer months (June and July) many streams and drainage channels dry while larger rivers sustain only pools or low flows. It is thought that major watercourses and associated remnant riparian vegetation are to a degree dependant on groundwater to maintain a series of semi-permanent and permanent waterholes in regions upstream of the Project (Mine).

5.2.2 Sensitive Environmental Areas

Nature conservation values of relevance to the Study Area include those listed at the regional, State or Commonwealth level. Table 5-4 summarises the nature conservation values identified by desktop and field investigations for the Project (Mine).

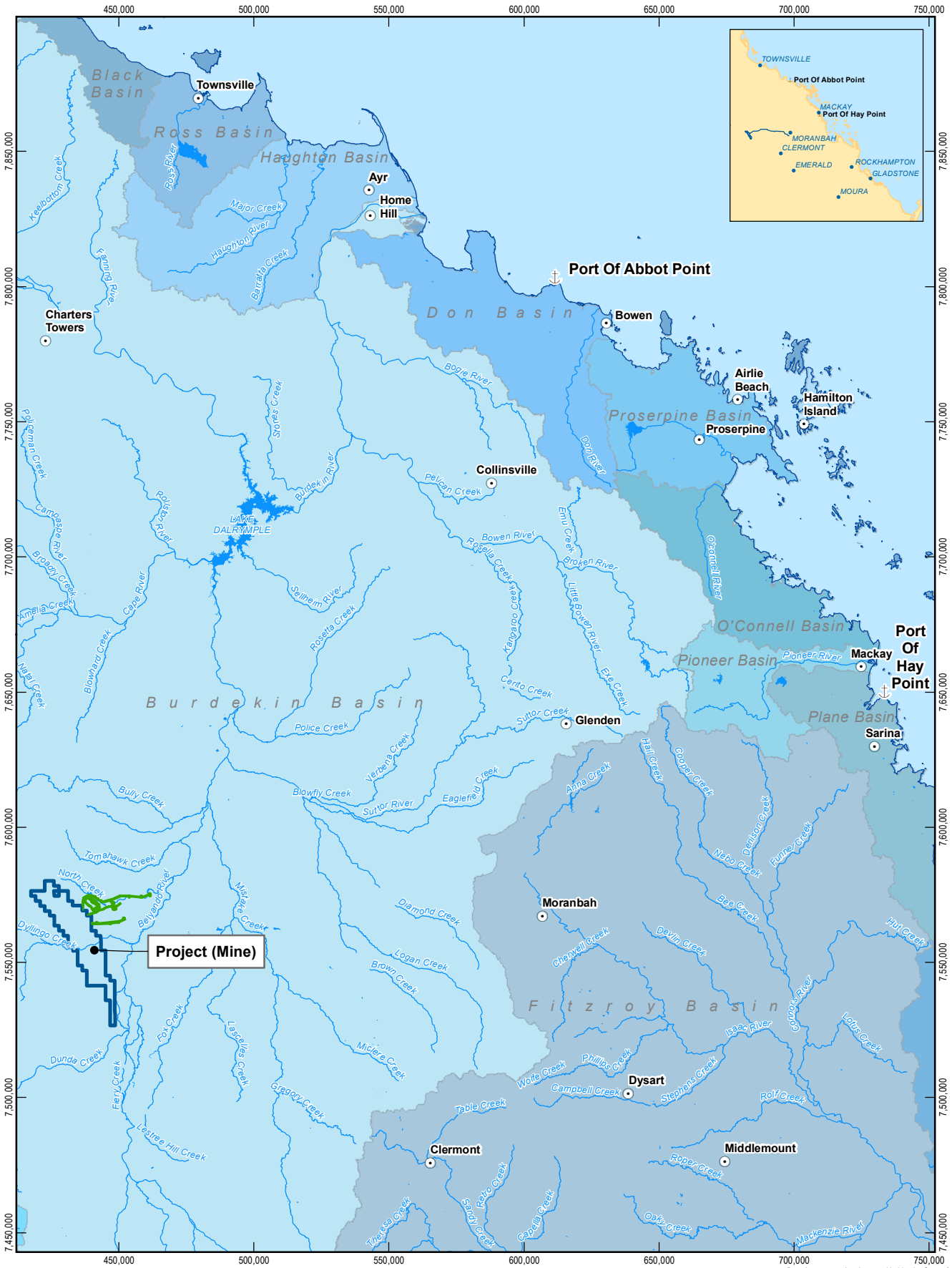
Table 5-4 Summary of Conservation Significant Nature Conservation Values of Study Area

Significance classification	Summary	Section discussed
Commonwealth		
Commonwealth EPBC Act – matters of national environmental significance (controlling provisions based on referral of Project (2010/5736))		
World Heritage properties (section 12 & 15A)	No World Heritage properties within or of relevance to Study Area. The Study Area is located over 300 km due west and approximately 320 km upstream of the Great Barrier Reef World Heritage area and over 300 km south of the Wet Tropics World Heritage area/	Volume 1 Section 13 Volume 4 Appendix N Appendix O

Significance classification	Summary	Section discussed
National Heritage places (section 15B & 15C)	No National Heritage places within or of relevance to Study Area. The Tree of Knowledge and curtilage at Barcaldine is the closest National Heritage place to the Study Area and outside the influence of the Burdekin River. It is located approximately 200 km south-west of the Study Area and not downstream.	Volume 1 Section 13 Volume 4 Appendix N Appendix O
Wetlands (Ramsar) (section 16 & 17B)	No World Heritage properties within or of relevance to Study Area. Shoalwater and Corio Bay is approximately 380 km east of the Study Area, and Coongie Lakes is approximately 800 km south-west of the Study Area.	Volume 1 Section 13 Volume 4 Appendix N Appendix O
Listed threatened species and communities (sections 18 & 18a)	One EPBC Act listed threatened flora species recorded during field surveys in Study Area Three EPBC Act listed threatened fauna species recorded during field surveys in Study Area (a further two EPBC Act listed threatened fauna species considered likely to occur) One EPBC Act listed threatened ecological community (TEC) recorded during field surveys in Study Area	Section 5.2.2.1 (and Volume 1 Section 13)
Listed migratory species (section 20 & 20A)	Three EPBC Act listed migratory species recorded during field surveys in Study Area (a further 11 EPBC Act listed migratory species considered likely to occur)	Section 5.2.2.1 (and Volume 1 Section 13)
Great Barrier Reef Marine Park (section 24B & 24C)	The Study Area is located over 300 km due west and approximately 320 km upstream of the Great Barrier Reef marine park. Significant overland barriers would inhibit any site attributes having an influence on the Marine Park and, as such, this is considered to be not applicable to the Study Area.	Volume 4 Appendix N Appendix O (and Volume 1 Section 13)
Other Commonwealth matters		
Listed marine species	23 EPBC Act listed marine species recorded during field surveys in Study Area (a further 15 EPBC Act listed marine species considered likely to occur)	Section 5.2.2.1
Nationally Important Wetlands	Doongmabulla Springs are listed under the Directory of Important Wetlands and located outside the footprint of the Study Area approximately 11 km west of the centre of the Study Area. The springs are located within the Burdekin catchment and Belyando River subcatchments. Lake Galilee is also listed under the Directory of Important Wetlands though is located over 40 km south-west of the Study Area and not in the same drainage basin.	Section 0
State		
Queensland VM Act		

Significance classification	Summary	Section discussed
Regional ecosystems	Approximately 28,752 ha of REs occur in Study Area (based on amended RE mapping) including areas categorised as least concern, of concern and endangered	Section 0 and 5.2.3
Regrowth vegetation	54 ha of mapped regrowth vegetation occurs in the Study Area	Section 0 and 5.2.3
Essential habitat	No Essential Habitat occurs within the Study Area	Volume 4 Appendix N Appendix O
Queensland EP Act		
Environmentally Sensitive Areas	No Category A ESAs are located within the Study Area. Approximately 1,060 ha of Category B ESAs (endangered Biodiversity Status REs) are located within the Study Area (based on amended RE mapping). The Category C ESA of Bygana West Nature Refuge is located within the Study Area.	Section 0 and 5.2.3
Queensland NC Act		
Threatened flora species	One NC Act-listed threatened flora species recorded during field surveys in Study Area	Section 0 and 5.2.3.3
Threatened fauna species	Five NC Act-listed threatened fauna species recorded during field surveys in Study Area (a further four NC Act listed threatened fauna species considered likely to occur) Five special least concern animals recorded during field surveys in Study Area (a further 11 NC Act listed special least concern species considered likely to occur)	Section 0
Protected areas	Six protected areas occur within 50 km of the Study Area. ◗ Bygana West Nature Refuge – occurs within southern part of Study Area ◗ Epping Forest National Park (Scientific) – approx. 45 km SE of centre of Study Area ◗ Doongmabulla Mound Springs Nature Refuge – approx. 10 km W of Study Area ◗ Bygana Nature Refuge – approx. 25 km SE of centre of Study Area ◗ East Top Nature Refuge – approx. 35 km SE of centre of Study Area ◗ Wilandspey Conservation Park – approx. 40 km NE of centre of Study Area	Section 0
GBR Wetland Protection Areas	Three GBR Wetland Protection Areas are mapped within the Study Area.	Section 0
Regional		

Significance classification	Summary	Section discussed
DEHP Biodiversity Planning Assessment	Regionally significant RE patches occur in the landscape around the EPC 1690 Study Area and in the southern section of the EPC 1080 Study Area, mainly with Bygana West Nature Refuge All remnant vegetation at the EPC 1690 Study Area is categorised as having very high or high ecosystem diversity. Remnant vegetation is more fragmented within the offsite infrastructure and and central parts of the EPC 1080 Study Area. Much of the EPC 1690 Study Area is mapped as very high connectivity, particularly the northern and southern sections. Connectivity is categorised as high or very high in the north section of the EPC 1080 Study Area and in areas south of Cabbage Tree Creek.	Section 0
Burdekin Natural Resource Management (NRM) Region Back on Track Actions for Biodiversity report priority taxa	One priority species, the black throated finch, was confirmed present during field surveys of the Study Area. Two priority species, the ornamental snake and the yakka skink, were likely to occur in the likelihood of occurrence assessment.	Section 5.2.2.3



LEGEND

- Town
- Major Port
- Watercourse
- Waterbody
- Mine (Onsite)
- Mine (Offsite)

1:2,000,000 (at A4)

0 10 20 30 40 50

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Relationship of Study Area to River Catchments

Job Number 41-25215
Revision C
Date 05-10-2012

Figure: 5-2

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DERM: Drainage Basins (2009); GA: Towns, Mainland, Watercourses, Waterbodies (2007); Adani: Mine Layout / Infrastructure (2012); Gassman/Hyder: Mine (Offsite) (2012),Major Ports (2010); DME: EPC1690 (2010), EPC1080 (2011). Created by: BW.

5.2.2.1 Commonwealth Matters of Conservation Significance

A Commonwealth matters of national environmental significance (matters of NES) are relevant to the Study Area (refer to Table 5-4). These include threatened flora, threatened ecological communities (TECs) and threatened fauna, including migratory and marine species listed under the EPBC Act. These matters of NES are discussed here and again in Volume 1 Section 10 Matters of NES Report. Further detail on the likelihood of occurrence assessment of EPBC Act listed threatened flora and fauna is provided in Volume 4 Appendix N Mine Terrestrial Ecology Report.

Listed Threatened Flora

The desktop assessment and Project terms of reference identified 11 EPBC Act listed threatened flora species with the potential to occur within the Study Area. None were confirmed present by field surveys of the Study Area. A likelihood of occurrence assessment for EPBC Act listed threatened flora was undertaken and no species were ranked likely to occur.

The following EPBC Act listed threatened flora species was confirmed present during a flora field survey of the EPC 1690 Study Area.

- Waxy cabbage palm (Livistona lanuginosa)

Listed Threatened Ecological Communities

TECs are ecological communities that have been assessed under the EPBC Act and assigned one of the following categories based on the level of threat to the community.

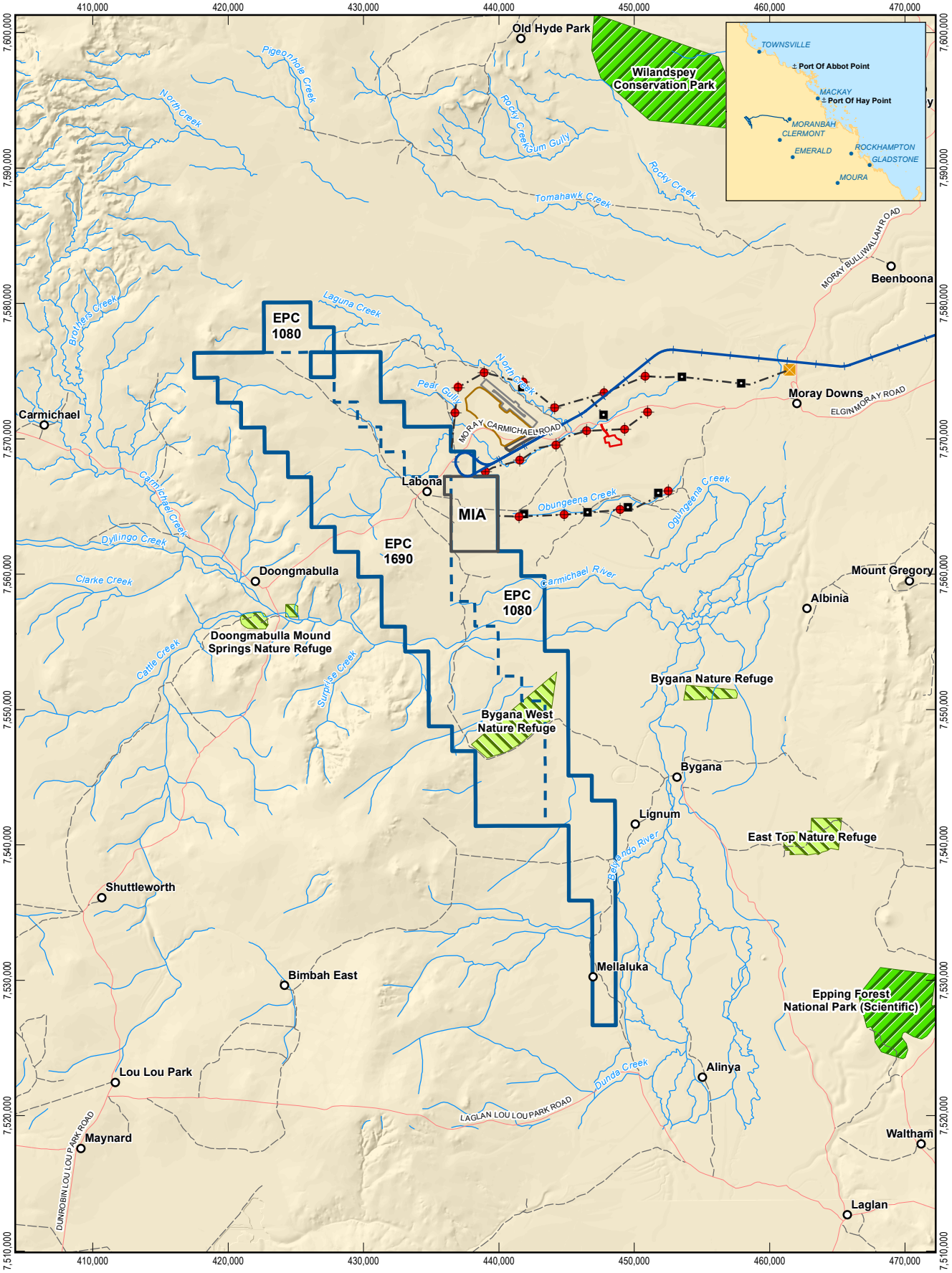
- conservation dependent
- vulnerable
- endangered
- critically endangered
- extinct in the wild

The desktop assessment identified the two following TECs with potential to occur in the Study Area. Both TECs are classified as endangered.

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin

Only the Brigalow TEC was identified as occurring in the Study Area from field surveys. However, impacts to regional aquifers as a result of groundwater draw down have the potential to impact the community of native species dependent on natural discharge of groundwater from the GAB.

The nearest GAB discharge spring is a cluster of 11 springs approximately 10 km west of the Study Area, known of Doongmabulla Springs (refer to Figure 5-3). Doongmabulla springs contains six flora species of conservation significance, including two endemic species (the herb *Eryngium fontanum* and the grass *Sporobolus pamelae*). Doongmabulla Springs was given a GAB discharge spring wetland conservation ranking of 1a (the highest), based on the presence of these endemic species (Fensham et al, 2010). The existing environment of Doongmabulla Springs is discussed further in Section 5.2.2.2.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Protected Area
- Nature Refuge
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

1:400,000 (at A4)

0 2.5 5 7.5 10

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Protected Areas Within 50 km of Project Area

Figure 5-3

Job Number	41-25215
Revision	B
Date	05-10-2012

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Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Protected Area, Nature Refuge (2010); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

Listed Threatened Fauna

The desktop assessment and Project terms of reference identified 15 EPBC Act listed threatened fauna species within Study Area. The following three species were confirmed present during field surveys.

- Black-throated finch (southern) (*Poephila cincta cincta*)
- Squatter pigeon (southern) (*Geophaps scripta scripta*)
- Koala (*Phascolarctos cinereus*) (combined populations of Queensland, New South Wales and the Australian Capital Territory)

A likelihood of occurrence assessment for EPBC Act listed threatened fauna was undertaken and the following two species were ranked likely to occur.

- Ornamental snake (*Denisonia maculata*)
- Yakka skink (*Egernia rugosa*)

Listed Migratory Species

Three EPBC Act listed migratory birds were confirmed present during field surveys.

- Eastern great egret (*Ardea alba*)
- Rainbow bee-eater (*Merops ornatus*)
- Satin flycatcher (*Myiagra cyanoleuca*)

A likelihood of occurrence assessment for EPBC Act listed threatened fauna was undertaken and an additional 11 migratory birds were ranked likely to occur.

- Common sandpiper (Actitis hypoleucos)
- Fork-tailed swift (Apus pacificus)
- Curlew sandpiper (Calidris ferruginea)
- Latham's snipe (Gallinago hardwickii)
- White-bellied sea eagle (Haliaeetus leucogaster)
- White-throated needletail (Hirundapus caudacutus)
- Caspian tern (Hydroprogne caspia)
- Black-tailed godwit (Limosa limosa)
- Glossy ibis (Plegadis falcinellus)
- Common greenshank (Tringa nebularia)
- Marsh sandpiper (Tringa stagnatilis)

These species are common and widespread, and suitable habitat is likely to occur over much of the surrounding landscape. As such, the Study Area was not considered 'important habitat' defined in the Significant Impact Guidelines (DEWHA, 2009c).

Listed Marine Species

A total of 23 EPBC Act listed marine species were recorded during field surveys in the Study Area (refer to Volume 4 Appendix N Mine Terrestrial Ecology Report). These species included the three

EPBC Act listed migratory species confirmed present during field surveys. These EPBC Act listed marine birds are widespread, common woodland and/or wetland species, and are likely to occur across the surrounding landscape wherever suitable habitat is available. As such, the Study Area was not considered 'important habitat' defined in the Significant Impact Guidelines (DEWHA, 2009c).

5.2.2.2 State Matters of Conservation Significance

Regional Ecosystems

A total of 36 field REs were field verified within the Study Area. All are classified by the VM Act as being least concern with the exception of:

- RE 10.7.4, RE 11.3.3 and RE 11.4.6 – of concern
- RE 11.3.1, RE 11.4.8 and RE 11.4.9 – endangered

The occurrence and extent of REs within the Study Area is described in Section 5.2.3 and mapped in Figure 5-8.

Environmentally Sensitive Areas

Regional ecosystems (RE) with a biodiversity status of endangered are classified as Category B ESAs. The DEHP ESA Map for Mining Activities identifies a number of Category B ESAs within the Study Area. Field verifications of the DEHP certified RE mapping confirmed the presence of seven Category B ESAs (10.4.3, 10.9.3, 11.3.1, 11.4.5, 11.4.6, 11.4.8 and 11.4.9) covering an area of 1054 ha (refer to Figure 5-4). A summarised description of Category B ESA RE types is provided in Table 5-6 in Section 5.2.3. The Bygana West Nature Refuge located in the south of the Study Area is classified as a Category C ESA. The refuge is shown in Figure 5-3. No Category A Environmentally Sensitive Areas (ESA) are present within the Study Area.

Mapped Regrowth Vegetation

The Study Area includes four patches of regulated, non-remnant regrowth vegetation, covering an area of approximately 45 ha. The regrowth is mapped as least concern regrowth REs 11.3.28a and 11.3.6a. Mapped regrowth is discussed in further detail in Section 5.2.3. The regrowth mapping is provided as Figure 5-9.

Essential Habitat

No DNRM Essential Habitat is mapped within the Study Area. Essential Habitat for nine NC Act listed species occurs within 50 km of the Study Area. Potential habitat for threatened species is discussed in Section 5.2.4.

Listed Threatened Flora

Waxy cabbage palm was the only flora species listed as threatened under the NC Act to be confirmed present within the Study Area. This species is listed as vulnerable, and was observed as two mature individuals in the channel of the Carmichael River. The desktop assessment indicated that 11 NC Act listed threatened flora species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Study Area and a further six NC Act listed threatened flora species were identified in the Project terms of reference for consideration in this assessment. Of these, none were confirmed present during field surveys in the Study Area. The waxy cabbage palm

was identified during a flora field survey of the EPC 1690 Study Area, despite not being identified by the desktop assessment.

Listed Threatened Fauna

The desktop assessment indicated that 19 NC Act listed threatened fauna species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Study Area. Of these, five were confirmed present during field surveys in the Study Area:

- Black-throated finch (southern)
- Squatter pigeon (southern)
- Black-necked stork (Ephippiorhynchus asiaticus)
- Cotton pygmy-goose (Nettapus coromandelianus)
- Little pied bat (Chalinolobus picatus)

A likelihood of occurrence assessment for NC Act listed threatened fauna species was undertaken and an additional two species are considered likely to occur within the Study Area:

- Square-tailed kite (Lophoictinia isura)
- Black-chinned honeyeater (*Melithreptus gularis*)

These species have the potential to occur in remnant open woodland vegetation at the Study Area (i.e. *Ironbark-box grassy woodlands and open woodlands on grey sand plains*). Riparian and floodplain vegetation associated with the Carmichael River are likely to represent particularly ideal habitat for the square-tailed kite and black-chinned honeyeater.

Information regarding these species and their habitat availability within the Study Area is provided in Section 5.2.4.2.

An additional NC Act listed threatened fauna species (greater long-eared bat (*Nyctophilus timoriensis*)) was identified in the Project terms of reference for consideration in this assessment. This species was not identified through the desktop assessment (i.e. predicted to occur or previously recorded in desktop search extent), nor was it confirmed present during field investigations.

EPBC listed migratory species are also considered special least concern under the NC Act. Three EPBC Act listed migratory birds were recorded in the Study Area, and an additional 11 migratory birds were considered likely to occur (refer to Section 5.2.2.1).

Protected Areas

Two protected areas are considered to be relevant to the Study Area:

- Bygana West Nature Refuge within the southern section of Study Area
- Doongmabulla Mound Springs Nature Refuge 10 km west of the Study Area centre

The Bygana West Nature Refuge covers 1,487 ha at a south west to north east angle across the southern part of the Study Area, to the south of the Carmichael River (see Figure 5-3).

As documented in the Queensland *Nature Conservation (Protected Areas) Amendment Regulation* (No. 1) 2005, Bygana West Nature Refuge is characterised by the following values:

Contains endangered RE 11.4.6 (*Acacia cambagei* woodland on Cainozoic clay plains), confirmed during the field survey as present within the Study Area

Contains endangered RE 11.4.8 (*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains) – this RE has low representation in the protected areas estate and was not observed within the Study Area

Contains other REs that are poorly represented in the protected area estate

Due to its location at the boundary of the Brigalow Belt and Desert Uplands bioregions, Bygana West has potential to support high diversity of species and REs

Contains suitable habitat for a variety of animals, including the koala - a special least concern species under the NC Act confirmed present in the Study Area

Four fauna habitat types were described in the Bygana West Nature Refuge:

- Ironbark-box grassy woodlands and open woodlands on grey sand plains
- Yellow jacket and rough-leaved bloodwood shrubby low open woodland on red sand plains
- Tall mixed shrubland on red sand plains and over ferricrete
- Gidgee and/or brigalow shrubby woodland, sometimes with Dawson's gum emergents, on clay and loam plains

Disturbance (i.e. weeds, erosion, and cattle degradation) was not obvious at Bygana West Nature Refuge, although cattle grazing does occur. Habitats were typically in good condition, and retained connectivity to remnant vegetation to the northwest, west, south and east. Fauna diversity was similar to that from other open woodland habitats in the Study Area, comprising a variety of common woodland and grassland birds, reptiles and ground-dwelling mammals. The black-throated finch (southern) and squatter pigeon (southern) were observed near the southern boundary of the nature refuge – it is likely that both species utilise habitats within the nature refuge. Koalas were not recorded however are considered likely to occur, at low densities.

Plate 5-1 *Eucalyptus brownii* woodland with grass understorey that typified southern part of Bygana West Nature Refuge (April 2011); acacia (right) woodland fringing ephemeral drainage line – southern part of Bygana West Nature Refuge (April 2011)

Doongmabulla Mound Springs Nature Refuge corresponds with the area listed under the directory of nationally important wetland discussed in Section 5.2.2.1. The nature refuge consists of two discrete sections that cover 280 ha.

Doongmabulla Springs are a permanent habitat type unique to the surrounding area. The springs are habitat for a number of threatened plant species (DSEWPaC, 2010). The plant communities include mixed grassland, sedgeland and forbland (DSEWPaC, 2010). The site is currently, and has historically been, used for watering domestic stock and existing key threats are identified as trampling and grazing by stock and feral animals, as well as aquifer draw down (DSEWPaC, 2010). The springs are expected to provide a permanent refuge habitat for aquatic flora and fauna in an area where most watercourses are ephemeral and only large watercourses sustain standing water throughout the year. The opportunity for recruitment may be reduced as a result of low connectivity to migration paths (rivers, streams).

Doongmabulla Springs is also recognised as a Great Artesian Basin (GAB) discharge spring. The EPBC Act lists the community of native species dependant on natural discharge of groundwater from the GAB as a TEC (refer to Section 5.2.2.1). The community comprises species of flora and fauna including fish, invertebrates and aquatic and terrestrial plants clustered around discharge springs emanating from the GAB (Fensham, Ponder and Fairfax, 2010).

As documented in the *Nature Conservation (Protected Areas) Amendment Regulation* (No. 5) 2000, Doongmabulla Mound Springs Nature Refuge is characterised by the following values:

- Contains significant artesian springs
- Supports the largest Australian populations of the plants Eryngium fontanum (endangered – EPBC Act; NC Act) and Sporobolus pamelae (endangered – NC Act)
- Supports the endangered plant Eriocaulon carsonii (near artesian springs).

Remnant vegetation is mapped as occurring within and surrounding the Doongmabulla Mound Springs Nature Refuge. This remnant vegetation extends in a largely intact tract to the north, south and west of the nature refuge. Remnant vegetation extends eastwards from the nature refuge to the Study Area.

An additional four protected areas occur within 50 km of the Study Area:

- Bygana Nature Refuge – approximately 25 km south east of centre of Study Area
- Epping Forest National Park (Scientific) – approximately 45 km south east of centre of Study Area
- East Top Nature Refuge – approximately 35 km south east of centre of Study Area
- Wilandspey Conservation Park – approximately 40 km north east of centre of Study Area

Great Barrier Reef Wetland Protection Areas

Great Barrier Reef (GBR) Wetland Protection Areas have been mapped by DEHP using the Aquatic Biodiversity Assessment Mapping Methodology (AquaBAMM) (Clayton *et al*., 2006) which identifies relative wetland conservation values within a catchment. The mapping uses a range of criteria, indicators and measures in combination with peer review to categorise the riverine and non-riverine freshwater wetlands in the catchment. Where more detailed site information is available mapped areas can be refined using the Queensland Wetland Definition and Delineation Guideline (DERM, 2010).

Three GBR Wetland Protection Areas (WPA) are mapped in the Study Area (Figure 5-3). The mapping data describes the mapped areas as displaying one of the 'priority ecosystem/special features' within the catchment. That being that these mapped areas are 'seasonal palustrine/swamps

of the floodplain with native macrophyte communities (Regional Ecosystem (RE) 11.3.27)'. Ground-truthing of the vegetation communities in the three WPA areas did not confirm the presence of RE 11.3.27 and in some cases no remnant vegetation was detected.

The WPAs are mapped north of the Carmichael River up to two kilometres from the waterway. Ground-truthing at these locations did not detect any standing water at the time of survey.

The western most mapped WPA and the WPA mapped where the boundaries of EPC 1690 and EPC 1080 meet displayed little evidence of water retention. Ground-truthing of the vegetation confirmed that the area is comprised on non-remnant vegetation and does not appear to provide ecological values for aquatic flora and fauna (Plate 5-2).

Plate 5-2 Western most mapped WPA (August 2011); WPA on the boundary between EPC1690 and EPC1080 (November 2011)

The third WPA is mapped at the east of the Study Area on a first order stream that joins the Carmichael River downstream of the area. Ground-truthing of this location detected remnant vegetation RE 11.3.3 within a shaded depression. The watercourse is expected to channel localised rainfall into the mapped wetland area. The area surrounding the WPA is predominantly cleared, and dominated by grasses and some woody regrowth. No standing water or associated aquatic vegetation was present at the time of the survey (Plate 5-3). Evidence of recent water was noted with many of the surrounding trees exhibiting a watermark at about 0.5 m from the ground level. Recent waterbird nesting activity was also observed in the form of numerous nests (no longer being used). Although the special feature regional ecosystem community was not present, the WPA is likely to provide seasonal habitat for aquatic species including waterbirds during the wet season or after significant rainfall.

Plate 5-3 Great Barrier Reef Wetland Protection Area at the east of the Study Area (November, 2011)

5.2.2.3 Regional Matters of Conservation Significance

DEHP Biodiversity Planning Assessment Mapping

Three BPA mapping criteria were applied to the Study Area and surrounding landscape, such that the potential habitat values within and beyond the Study Area could be described. The criteria applied include:

Criteria B2 – Ecosystem value at regional scale (Figure 5-5). A number of remnant vegetation patches considered to be regionally significant with respect to biodiversity value occur in the landscape around the Study Area, while several small patches occur within the Study Area (corresponding with of concern remnant vegetation).

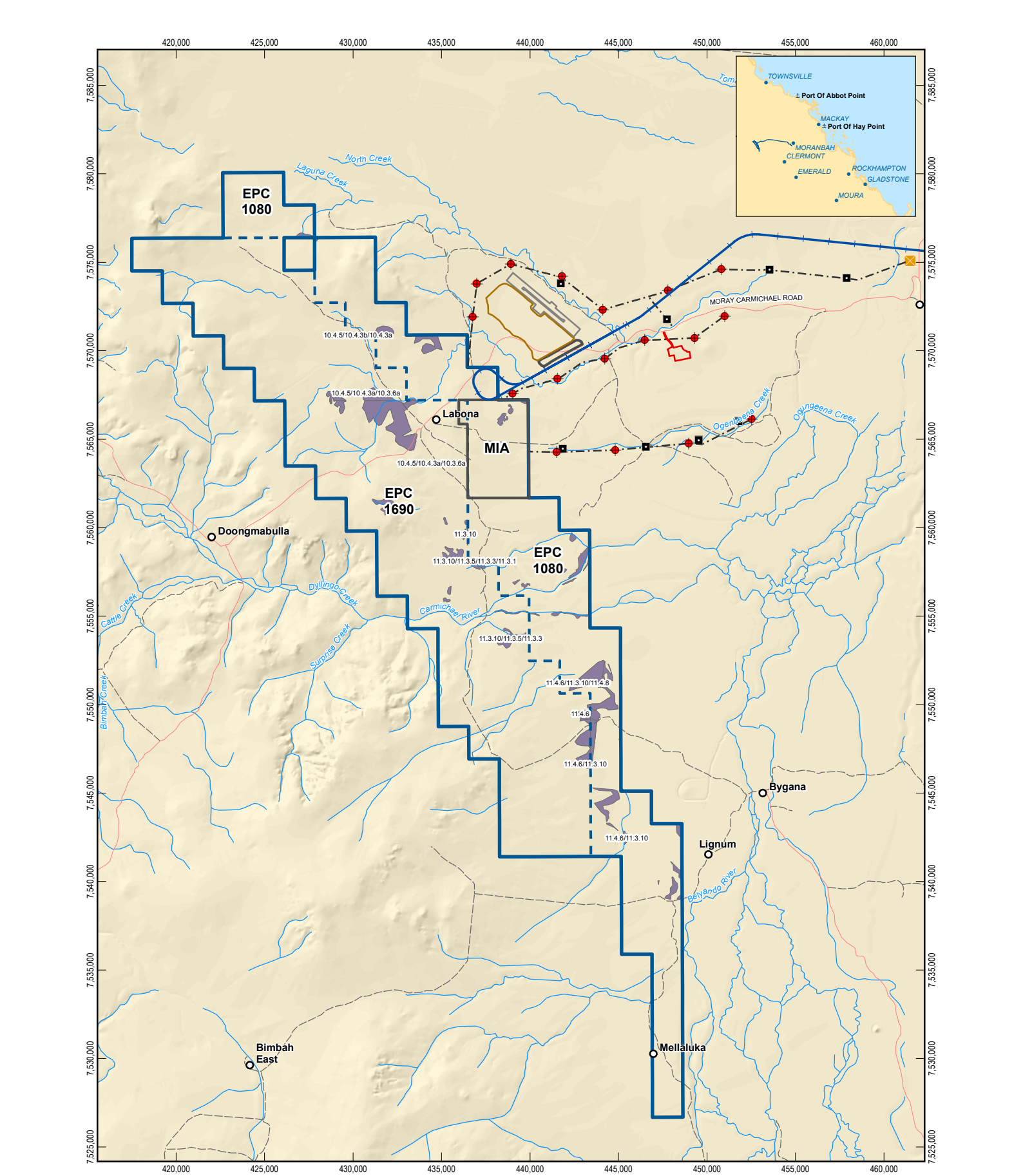
Criteria F – Ecosystem diversity (Figure 5-6). All remnant vegetation at the Study Area is categorised as having very high or high ecosystem diversity. Much of the landscape to the north, west and south of the Study Area is similarly ranked as having very high or high ecosystem diversity. Remnant vegetation coverage is more patchy to the east of the central part of the Study Area, and thus, REs considered to be of very high or high ecosystem diversity are more fragmented at this location. However remnant vegetation ranked as having very high or high ecosystem diversity does form an east to west linkage from the Belyando River through the southern part of the Study Area (i.e. within and to the south of Bygana West Nature Refuge) to the west of the Study Area (where remnant vegetation coverage is extensive).

Criteria G – Context and connection (Figure 5-7). Much of the Study Area is mapped as very high, particularly the northern and southern parts of the Study Area. This very high mapped remnant vegetation continues largely uninterrupted to the north and south of the Study Area, whilst to the west

it is more fragmented. To the east of the central part of the Study Area, large tracts of non-remnant vegetation are present and are thus not mapped under this criterion. The remnant vegetation that connects the Belyando River with the southern part of the Study Area is predominantly ranked as being very high or high under Criteria G.

Burdekin Natural Resource Management Region Priority Taxa

The Burdekin NRM 'Back on Track Actions for Biodiversity' report (the 'Back on Track report') (DERM, 2010a) identifies priority species in the Burdekin NRM region, details the regional threatening processes impacting upon these species, and proposes a range of actions to address regional threats. Six priority plant species and eight priority vertebrate fauna species listed in the Back on Track report have been historically recorded in the desktop search extent for the Study Area. Of these, one species – black-throated finch (southern) was recorded during field surveys at the Study Area and two species, ornamental snake and yakka skink, are considered likely to occur. Listed fauna species are discussed in greater detail in Section 5.2.4.2.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Endangered Regional Ecosystem (Biodiversity Status)
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Environmentally Sensitive Areas
Category B Field Verified

Job Number 41-25215
Revision C
Date 05-10-2012

Figure 5-4

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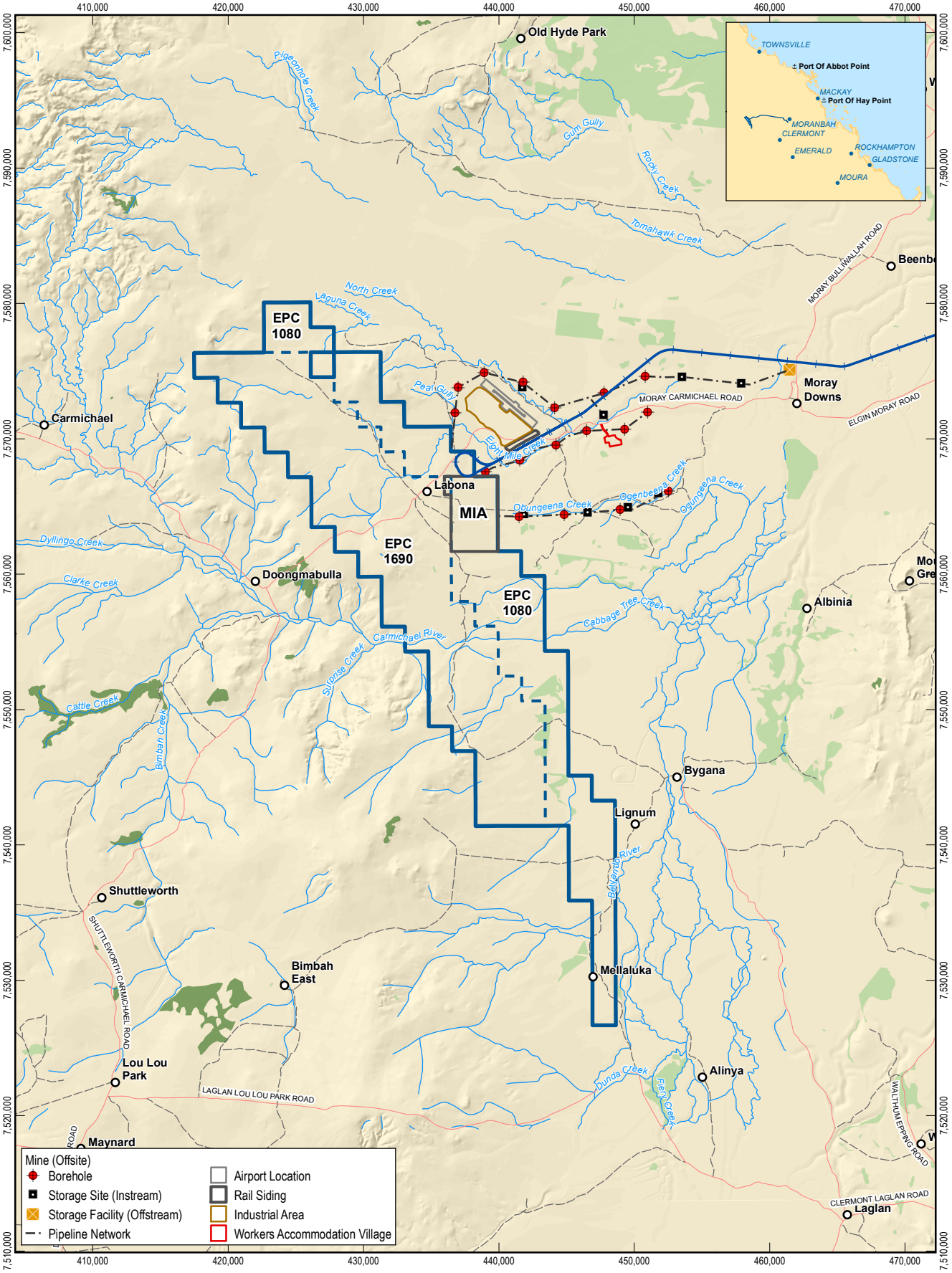
Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Regional Ecosystems v6.1 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Verified Sensitive Areas (2011). Created by: BW, CA



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Biodiversity Planning Assessment - Criteria B2
Ecosystem Value at Regional Level
- Very High
- High

1:400,000 (at A4)
0 2.5 5 7.5 10
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

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BPA Mapping - Ecosystem Value at Regional Level

Job Number 41-25215
Revision C
Date 05-10-2012

Figure 5-5

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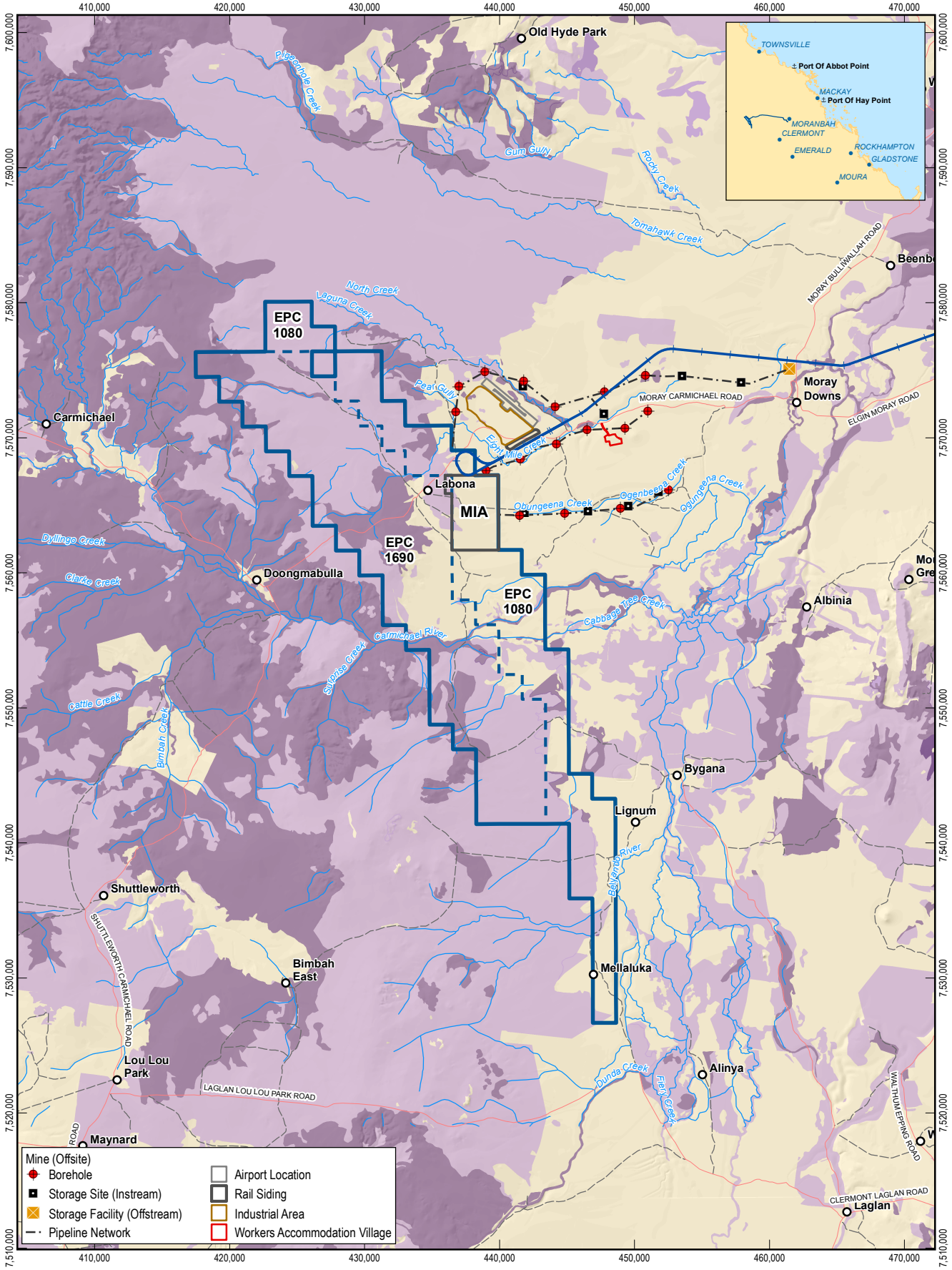

LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Biodiversity Planning Assessment - Criteria F
Ecosystem Diversity
- Very High
- High

1:400,000 (at A4)
0 2.5 5 7.5 10
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision C
Date 05-10-2012

BPA Mapping - Ecosystem Diversity Figure 5-6

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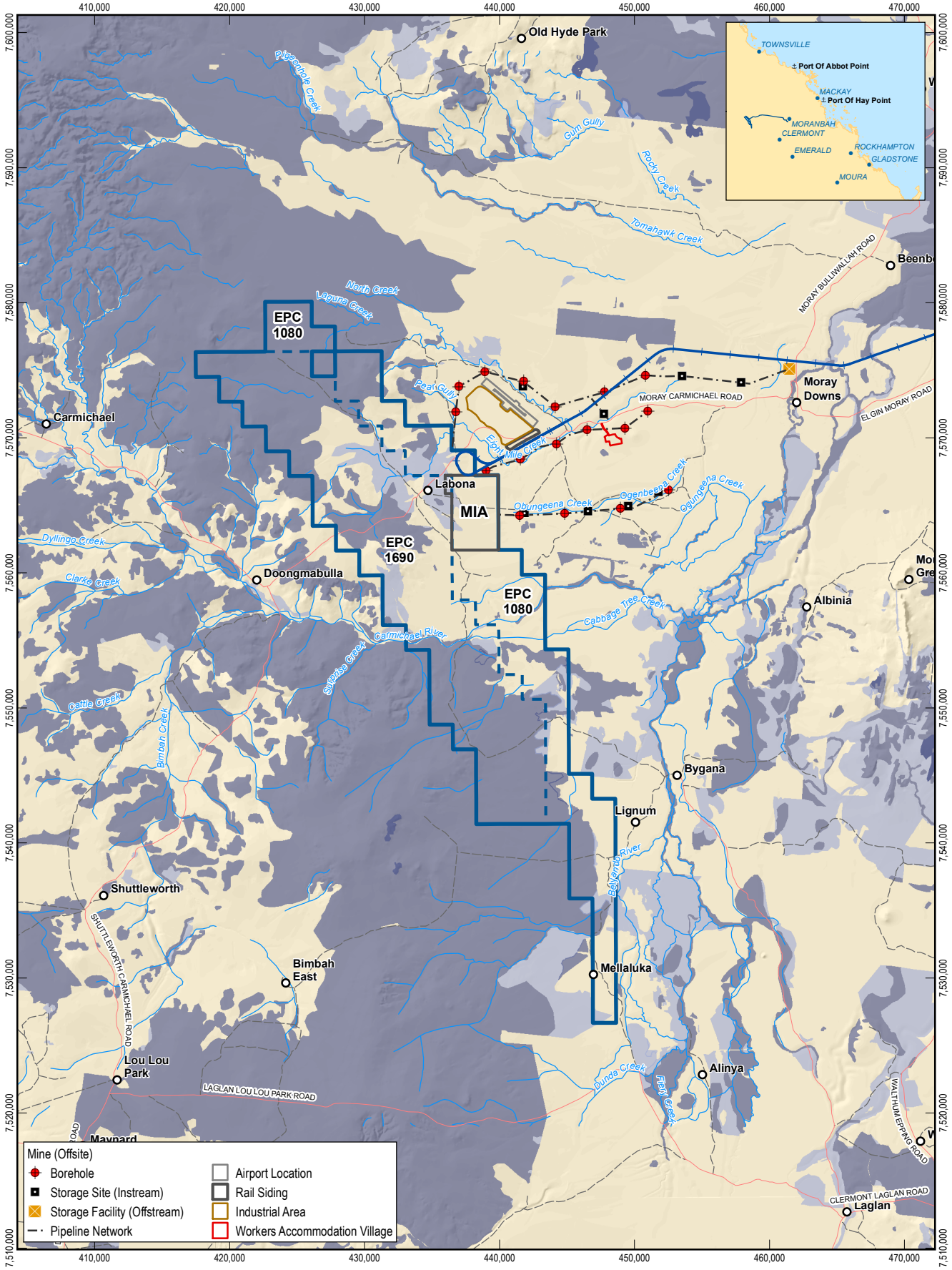
Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Biodiversity Planning Assessment (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012);. Created by: BW, CA



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Biodiversity Planning Assessment - Criteria G
Context and Connection
- Very High
- High

1:400,000 (at A4)
0 2.5 5 7.5 10
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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BPA Mapping - Context and Connection

Job Number 41-25215
Revision D
Date 05-10-2012

Figure 5-7

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Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Biodiversity Planning Assessment (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012);. Created by: BW, CA

5.2.3 Terrestrial Flora

Regional Ecosystems

A total of 22 Desert Uplands REs and 14 Brigalow Belt REs are within the Study Area based on field verified RE mapping. All are classified by the VM Act as being least concern with the exception of:

- RE 10.7.4, RE 11.3.3 and RE 11.4.6 – of concern
- RE 11.3.1, RE 11.4.8 and RE 11.4.9 – endangered

Ground-truthing detected a number of changes from the latest DEHP certified RE mapping where identified. Table 5-5 summarises the changes. Figure 5-8 depicts the field verified RE mapping and henceforth, this report will refer to the field verified REs unless otherwise indicated (by the prefix 'officially mapped'). Smaller scale ground-truthed mapping (1:10 000) and the latest DEHP certified mapping, is provided in Volume 4 Appendix N.

Table 5-5 Summary of Regional Ecosystem Mapping Changes from Ground-truthing

Bioregion	Officially mapped but not present	Present but not officially mapped
Brigalow Belt	11.3.3	11.4.9
	11.3.5	11.3.27
	11.4.5[1]	
	11.4.8	
	11.4.11[1]	
Desert Uplands	10.3.12	10.3.13
	10.3.25	10.3.14
	10.5.2	10.5.1
	10.7.10	10.5.7
	10.7.11	10.5.8
		10.7.2
		10.7.5
		10.7.7
		10.9.3

1 RE was not observed from field verifications undertaken within the EPC 1080 during the Spring 2011 survey, however RE is officially mapped within the offsite infrastructure where field verification was not undertaken.

Regulated Regrowth Vegetation

A number of small patches of regulated regrowth vegetation in the EPC 1080 Study Area cover 35 ha. A single patch of regulated regrowth vegetation in the EPC 1690 Study Area covers 6 ha. Regrowth mapping is provided as Figure 5-9.

Table 5-6 Regional Ecosystems within the Study Area

RE	VM Act class/ Biodiversity status	Short Description	Area within the Study Area (based on field verified mapping)
Desert Uplands REs			
10.3.3	least concern/ no concern at present	*Acacia harpophylla* +/- *Eucalyptus cambageana* low open woodland to open woodland on alluvial plains.	Present in a lower catchment location on alluvial associated with, and south of, the Carmichael River and in mixed polygon north of the Moray-Carmichael Road. Approximately 136 ha within the EPC 1690 Study Area. Approximately 47 ha within the EPC 1080. Approximately 183 ha in total.
10.3.4	least concern/ of concern	*Acacia cambagei* low open woodland to low woodland on alluvial plains.	Present south of the Carmichael River in two small patches and in mixed polygon north of the Moray-Carmichael Road. Approximately 20 ha within the EPC 1690 Study Area. Approximately 101 ha within the EPC 1080 Study Area. Approximately 121 ha in total.
10.3.6	least concern/ no concern at present	*Eucalyptus brownii* open woodland on alluvial plains.	Present on plains in large tracts contiguous with ironbark woodland. Approximately 2,933 ha within the EPC 1690 Study Area. Approximately 1,141 ha within the EPC 1080 Study Area. Approximately 4,074 ha in total.
10.3.12	least concern/ no concern at present	*Corymbia dallachiana and C. plena* or *C. terminalis* open woodland on sandy alluvial terraces (eastern).	Present in association with box woodland and RE 10.3.6 located south of Cabbage Tree Creek. Not observed in EPC 1690 Study Area. Approximately 198 ha within the EPC 1080 Study Area.

RE	VM Act class/ Biodiversity status	Short Description	Area within the Study Area (based on field verified mapping)
10.3.13	least concern/of concern	*Melaleuca fluviatilis* +/- *Eucalyptus camaldulensis* woodland along watercourses.	Present in one patch on a scroll plain associated with the Carmichael River and as fringing vegetation along the Carmichael River. Approximately 18 ha within the EPC 1690 Study Area. Approximately 52 ha within the EPC 1080 Study Area. Approximately 70 ha in total.
10.3.14	least concern/ of concern	*Eucalyptus camaldulensis* +/- *E. coolabah* open woodlands along channels and floodplains.	Present along the Carmichael River and in small patches on the Carmichael River floodplain. Approximately 32 ha within the EPC 1690 Study Area. Approximately 7 ha within the EPC 1080 Study Area. Approximately 39 ha in total.
10.3.28	least concern/ no concern at present	*Eucalyptus melanophloia* or *Eucalyptus crebra* open woodland on sandy alluvial fans.	One of the major vegetation communities, present in large patches contiguous with box woodland. Approximately 4567 ha within the EPC 1690 Study Area. Approximately 1881 ha within the EPC 1080 Study Area. Approximately 6,448 ha in total.
10.4.3	least concern/ endangered	*Acacia harpophylla* and/or *Eucalyptus cambageana* open woodland on Cainozoic lake beds.	Present as *A. harpophylla* woodland with *E. cambageana* emergents in relatively large patches in the vicinity of the Moray-Carmichael Rd, intergrading with box woodland. Present within patches either singularly or within a mosaic with *A. cambagei* that is contiguous with ironbark woodland, north of the Moray-Carmichael Road. Approximately 472 ha within the EPC 1690 Study Area. Approximately 73 ha within the EPC 1080 Study Area. Approximately 545 ha in total.

RE	VM Act class/ Biodiversity status	Short Description	Area within the Study Area (based on field verified mapping)
10.4.5	least concern/ of concern	*Acacia cambagei* low woodland on Cainozoic lake beds.	Present within a mosaic with brigalow, in relatively dense patches to the west and north west of the Labona homestead. Approximately 98 ha within the EPC 1690 Study Area. Approximately 91 ha within the EPC 1080 Study Area. Approximately 189 ha in total.
10.5.1	least concern/ no concern at present	*Eucalyptus similis* +/- *Corymbia brachycarpa* +/- *Corymbia setosa* low open woodland to open woodland on sand plains.	Present in a 'red sand plain mosaic' and found roughly along the western boundary, mostly north of the Carmichael River but with a patch in southern section. Hosts a number of endemic and/or threatened species. Considered to have high faunal values. This RE comprises recharge zones for the Great Artesian Basin aquifers (Qld Herbarium 2009). Habitat for the vulnerable *Acacia ramiflora* (which was not found). Approximately 2833 ha within the EPC 1690 Study Area. Approximately 307 ha within the EPC 1080 Study Area. Approximately 3,140 ha in total.
10.5.2	least concern/ no concern at present	*Corymbia dallachiana* with or without *C. plena* open woodland on sand plains.	Approximately 26 ha within the EPC 1690 Study Area. Not observed in EPC 1080 Study Area.
10.5.4	least concern/ no concern at present	*Eucalyptus crebra* or *E. drepanophylla* open woodland on sand plains.	Present in an upper catchment location in the north and north west of the Study Area. Approximately 160 ha within the EPC 1690 Study Area. Approximately 162 ha within the EPC 1080 Study Area. Approximately 322 ha in total.
10.5.5	least concern/ no concern at present	*Eucalyptus melanophloia* open-woodland on sand plains.	One of the most common communities within the Study Area, present in large tracts contiguous with box woodland. Habitat for *Acacia ramiflora.* Approximately 7,343 ha within the EPC 1690 Study Area Approximately 2,631 ha within the EPC 1080 Study Area. Approximately 9,974 ha in total.

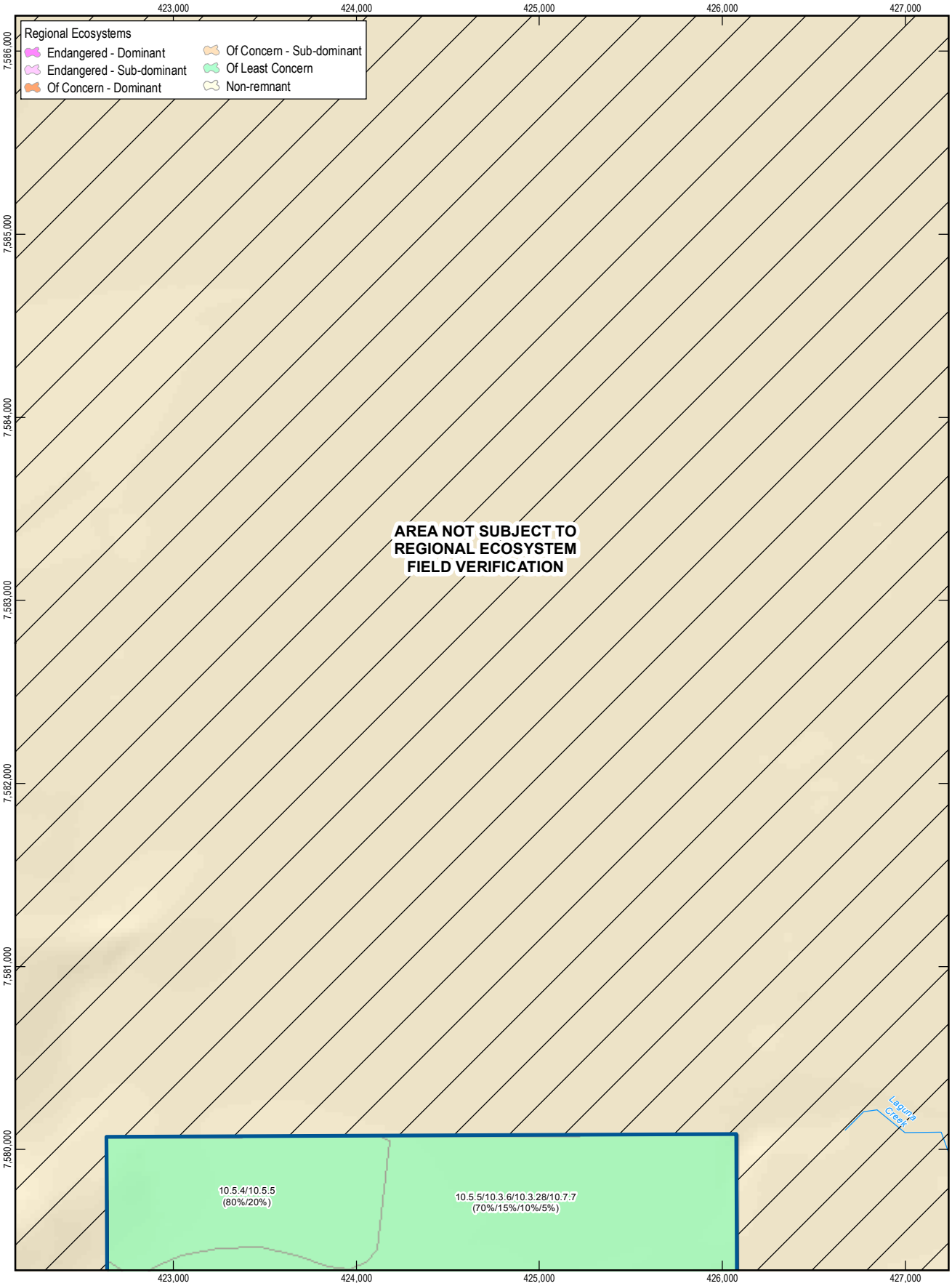
RE	VM Act class/ Biodiversity status	Short Description	Area within the Study Area (based on field verified mapping)
10.5.7	least concern/ of concern	*Grevillea striata, G. parallela* and *Acacia coriacea* low open woodland or *Corymbia terminalis* open woodland on relict sand plain.	Present in one patch south of the Carmichael River, in a mid-catchment position. Approximately 248 ha within the EPC 1690 Study Area. Not observed in EPC 1080 Study Area.
10.5.8	least concern/ no concern at present	*Corymbia setosa* with *Grevillea pteridifolia* +/- *Melaleuca nervosa* low open woodland on sand plains.	This RE dominates large areas along the north western boundary. Approximately 77 ha within the EPC 1690 Study Area. Approximately 3 ha within the EPC 1080 Study Area. Approximately 80 ha in total.
10.7.2	least concern/ no concern at present	*Eucalyptus persistens* or *Corymbia dallachiana* low open woodland or *Troidia pungens* hummock grassland on ferricrete above scarps.	Present as low open woodland of *E. persistens* with *Triodia pungens* located along the top of a series of low rises in the centre Study Area, north of the Carmichael River. Occurs on hard, stony country with a 'mulch' of lateritic pea gravel. Approximately 141 ha within the EPC 1690 Study Area. Approximately 4 ha within the EPC 1080 Study Area. Approximately 145 ha in total.
10.7.3	least concern/ no concern at present	*Acacia shirleyi* woodland +/- *A. catenulata* low woodland at margins of plateaus.	Occurs in one small patch dominated by *Acacia shirleyi* in an upper catchment position, just to the north of the Carmichael River. Approximately 40 ha within the EPC 1690 Study Area. Not observed in EPC 1080 Study Area.
10.7.4	of concern/ of concern	*Eucalyptus persistens* low open-woodland on pediments below scarps.	Present along the apron slope of low rises in the centre west of the Study Area, to the north of the Carmichael River. Occurs on hard, stony country with a 'mulch' of lateritic pea gravel. Approximately 103 ha within the EPC 1690 Study Area. Not observed in EPC 1080 Study Area.

RE	VM Act class/ Biodiversity status	Short Description	Area within the Study Area (based on field verified mapping)
10.7.5	least concern/ of concern	*Eucalyptus thozetiana* open woodland on scarps and on pediments below scarps.	Observed along base of laterised low hills/rolling rises on minor pediments. Approximately 10 ha within the EPC 1690 Study Area. Not observed in EPC 1080 Study Area.
10.7.7	least concern/ no concern at present	*Melaleuca* spp +/- *Acacia leptostachya* shrubland on ferricrete (eastern).	Approximately 888 ha within the EPC 1690 Study Area. Approximately 173 ha within the EPC 1080 Study Area. Approximately 1061 ha in total.
10.7.11	least concern/ no concern at present	*Eucalyptus melanophloia* low open woodland on ferricrete.	Approximately 4 ha within the EPC 1690 Study Area. Not observed in EPC 1080 Study Area.
10.9.3	least concern/ endangered	*Acacia harpophylla +/- Eucalyptus cambageana* open woodland to woodland on Mesozoic sediments.	Present in association with RE 10.7.7. Approximately 91 ha within the EPC 1690 Study Area. Not observed in EPC 1080 Study Area.
Brigalow Belt REs			
11.3.1	endangered/ endangered	*Acacia harpophylla +/- Casuarina cristata* open forest on alluvial plains.	Present in small patches in association with other brigalow and gidgee communities, on alluvial plains associated with the Carmichael River. Part of the EPBC Act Threatened Ecological Community 'Brigalow'. Approximately 49 ha within the EPC 1690 Study Area. Approximately 8 ha within the EPC 1080 Study Area. Approximately 57 ha in total.
11.3.3	of concern/ of concern	*Eucalyptus coolabah* woodland on alluvial plains.	Present in the south of the Study Area within mixed polygons with other eucalypt, brigalow and gidgee communities. Not observed in EPC 1690 Study Area. Approximately 92 ha within the EPC 1080 Study Area.

RE	VM Act class/ Biodiversity status	Short Description	Area within the Study Area (based on field verified mapping)
11.3.5	least concern/ of concern	*Acacia cambagei* woodland on alluvial plains.	Present mainly south of the Carmichael River. Approximately 3 ha within the EPC 1690 Study Area. Approximately 456 ha within the EPC 1080 Study Area. Approximately 459 ha in total.
11.3.7	least concern/ of concern	*Corymbia* spp. woodland on alluvial plains. Sandy soils.	Present south of the Carmichael River in large patches that are contiguous with box woodland. Not observed in EPC 1690 Study Area. Approximately 55 ha within the EPC 1080 Study Area.
11.3.10	least concern/ no concern at present	*Eucalyptus brownii* woodland on alluvial plains.	Present in a small patches on the outer edge of the northern Carmichael River flood plain, on yellow alluvial outwash. Approximately 57 ha within the EPC 1690 Study Area. Approximately 269 ha within the EPC 1080 Study Area. Approximately 326 ha in total.
11.3.25	least concern/ of concern	*Eucalyptus tereticornis or E. camaldulensis* woodland fringing drainage lines.	Comprises the vegetation fringing the Carmichael River, in the form of *E. camaldulensis* open forest with *Melaleuca leucadendra* lining the actual channel, and forming woodland along the banks. A groundwater dependant ecosystem. Approximately 98 ha within the EPC 1690 Study Area. Approximately 84 ha within the EPC 1080 Study Area. Approximately 182 ha in total.

RE	VM Act class/ Biodiversity status	Short Description	Area within the Study Area (based on field verified mapping)
11.3.27	least concern/of concern	Freshwater wetlands.	Located as a fringing open forest/woodland along Cabbage Tree Creek, just to the south of the Carmichael River (Cabbage Tree Creek is a relict stream channel formerly part of the Carmichael). Approximately 10 ha within the EPC 1690 Study Area. Approximately 22 ha within the EPC 1080 Study Area. Approximately 32 ha in total.
11.4.5	of concern/ endangered	Occurs on gently undulating plains formed from Cainozoic sediments. Associated soils are texture contrast with thin sandy or loamy surface horizons and strongly alkaline clay subsoils.	Not observed in EPC 1690 Study Area. Not observed in EPC 1080 Study Area. 6 ha mapped within offsite infrastructure area (not field verified).
11.4.6	of concern/ endangered	*Acacia cambagei* woodland on Cainozoic clay plains.	Located with brigalow in the south of the Study Area. Approximately 3 ha within the EPC 1690 Study Area. Approximately 147 ha within the EPC 1080 Study Area. Approximately 150 ha in total.
11.4.8	endangered/ endangered	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.	Part of the EPBC Act Threatened Ecological Community 'Brigalow'. <1 ha within the EPC 1690 Study Area. Not observed in EPC 1080 Study Area.
11.4.9	endangered/ endangered	*Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains.	Approximately 113 ha within the EPC 1690 Study Area. Approximately 97 ha within the EPC 1080 Study Area. Approximately 210 ha in total.
11.4.11	of concern/ of concern	*Occurs in shallow open valleys and poorly drained Cainozoic clay plains with deep cracking clay soils.*	Not observed in EPC 1690 Study Area. Not observed in EPC 1080 Study Area. 53 ha mapped (DEHP) within offsite infrastructure area (not field verified).

RE	VM Act class/ Biodiversity status	Short Description	Area within the Study Area (based on field verified mapping)
11.5.3	least concern/ no concern at present	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces.	Present in the south of the Study Area within mixed polygons with other eucalypt, brigalow and gidgee communities. Approximately 17 ha within the EPC 1080 Study Area.



LEGEND

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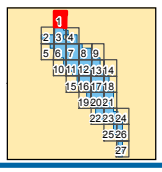

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Carmichael Coal Mine and Rail Project

Regional Ecosystems
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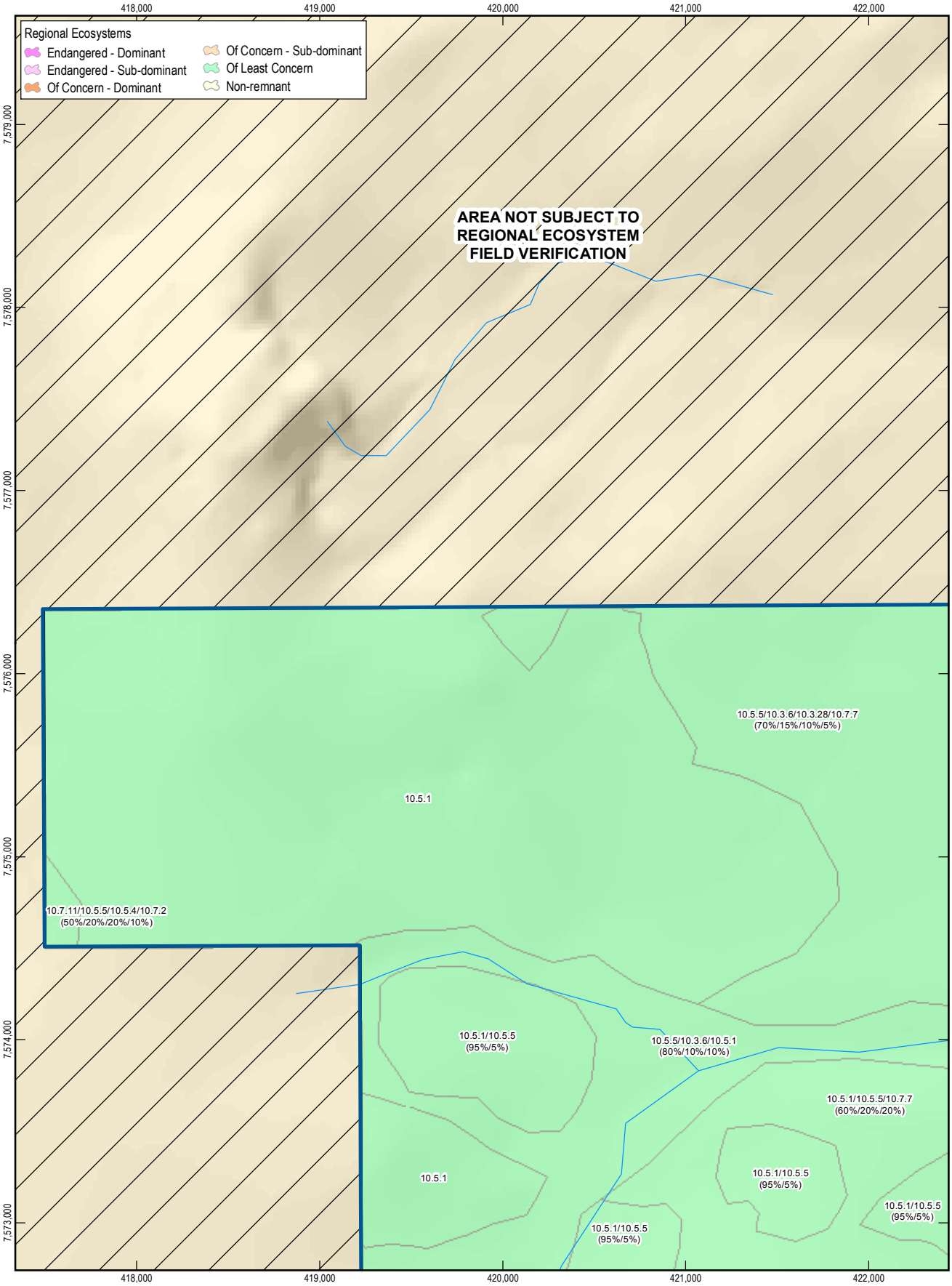

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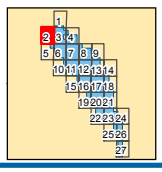

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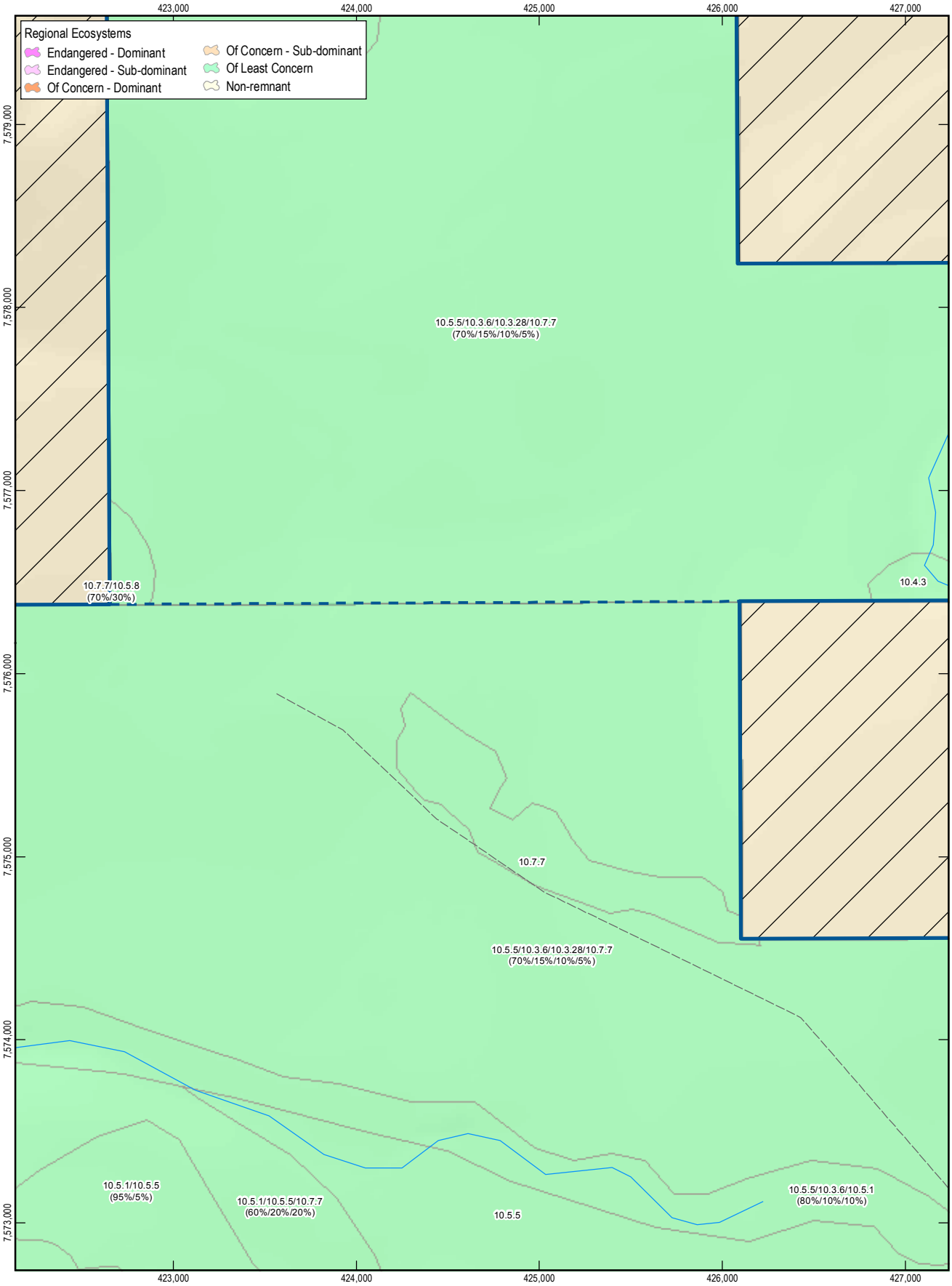

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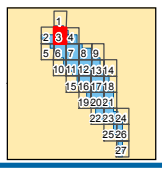

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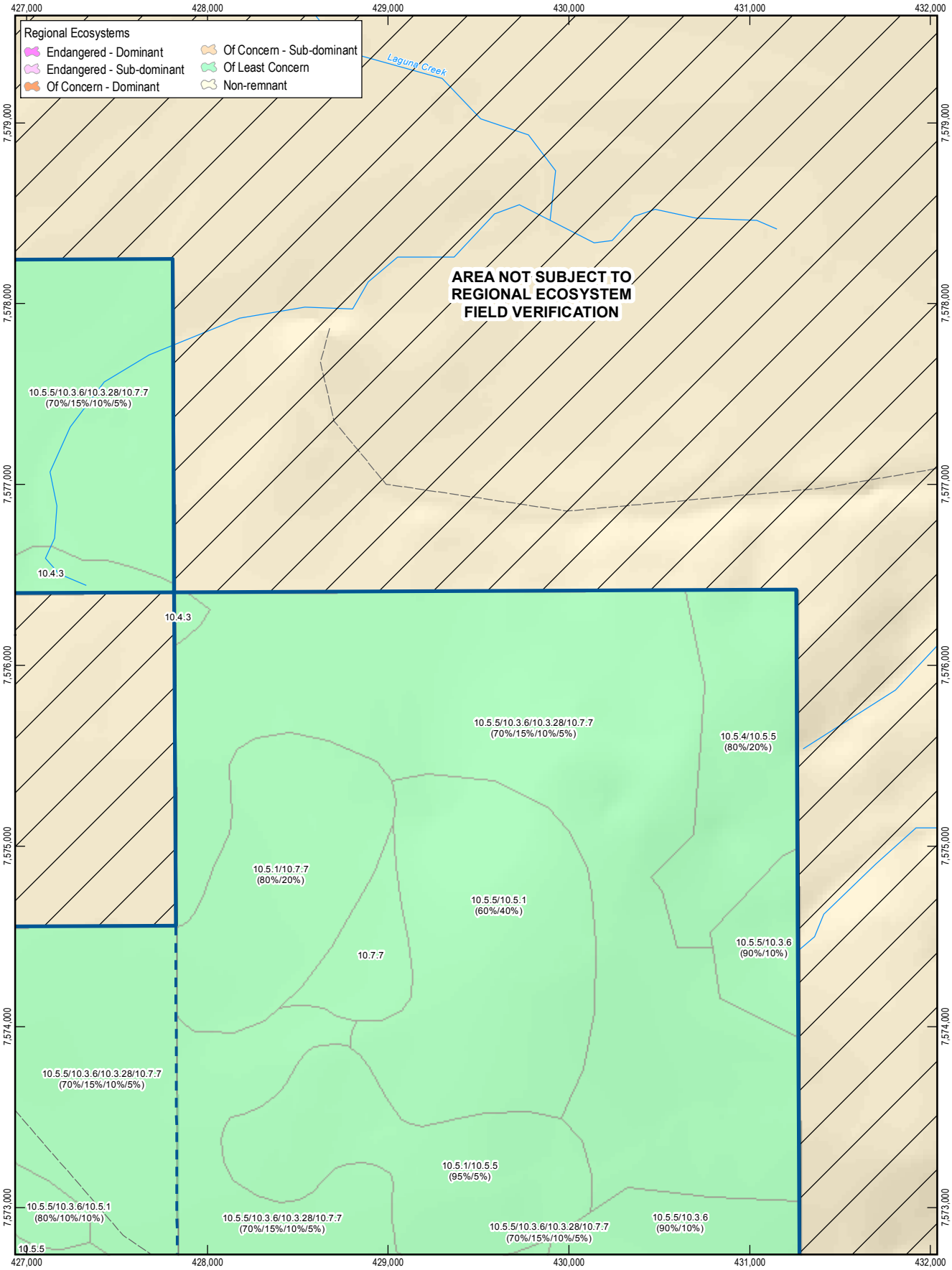

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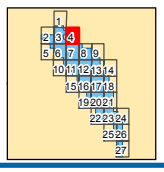

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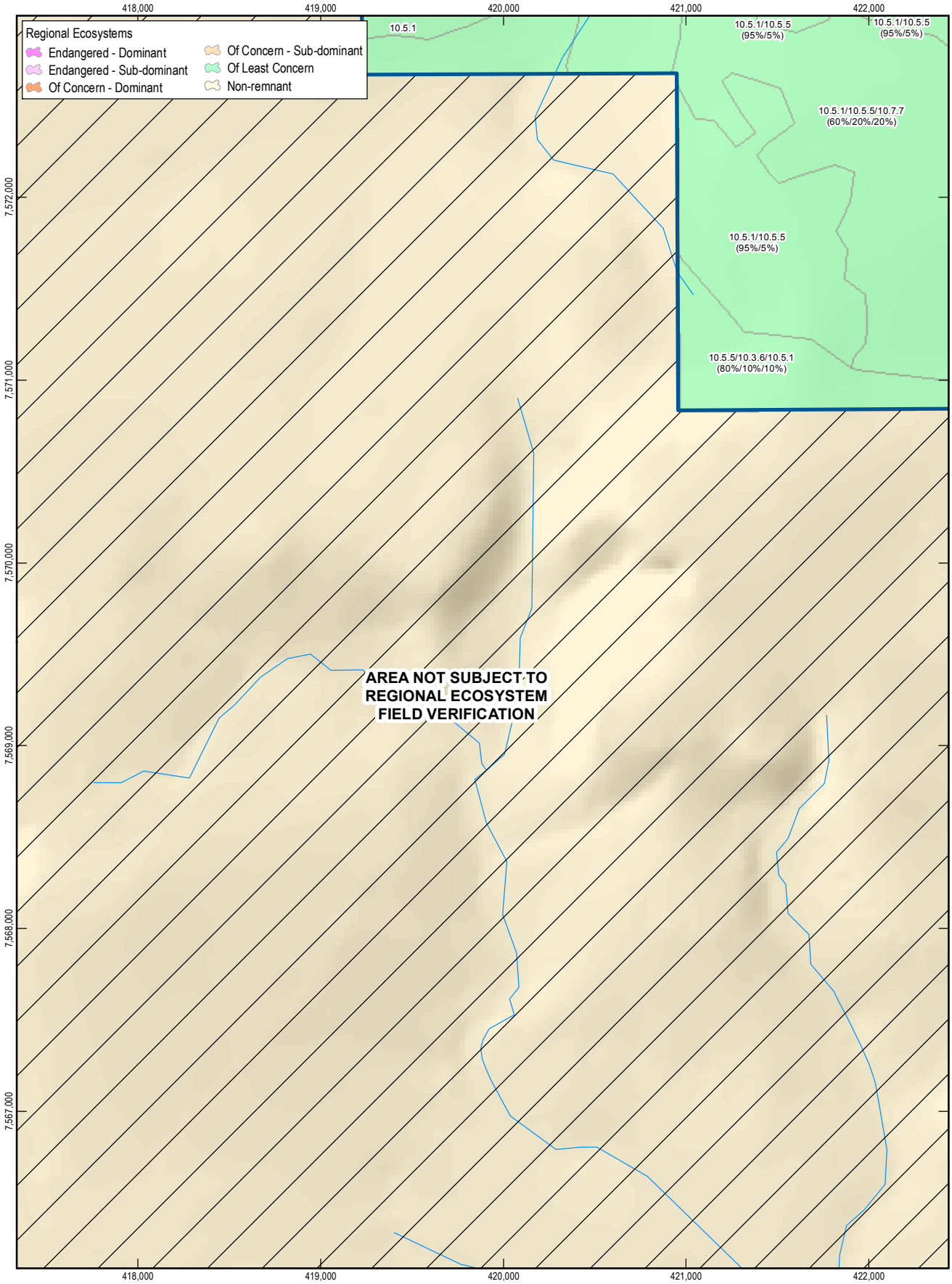

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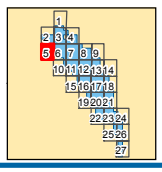

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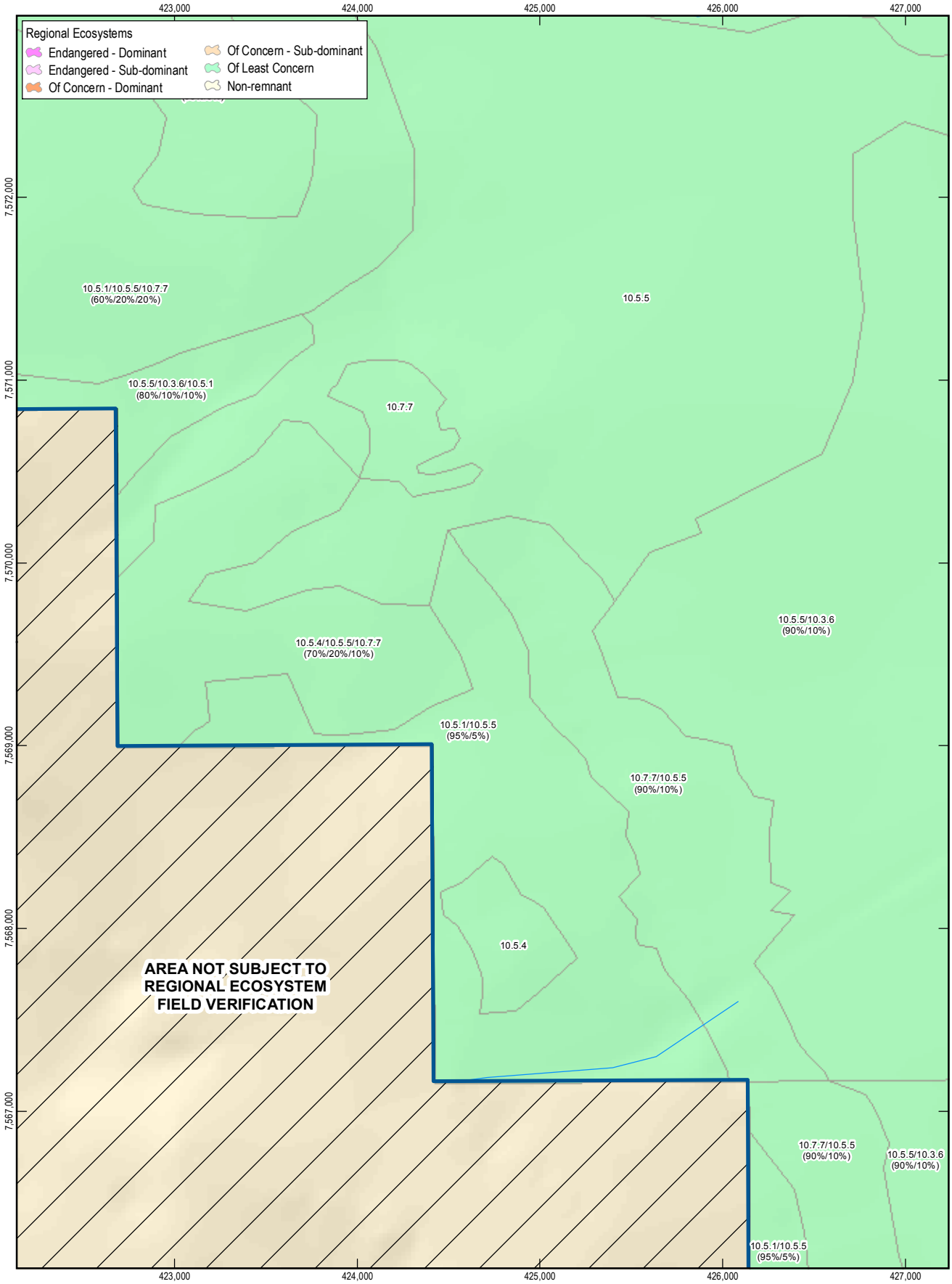

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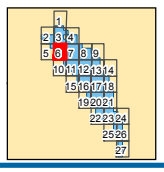

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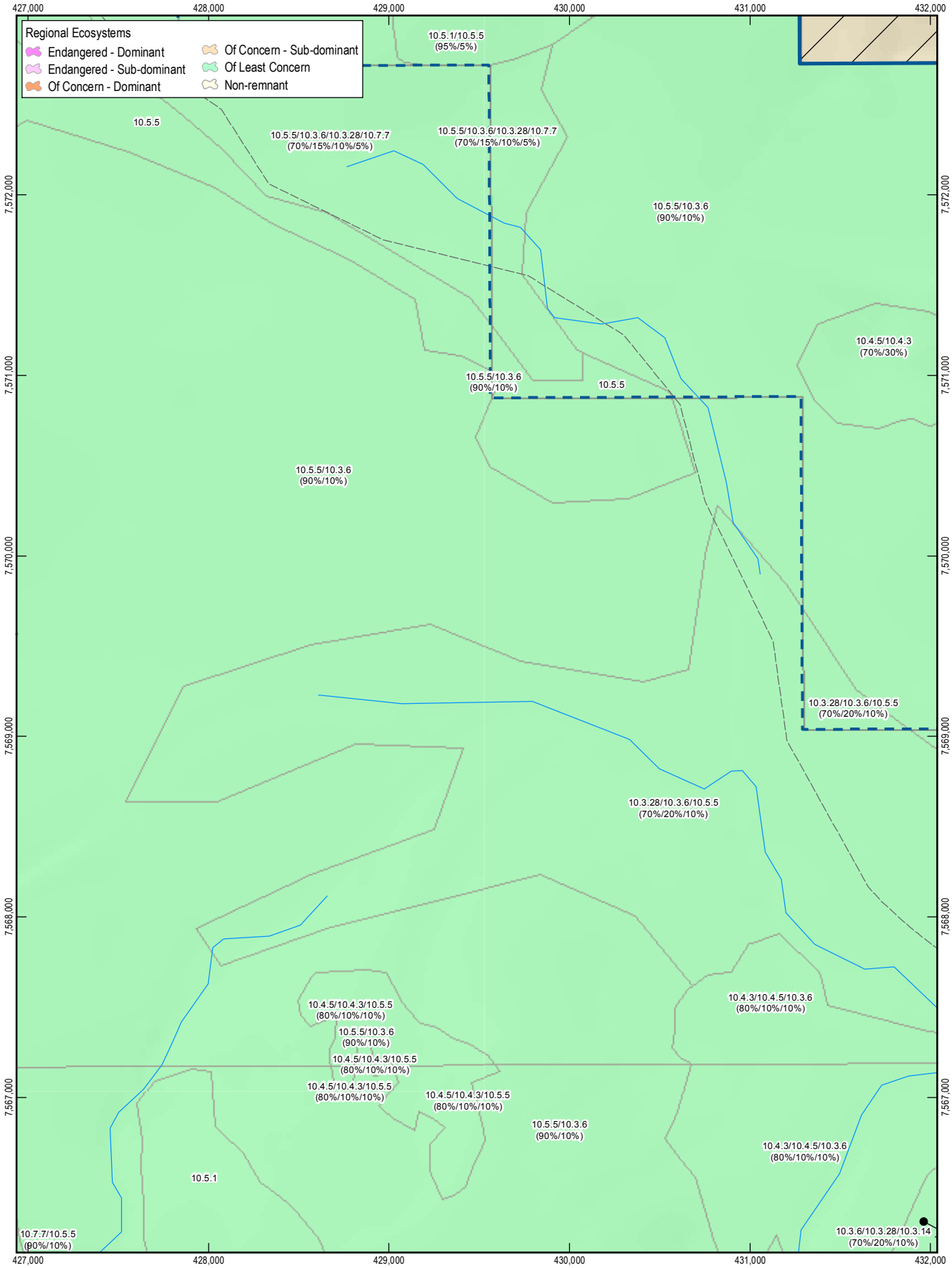

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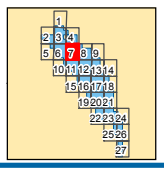

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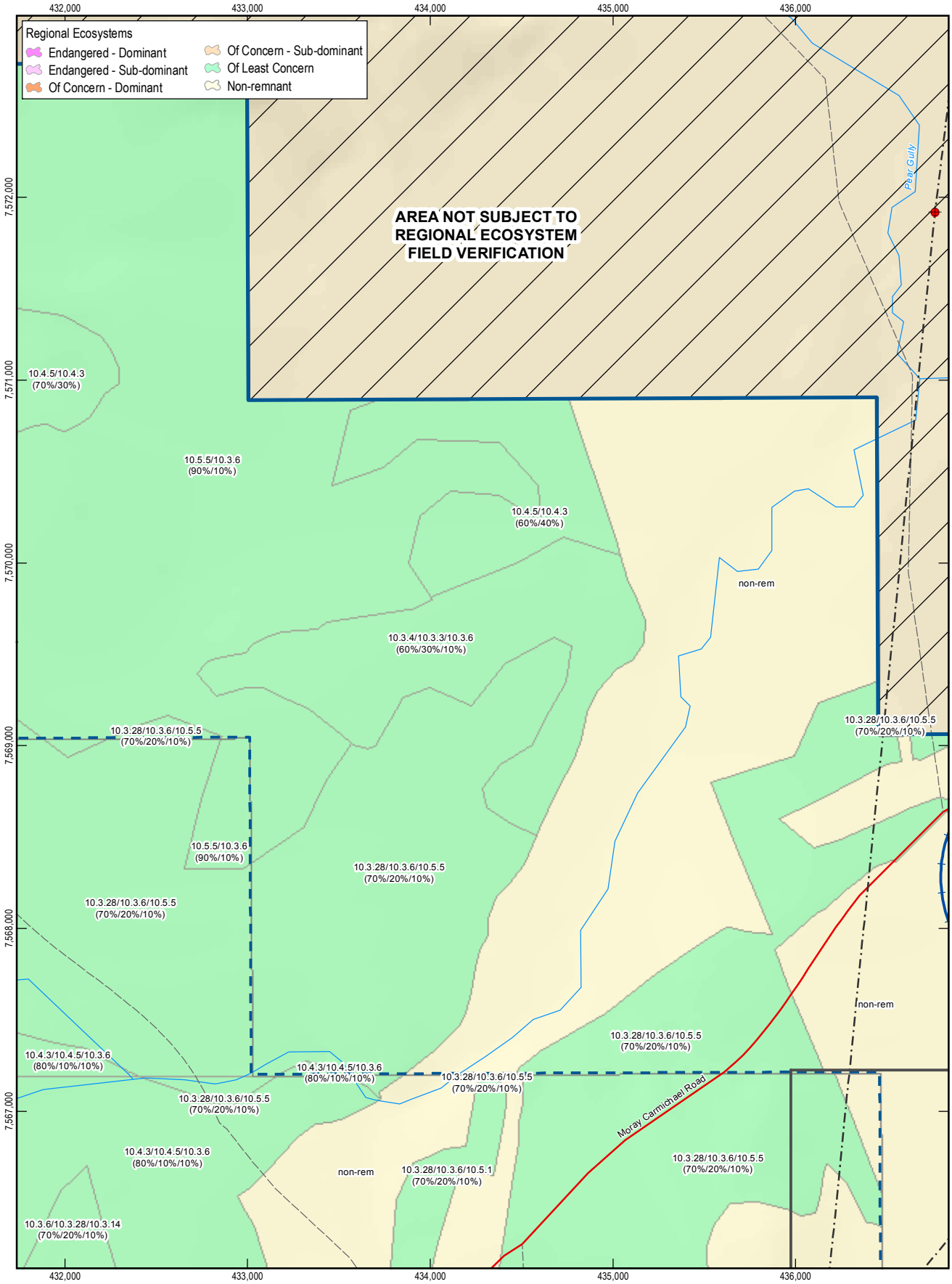

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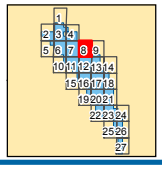

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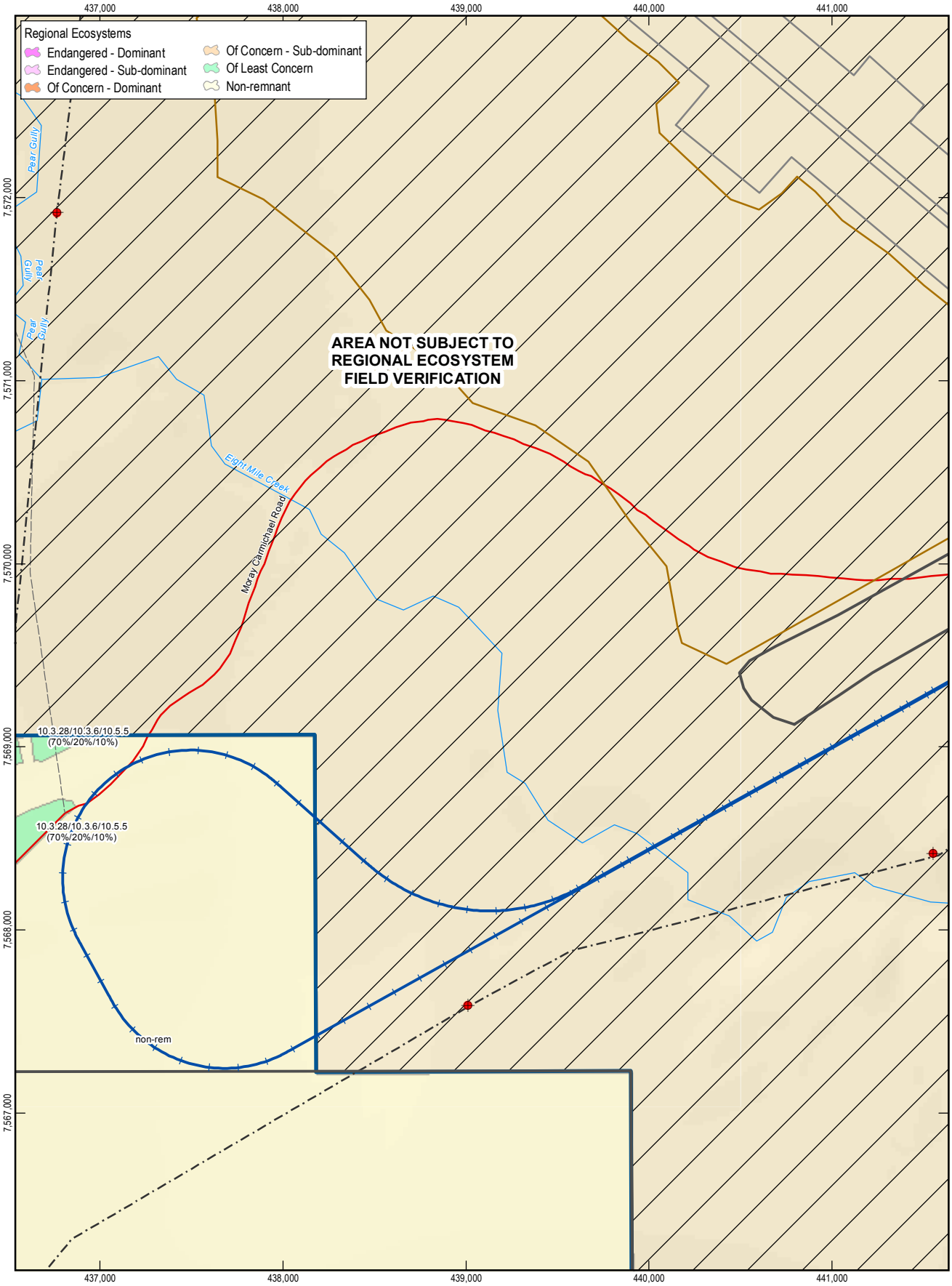
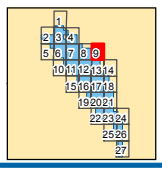


LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village



1:30,000 (at A4)

0 200 400 600 800 1,000

Metres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

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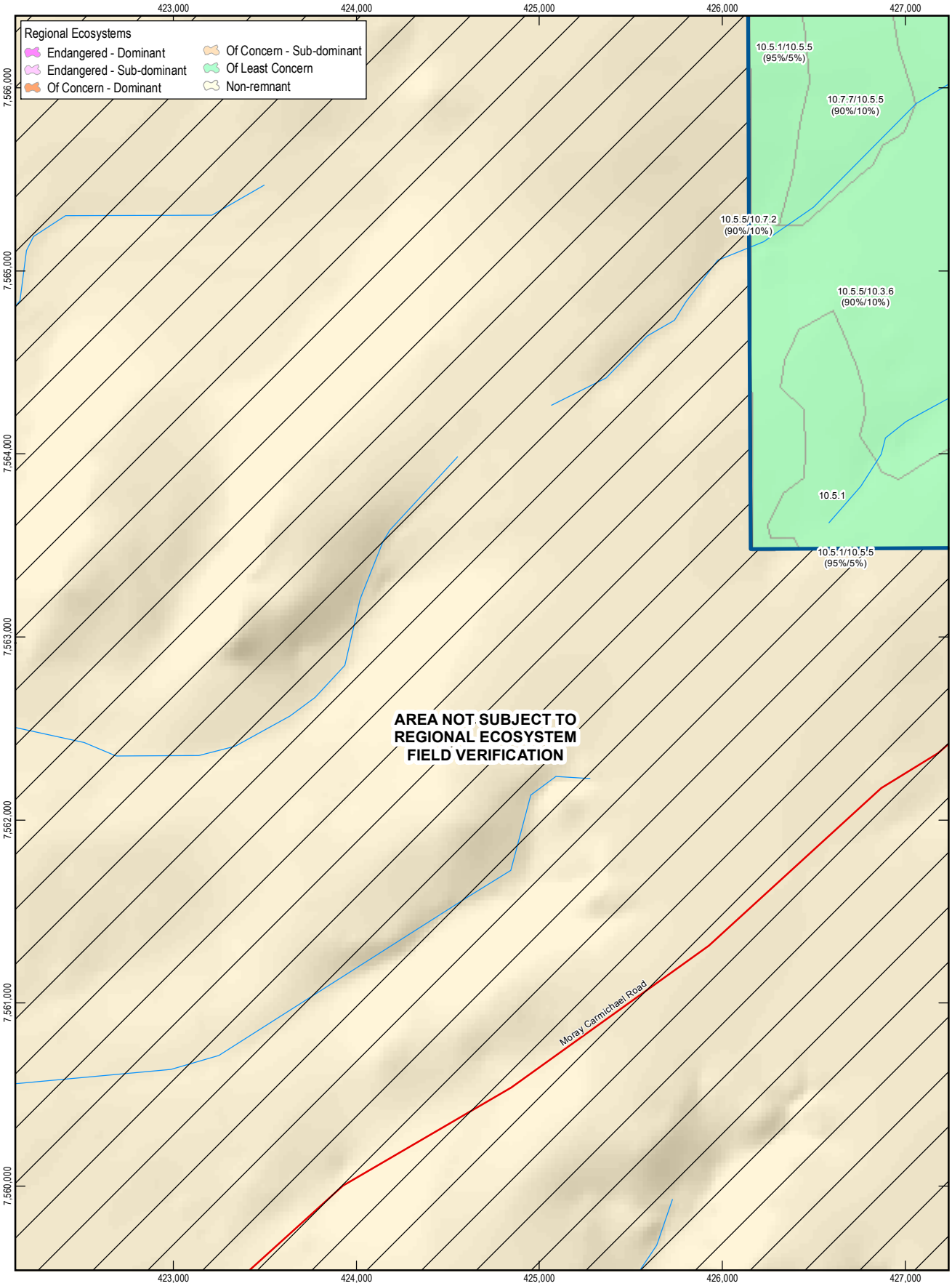

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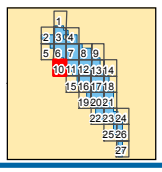

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Metres

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Regional Ecosystems
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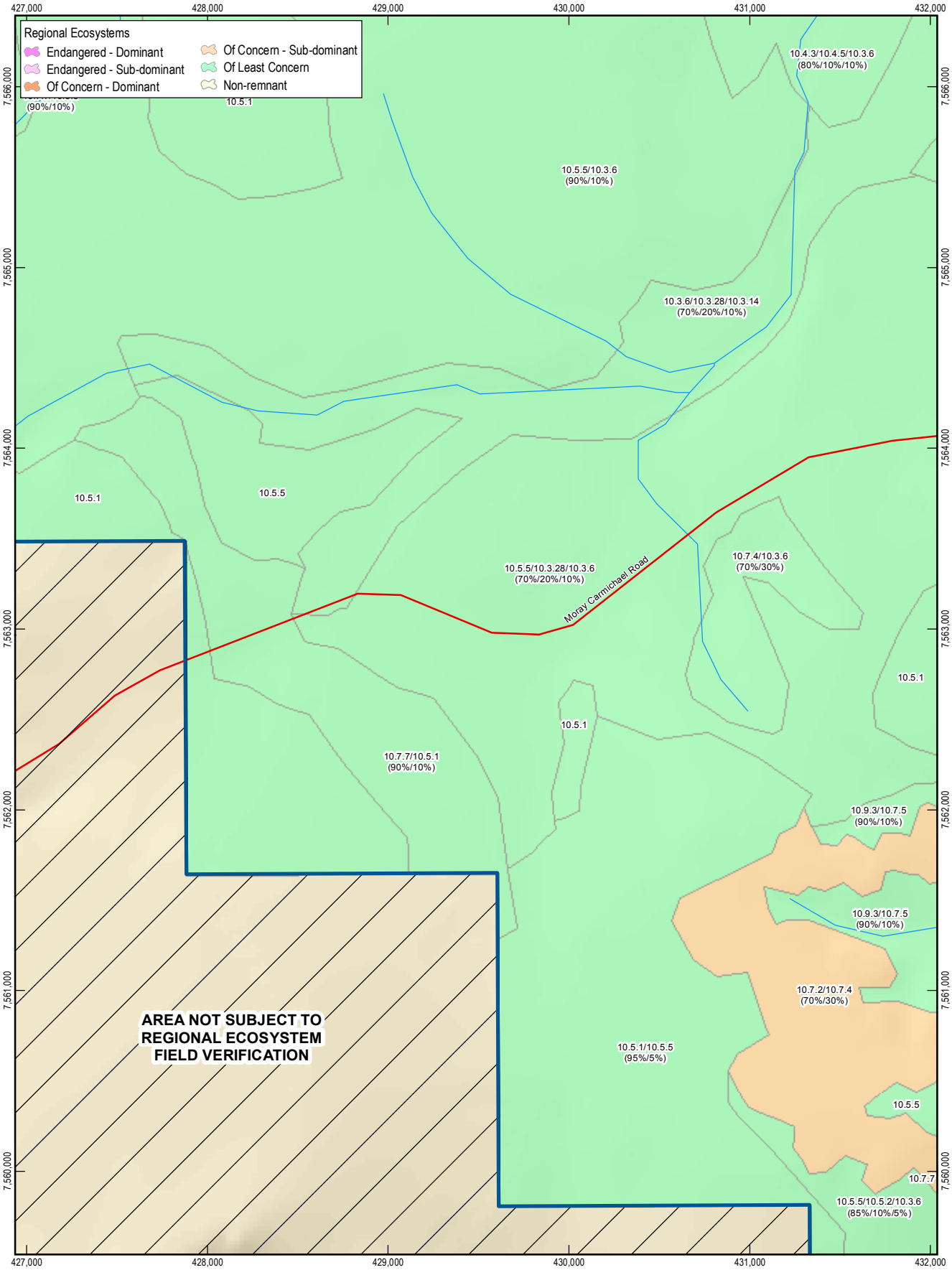

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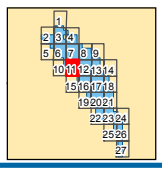

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Metres

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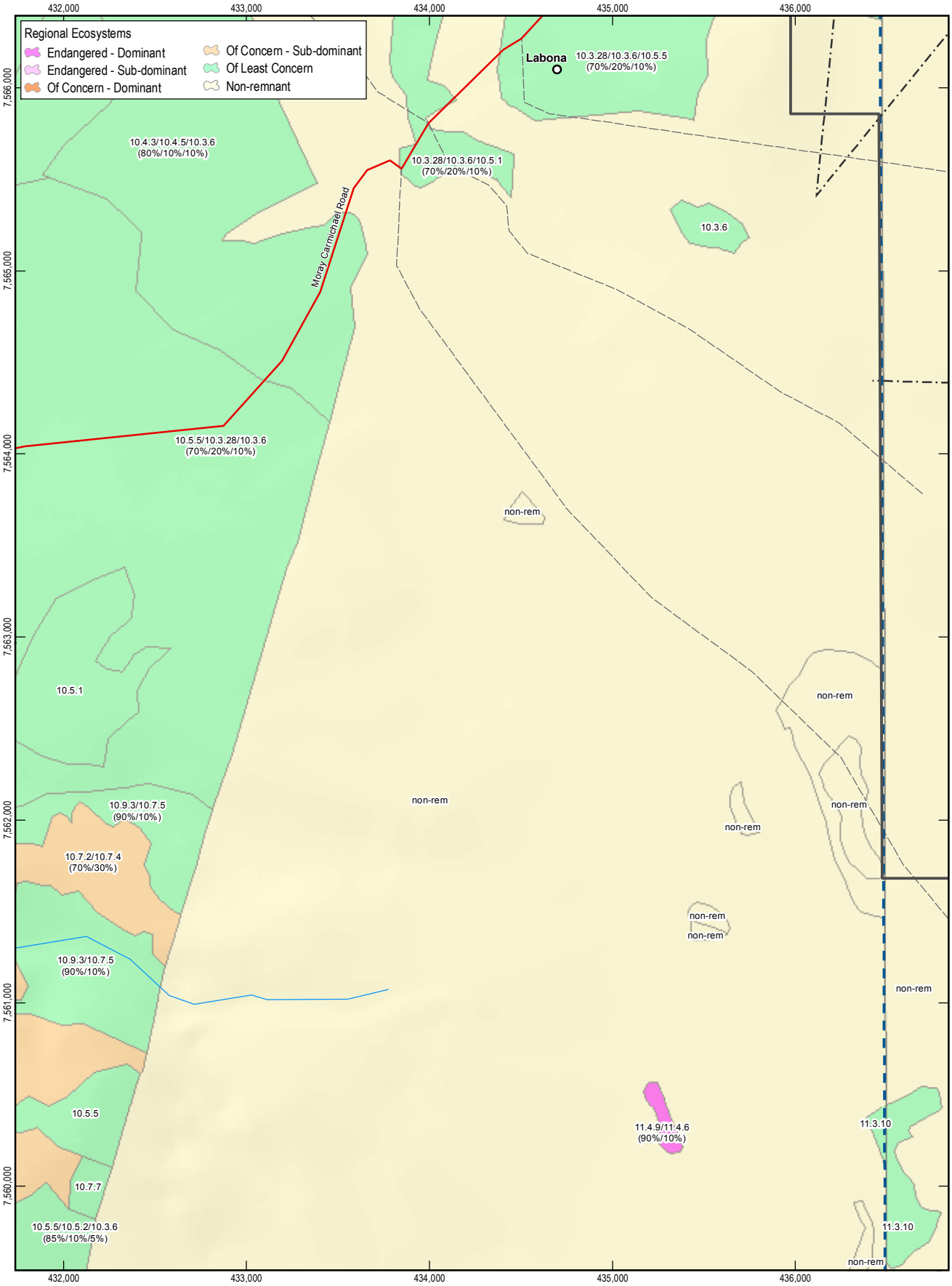

LEGEND

- Homestead
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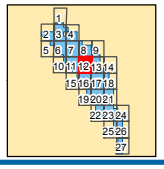

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Metres

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Carmichael Coal Mine and Rail Project

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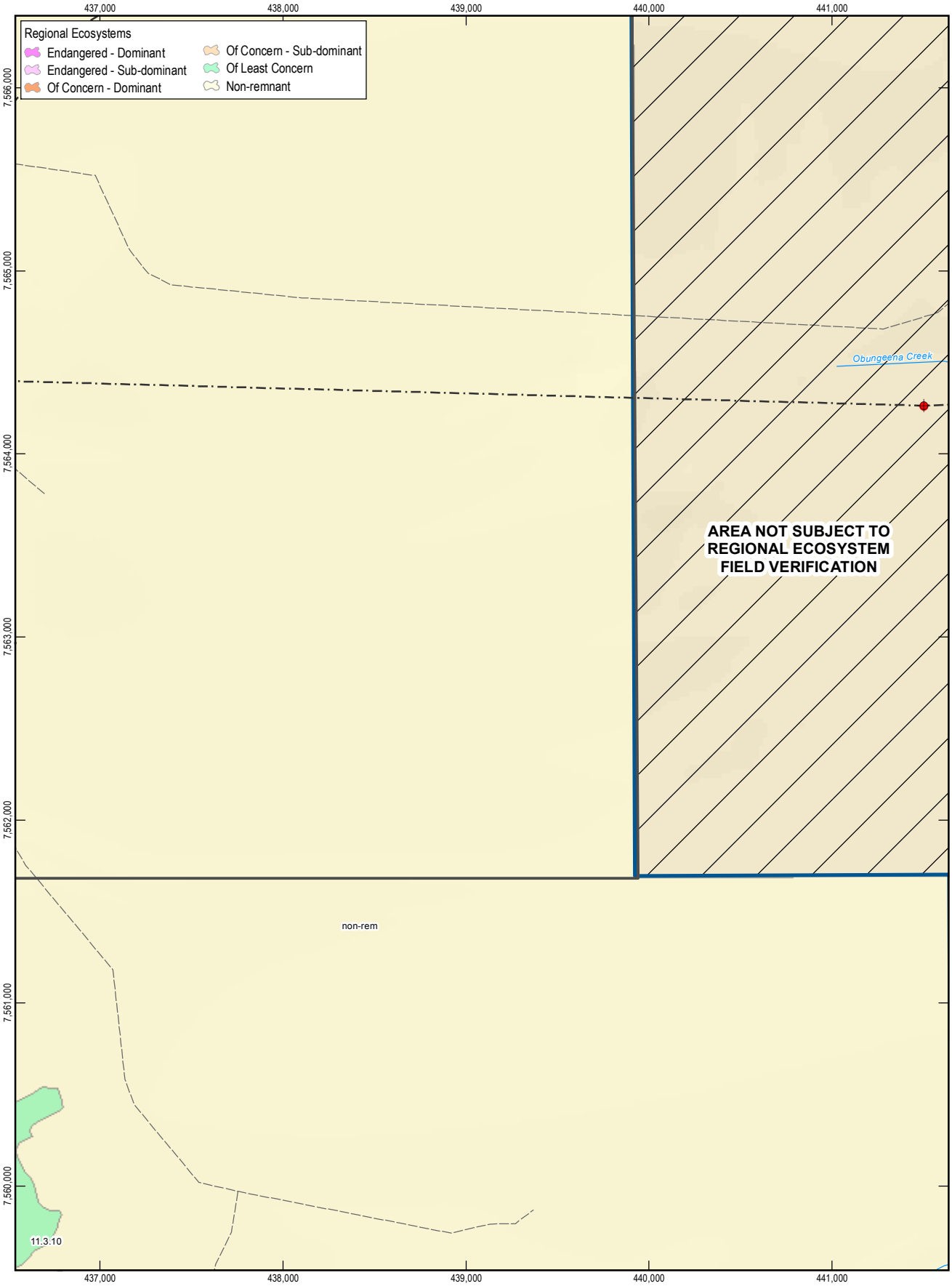

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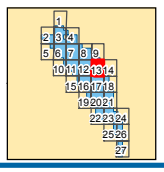

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Regional Ecosystems
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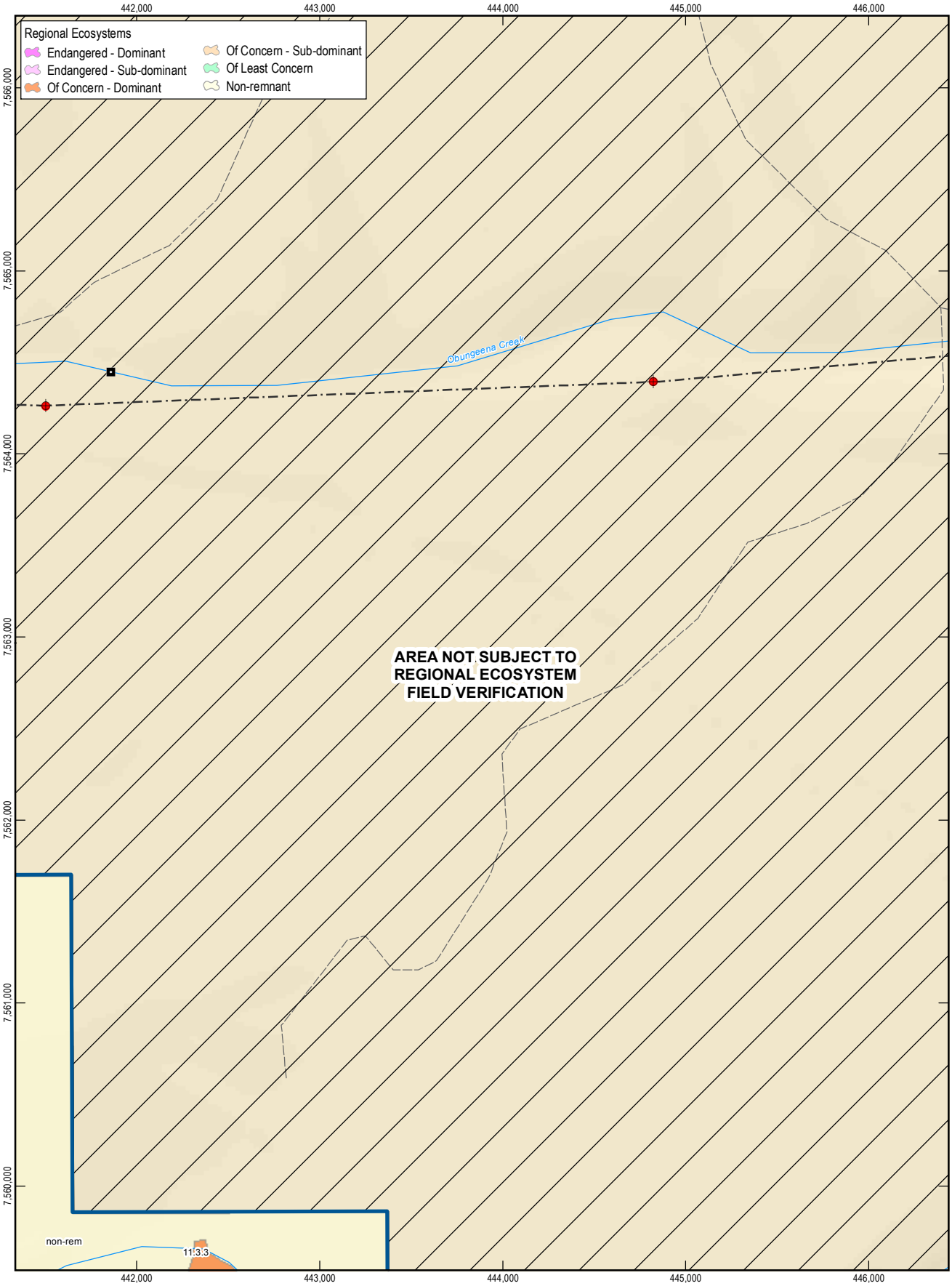

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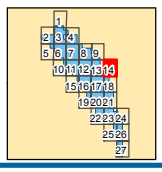

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Carmichael Coal Mine and Rail Project

Regional Ecosystems
Field Verified

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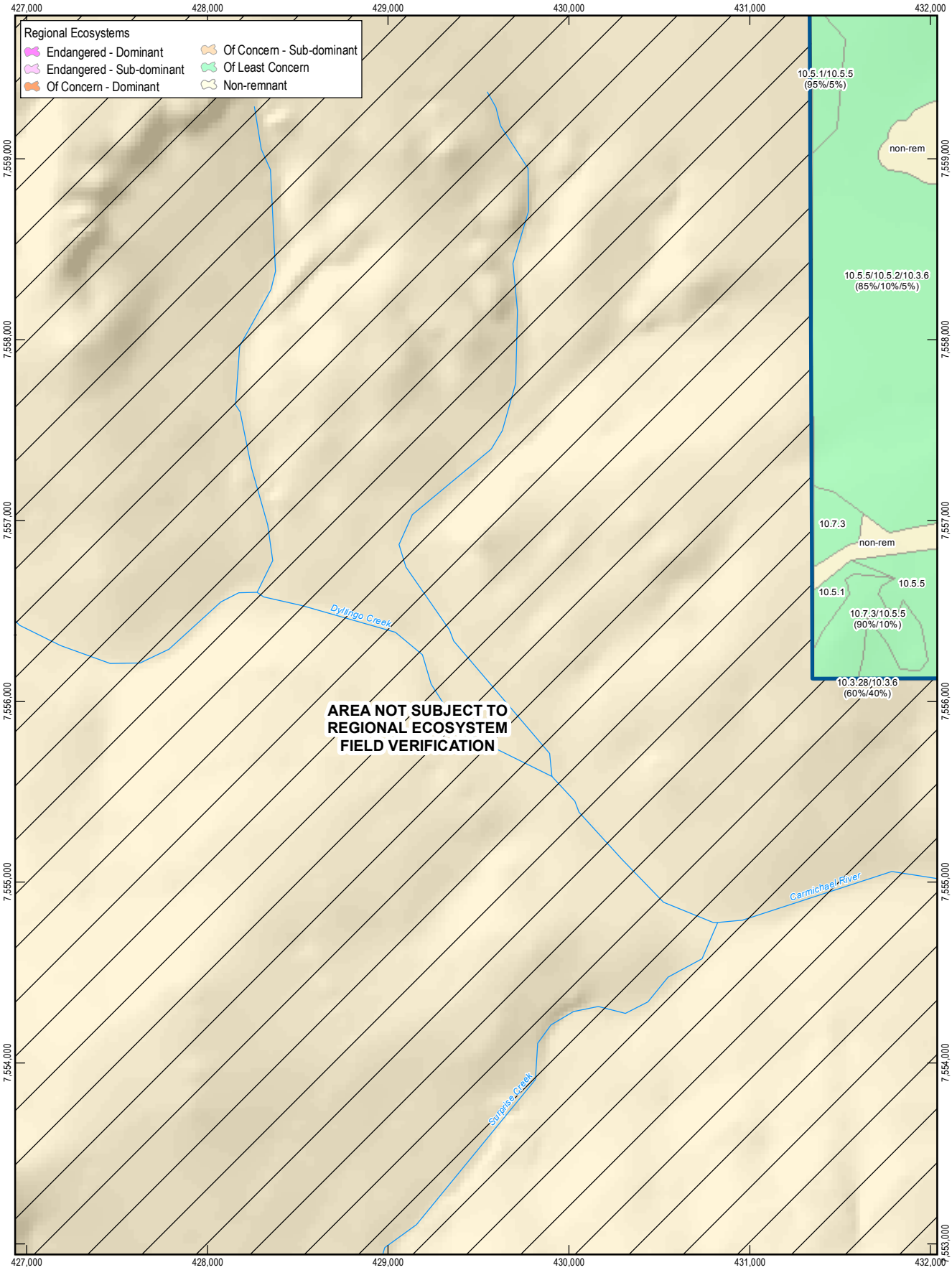

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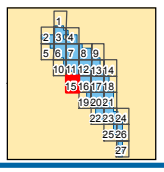

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Metres

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Carmichael Coal Mine and Rail Project

Regional Ecosystems
Field Verified

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Sheet 15 of 27

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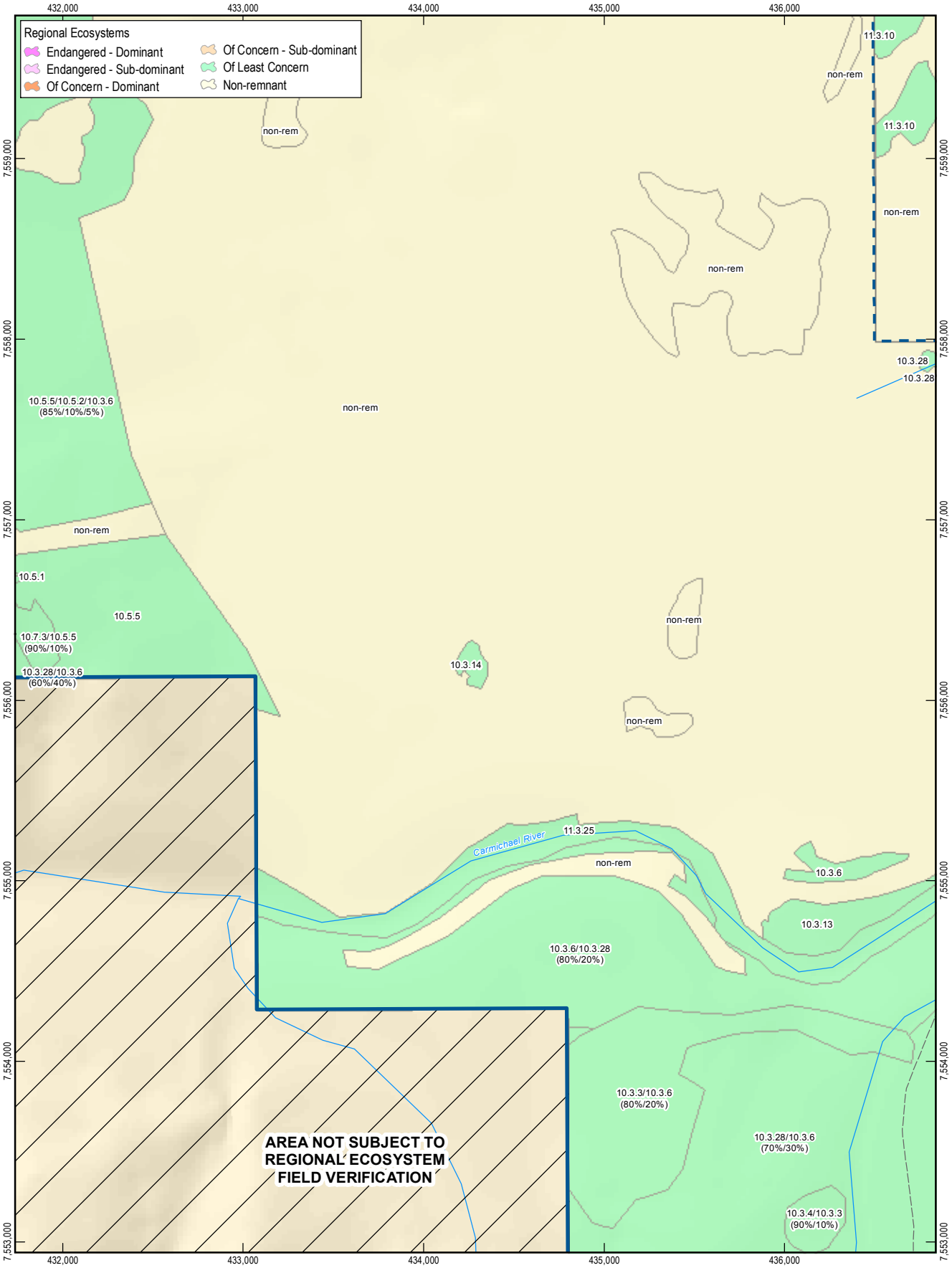

LEGEND

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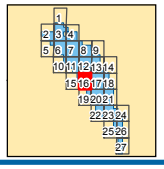

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Carmichael Coal Mine and Rail Project

Regional Ecosystems
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Sheet 16 of 27

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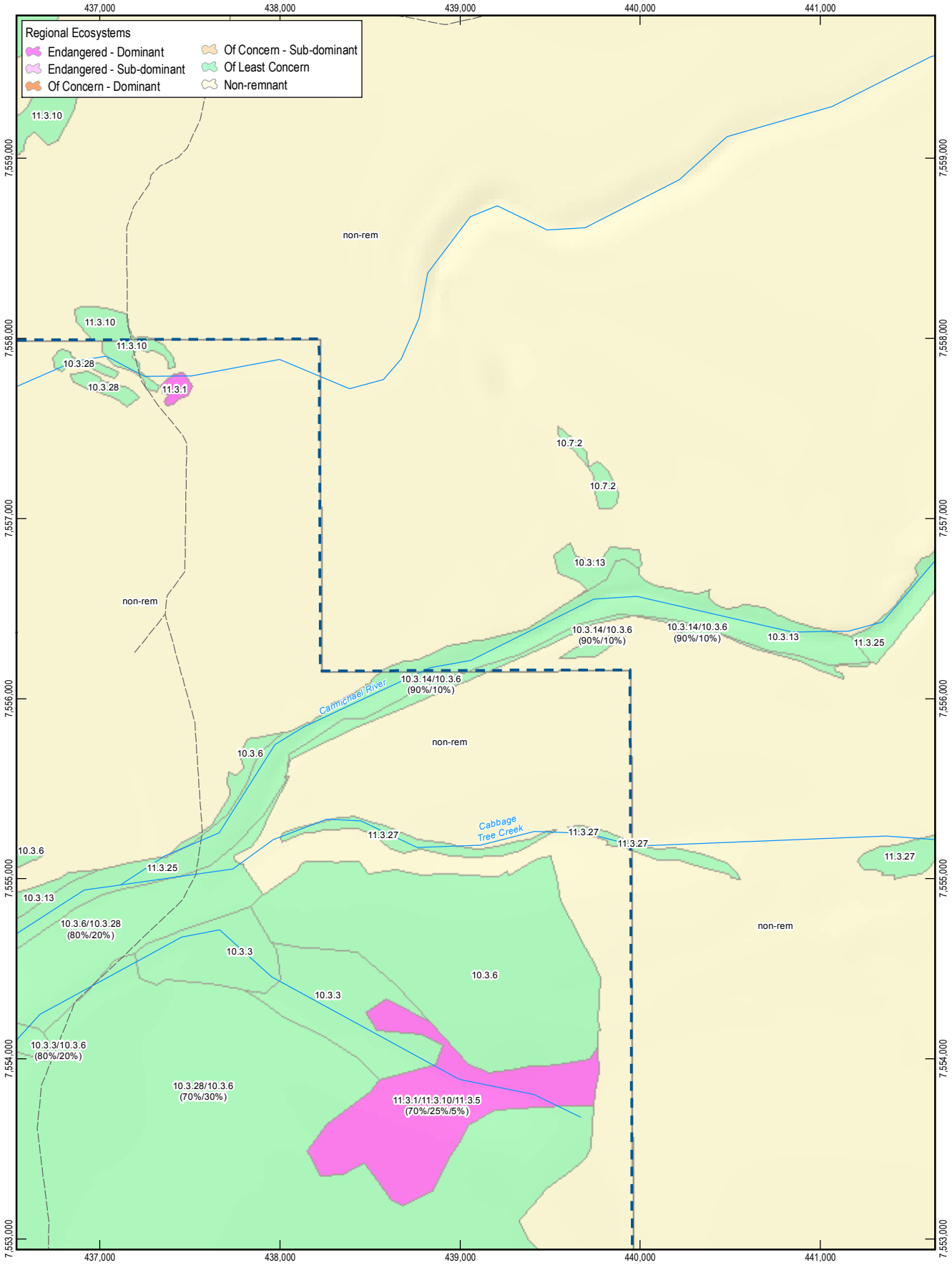

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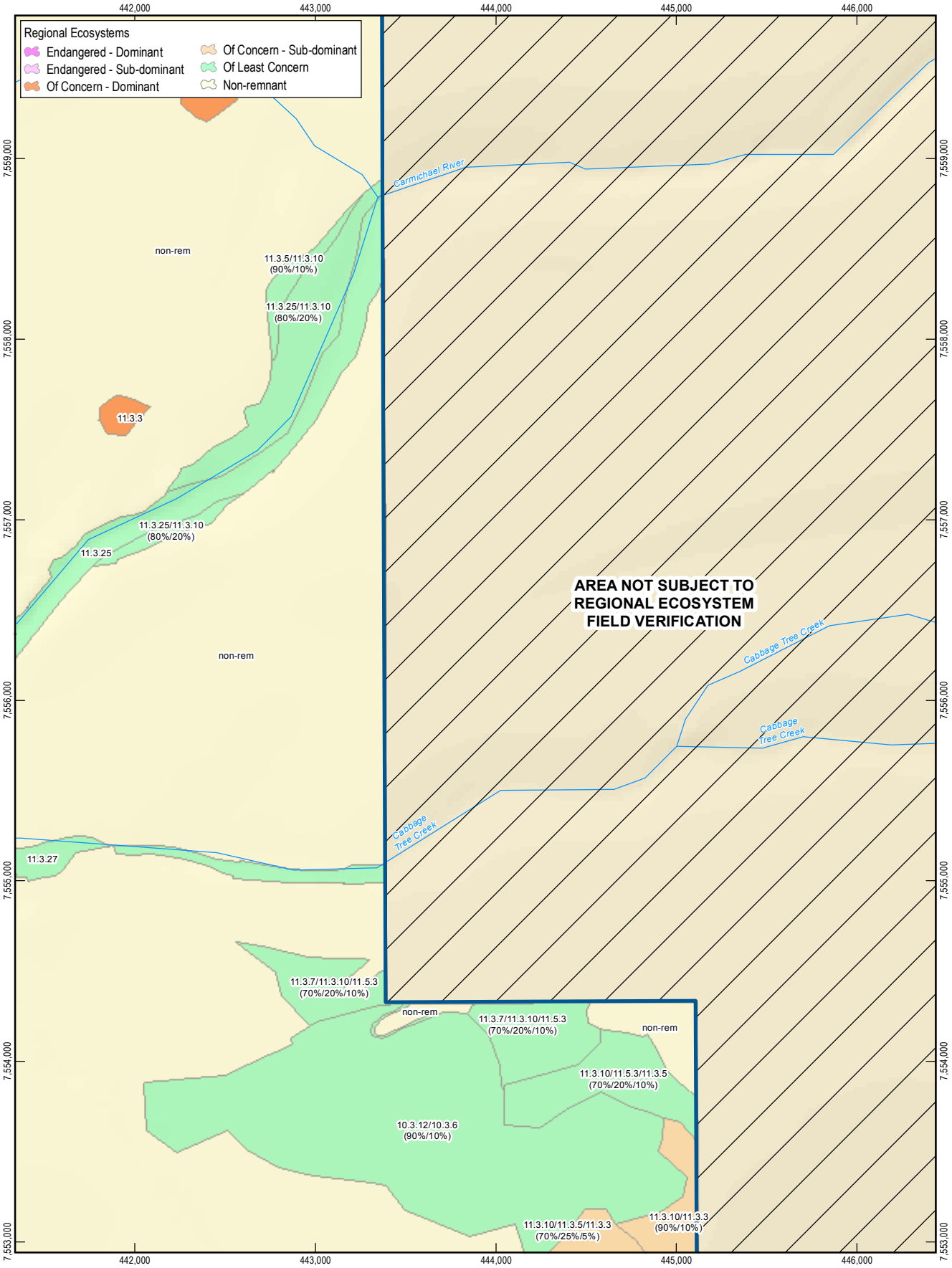

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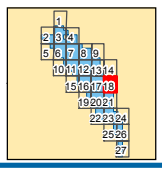

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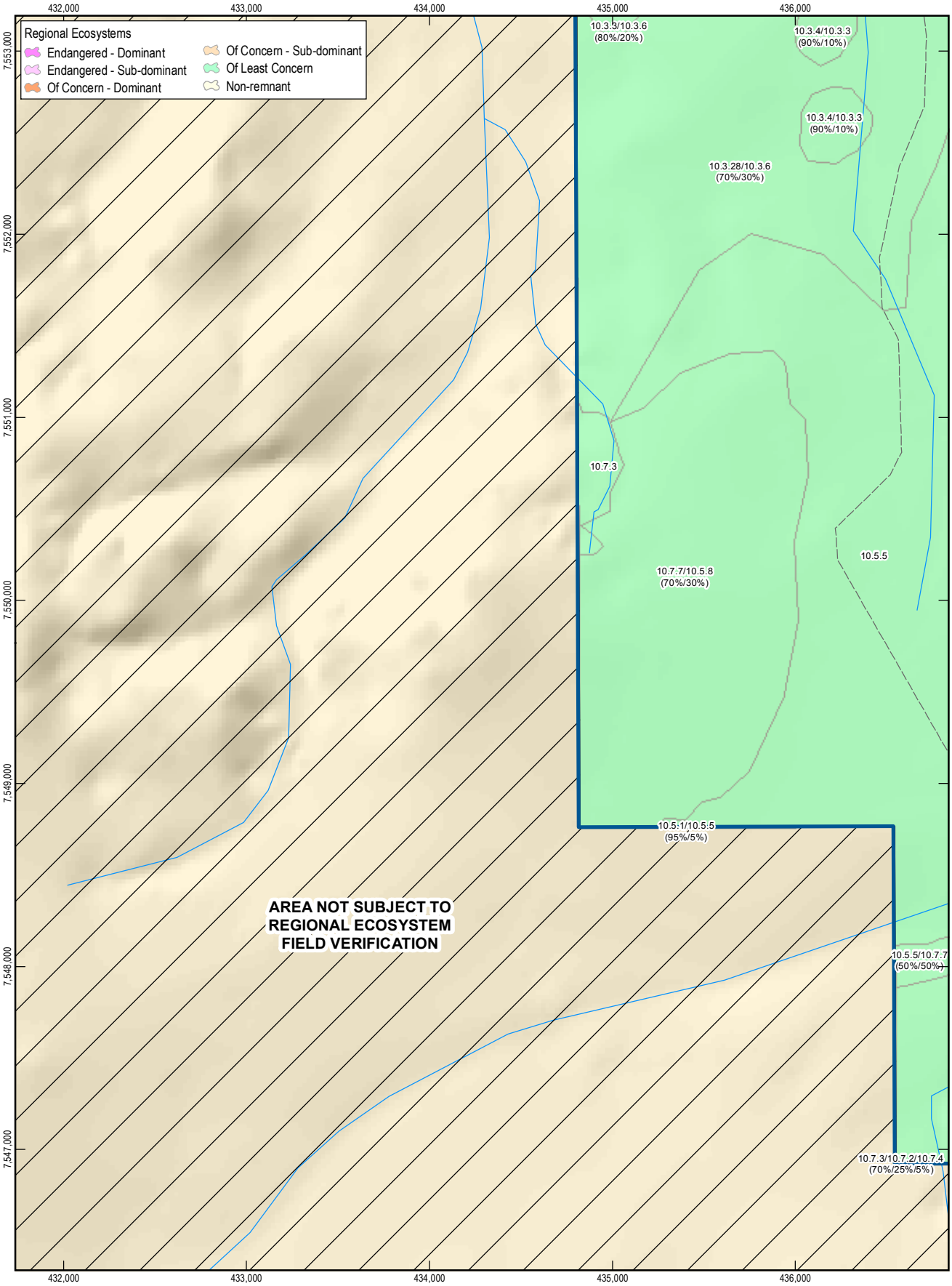

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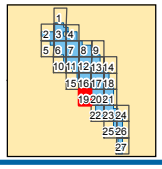

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Carmichael Coal Mine and Rail Project

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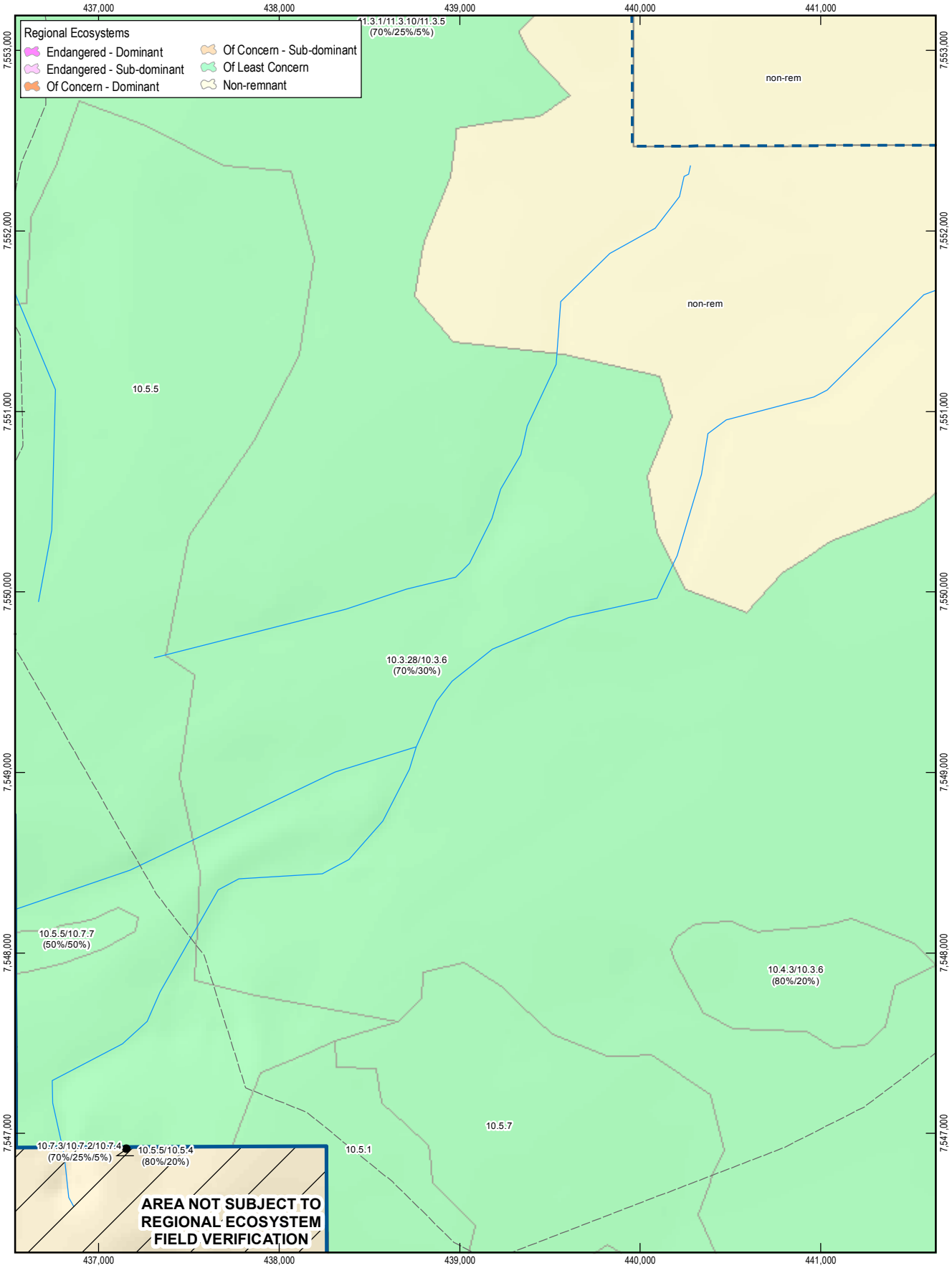

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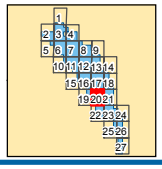

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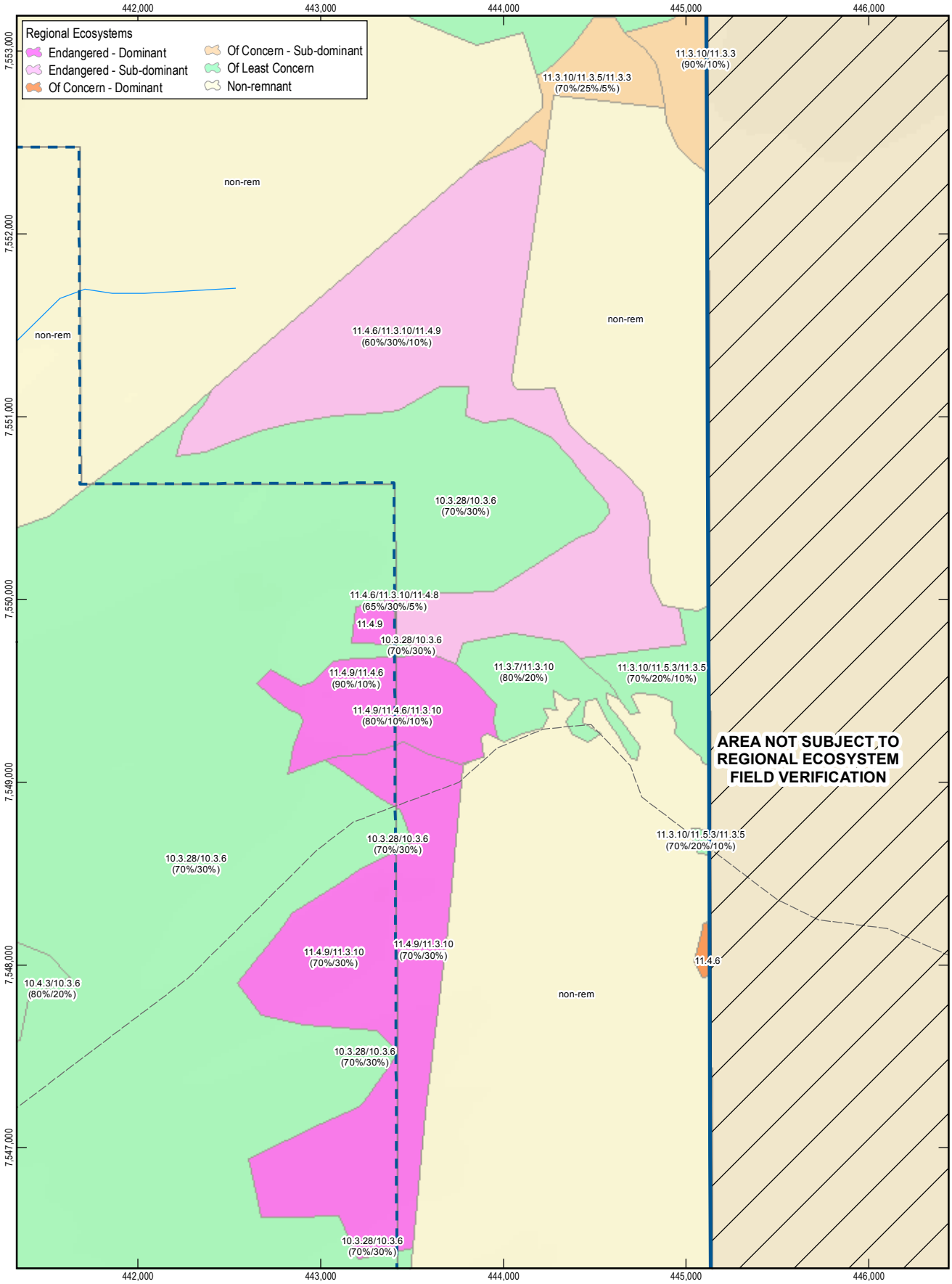
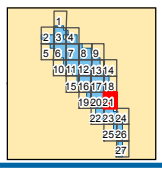


LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village



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Metres

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

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Regional Ecosystems
Field Verified

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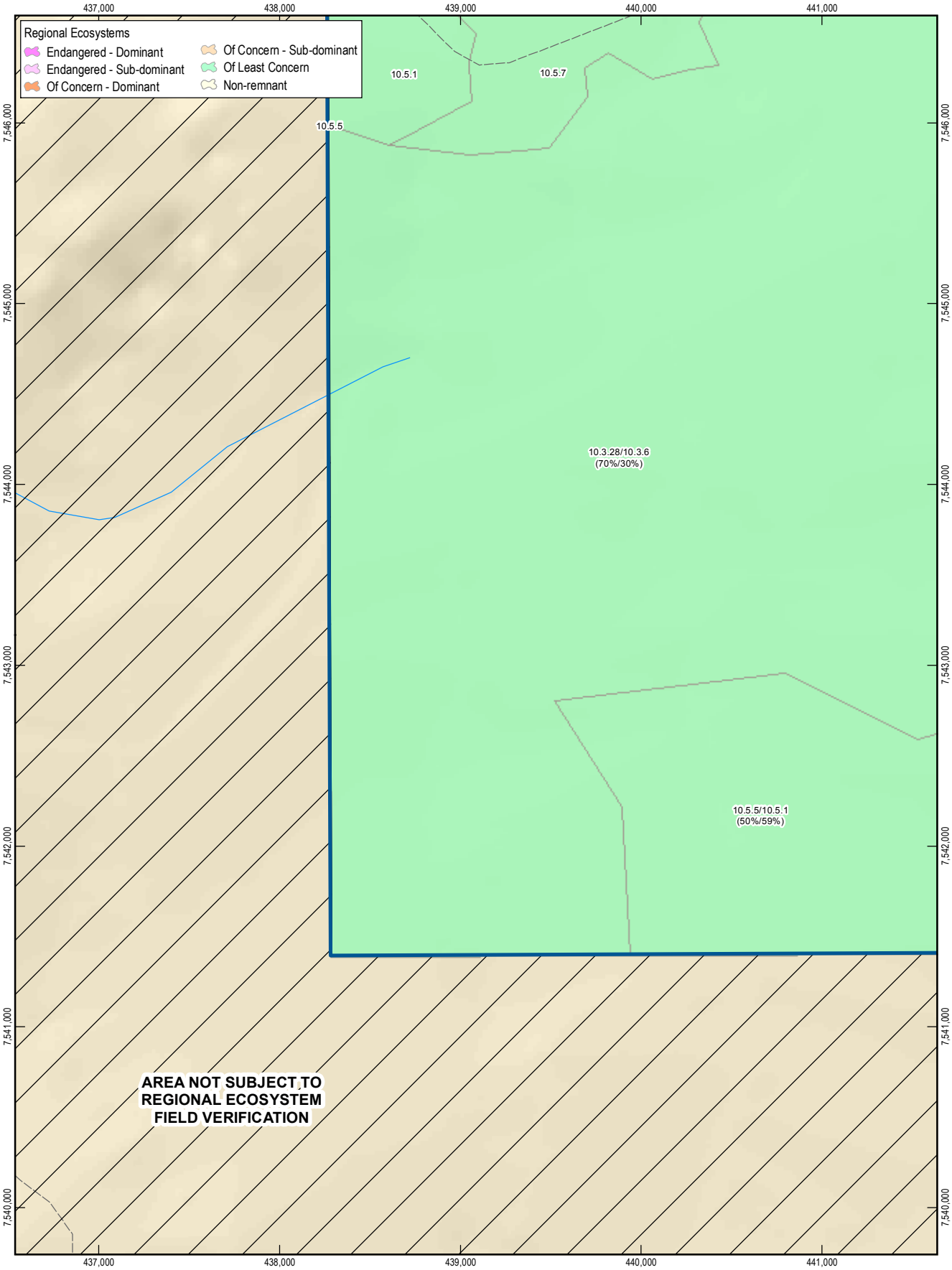
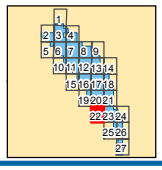


LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village



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Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Regional Ecosystems
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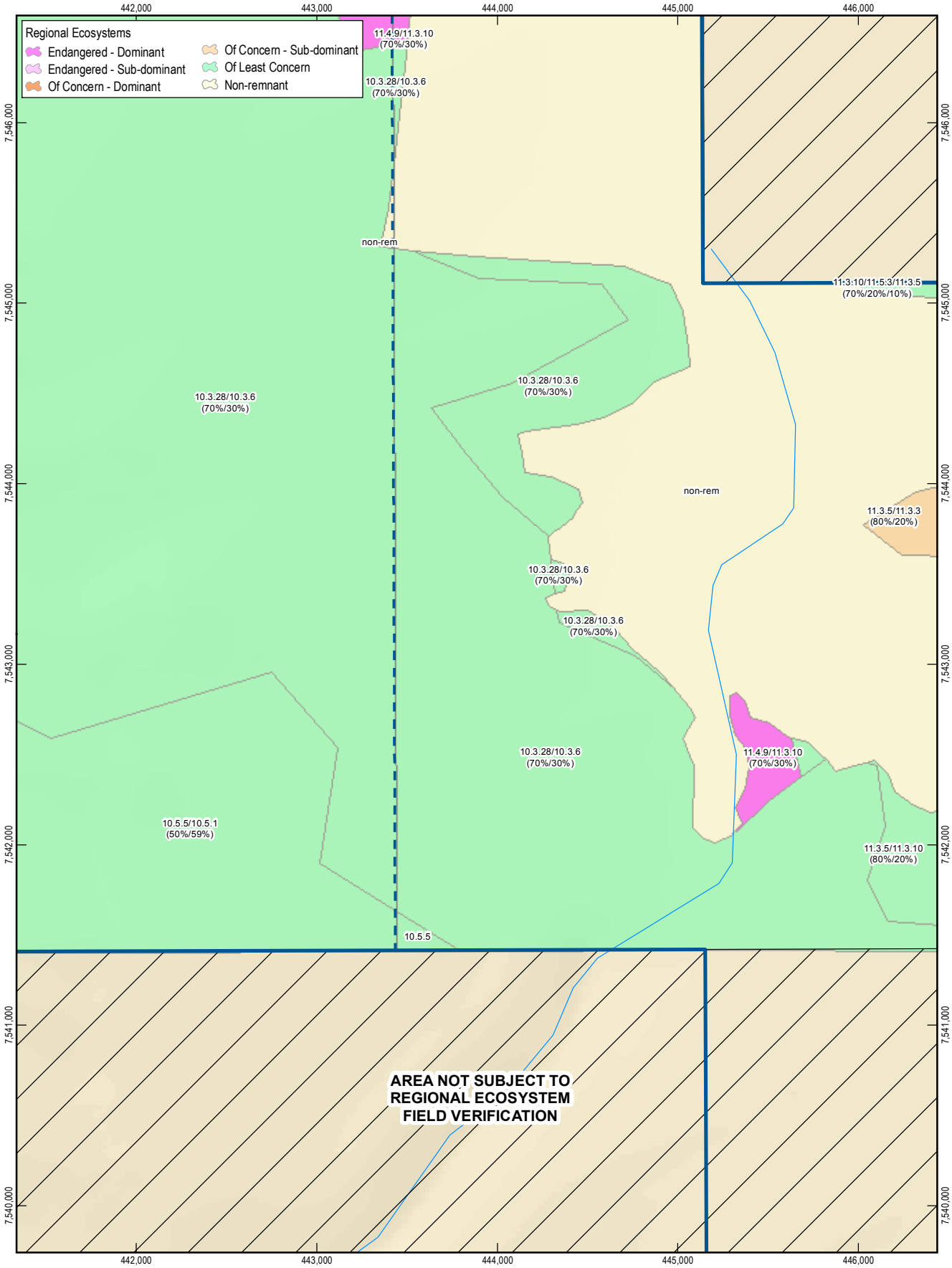
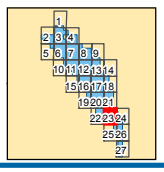


LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village



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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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Carmichael Coal Mine and Rail Project

Regional Ecosystems
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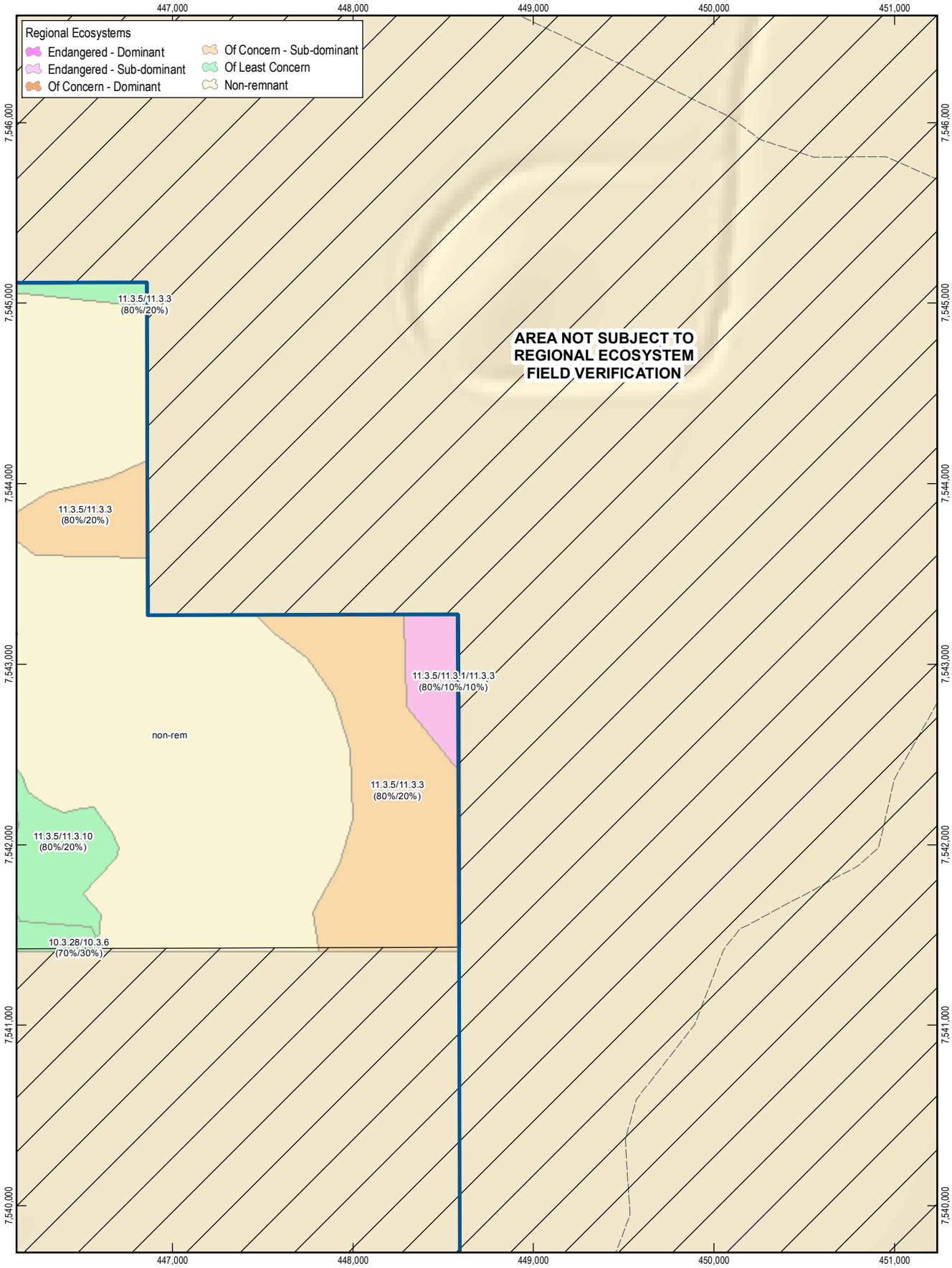
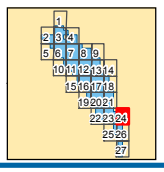
Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Regional Ecosystems v6.1, Essential Habitat (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Field Verified Regional Ecosystems (2011). Created by: BW, CA



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village



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Metres

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Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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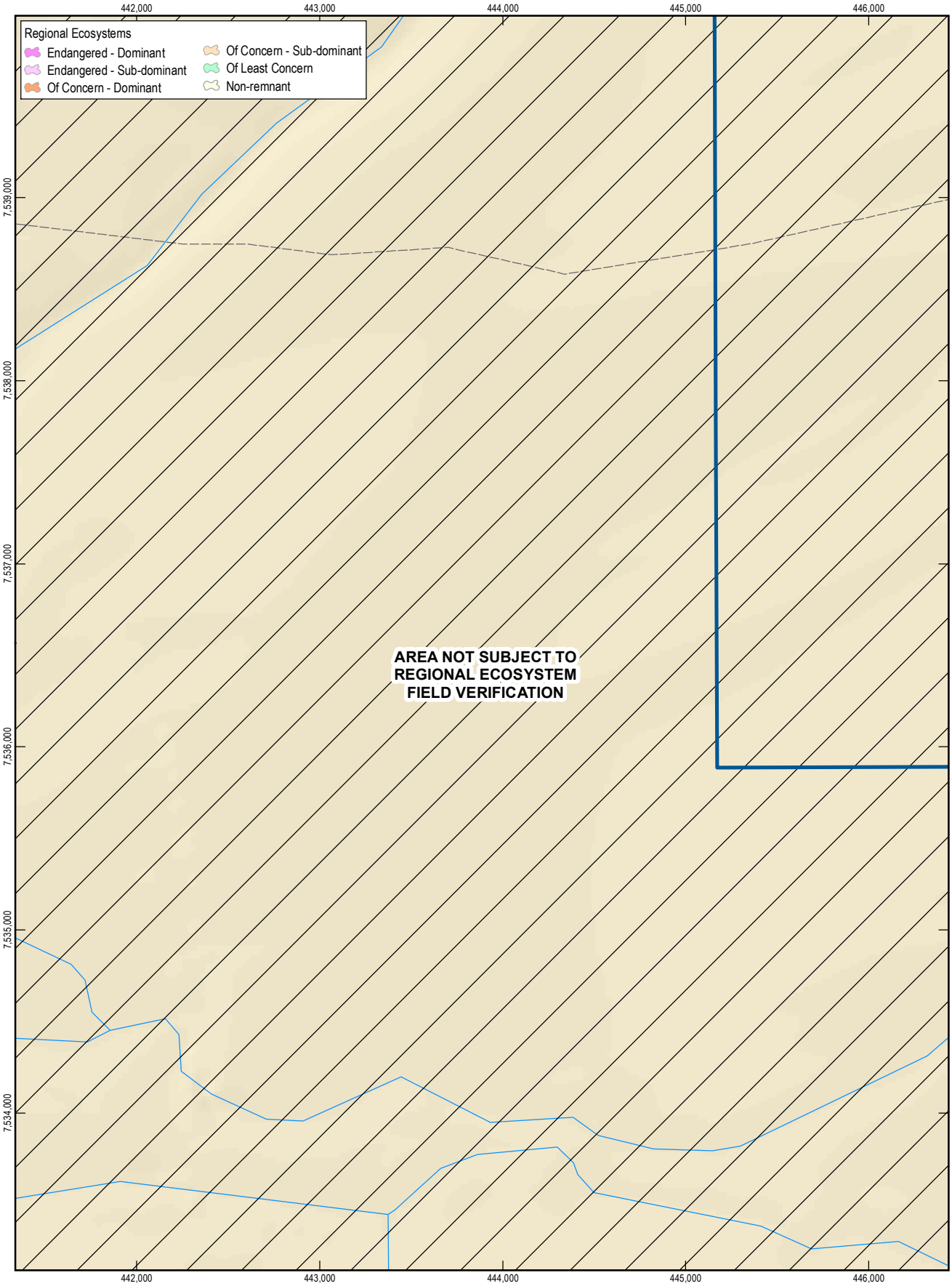
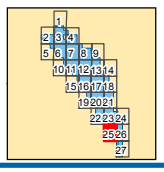
Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Regional Ecosystems v6.1, Essential Habitat (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Field Verified Regional Ecosystems (2011). Created by: BW, CA



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village



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Metres

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

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Carmichael Coal Mine and Rail Project

Regional Ecosystems
Field Verified

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Figure 5-8
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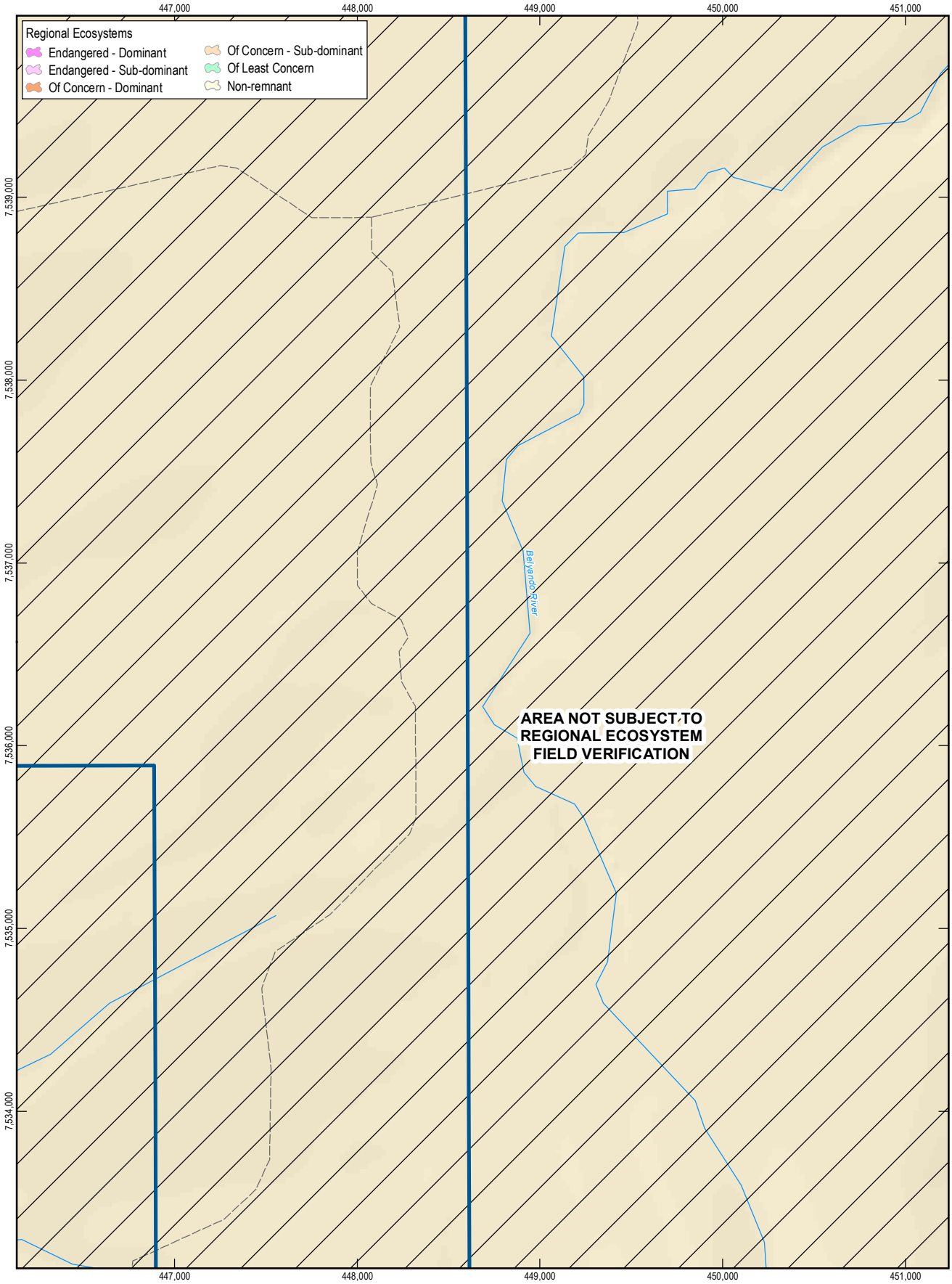
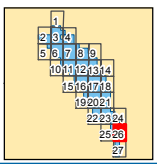


LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village



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Metres

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

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Carmichael Coal Mine and Rail Project

Regional Ecosystems
Field Verified

Job Number 41-25215
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Date 05-10-2012

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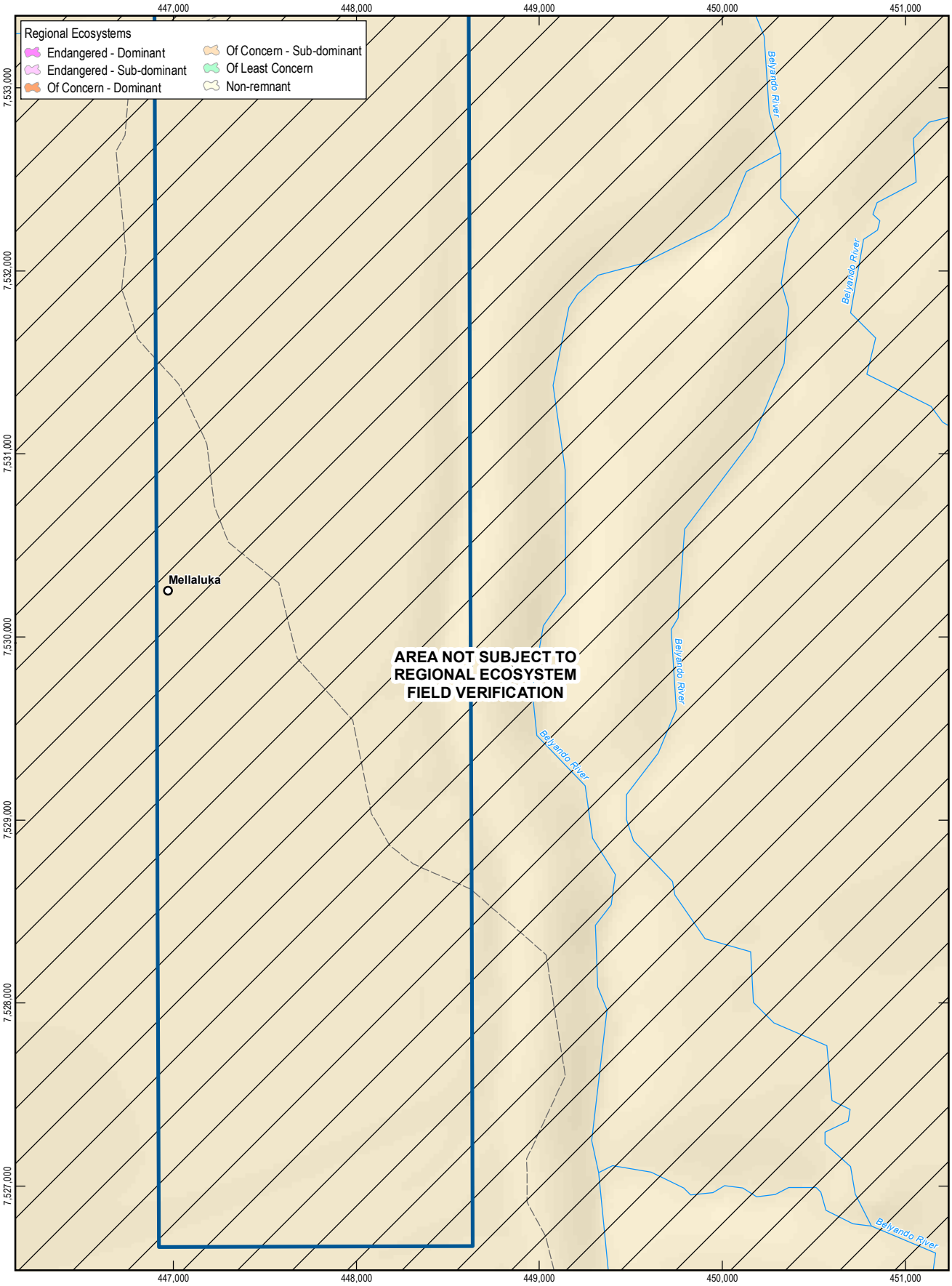
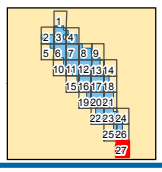


LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village



1:30,000 (at A4)

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Metres

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

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Carmichael Coal Mine and Rail Project

Regional Ecosystems
Field Verified

Job Number	41-25215
Revision	D
Date	05-10-2012

Figure 5-8
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G:\41\25215\GIS\Maps\MXD\400_Ecology\41-25215_473_rev_d.mxd Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

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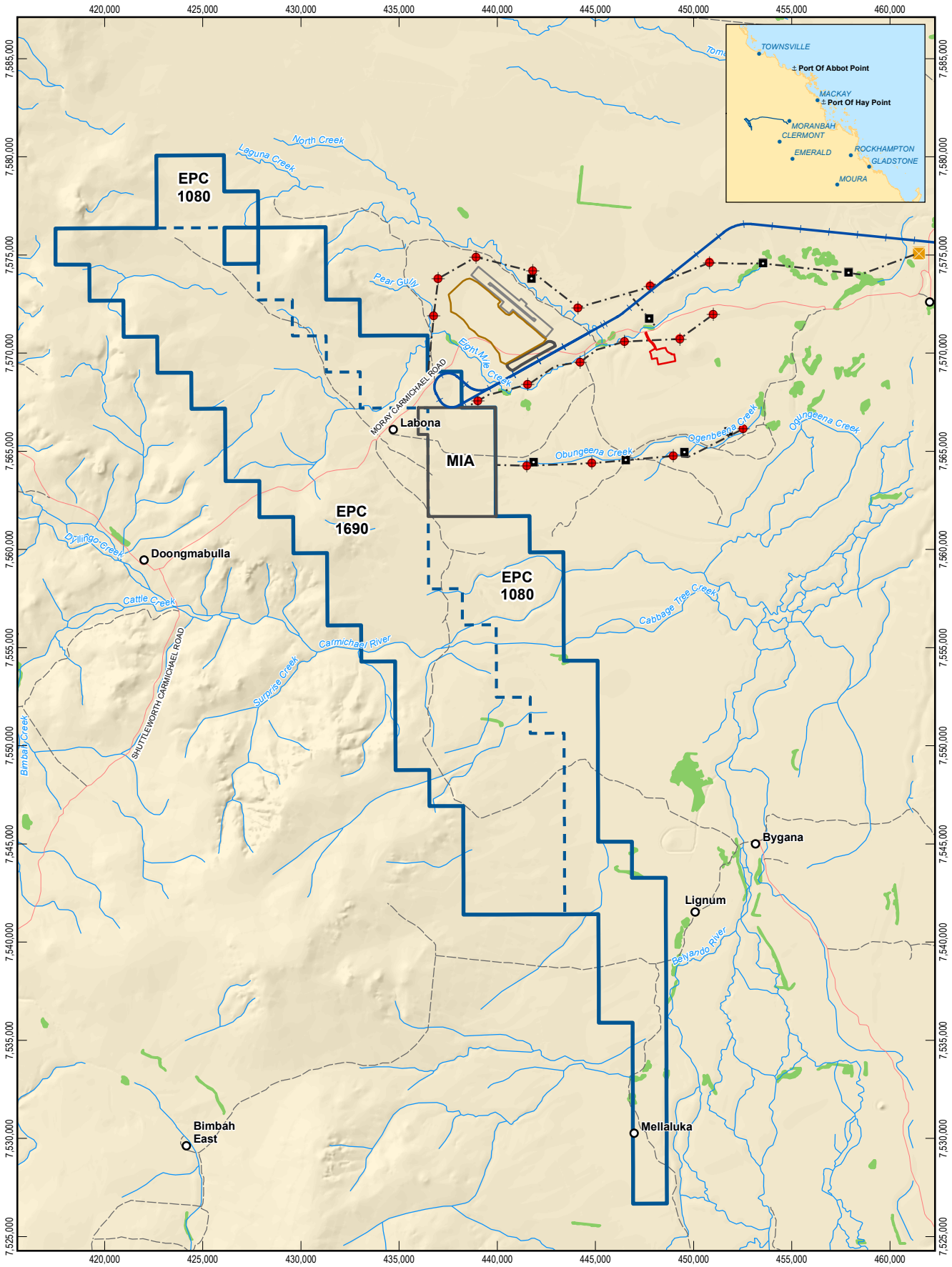

LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- High Value Regrowth Vegetation
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision C
Date 08-10-2012

Regrowth Vegetation

Figure 5-9

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Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: High Value Regrowth (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

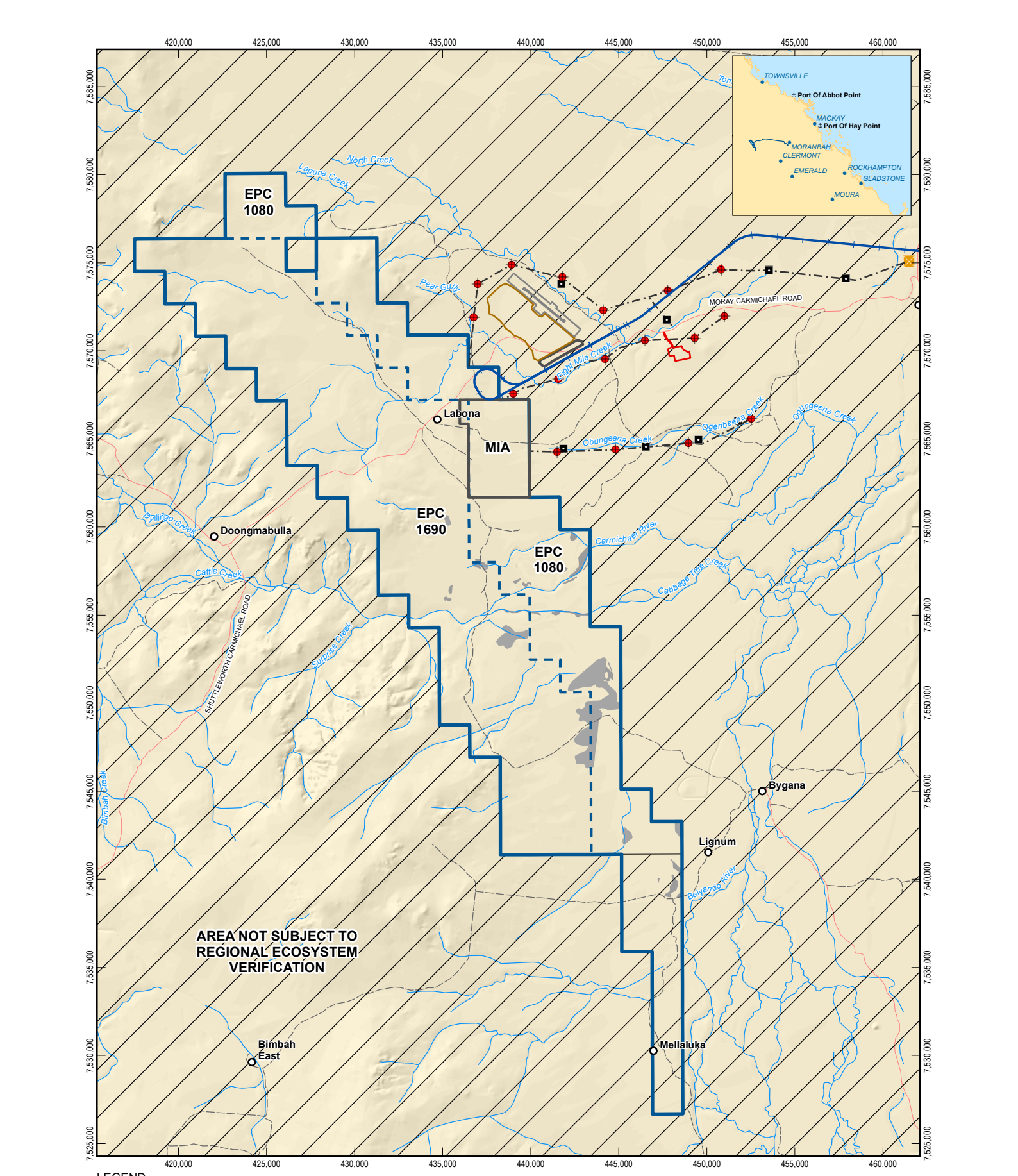
5.2.3.1 Threatened Ecological Communities

Three TECs listed as endangered under the EPBC Act were identified as having potential to occur in the Study Area from desktop results. The TECs are as follows:

Brigalow (*Acacia harpophylla* dominant and co-dominant) - Within Queensland, 16 REs are described as forming part of this TEC. Of the REs listed as forming part of the TEC, only the REs 11.3.1, 11.4.8 and 11.4.9 occur within the Study Area. Ground-truthing has determined that approximately 267 ha of these REs are present within the Study Area. The majority of this brigalow is located south of the Carmichael River to the east of the Study Area, generally within contiguous remnant vegetation with low levels of fragmentation and high levels of community integrity. The sections north of the Carmichael River are present in small, highly fragmented portions within which the community structure and species composition is generally highly modified from its natural state. The distribution of Brigalow TEC at the Study Area is presented in Figure 5-10.

The community of native species dependant on natural discharge of groundwater from the Great Artesian Basin (GAB). The nearest GAB discharge spring is the Doongmabulla wetland (shown on Figure 5-3 and discussed in Section 5.2.2.1), a cluster of 11 springs located within a 4 km radius of each other along the Carmichael River, approximately 10 km upstream (west) from the western boundary of the Study Area (Fensham pers. comm., 2012). This wetland has an area of 5 ha, and contains six flora species of conservation significance, including two species known to be endemic to the Doongmabulla spring (the herb *Erygynium fontanum* and the grass *Sporobolus pamelae*). It has been given a GAB discharge spring wetland conservation ranking of 1a (the highest), based on the presence of endemic species (Fensham et al., 2010).

Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin. This TEC is found on fine textured soils derived from either basalt or fine-grained sedimentary rocks, on flat or gently undulating rises. Of the REs listed as forming part of the TEC, only RE 11.4.11 appears on DEHP certified RE mapping within the Study Area. Ground-truthing has determined that RE 11.4.11 is not present within the Study Area. RE 11.4.11 was mapped (DEHP) covering 53 ha within the offsite infrastructure area, however this RE was not field verified.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Brigalow Threatened Ecological Community
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Carmichael Coal Mine and Rail Project

Brigalow Threatened Ecological Community - Project Area

Job Number 41-25215
Revision B
Date 08-10-2012

Figure 5-10

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5.2.3.2 Vegetation Communities

Vegetation communities can be described at a number of levels depending on the level of detail required (or the mapping scale it is intended to be utilised with) by focusing on the varying species composition of understorey layers, the landform and substrate that a community usually occurs on (e.g. hills and ranges of Palaeozoic granite), or even the geography (coastal, sub-coastal, within a certain bioregion etc.).

In order to provide a broad understanding of the vegetation alliances within the Study Area, a unique set of seven BVGs (called Broad Vegetation Communities or BVCs for this Project) have been developed, based on the particular communities and land forms present within the Study Area. These BVCs are presented in Table 5-7, and mapped in Figure 5-11. The table also incorporates general fauna habitat characteristics that are relevant to the discussion in Section 5.2.4

Table 5-7 Broad Vegetation Communities and Habitat Types within the Study Area

Community name	REs	Landform	Characteristic species	Sites[1]	Comments
Ironbark-box grassy woodland and open woodland on grey sand plains	10.3.6 10.3.12 10.3.28 10.5.4 10.5.5 11.3.3 11.3.7 11.3.10 11.5.3	Level to gently undulating Tertiary sand plains, sometimes derived from alluvium (10.3.6, 10.3.28, 11.3.10). Soils are sands, sandy loams, and clay loams (the latter often duplex soils).	*Eucalyptus melanophloia, E. brownii, E. drepanophylla, Corymbia dallachiana, Melaleuca nervosa*, *Eremophila mitchellii, Acacia excelsa, A. sericophylla, Carissa ovata, Aristida latifolia, Aristida calycina* var. *praealta, Schizachyrium fragile, Eragrostis cumingii.*	C4, C10, C16, C17, C19, C20; Q152, Q153, Q158, Q160, R2, R3, R5, R6, R8, R9, R10, R11, R12, R15, R17, R18, R20, R21, R30, R31, R32, R34, R36, R39, R41, R42, R43, R47, R48	15,131 ha within EPC 1690 Study Area. 6,395 ha within EPC 1080 Study Area. 21,526 ha in total. Generally with high native grass species diversity.
‘ironbark box woodland’	**General Habitat Characteristics:** Most widespread fauna habitat type. Typically comprised sparse canopy layer, sparse to absent shrub layer and ground layer of native (less often introduced) grasses. Forage resources for folivorous mammals, nectarivorous mammals and birds, granivores, insectivorous mammals, reptiles and birds, and grazing mammals. Predators including birds of prey, snakes and dingos. Shelter resources include occasional hollows in mature eucalypts (density dependent on age of woodland and tree species), log piles, dense ground cover. Ephemeral waterways and drainage lines often associated with habitat type – permanent water present occasionally in form of farm dams and troughs.				

Community name	REs	Landform	Characteristic species	Sites[1]	Comments
Open grassland, previously cleared areas, lacking native vegetative cover	Non-remnant 11.4.11	Generally located on clay plains in lower catchment positions immediately to the north (and less so to the south) of the Carmichael River.	Buffel grass (*Cenchrus ciliaris*)	R19	5,441 ha within EPC 1690 Study Area. 13,893 ha within EPC 1080 Study Area and including 53 ha mapped in offsite infrastructure area. 19,334 ha in total. Primarily on the more fertile clay plains.
'open cleared land'	**General Habitat Characteristics:** Large patch of cleared land occurs in central eastern part of the Study Area (north of Carmichael River), with several smaller patches south of the Carmichael River. Typically dominated by introduced buffel grass (*Cenchrus ciliaris*). Forage resources limited, although habitat supports some granivores and insectivores, and grazing mammals. Predators including birds of prey, snakes and dingos. Shelter resources limited, although log piles resultant from historic clearing likely to shelter grassland reptile species.				

Community name	REs	Landform	Characteristic species	Sites[1]	Comments
Yellow jacket and rough-leaved bloodwood shrubby low open woodland on red sand plains	10.5.1, 10.5.1b 10.5.1c 10.5.1d 10.5.8	Level to gently undulating Tertiary sand plains, usually over deep red earths and sandy loams (10.5.1) but occasionally over paler sandy loams (10.5.8).	*Eucalyptus similis, Corymbia setosa, C. brachycarpa, C. dallachiana, Petalostigma banksii, Acacia leptostachya, Triodia pungens, Themeda triandra, A. latifolia, S. fragile, Panicum effusum.*	C2, C12, C13, R13, R14	2,288 ha within EPC 1690 Study Area. 261 ha within EPC 1080 Study Area. 2,549 ha in total. Present mostly north of the Carmichael River. Generally has good native grass species diversity & has the highest overall species. Fire affected at the time of EPC 1080 survey.
‘shrubby low woodland’	**General Habitat Characteristics:** More prevalent in western part of Study Area. Habitat characteristics similar to ironbark-box woodland habitat, however occasionally denser shrub layer, and different suite of native grasses. Percentage of trees with hollows observed along 50 m transect* = 17 per cent (n=4 transects).				

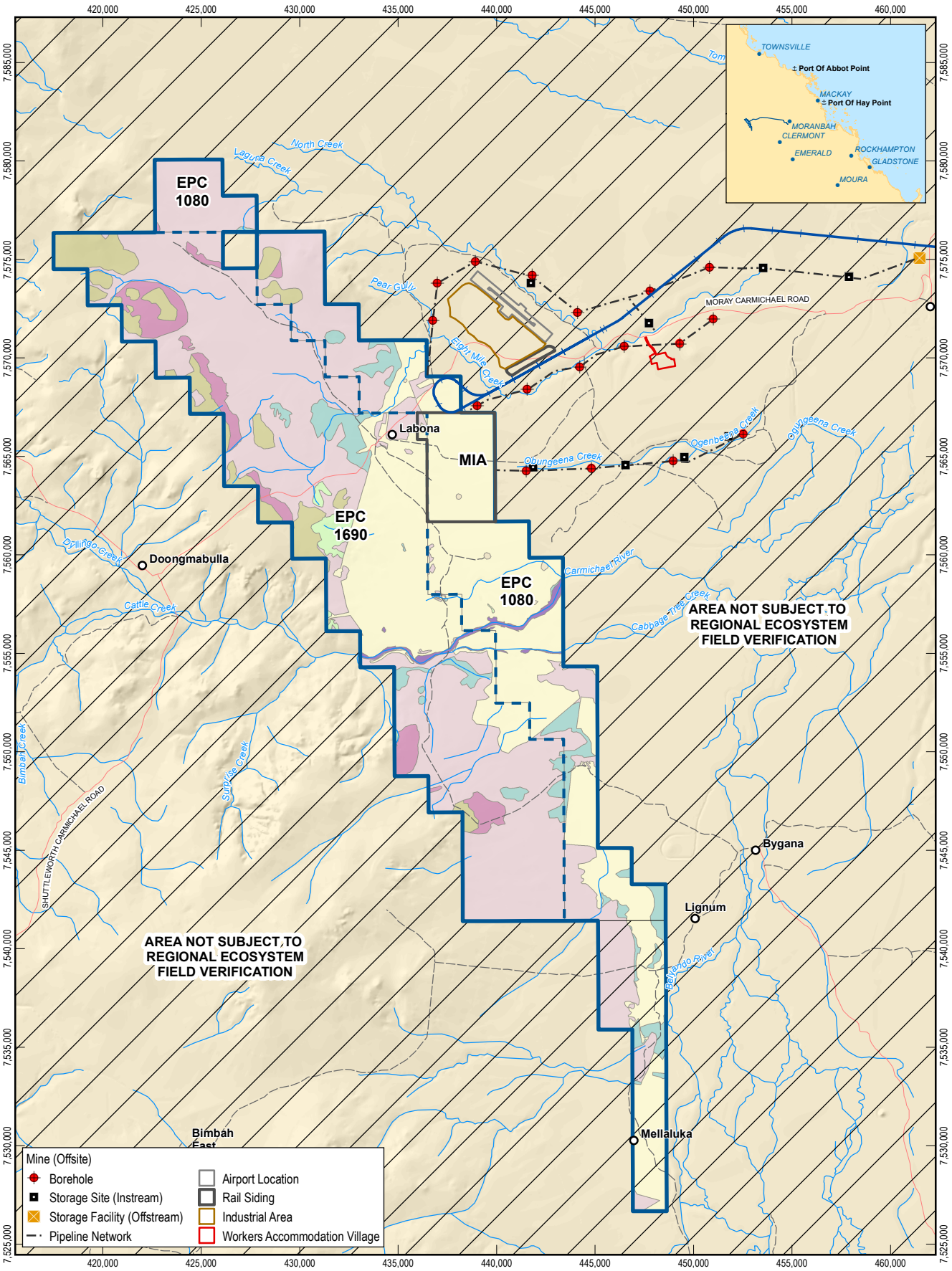
Community name	REs	Landform	Characteristic species	Sites[1]	Comments
Tall mixed shrubland on red sand plains and over ferricrete	10.5.7a 10.7.7a	Level to gently undulating Tertiary red sand plains, sometimes with ferricrete at shallow depth (10.7.7). Soils are red sands and orange/brown sandy loams.	*Acacia leptostachya, A. stipuligera, Melaleuca nervosa, Comesperma pallida, Platysace valida, Calytrix microcoma, Keraudrenia collina, Grevillea pteridifolia, E. melanophloia, C. dallachiana, Bursaria incana, Heteropogon contortus, A. latifolia, Eriachne aristidea, Fimbristylis squarrulosa.*	C1, C6, C18, R7	1,574 ha in EPC 1690 Study Area. 44 ha in EPC 1080 Study Area. 1,618 ha in total. Species diversity relatively low, but community integrity is high with no weeds noted. Fire affected at the time of EPC 1080 survey but no weeds were observed.
‘tall mixed shrubland’	**General Habitat Characteristics:** More prevalent in western part of the Study Area. Sparse to dense (low) canopy. PercentagePercentage of trees with hollows observed along 50 m transect* = 4 per cent (n=4 transects). Often dense shrub layer. Ground layer of native grasses, although often bare ground. Forage resources for nectarivorous mammals and birds, granivores and insectivores. Predators including birds of prey, snakes. Ephemeral waterways and drainage lines often associated with habitat type – permanent water present occasionally in form of farm dams and troughs.				

Community name	REs	Landform	Characteristic species	Sites[1]	Comments
Gidgee and/or brigalow shrubby woodland and low woodland, sometimes with Dawson's gum emergents, on clay and clay loam plains	10.3.3 10.3.3 10.3.4 10.4.3 10.4.5 10.9.3 11.3.1 11.3.5 11.4.5 11.4.6 11.4.9	Level to undulating Cainozoic clay plains, generally with heavy, cracking clay soils.	*Acacia cambagei, A. harpophylla, Eucalyptus cambageana, E. brownii, E. mitchellii, Flindersia dissosperma, Terminalia oblongata, C. ovata, Salsola kali, Sporobolus actinocladus, A. calycina* var. *calycina, Eragrostis speciosa, Eragrostis sororia, Enneapogon polyphyllus, Alloteropsis semialata, Leptochloa fusca, Chrysopogon fallax, Eriochloa pseudoacrotricha, H. contortus.*	C3, C5, C11, C15, Q151, Q157, R1, R4, R16, R23, R35, R37, R38, R40, R44, R45, R46	1,034 ha within EPC 1690 Study Area. 1227 ha within EPC 1080 Study Area. 2261 ha in total. Relatively high quality, intact and large patches across the Study Area.
'gidgee/brigalow shrubland'	**General Habitat Characteristics:** Sparse to dense canopy layer. Typically sparse shrub layer, with understorey of native (less often introduced) grasses. Forage resources for nectarivorous mammals and birds, granivores and insectivores. Predators including birds of prey, snakes and dingos. Shelter resources including log piles and shed bark, defoliating bark and cracking soils; few hollows. Percentage of trees with hollows observed along 50 m transect* = 4 per cent (n=11 transects). Gilgais often associated with this habitat type – seasonal water source and localised habitat node.				
Woodland and low open woodland associated with laterised sandstone rises and minor pediments	10.7.2a 10.7.3b, 10.7.4, 10.7.5, 10.7.7b, 10.9.3a	Rolling rises with skeletal soils, generally with a laterite capping and often with an abundant covering of laterised pea-gravel.	*Eucalyptus persistens, Corymbia dallachiana, E. thozetiana, Acacia shirleyi, Melaleuca tamariscina, Grevillea pteridifolia, A. leptostachya, Triodia pungens.*	C7, C8, Q154, R29	409 ha within EPC 1690 Study Area. 4 ha within EPC 1080 Study Area. 413 ha in total. Characterised by very hard, stony ground, with no weeds noted.

Community name	REs	Landform	Characteristic species	Sites[1]	Comments
'low woodland (sandstone rises)'	**General Habitat Characteristics:** Occurs in small area in central-west of Study Area. Habitat characteristics similar to ironbark-box woodland habitat, however rocky substrate may provide shelter resources for a different assemblage of small reptiles. PercentagePercentage of trees with hollows observed along 50 m transect* = 25 per cent (n=4 transects).				
Open forest and woodland fringing watercourses and relict stream channels, and alluvial plains subject to flooding	10.3.13 10.3.14 11.3.25 11.3.27	Watercourse banks, meander plains and flood plains. Soils are sandy alluvium.	*Eucalyptus camaldulensis, Melaleuca leucadendra, E. coolabah, Corymbia tessellaris, Acacia salicina, Lomandra longifolia, Dichanthium sericeum, C. fallax, Bothriochloa pertusa, H. contortus.*	C9, C14; Q150	135 ha within EPC 1690 Study Area. 172 ha within EPC 1080 Study Area. 307 ha in total. Primarily present along the Carmichael River and Cabbage Tree Creek and is considered to be a groundwater dependent ecosystem. The presence of weeds was observed within this BVC in the EPC 1080 Study Area.

Community name	REs	Landform	Characteristic species	Sites[1]	Comments
'fringing open forest/woodland'	**General Habitat Characteristics:** Restricted to riparian zone and adjacent floodplain of Carmichael River and nearby Cabbage Tree Creek. Moderate to dense canopy layer. Shrub layer generally lacking. Dense ground cover of grasses (Iomandra in riparian zone) and occasionally weeds. Sandy substrate. Forage resources for folivorous mammals, nectarivorous mammals and birds, granivores, insectivorous mammals, reptiles and birds, and grazing mammals. Predators including birds of prey, snakes and dingos. Mature Eucalyptus camaldulensis support relatively high density of hollows; Other shelter resources include log piles (flood debris), and in places, dense ground cover. PercentagePercentage of trees with hollows observed along 50 m transect* = 15 per cent (n=6 transects).				

1 C sites are comprehensive sites conducted during the wet season survey at EPC 1690; Q sites are quaternary sites undertaken during both seasons at EPC 1690 – only the major Q sites where detailed species lists were recorded are included here; R sites indicate the rapid quaternary flora survey sites within EPC 1080. All sites are mapped in Figure 5-1.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Broad Vegetation Communities and Fauna Habitat Type

- Gidgee and brigalow woodland on clay plains
- Ironbark-box grassy woodland on grey sand plains
- Low open woodland on ferricrete/laterised sandstone
- Open forest and woodland fringing streams and on flood plains
- Tall mixed shrubland on red sand plains and over ferricrete
- Yellowjacket-rough leaved bloodwood open woodland on red sand plains
- Open cleared land

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Broad Vegetation Communities and Fauna Habitat Types

Job Number 41-25215
Revision C
Date 08-10-2012

Figure 5-11

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Broad Vegetation Communities, Fauna Habitat Types (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW, CA

5.2.3.3 Flora Species Diversity

Desktop Results

Searches of relevant databases and existing reports for the area identified a broad diversity of flora species within the Study Area and broader region. These investigations were combined and summarised below:

- Predicted species data:
  - Protected matters Search Tool and Environment Reporting Tool: three threatened flora species, and five Weeds of National Significance
- Existing species records databases:
  - Wildlife Online: 962 vascular taxa of which 56 were introduced species
  - HERBRECS: 701 vascular taxa of which 38 were introduced species

A total of 13 threatened flora species were identified as being relevant to the Study Area or surrounding region through desktop review. The likelihood of occurrence assessment identified that none of these are likely to occur within the Study Area. Further detail on the likelihood of occurrence assessment is provided in Volume 4 Appendix N Mine Terrestrial Ecology Report.

Field Survey Flora Diversity

Field surveys of the EPC 1690 Study Area recorded 342 plant taxa, of which 320 were native (approximately 93.5 per cent). Ninety-seven of these taxa (including one introduced species) were recorded in the dry season. Overall, 54 plant families are represented in the EPC 1690 Study Area. The most represented plant families at the time of survey were as follows.

- Poaceae (87 taxa)
- Fabaceae (24 taxa)
- Myrtaceae (21 taxa)
- Cyperaceae (20 taxa)
- Mimosaceae (18 taxa)
- Malvaceae (17 taxa)

Field surveys of the EPC 1080 Study Area recorded 120 plant taxa, of which 110 were native (92 per cent). Overall, 41 plant families are represented in the EPC 1080 Study Area. The most represented plant families at the time of survey were as follows.

- Myrtaceae (17 taxa)
- Poaceae (16 taxa)
- Mimosaceae (16 taxa)
- Asteraceae (7 taxa)

Exotic or Weed Flora Species

A desktop review for weed and exotic flora species within the Study Area and surrounding region was undertaken utilising the following resources:

- EPBC Environment Reporting Tool search results
- Queensland Herbarium specimen database (HERBRECS) search results
- DEHP Wildlife Online search results
- Biosecurity Queensland's Annual Pest Distribution Survey 2008 data and predictive maps
- Isaac Regional Council (IRC) Draft Pest Management Plan 2011-2015 (IRC, 2011). The draft plan lists 17 weed species that are identified as a priority for management within the Local Government Area (LGA).

The information gathered from the above sources included predictive weed mapping information (based on climate suitability) over the region and historical confirmed records of weed species in the Study Area and surrounding region. The desktop review for weed species identified 19 species of 'declared plants' under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) that have been recorded or are within potentially suitable distribution.

Field surveys of the EPC 1690 Study Area confirmed the presence of 22 introduced species, 4 of which are 'declared plants' under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act). Two of the 'declared plants', Parthenium weed (*Parthenium hysterophorus*) and rubber vine (*Cryptostegia grandiflora)*, are also listed Weed of National Significance (WONS) (refer to Table 5-8).

Field surveys of the EPC 1080 Study Area confirmed the presence of 10 exotic introduced species, of which three species are 'declared plants' under LP Act. A separate rapid site inspection undertaken by Hyder Consulting identified an additional two 'declared plants'. The five 'declared plants' are also listed WONS (refer to Table 5-8).

Table 5-8 WONS Within the Study Area

Scientific name	Common name	EPC 1690 Study Area distribution
Class 2		
Cryptostegia grandiflora	rubber vine	Fringing vegetation of the Carmichael River
Parkinsonia aculeata	parkinsonia	recorded near offsite infrastructure dam storage on Obungeena Creek
Opuntia stricta	prickly pear	Brigalow patches Multiple locations within offsite infrastructure and adjacent to water storages
Opuntia tomentosa	velvety tree pear	Brigalow patches
Parthenium hysterophorus	parthenium weed	Non-remnant areas, brigalow, box woodland and within the Carmichael River, generally in very sparse clusters

5.2.4 Terrestrial Fauna

5.2.4.1 Terrestrial Fauna Habitats

Fauna Habitats

Eight broad fauna habitat types were described across the Study Area. The general characteristics of seven of these habitat types are consistent with the descriptions of BVCs provided in Table 5-7. Natural and artificial water bodies were considered a broad habitat type in addition to the BVCs. **T**hese include natural waterways Carmichael River, Cabbage Tree Creek and gilgais as well as numerous small to large farms dams. Water bodies (and adjacent vegetation) provide drinking resource for numerous animal species and breeding habitat for some (i.e. amphibians, some birds) and foraging habitat for water birds, wading birds, some birds of prey and some snakes. Photographic example of this habitat type within the Study Area is shown in Plate 5-4.

Plate 5-4 Natural and Artificial Water bodies Habitat: Carmichael River (November 2010; Dam (April/May 2011)

The spatial distribution of fauna habitats (analogous to vegetation community mapping) at the Study Area is presented in Figure 5-11.

Excluding cleared areas, fauna habitats at the Study Area were relatively disturbance-free, and retained habitat features for an assortment of fauna species. The observed evidence of weeds, pest animals and disturbances associated with cattle (i.e. loss of vegetative cover, compaction of ground, degradation of riparian areas and waterways) was generally low despite the agricultural land use within and surrounding the Study Area. In localised areas, the level of disturbance observed was relatively higher – for example in the vicinity of cattle water points (farm dams, some stock troughs), and parts of the riparian zone of the Carmichael River. Recent fire disturbance was observed in parts of the EPC 1080 Study Area. Habitats characterised by remnant vegetation retained connectivity across much of the Study Area (and beyond).

While much of the Study Area contains remnant vegetation, a large patch of cleared land dominates the central part of the Study Area between the Carmichael River and the Moray-Carmichael Road. Habitat values for native fauna are limited in this cleared land, due to the lack of microhabitats and the prevalence of buffel grass.

Marked seasonal variability in the structure and composition of fauna habitat types was not observed across the Study Area (i.e. between the spring and autumn surveys). This may be attributable to the

unseasonably high rainfall preceding the Spring 2010 survey (typically this time of year would have corresponded with the end of the central Queensland 'dry' season). With respect to fauna habitats, it is considered likely that:

- Availability of forage resources for herbivorous animals (i.e. grazers, nectarivores, grainivores and folivores) likely to be seasonally variable, and driven by local climatic conditions. This may result in variable use of different habitats by resident and sedentary species during the year and temporary occupancy in response to availability of forage resources by nomadic and migratory species.
- Availability of prey for predators may change during the year in response to variable densities and diversity of herbivorous animals.
- Extent of habitat for semi-aquatic species (i.e. amphibians, water birds) likely to fluctuate during year in response to rainfall. Large water bodies (i.e. some farm dams) that retain water throughout year may become localised nodes for water birds in response to regional reduction in extent of aquatic habitat.
- Microhabitats may vary during year in response to climate (i.e. reduced ground cover during dry season).
- Less predictable forces such as fire and flooding may alter the availability of important habitat resources for ground-dwelling / ground-foraging animals and arboreal animals.

Fauna survey results by fauna habitat type (from comprehensive survey sites) are summarised in Volume 4 Appendix N Mine Terrestrial Ecology Report.

5.2.4.2 Terrestrial Fauna Species Diversity

Desktop Assessment Summary

Table 5-9 provides a summary of the results of the desktop assessment of terrestrial fauna species with the potential to occur, or previously recorded, in the Study Area.

Table 5-9 Summary of Desktop Assessment of Terrestrial Fauna

	Protected Matters search and Environmental Reporting tool (predicted to occur)	DEHP Wildlife Online database (historically recorded)	QLD Museum specimen database (historically recorded)	Birds Australia Atlas (historically recorded)
Species diversity		17 amphibians 78 reptiles 52 mammals 207 birds	13 amphibians 40 reptiles 24 mammals 37 birds	140 birds
EPBC Act and/or NC Act threatened species	2 reptiles 1 mammal 5 birds	4 reptiles 3 mammals 6 birds	2 reptiles 2 mammals	3 birds
EPBC marine and/or migratory birds	10 migratory 11 marine	14 migratory 50 marine	2 marine	1 migratory 23 marine

	Protected Matters search and Environmental Reporting tool (predicted to occur)	DEHP Wildlife Online database (historically recorded)	QLD Museum specimen database (historically recorded)	Birds Australia Atlas (historically recorded)
Introduced/pest species	1 amphibian 5 mammals	1 amphibian 1 bird 9 mammals	1 amphibian 2 mammals	-

Consolidation of the results of the three databases from which historical terrestrial fauna species records were obtained (Wildlife Online, Queensland Museum and Birds Australia) revealed that 372 species have been previously recorded from the desktop search area, comprising:

- 18 amphibian species (17 common native species, 1 introduced species)
- 84 reptile species (79 common native species, 5 threatened species)
- 55 mammal species (43 common native species, 3 threatened species, 9 introduced species)
- 209 birds (202 common native species, 5 threatened species, 1 introduced species)

Field Assessment Summary

Table 5-10 provides a summary of the results of field studies across the Study Area. The terrestrial fauna field survey results, including Spring 2010, Spring 2011 and Autumn 2011 surveys (site-specific) species lists are provided in Volume 4 Appendix N Mine Terrestrial Ecology Report.

Table 5-10 Summary of Field Assessment Results – Terrestrial Fauna

Survey	Species	Amphibians	Reptiles	Mammals	Birds	Total
Spring 2010 survey (November 2010)	Total species	9	17	24	82	**132**
	Introduced species	1	-	4	-	**5**
	Threatened species	-	-	-	2	**2**
	EPBC Act migratory	-	-	-	3	**3**
	EPBC Act marine	-	-	-	16	**16**
Autumn 2011 survey (April-May 2011)	Total species	11	30	29	119	**189**
	Introduced species	1	-	6	1	**8**
	Threatened species	-	-	1	3	**4**
	EPBC Act migratory	-	-	-	2	**2**
	EPBC Act marine	-	-	-	18	**18**
Spring 2011 survey (November 2011)	Total species	5	21	24	121	**171**
	Introduced species	1	-	5	1	**7**
	Threatened species	-	-	1	4	**5**
	EPBC Act migratory	-	-	-	3	**3**

Survey	Species	Amphibians	Reptiles	Mammals	Birds	Total
	EPBC Act marine	-	-	-	17	**17**
Total	Total species	11	41	36	154	**242**
(both surveys)	Introduced species	1	-	6	2	**9**
	Threatened species	-	-	1	3	**4**
	EPBC Act migratory	-	-	-	3	**3**
	EPBC Act marine	-	-	-	22	22

Native Terrestrial Fauna

Volume 4 Appendix N Mine Terrestrial Ecology Report provides detailed discussion of the results of the field survey and the results of survey within each habitat type. In summary:

Eleven amphibian species from three families were recorded from the Study Area during field investigations. No species of Commonwealth, State or regional significance were detected. One introduced species (cane toad (*Rhinella marina*)) was recorded. The amphibian diversity was dominated by common tree frogs (genus Litoria) and burrowing frogs (genus Cyclorana) from the family Hylidae, and ground-dwelling frogs from the family Myobatrachidae (genera Limnodynastes, Platyplectrum, Uperoleia). Species diversity was typically higher in those habitats near water bodies (i.e. Carmichael River, ephemeral waterways, and gilgais). The most abundant species were the ornate burrowing frog (*Platyplectrum ornatum*) (Plate 5-5), spotted grass frog (*Limnodynastes tasmaniensis*) (Plate 5-6) and cane toad.

Forty-one native reptile species were recorded from the Study Area during field surveys. None are listed as Commonwealth, State or regionally significant. Skinks dominated the reptile diversity with the most commonly encountered species being *Carlia munda* (Plate 5-7) and *Ctenotus robustus*. Dragons (family Agamidae) were also well represented including the abundant nobbi dragon (*Amphibolurus nobbi*), bearded dragon (*Pogona barbata*) (Plate 5-8) and frill-necked lizard (*Chlamydosaurus kingii*). Less frequently recorded reptiles included geckos, snakes, monitor lizards and one blind snake.

Thirty-six mammal species were recorded from the Study Area during field surveys, including three species of State significance. The little pied bat (*Chalinolobus picatus* (NC Act near threatened)) was detected from four locations during the Autumn 2011 survey and one location during the Spring 2011 survey and a koala was recorded in Spring 2011. Traces (characteristic diggings and scats) of the echidna (*Tachyglossus aculeatus*) were detected during all surveys. These species are listed as a special least concern species under the Queensland Nature Conservation (Wildlife) Regulation 2006.

The most commonly recorded bat species were Gould's wattled bat (Chalinolobus gouldii) and the inland forest bat (Vespadelus baverstocki). Two arboreal mammal species were recorded – common brushtail possum (Trichosurus vulpecula) and sugar glider (Petaurus breviceps). Habitat for arboreal mammals was present though much of the (mature) open woodland habitat that characterised large parts of the Study Area. Particularly notable arboreal mammal habitat occurred along the Carmichael River, where mature river red gum (Eucalyptus camaldulensis) trees supported a relatively large number of hollows of varying sizes.

The native ground mammal fauna was dominated by rodents (family Muridae) and kangaroos (family Macropodidae). The desert mouse (Pseudomys desertor) was frequently caught in Elliott traps in open ironbark woodland and native shrubland habitats in the northern part of the Study Area. Infrequently recorded rodents included stripe-faced dunnart (Sminthopsis macroura) (Plate 5-9), delicate mouse (Pseudomys delicatulus) and water rat (Hydromys chrysogaster). Red kangaroos (Macropus rufus)) and eastern grey kangaroos (Macropus giganteus) (Plate 5-10) were commonly observed throughout the Study Area, whilst the common wallaroo (Macropus robustus) was less frequently recorded.

One hundred and fifty-four bird species were recorded from the Study Area during field investigations. A number of conservation significant bird species were confirmed present in the Study Area, namely:

- One bird listed as endangered under the EPBC Act and NC Act – black-throated finch (southern) (Poephila cincta cincta). This species is also listed as a Priority Species for the Burdekin NRM Region (under the Burdekin NRM Region Back on Track Actions for the Biodiversity report (DERM, 2010a)
- One bird listed as vulnerable under the EPBC Act and NC Act – squatter pigeon (southern) (Geophaps scripta scripta)
- Two birds listed as near threatened under the NC Act – black-necked stork (Ephippiorhynchus asiaticus) and cotton pygmy-goose (Nettapus coromandelianus).
- Three birds listed as migratory under the EPBC Act and special least concern under the NC Act;
- Twenty-two birds listed as marine under the EPBC Act

In general, the avian fauna of the Study Area comprised a mix of common and widespread woodland, grassland and water birds. Honeyeaters (family Meliphagidae) were the most diverse assemblage. Other dominant groups were parrots (Plate 5-11), flycatchers and raptors (Plate 5-12).

Plate 5-5 Ornate burrowing frog

Plate 5-6 Spotted grass frog

Plate 5-7 ***Carlia munda*** **(November 2010)**

Plate 5-8 **Bearded dragon (November 2010)**

Plate 5-9 **Stripe-faced dunnart (May 2011)**

Plate 5-10 **Eastern grey kangaroo (May 2011)**

(photo taken by remote camera)

Plate 5-11 **Red-tailed black-cockatoo (April 2011)**

Plate 5-12 **Brown falcon (May 2011)**

Introduced Fauna Species

Nine introduced terrestrial vertebrates were recorded from the Study Area. This comprised:

- One amphibian – cane toad

- Two birds – mallard and spotted turtle-dove
- Six mammals – dingo (Canis lupus dingo), cat (Felis catus), European rabbit (Oryctolagus cuniculus), house mouse (Mus musculus), black rat (Rattus rattus) and pig (Sus scrofa)

Of these species the cane toad, dingo, cat, European rabbit and pig are Class 2 Declared Animals under the LP Act. Local governments, communities and landowners are required to manage these species under the LP Act.

The Isaac Regional Council (IRC) Draft Pest Management Plan (IRC, 2011) identifies the mammal and amphibian species detected as priority species (for management).

Further discussion on the distribution and prevalence of introduced fauna species is provided in Volume 4 Appendix N.

5.2.4.3 Terrestrial Threatened Species Habitats

The following terrestrial threatened species were either confirmed or likely to occur in the Study Area, as determined by desktop assessment, likelihood of occurrence assessment and field surveys:

- Six confirmed present EPBC Act listed fauna species - black-throated finch (southern), squatter pigeon (southern) and koala; three migratory birds – eastern great egret, rainbow bee-eater and satin flycatcher.
- Six confirmed present NC Act listed species –Black-necked stork, cotton pygmy goose and little pied bat in addition to the EPBC listed black throated finch, squatter pigeon (southern) and koala.
- 13 likely to occur EPBC Act listed species;
- two terrestrial species - ornamental snake and yakka skink;
- eleven migratory birds – common sandpiper, fork-tailed swift, curlew sandpiper, latham's snipe, white-bellied sea eagle, white-throated needletail, caspian tern, black-tailed godwit, glossy ibis, common greenshank and marsh sandpiper.
- Two likely to occur NC Act listed species– square tailed kite and black-chinned honey-eater

Results of surveys for these species and their habitats within the Study Area and surrounds are summarised below. For EPBC Act listed species confirmed or likely to occur habitat mapping was undertaken and is provided in Section 5.2.4.3.

The likelihood of occurrence assessment determined a number of other EPBC Act or NC Act listed species that 'may occur' in the Study Area. These species are discussed in Volume 4 Appendix N Mine Terrestrial Ecology Report.

Black-throated Finch (southern)

The black-throated finch (southern) is listed as endangered under the EPBC Act (and endangered under the NC Act). Where it was once previously found throughout eastern and central Queensland north of the New South Wales border, it is now only known from the Townsville region and scattered sites in central Queensland (SEWPAC, 2011k). The extent of occurrence of the species (i.e. *Poephila cincta*) has declined by approximately 80 per cent since the 1980s, with the majority of this decline in the range of the endangered southern subspecies (SEWPAC, 2011k).

The subspecies inhabits grassy open woodland and open forest habitats characterised by trees belonging to the genera Eucalyptus, Corymbia, Acacia and Melaleuca (SEWPAC, 2011k). Generally

it occurs in habitats near watercourses or water bodies - almost all recent records of the subspecies south of the tropics have been in riparian areas (SEWPAC, 2011k). Three critical habitat resources are required to support the subspecies:

- Water sources – natural and artificial
- Grass seeds - a mosaic of species that provide forage, particularly during the wet season
- Trees that provide suitable nesting habitat (DEWHA, 2009a; SEWPAC, 2011k)

Grass species that are considered to be important forage species for the black-throated finch (southern) include *Urochloa mosambicensis, Enteropogon acicularis, Panicum decompositum, Panicum effusum, Dichanthium sericeum, Alloteropsis semialata, Eragrostis sororia* and *Themeda triandra* (DEWHA, 2009a). REs at which the subspecies has been recorded in north Queensland since 1994 (Black-throated Finch Recovery Team, 2007) that are present at the Study Area include:

- RE 10.3.6 Eucalyptus brownii open woodland on alluvial plains
- RE 10.3.13 Melaleuca fluviatilis and/or Eucalyptus camaldulensis woodland along watercourses
- RE 10.3.28 Eucalyptus melanophloia or E. crebra open woodland on sandy alluvial fans
- RE 10.5.1 Eucalyptus similis and/or Corymbia brachycarpa and/or Corymbia setosa low open woodland to open woodland on sand plains
- RE 10.5.5 Eucalyptus melanophloia open woodland on sand plains
- RE 11.3.25 Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines
- RE 11.3.27 Freshwater wetlands

Black-throated Finch (southern) at the Study Area

Black-throated finches (southern) were recorded at the Study Area at the following times:

- Autumn 2011 survey (27 occasions, noting that some sightings may have been of the same individual or group of individuals on separate days)
- August and September 2011 (3 occasions by an ecologist accompanying a soil assessment team)
- Spring 2011 survey (4 occasions, at or near the Study Area)
- May 2012 targeted black-throated finch survey (9 occasions, at or near the Study Area)

Black-throated finches (southern) observed at the Study Area are shown in Plate 5-13.

Plate 5-13 Black-throated finches (southern) observed at stock troughs near southern boundary of Bygana West Nature Refuge (April 2011); Black-throated finches (southern) observed at north-west of Study Area (May 2011)


Figure 5-12 displays the locations of black-throated finch (southern) sightings from the Study Area. Habitat at these locations was typically characterised by open eucalypt (ironbark and/or box) woodland with a native grass understorey and locally-available surface water, although several sightings of finches drinking from farm dams surrounded by non-remnant vegetation were made during the Spring 2011 survey. Examples of locations from which sightings at the Study Area were made are presented in Plate 5-14 and Plate 5-15. Records obtained from the Study Area are towards the south-western extent of the subspecies' current known (i.e. post-1998) distribution.

Plate 5-14 Water sources at southern part of Study Area from which black-throated finches (southern) were observed drinking (April 2011)

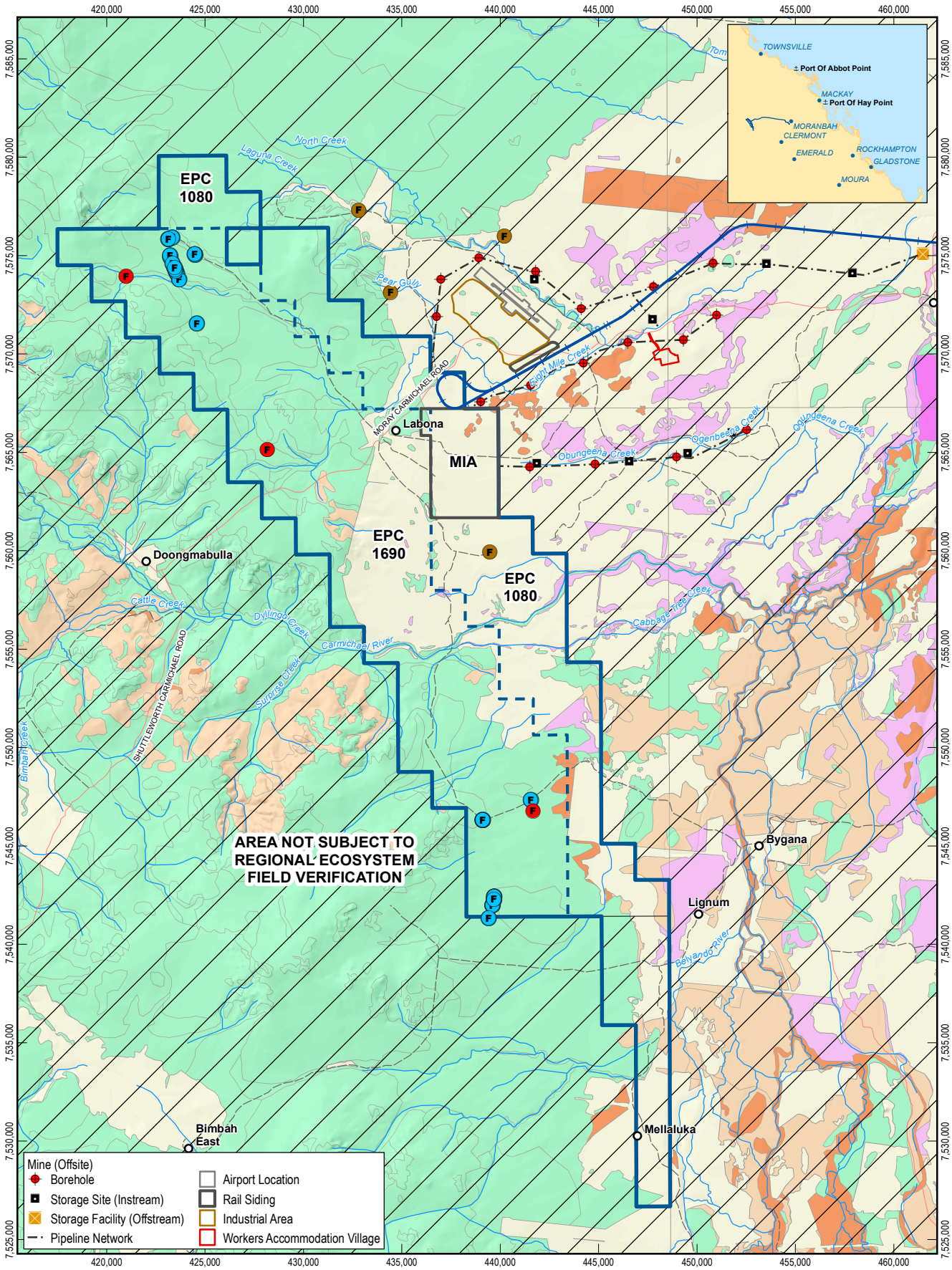

Plate 5-15 Open eucalypt woodland with native grass understorey at southern part of Study Area (April 2011); Open eucalypt woodland with native grass understorey at northern part of Study Area (May 2011)


Full details of black-throated finch (southern) sightings are presented in Volume 4 Appendix N Mine Terrestrial Ecology Report. In summary:

- Group size ranged from a single bird to approximately 40 birds
- Sightings were made between (approximately) 8:30 am and 6:30 pm
- Finches were typically observed drinking at dams/stock troughs, or flushed from tracks by slow moving vehicles whilst foraging on the ground
- Weather conditions when sightings were made were typically fine, warm and clear
- Black-throated finches (southern) were occasionally observed in the presence of other finch species – namely double-barred finch (*Taeniopygia bichenovii*) and plum-headed finch (*Neochmia modesta*)

Figure 5-13 provides an indication of habitat that may be utilised by the subspecies at the Study Area. Those REs from which the subspecies has been recorded in north Queensland since 1994 (Black-throated Finch Recovery Team, 2007), and that may represent potentially suitable habitat for the subspecies at the Study Area, were mapped (using the field verified RE mapping). The limiting factor to utilisation of this potentially suitable habitat is likely to be availability of water. It was considered likely that the black-throated finch would be present near water sources such as farm dams, stock troughs, gilgais and the Carmichael River. No evidence of breeding for the species was detected at the Study Area. However, in consideration of the largely sedentary nature of the subspecies, and the availability of suitable habitat resources, it is considered likely that the black-throated finch (southern) is breeding at the Study Area.

Approximately 26,050 ha of remnant vegetation at the Study Area may represent potentially suitable habitat for the black-throated finch (southern).



LEGEND

- Black-throated Finch - Autumn 2011
- Black-throated Finch - August/September 2011 - Opportunistic sightings
- Black-throated Finch - Spring 2011
- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Regional Ecosystems v6.1

- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- Of Least Concern
- Non-remnant

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

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Carmichael Coal Mine and Rail Project

Location of Black-throated Finch (southern) Sightings - Project Area

Job Number 41-25215
Revision B
Date 08-10-2012

Figure 5-12

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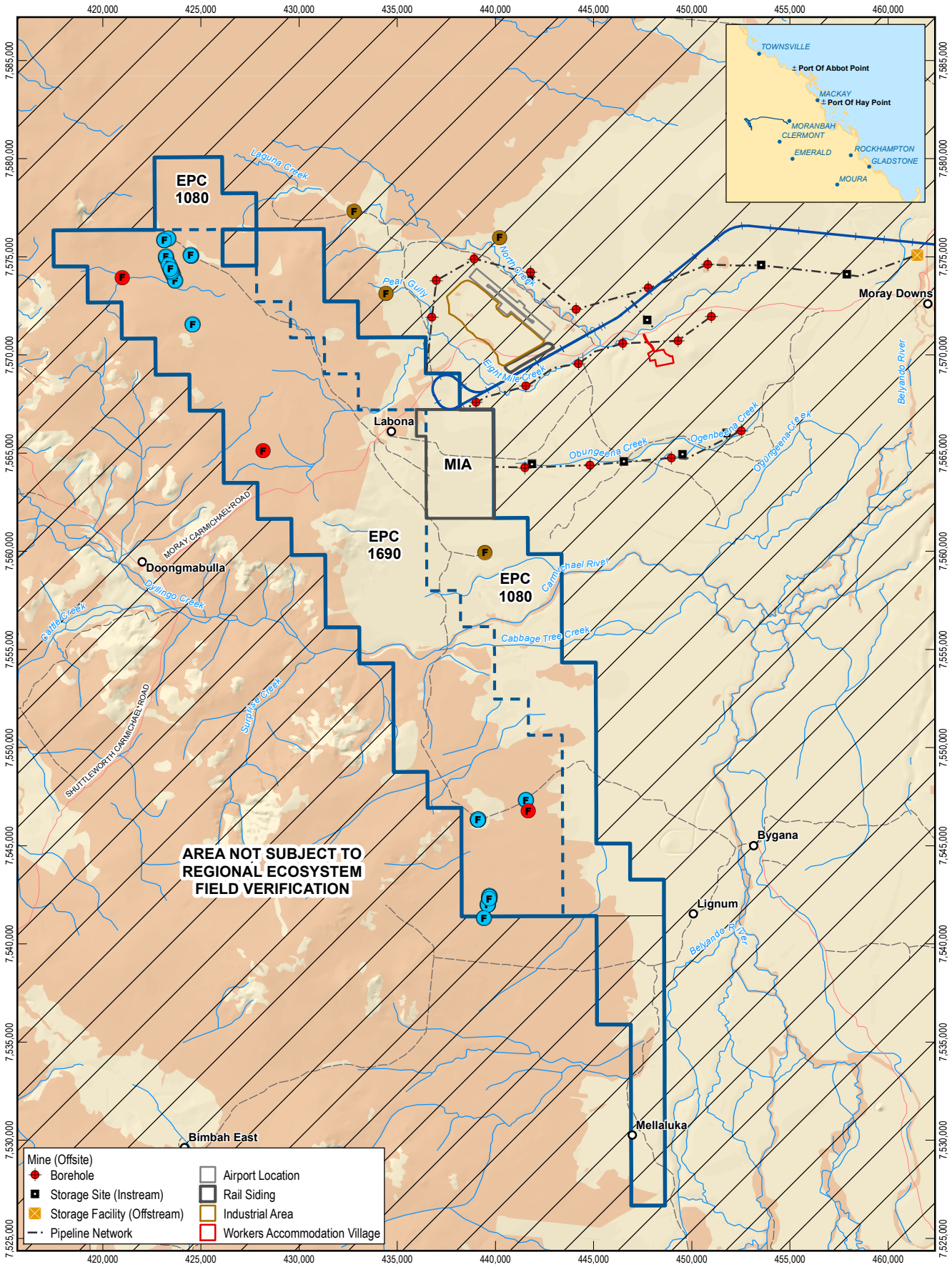
Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Regional Ecosystems v6.1 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Black Throated Finch Sightings (2011). Created by: BW, CA



LEGEND

- Black-throated Finch - Autumn 2011
- Black-throated Finch - August/September 2011 - Opportunistic sightings
- Black-throated Finch - Spring 2011
- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Potential Black-Throated Finch (Southern) Habitat - Based on Field Verified Regional Ecosystems within the Mine Site and DERM Certified Regional Ecosystems Version 6.0b outside the Mine Site

1:275,000 (at A4)
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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

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Potential Black-throated Finch (southern) Habitat - Project Area

Job Number 41-25215
Revision C
Date 08-10-2012

Figure 5-13

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Regional Ecosystems v6.0 (2010); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Black Throated Finch Sightings, Potential Habitat (2011). Created by: BW, CA

The REs from which the subspecies has been recorded in north Queensland (i.e. Brigalow Belt North and Desert Uplands) since 1994 (as presented in the *National Recovery Plan for the Black-throated Finch Southern Subspecies* (Black-throated Finch Recovery Team, 2007) that may represent potentially suitable habitat for the subspecies *beyond* the Study Area, were mapped (using DEHP certified REs – mixed polygons containing suitable REs were included in the mapping) – see Figure 5-14. This map indicates that much of the remnant vegetation to the north, west and south of the Study Area may provide potentially suitable habitat for the black-throated finch (southern), based on the underlying RE mapping. Little potentially suitable habitat occurs to the east of the Study Area.

Habitat utilisation beyond the Study Area will be largely based upon the degree of connectivity/fragmentation of potential habitat patches, and the presence of the three critical habitat resources required by the subspecies (mosaic of native grasses, nesting trees and access to water). The subspecies has been recorded (post-1998) by the Black-throated Finch Recovery Team within approximately 10-20 km of the Study Area (at Doongmabulla Station) (SEWPAC, 2011k). These records, in combination with unpublished data relating to recent (2012) field assessments by Birdlife Australia in the Galilee Basin, indicate that the subspecies occurs in the wider landscape beyond the Study Area, where suitable habitat is present. It is likely that populations in this landscape fluctuate in response to local climatic conditions, with a 'boom-bust' cycle of rapid population increases and declines linked to seasonal rainfall (and the influence this is has on the subspecies' key food source, seeding grasses).

Existing populations of the black-throated finch (southern) are thought to be highly fragmented (SEWPAC, 2011k). As such, the Significant Impact Guidelines for the Endangered Black-throated Finch (southern) (Poephila cincta cincta) (DEWHA, 2009b) define any habitat within five km of a post-1995 sighting as an 'important area' for the subspecies. The guidelines also state "that the presence of the black-throated finch (southern) at a site indicates that existing management regime is likely to be compatible with maintaining suitable habitat for the subspecies".

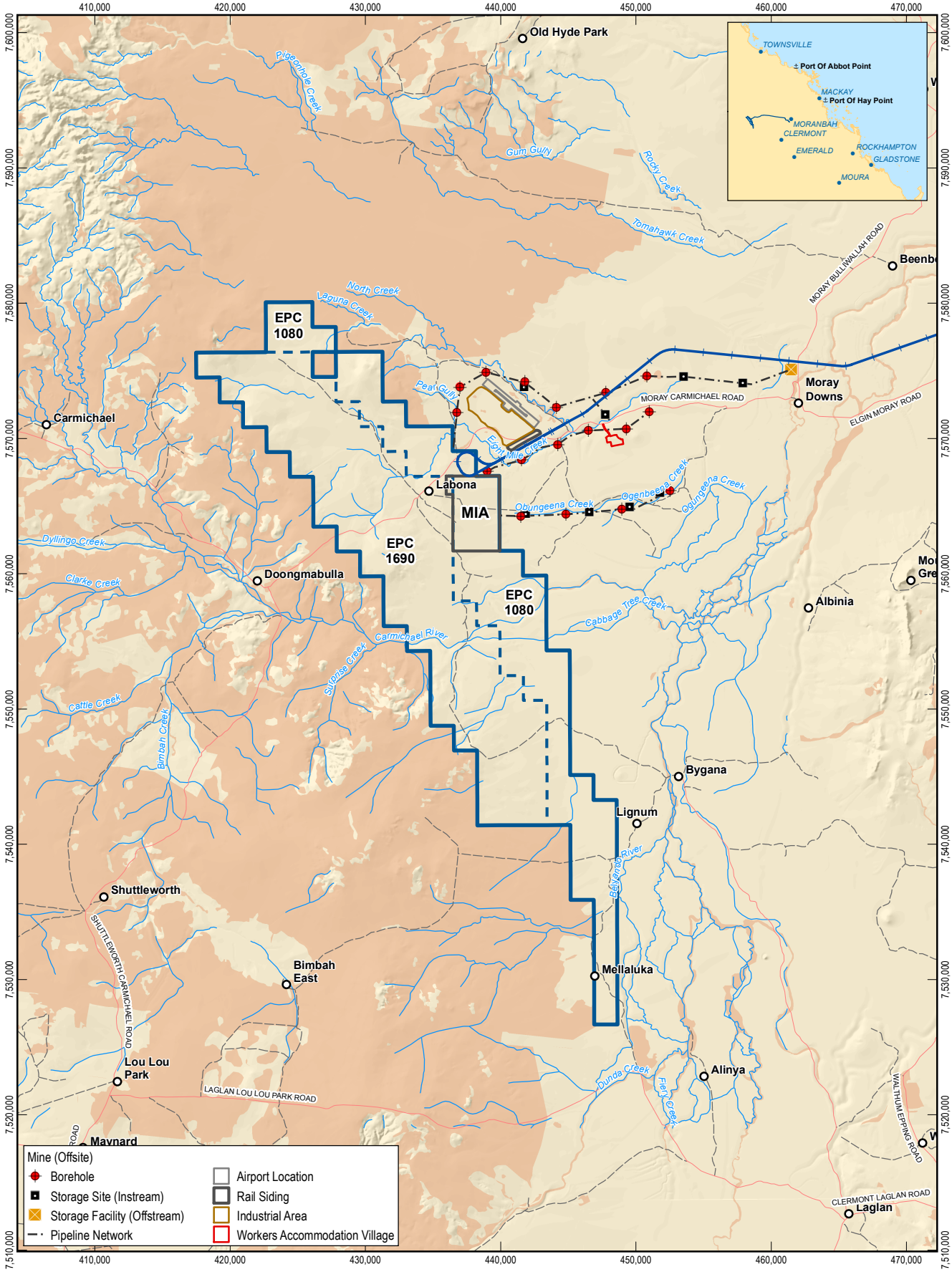
Figure 5-15 displays black-throated finch (southern) important areas at and near the Study Area. These important areas were identified by applying a 5 km buffer to sighting records from the Study Area, and selecting potential habitat (as depicted in Figure 5-14, based on those (field verified) REs from which the subspecies has been recorded in north Queensland since 1994 (as presented in the *National Recovery Plan for the Black-throated Finch Southern Subspecies* (Black-throated Finch Recovery Team, 2007)) within the 5 km buffer.

The approximate extent of important areas for the subspecies in the Study Area is 21,246 ha.

Based on the (currently available) information acquired from desktop and field studies, and in consideration of the Commonwealth *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Significant Impact Guidelines), (DEWHA, 2009c), it is considered that the Study Area supports a 'population' of the black-throated finch (southern), noting that a 'population' of an (EPBC Act) endangered species is defined in the Significant Impact Guidelines as 'the occurrence of the species in a particular area', where occurrence relates to:

1. *A geographically distinct regional population, or collection of local populations, or*
2. *A population, or collection of local populations, that occurs within a particular bioregion* (DEWHA, 2009c).

The Study Area is within approximately 50 km of a cluster of 'important areas' (i.e. habitat within 5 km of a post-1995 sighting) for the subspecies exhibited in the *Whole of range important areas* map presented in the black-throated finch (southern) significant impact guidelines (DEWHA, 2009b). As such it is considered that black-throated finches (southern) occurring at the Study Area represent part of a collection of local populations.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Potential Black-Throated Finch (Southern) Habitat - Based on DERM Certified Regional Ecosystems Version 6.0b

1:400,000 (at A4)

0 2.5 5 7.5 10

Kilometres

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

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Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Potential Black-throated Finch (southern) Habitat - Beyond Project Area Figure 5-14

Job Number	41-25215
Revision	B
Date	08-10-2012

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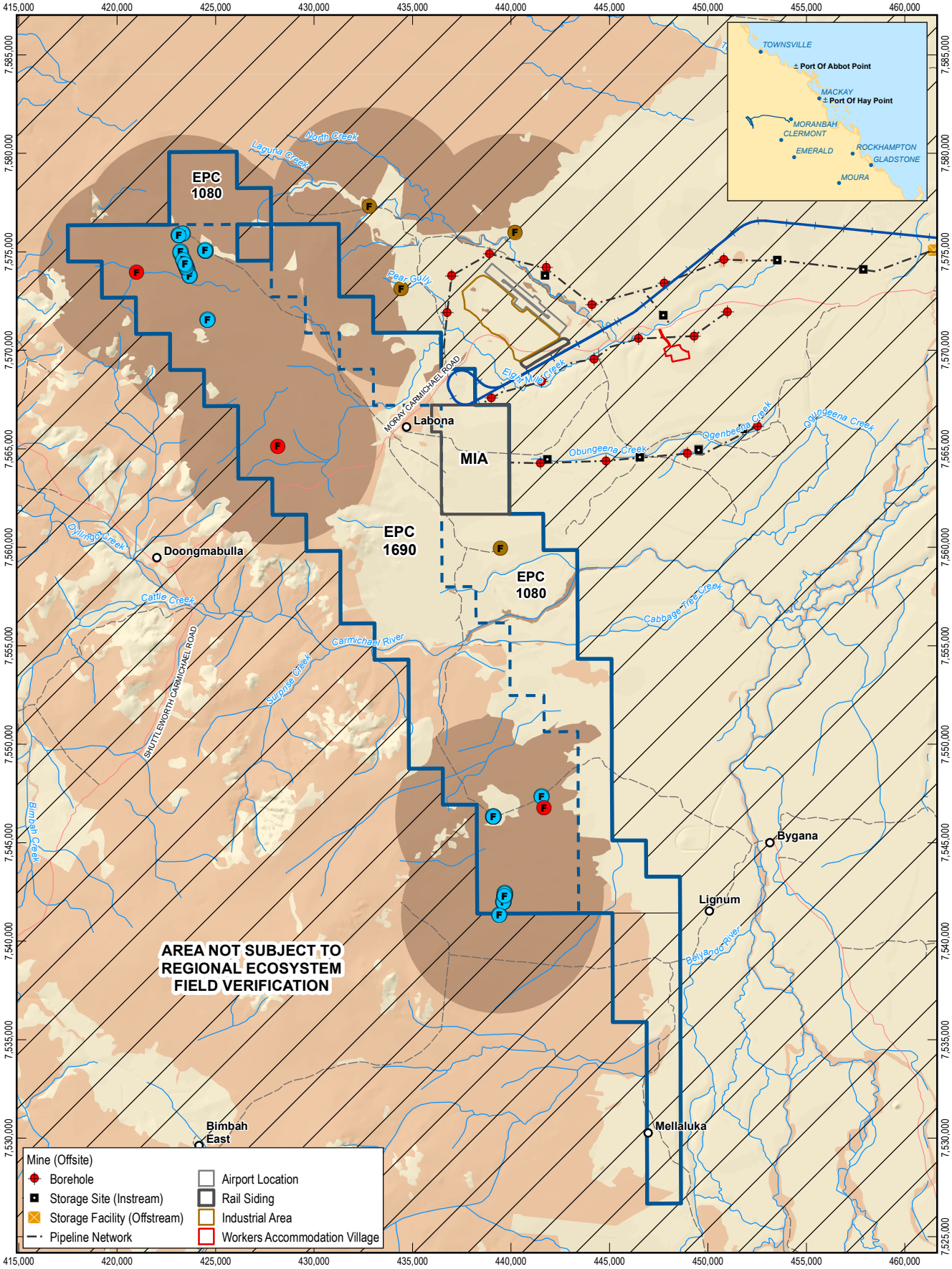

LEGEND

- Black-throated Finch - Autumn 2011
- Black-throated Finch - August/September 2011 - Opportunistic sightings
- Black-throated Finch - Spring 2011
- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Potential Black-Throated Finch (Southern) Habitat - Based on Field Verified Regional Ecosystems within the Mine Site and DERM Certified Regional Ecosystems Version 6.0b outside the Mine Site
- Black-Throated Finch Important Area -Based on SEWPAC Significant Impact Guidelines

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Carmichael Coal Mine and Rail Project

Black-throated Finch (southern) Important Areas

Job Number 41-25215
Revision B
Date 08-10-2012

Figure 5-15

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Squatter Pigeon (southern)

The squatter pigeon (southern) (vulnerable EPBC Act, NC Act) is a ground-dwelling pigeon that occurs from the dry tropics of central Queensland to the south east of the state (SEWPAC, 2011i). The subspecies experienced a northward range contraction during the 20th Century, and is now not known to occur in New South Wales (SEWPAC, 2011i). Both the extent of occurrence and population size (estimated at 40,000 breeding birds) are considered to be stable at present (SEWPAC, 2011i). The squatter pigeon (southern) is locally abundant at some locations in the northern part of its current distribution (SEWPAC, 2011i), and is considered to be common in cattle grazed country north of the Tropic of Capricorn (SEWPAC, 2011i).

The subspecies is typically associated with open eucalypt woodland or forest habitat with a grassy understorey, particularly near water (SEWPAC, 2011i). It is less frequently encountered in disturbed areas (i.e. around roads, stockyards) (SEWPAC, 2011i). A variety of food items are taken by this ground-dwelling forager, including seeds (grass, legumes, herbs, forbs), insects and ticks (SEWPAC, 2011i).

Breeding may occur all year when conditions suit, however it is thought to be concentrated from the end of winter through to the summer months (SEWPAC, 2011i). Typically two eggs are laid in a nest (comprising a depression in the substrate) (SEWPAC, 2011i).

The three principal threats to the squatter pigeon (southern) are habitat loss associated with land clearing (for agriculture/industry), habitat degradation by grazing mammals and predation by native and introduced predators (particularly cats and foxes) (SEWPAC, 2011i).

Squatter Pigeons (southern) at the Study Area

Squatter pigeons (southern) were recorded at the Study Area at the following times:

- Spring 2010 survey (5 occasions)
- Autumn 2011 survey (24 occasions, noting that some sightings may have been of the same individual or group of individuals on separate days).
- Spring 2011 survey (10 occasions, at or near the Study Area)

The subspecies was typically encountered on tracks in open eucalypt woodland habitat featuring a grassy understorey. Group size ranged from a single bird to 20 birds.

Squatter pigeons (southern) and an example of squatter pigeon habitat observed at the Study Area are shown in Plate 5-16. Squatter pigeons were recorded in open woodland habitats and near water bodies surrounded by non-remnant vegetation (Spring 2011 survey).

Locations of squatter pigeon (southern) records from the Study Area are presented in Figure 5-16.

Figure 5-17 provides an indication of habitat that may be utilised by the squatter pigeon (southern) at the Study Area. Field verified REs characterised by open woodland and forest vegetation were identified and mapped. REs from land zones 7 (ironstone jump-ups) and 9 (undulating country on fine grained sedimentary rocks) were not considered for the analysis as they are not considered likely to provide habitat for the subspecies. As for the black-throated finch (southern), the limiting factor to utilisation of this potentially suitable habitat is likely to be availability of water. It was considered likely that the squatter pigeon would be present near water sources such as farm dams, stock troughs, gilgais and the Carmichael River.

Plate 5-16 Squatter pigeons (southern) recorded from central part of Study Area (May 2011); Open ironbark woodland with native grass understorey habitat where squatter pigeons was recorded (April 2011) (right)

To map potential habitat for the squatter pigeon (southern) beyond the Study Area, (DNRM certified) REs characterised by open woodland and forest vegetation were identified and mapped. Potential squatter pigeon (southern) habitat beyond the Study Area is presented in Figure 5-18. The presence of potentially suitable habitat beyond the Study Area suggests that the squatter pigeon (southern) is likely to be present in much of the wider landscape (excluding to the east where non-remnant vegetation dominates the landscape). Habitat utilisation and abundance is likely to be influenced by availability of water and abundance of predators (especially cats and foxes). Predator abundance may be related to the management regime of individual properties in the landscape surrounding the Study Area.

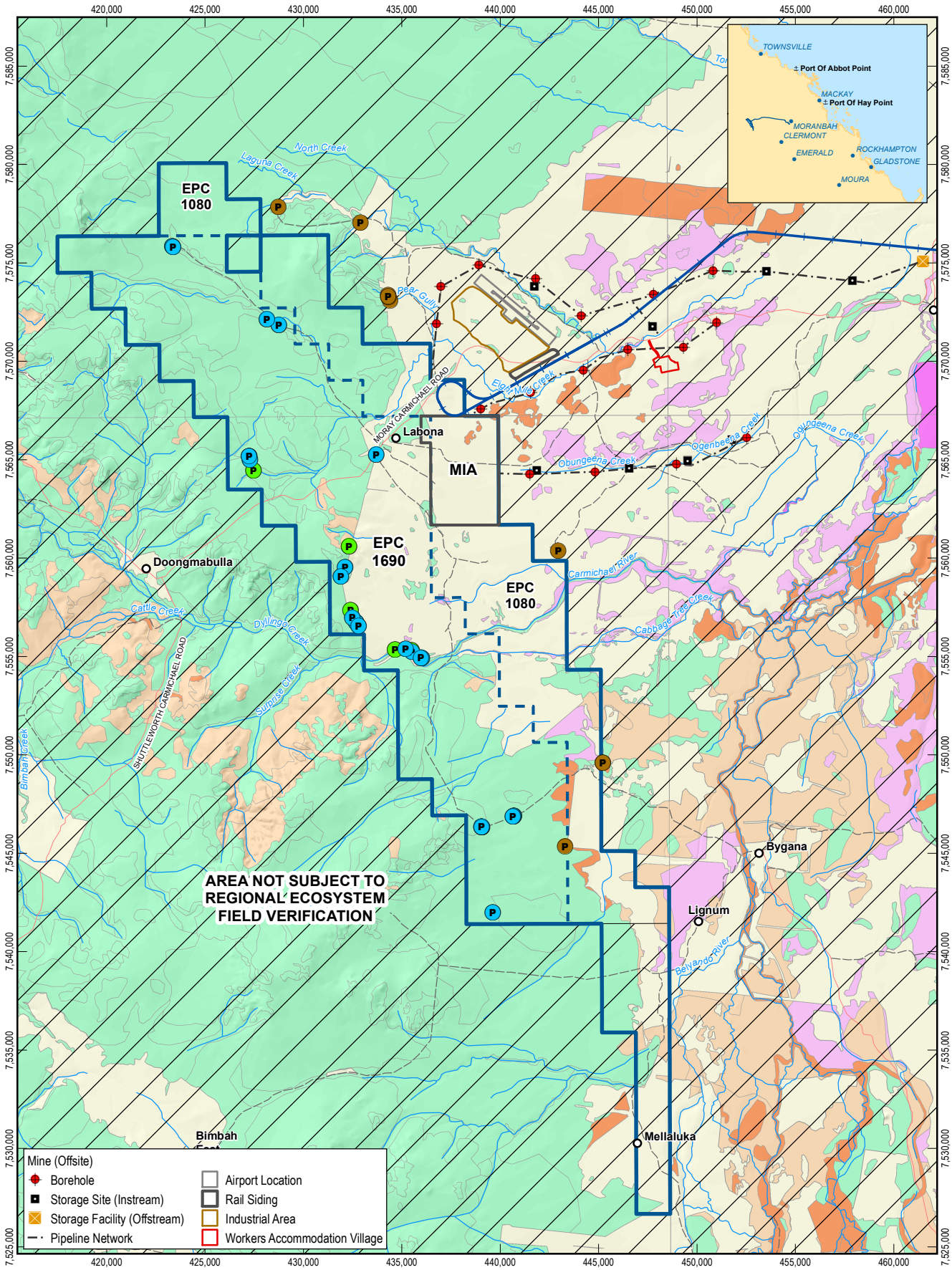
The squatter pigeon (southern) appeared to be common in suitable habitat at the Study Area, and is likely to be present where suitable habitat occurs in broader landscape. At the subspecies level, the squatter pigeon (southern) population is considered to be stable at present, with historic declines (in the southern part of its range - New South Wales and southern Queensland) considered to have ceased (SEWPAC, 2011i). Across its range the subspecies is thought to occur as a continuous, inter-breeding population, with no single populations identified as being important for its long-term survival or recovery (SEWPAC, 2011i). With respect to the Significant Impact Guidelines (DEWHA, 2009c), it is not considered that squatter pigeons (southern) at the Study Area are part of an 'important population' (of an EPBC Act listed vulnerable species). That is, squatter pigeons (southern) at the Study Area are not considered to be a part of a *population that is necessary for a species' long-term survival and recovery, including populations identified as such in recovery plans, and/or that are:*

Key source populations either for breeding or dispersal

Populations that are necessary for maintaining genetic diversity, and/or

Populations that are near the limit of the species range (DEWHA, 2009c)

Based on the availability of similarly suitable habitat in the landscape surrounding the Study Area, and the stable nature of the subspecies' population at present, it is not considered that the Study Area represents habitat critical to the survival of the subspecies.



LEGEND

- Squatter pigeon sightings - Spring 2010
- Squatter pigeon sightings - Autumn 2011
- Squatter pigeon sightings - Spring 2011
- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Regional Ecosystems v6.1

- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- Of Least Concern
- Non-remnant

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision B
Date 08-10-2012

Location of Squatter Pigeon (southern) Sightings - Project Area

Figure 5-16

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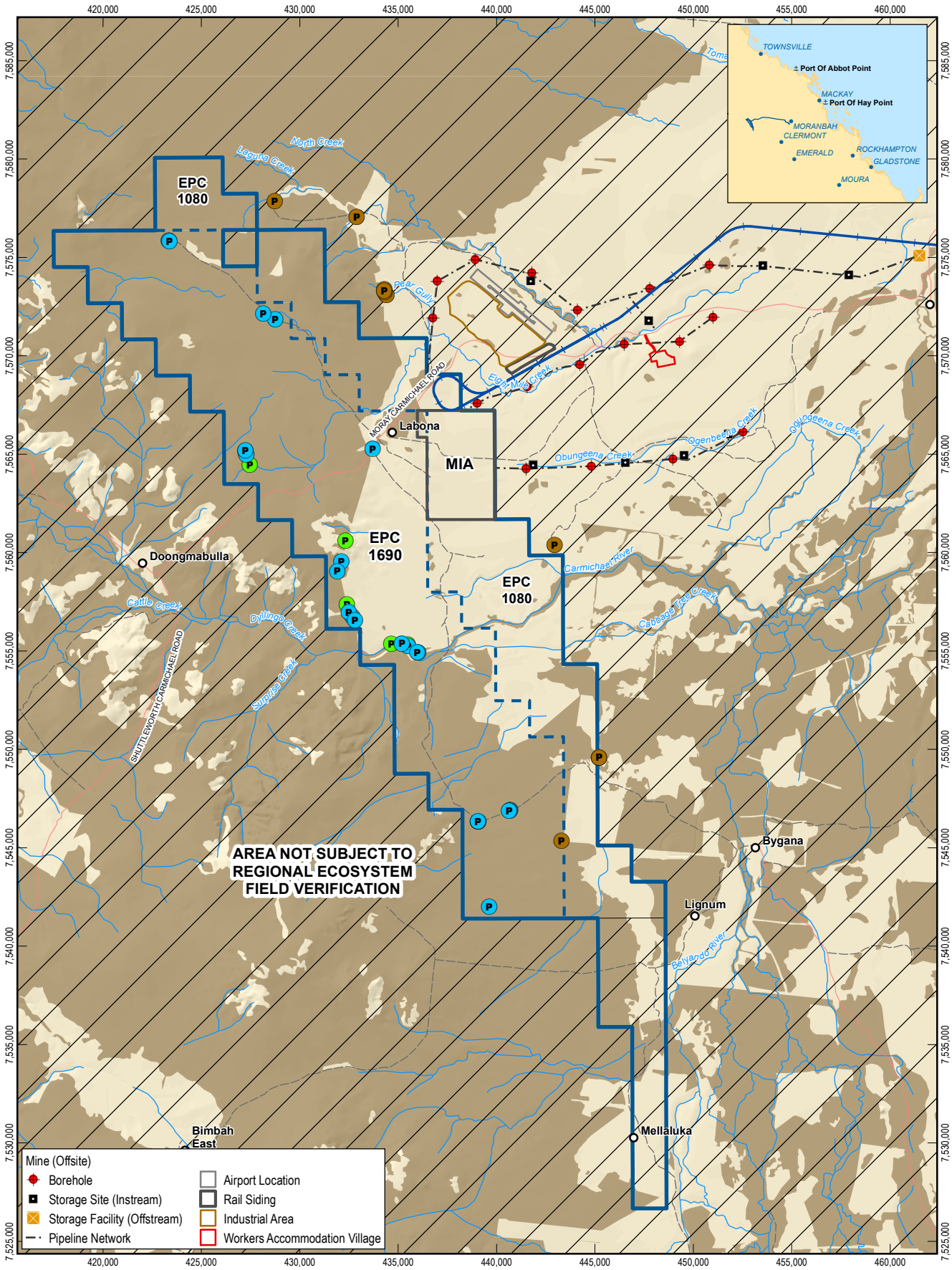

LEGEND

- Squatter pigeon sightings - Spring 2010
- Squatter pigeon sightings - Autumn 2011
- Squatter pigeon sightings - Spring 2011
- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Potential Squatter Pigeon (Southern) Habitat - Based on Field Verified Regional Ecosystems within the Mine Site and DERM Certified Regional Ecosystems Version 6.0b outside the Mine Site

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Carmichael Coal Mine and Rail Project

Potential Squatter Pigeon (southern) Habitat - Project Area

Job Number 41-25215
Revision B
Date 08-10-2012

Figure 5-17

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

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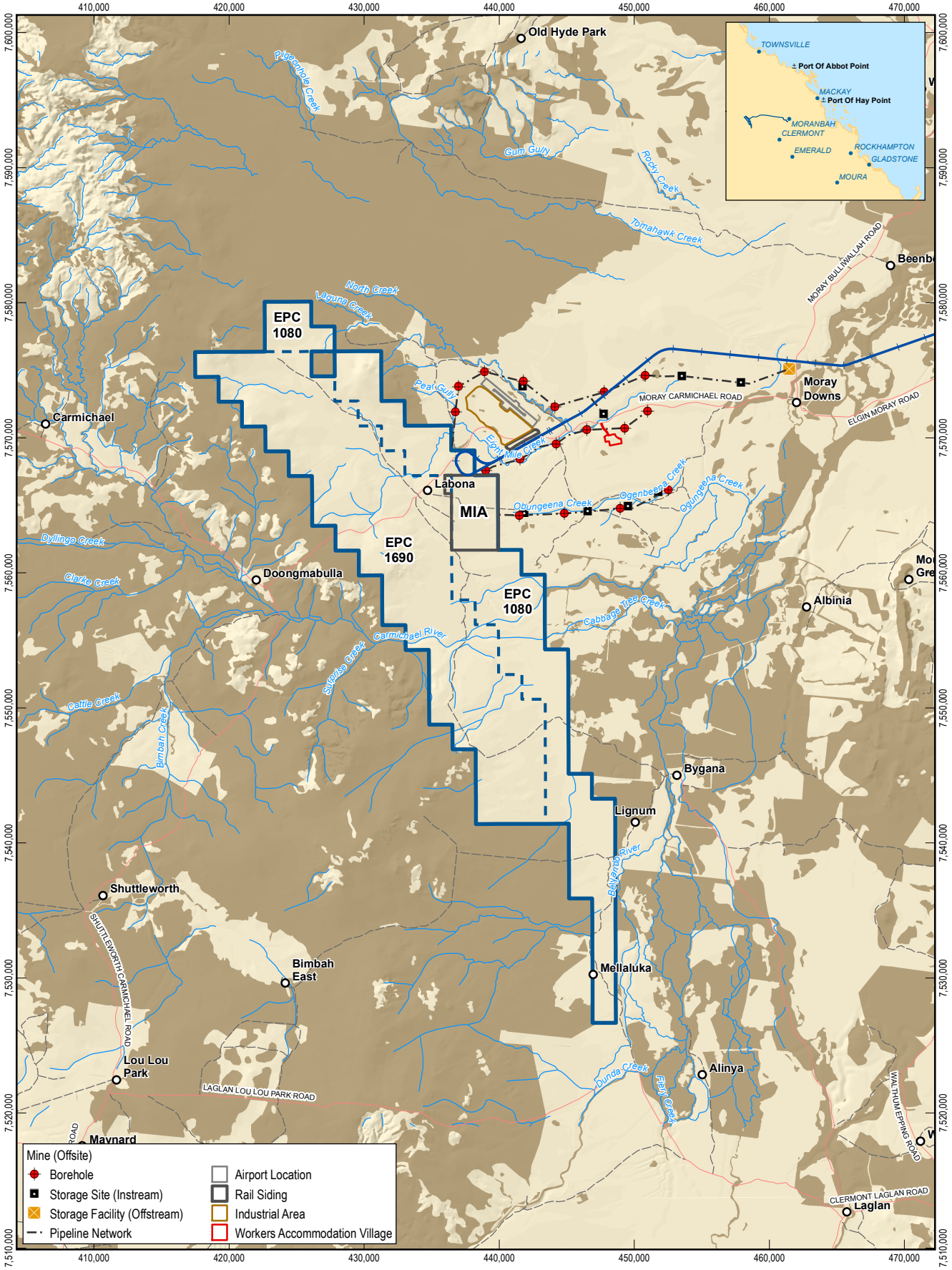

LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Potential Squatter Pigeon (Southern) Habitat - Based on DERM Certified Regional Ecosystems Version 6.0b

1:400,000 (at A4)
0 2.5 5 7.5 10
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Potential Squatter Pigeon (southern) Habitat - Beyond Project Area

Job Number 41-25215
Revision B
Date 08-10-2012

Figure 5-18

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Data Source: DERM: Regional Ecosystems v6.0 (2010); DME: EPC 1690 (2010), EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Potential Habitat (2012). Created by: BW, CA

Koala

The Koala (combined populations of QLD, NSW and ACT) (vulnerable EPBC Act, special least concern NC Act) is a tree dwelling marsupial that has a widespread distribution in both coastal and inland environments (SEWPAC, 2012b). The koala's diet is typically restricted to foliage of Eucalyptus spp. or related genera. However, the diet of individual koalas is usually limited to obtaining most of their nutrition from one or a few tree species present at a site. Species-level preferences may also vary between regions or seasons (SEWPAC, 2012b). Female koalas can potentially produce up to one offspring a year, giving birth between October and May, however research indicates that breeding averages are more likely to range between 0.3-0.8/year (SEWPAC, 2012b).

Koalas occupy a range of habitats including temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated eucalypt species (SEWPAC, 2012b). In central Queensland, the species occurs in scattered populations within eucalypt woodlands generally along watercourses. Koalas in the Brigalow Belt bioregion also typically occur in low densities, estimated at 0.005 koalas/ha and have large home ranges (SEWPAC, 2012b). Over a 20 year period from 1990, estimated koala populations within the Brigalow Belt bioregion have declined 30 to 40 per cent.

Generally, the home ranges of individual koalas can extensively overlap, however, these can be quite variable depending on the quality of the habitat and the location. Research undertaken at Blair Athol in central Queensland, approximately 140 km south-east of the Study Area, estimated home ranges at 135 ha for an individual male and 101 ha for females.

Koalas in the Study Area

No evidence of the koala was detected during the Spring 2010 and Autumn 2011 surveys. One koala was recorded on one occasion during spotlighting within the Study Area during the Spring 2011 survey. This individual was recorded within an open eucalypt woodland environment representing the '*Ironbark-box grassy woodlands and open woodlands on grey sand plains'* habitat type.

It is likely that the species occurs at low densities in remnant open eucalypt woodland across the Study Area. The Bygana West Nature Refuge in the southern part of the Study Area was proclaimed, amongst other reasons, as it contains suitable koala habitat. Furthermore, mature river red gum woodland along the Carmichael River within the '*Open forest and woodland fringing watercourses and relict stream channels, and alluvial plains subject to flooding*' represents additional potential koala habitat in the Study Area. The location of the koala observed within the Study Area and an indication of potential habitat that may be utilised by this species within the Study Area is presented in Figure 5-19.

To map potential habitat for the koala beyond the Study Area, (DERM certified) REs characterised by open eucalypt woodland and open eucalypt forest vegetation fringing watercourses were identified and mapped. Potential koala habitat beyond the Study Area is presented in Figure 5-20. The presence of potentially suitable habitat beyond the Study Area suggests that the koala is likely to be present in low densities in the wider landscape (excluding to the east where non-remnant vegetation dominates the landscape). Habitat utilisation and abundance is likely to be influenced by availability of preferred eucalypt species, abundance of predators (especially dogs), climate change and drought (SEWPAC, 2012b).

The koala is considered to have 'scattered populations throughout Queensland' and no defined 'important populations' have been listed by SEWPAC (2012b). With respect to the Significant Impact

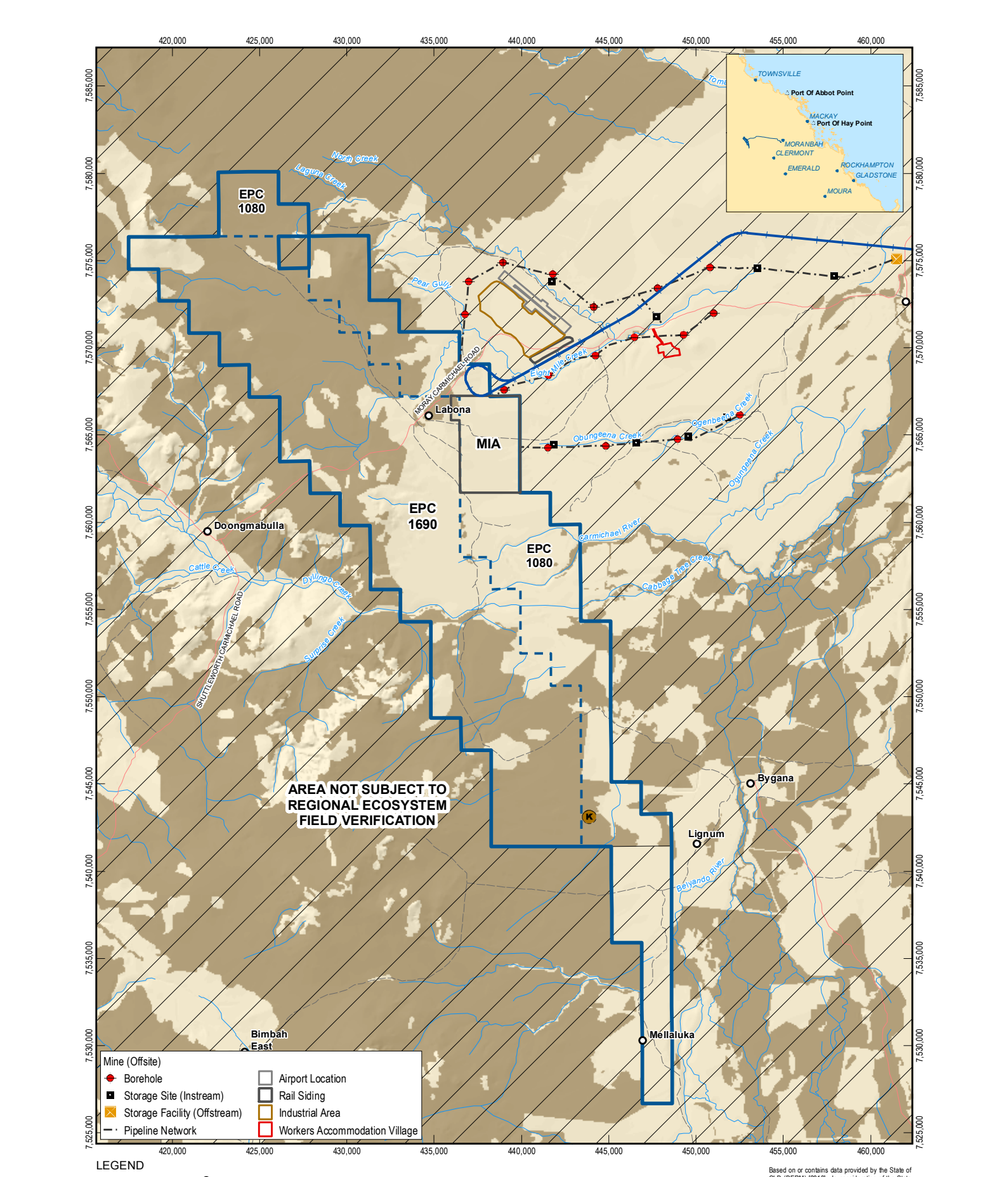
Guidelines (DEWHA, 2009c), it is not considered that the occurrence of a koala at the Study Area defines it as part of an 'important population' (of an EPBC Act listed vulnerable species). That is, koalas at the Study Area are not considered to be a part of *a population that is necessary for a species' long-term survival and recovery, including populations identified as such in recovery plans, and/or that are:*

Key source populations either for breeding or dispersal

Populations that are necessary for maintaining genetic diversity, and/or

Populations that are near the limit of the species range (DEWHA, 2009c)

Based on the low estimated density of koalas within the Brigalow Belt and the availability of similarly suitable habitat in the landscape surrounding the Study Area, it is not considered that the Study Area represents *habitat critical to the survival of the species.*



LEGEND

- Koala Sighting - Spring 2011
- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Potential Koala Habitat - Based on Field Verified Regional Ecosystems within the Mine Site and DERM Certified Regional Ecosystems Version 6.0b outside the Mine Site

1:275,000 (at A4)

0 1 2 3 4 5

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Location of Koala Sightings and Potential Habitat - Study Area

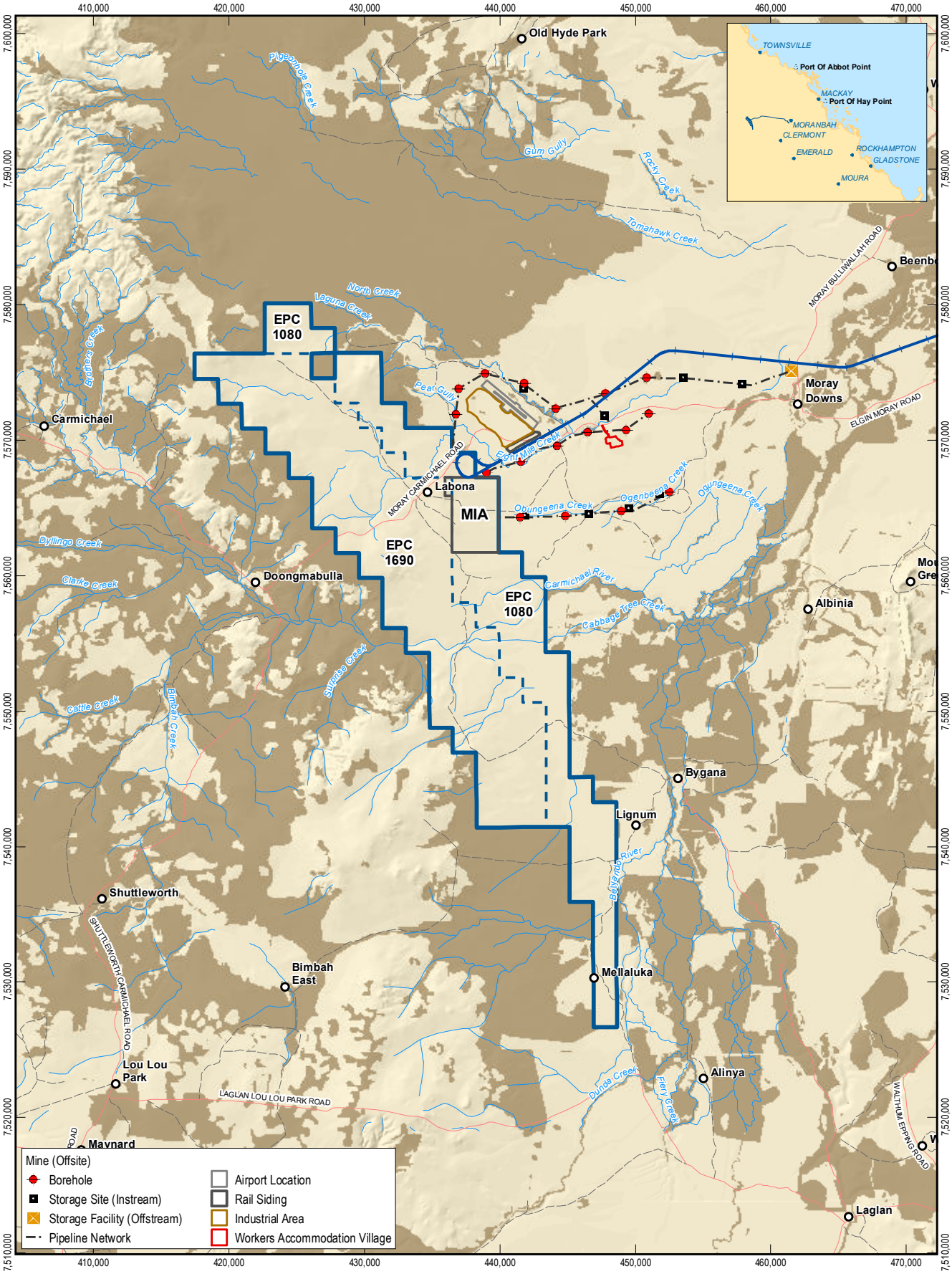
Job Number	41-25215
Revision	A
Date	14-11-2012

Figure 5-19

G:\41\25215\GIS\Maps\MXD\400_Ecology\41-25215_4048_rev_a.mxd

Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Regional Ecosystems v6.0 (2010); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Koala Sightings, Potential Habitat (2011). Created by: BW, CA



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Potential Koala Habitat - Based on DERM Certified Regional Ecosystems Version 6.1b

1:400,000 (at A4)

0 2.5 5 7.5 10

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Potential Koala Habitat- Beyond Study Area

Job Number	41-25215
Revision	A
Date	14-11-2012

Figure 5-20

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Data Source: DERM: Regional Ecosystems v6.1 (2011); DME: EPC 1690 (2010), EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Potential Habitat (2012). Created by: BW, CA

Ornamental Snake and Yakka Skink

The likelihood of occurrence assessment indicated that yakka skink and ornamental snake are likely to occur in the Study Area, based on distribution including modelling (SEWPAC, 2011b), presence of potentially suitable habitat and previous records from the region.

Trapping for ground-dwelling reptiles, opportunistic searches and spotlighting surveys failed to detect the threatened reptiles listed above. It is recognised that these are cryptic species, and as such, failure to detect them is not indicative of their absence from the Study Area. Rather, it is considered likely that these species occur at the Study Area, based on their known distribution, the presence of suitable habitat and the fact that they have been previously recorded within approximately 50 km of the Study Area (as documented in desktop sources queried (Table 5-1)). With respect to suitable habitat, it is considered possible that the following fauna habitat types may support listed threatened reptiles (refer to Figure 5-11) for spatial distribution of fauna habitat types at Study Area):

- *Ironbark-box grassy woodlands and open woodlands on grey sand plains* – yakka skink

  This open woodland habitat type includes REs from landzone 3 and landzone 5. The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (SEWPAC, 2011b) identifies woodland and open forest habitats on landzone 3 and landzone 5 as suitable habitat for the yakka skink, where ground layer microhabitats such as large hollow logs, cavities, large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes occur. Observations from the Study Area indicated that suitable ground layer microhabitats occur (in places) in this habitat type.
- *Yellow jacket and rough-leaved bloodwood shrubby low open woodland on red sand plains* – yakka skink

  This low open woodland habitat type includes REs from landzone 5. The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (SEWPAC, 2011b) identifies woodland and open forest habitats on landzone 5 as suitable habitat for the yakka skink, where ground layer microhabitats such as large hollow logs, cavities, large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes occur. Observations from the Study Area indicated that suitable ground layer microhabitats occur (in places) in this habitat type.
- *Gidgee and/or brigalow shrubby woodland, sometimes with Dawson's gum emergents, on clay and loam plains* – yakka skink, ornamental snake

  This open woodland/open forest habitat type includes REs from landzone 3, landzone 4 and landzone 9. The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (SEWPAC, 2011b) identifies woodland and open forest habitats on landzone 3, landzone 4 and landzone 9 as suitable habitat for the yakka skink, where ground layer microhabitats such as large hollow logs, cavities, large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes occur. Observations from the Study Area indicated that suitable ground layer microhabitats occur (in places) in this habitat type.

  REs 11.4.6 and 11.4.9, which are constituents of this habitat type, are identified as suitable habitat for the ornamental snake in the *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (SEWPAC, 2011b). Those other acacia-dominated habitat types growing on alluvial

and cracking clay soils (i.e. RE 10.3.3, 10.4.3, 10.4.5, 10.9.3, 11.3.1), have been included due to the structural similarity in habitat that they provide.

- *Open forest and woodland fringing watercourses and relict stream channels, and alluvial plains subject to flooding* – yakka skink, ornamental snake

  This open woodland/open forest habitat type includes REs from landzone 3. The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (SEWPAC, 2011b) identifies woodland and open forest habitats on landzone 3 as suitable habitat for the yakka skink, where ground layer microhabitats such as large hollow logs, cavities, large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes occur. Observations from the Study Area indicated that suitable ground layer microhabitats occur (in places) in this habitat type.

  The *Queensland Brigalow Belt Reptiles Recovery Plan* (Richardson, 2006) identifies riverside woodland and forest as being suitable habitat for the ornamental snake.

- *Woodland and low open woodland associated with laterised sandstone rises and minor pediments* – yakka skink

  This low open woodland habitat type includes REs from landzone 7 and landzone 9. The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (SEWPAC, 2011b) identifies woodland and open forest habitats on landzone 7 and landzone 9 as suitable habitat for the yakka skink, where ground layer microhabitats such as large hollow logs, cavities, large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes occur. Observations from the Study Area indicated that suitable ground layer microhabitats occur (in places) in this habitat type.

Potentially suitable habitats in the Study Area for yakka skink and ornamental snake are presented in Figure 5-21 and Figure 5-22 respectively, based on fauna habitat types identified in the Study Area. While 'known important habitat', as defined in the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles (SEWPAC, 2011b) for the yakka skink may occur within mapped potentially suitable habitat, where the requisite ground layer microhabitats provide shelter habitats for colonies, targeted searches failed to detect any evidence of such colonies at the Study Area.

In the case of the ornamental snake, the limiting factor to utilisation of the potentially suitable habitat is likely to be related to the density of frog populations, which in turn may be driven by the localised availability of frog breeding sites (i.e. standing water associated with gilgais, ephemeral creeks and rivers). Where gilgais occur, this habitat may constitute 'known important habitat' for the ornamental snake, as defined in the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles (SEWPAC, 2011b).

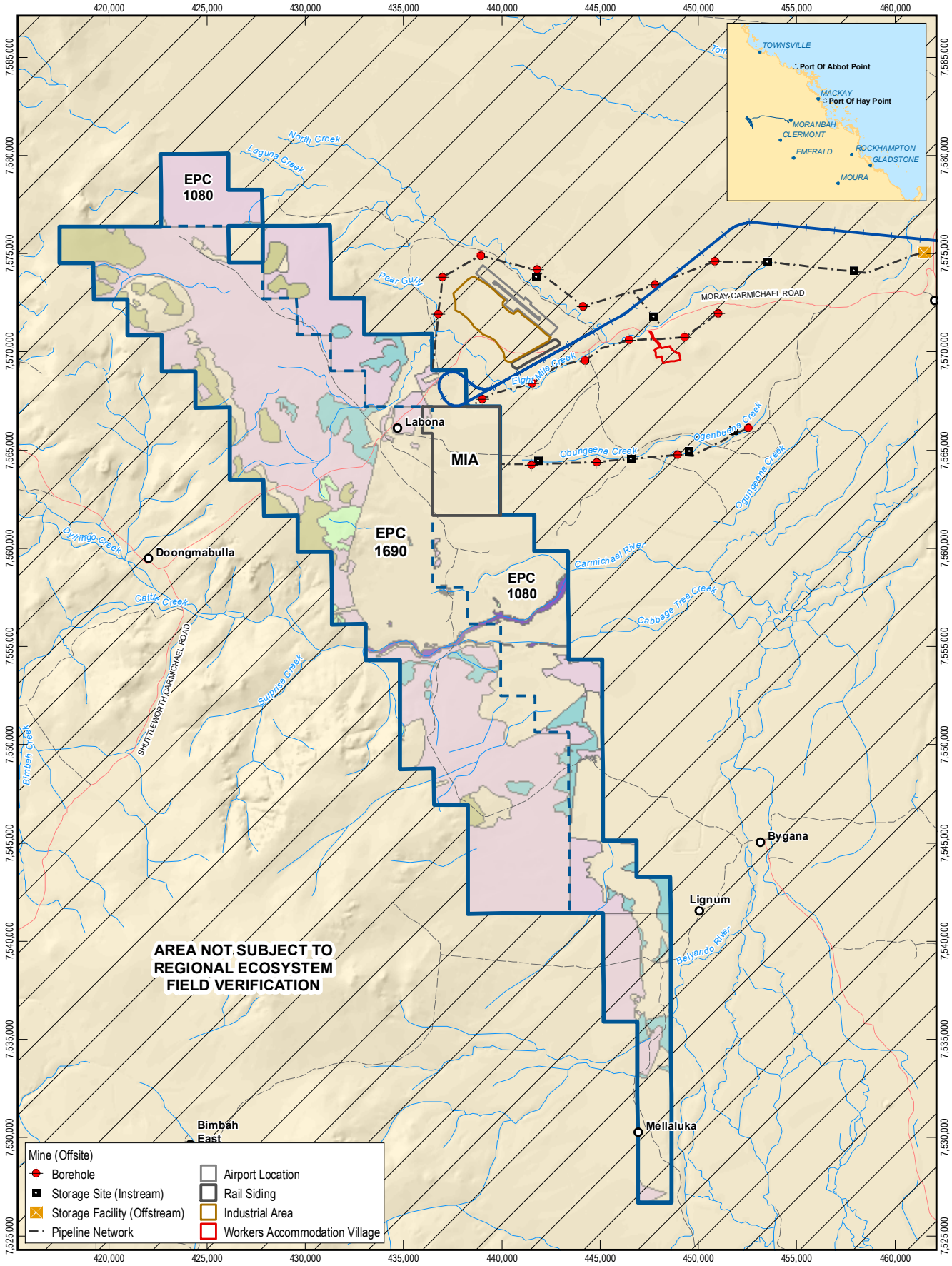
With respect to the Significant Impact Guidelines (DEWHA, 2009c), it is not considered that the Study Area supports an 'important population' of the EPBC Act listed vulnerable ornamental snake or yakka skink, in so much as:

- Neither species was detected at the Study Area during targeted surveys
- The Study Area is not considered to constitute habitat for key source (breeding/dispersal) populations, especially given the availability of similarly suitable habitat in the surrounding landscape
- The Study Area does not occur at or near the limit of either species' range

Ornamental snakes and yakka skinks, should they occur at the Study Area, are not considered to be a part of *a population that is necessary for a species' long-term survival and recovery, including populations identified as such in recovery plans, and/or that are:*

- *Key source populations either for breeding or dispersal*
- *Populations that are necessary for maintaining genetic diversity, and/or*
- *Populations that are near the limit of the species range* (DEWHA, 2009c).

Based on the fact that neither species was detected at the Study Area despite targeted surveys, and that similarly suitable habitat for both species is present in the landscape surrounding the Study Area, it is not considered that the Study Area represents *habitat critical to the survival of the species* for the yakka skink and ornamental snake.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Potential Yakka Skink Habitat Type

- Gidgee and brigalow woodland on clay plains
- Ironbark-box grassy woodland on grey sand plains
- Low open woodland on ferricrete/laterised sandstone
- Open forest and woodland fringing streams and on flood plains
- Yellowjacket-rough leaved bloodwood open woodland on red sand plains

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Potential Yakka Skink Habitat - Project Area

Job Number 41-25215
Revision B
Date 14-11-2012

Figure 5-21

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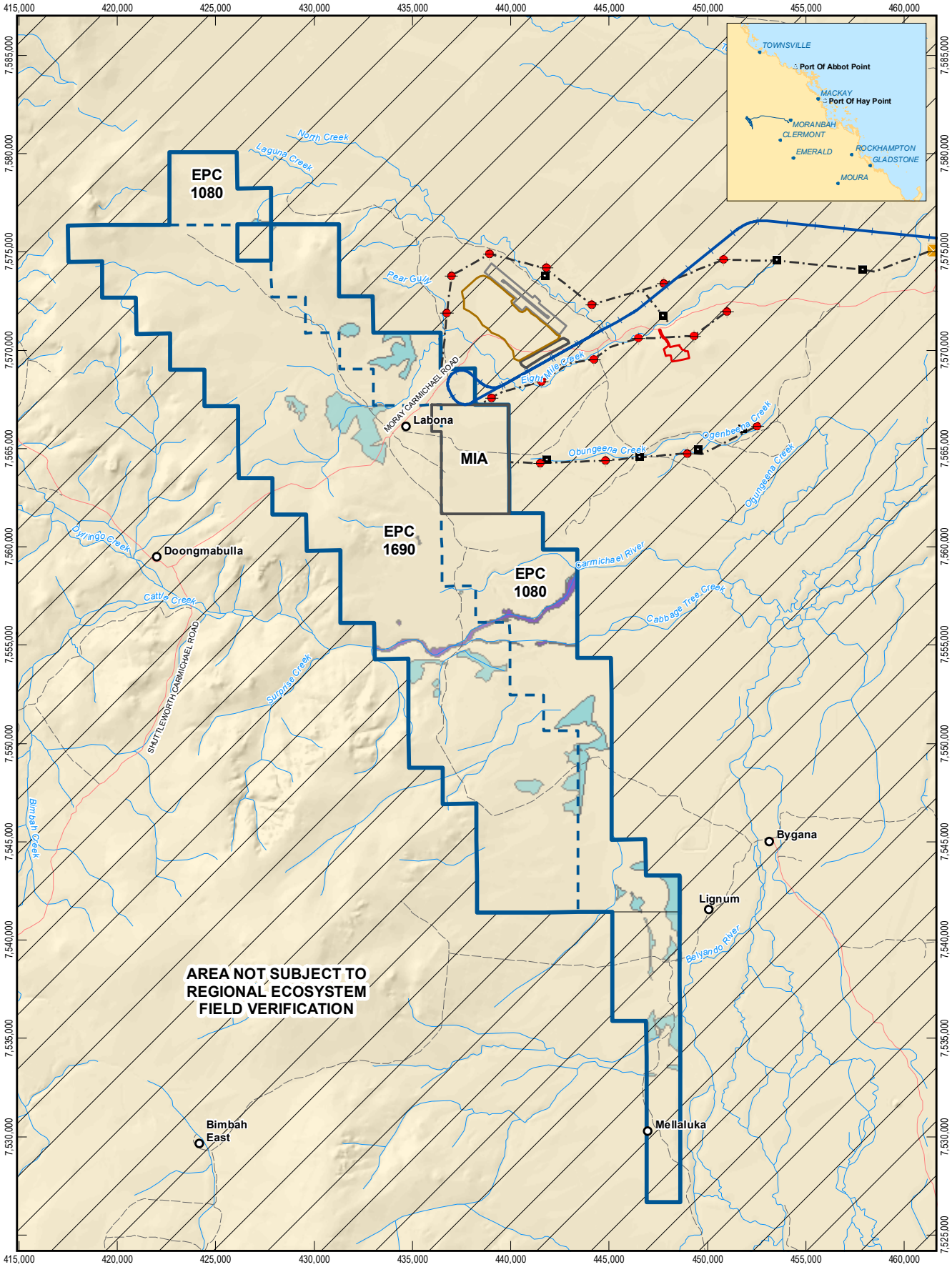
Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Potential Habitat (2011). Created by: BW, CA



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Gidgee and brigalow woodland on clay plains
- Open forest and woodland fringing streams and on flood plains
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Potential Ornamental Snake Habitat - Project Area

Job Number 41-25215
Revision B
Date 14-11-2012

Figure 5-22

G:\41\25215\GIS\Maps\MXD\400_Ecology\41-25215_495_rev_b.mxd
Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Potential Habitat (2011). Created by: BW, CA

Black-necked Stork

Black-necked stork was observed at farm dams at and near the Study Area during the Spring 2010, Autumn 2011 and Spring 2011 surveys.

The black-necked stork is widely distributed across northern and eastern Australia. It is generally associated with aquatic habitats including wetlands, lakes, dams, rivers, tidal flats and estuaries. It may also forage in nearby grassland and open woodland habitats. A large nest, which is often used over a series of successive breeding seasons, is constructed in a large tree, generally near water.

A number of large farm dams at the Study Area, in addition to the Carmichael River, are likely to provide habitat for the black-necked stork. Beyond the Study Area, farm dams, waterways associated with the Doongmabulla Springs to the west of the Study Area, and the Belyando River (into which the Carmichael River flows to the east of the Study Area) are likely to provide habitat for this species.

Cotton Pygmy-goose

Cotton Pygmy-goose inhabits coastal and inland waterways typified by large expanses of relatively deep water featuring floating and emergent macrophytes. Large farm dams, inland lakes, swamps and backwaters on large rivers provide such habitat for the cotton pygmy-goose.

Cotton Pygmy-goose was observed during the Spring 2011 survey (6 occasions), at dams in and near the eastern part of the Study Area. Larger dams featuring macrophyte growth within the Study Area, and in the surrounding landscape, are likely to provide habitat for this species.

Little Pied Bat

The little pied bat was detected with Anabat at four locations during the Autumn 2011 survey. Calls attributed to this species were recorded by an Anabat detector in melaleuca and eucalyptus woodland fringing the Carmichael River and eucalypt woodland habitat at the south of the Study Area.

The little pied bat occurs through southern and central Queensland and central New South Wales. It inhabits a range of dry open woodland vegetation types throughout its range (Thompson *et al*, 2011). In more arid parts of Queensland, riverine vegetation featuring river red gum is known to be utilised by the species (Thompson *et al*, 2011). Abundance of this species in semi-arid and arid regions may increase with proximity to permanent or semi-permanent water (Thompson *et al*, 2011). The little pied bat roosts in tree hollows, building, caves and abandoned mine shafts (Churchill, 2008).

Mature (i.e. remnant) woodland featuring roosting habitat (tree hollows) at the Study Area and surrounding landscape is likely to support this species. This corresponds with the following habitat types at the Study Area:

- *Ironbark-box grassy woodlands and open woodlands on grey sand plains*
- *Yellow jacket and rough-leaved bloodwood shrubby low open woodland on red sand plains*
- *Tall mixed shrubland on red sand plains and over ferricrete*
- *Gidgee and/or brigalow shrubby woodland, sometimes with Dawson's gum emergents, on clay and loam plains*
- *Open forest and woodland fringing watercourses and relict stream channels, and alluvial plains subject to flooding*
- *Woodland and low open woodland associated with laterised sandstone rises and minor pediments*

Large hollows were particularly prevalent in river red gum trees growing along the Carmichael River. As such, this may represent (locally) high quality habitat for the little pied bat.

Records of the black-necked stork, cotton pygmy-goose and little pied bat from field studies at the Study Area are presented in Figure 5-23.

Square-tailed Kite and Black-chinned Honeyeater

The square-tailed kite (*Lophoictinia isura*) and black-chinned honeyeater (*Melithreptus gularis*) are near threatened NC Act species considered likely to occur within the Study Area.

These species have the potential to occur in remnant open woodland vegetation at the Study Area (i.e. *Ironbark-box grassy woodlands and open woodlands on grey sand plains*). Riparian and floodplain vegetation associated with the Carmichael River are likely to represent particularly ideal habitat for the square-tailed kite and black-chinned honeyeater.

Other Threatened Species

A number of other threatened species were identified during the desktop assessment. The outcomes of the likelihood of occurrence assessment identified that they may occur or were unlikely to occur based on the criteria of the assessment. Further discussion on these species is provided in Volume 4 Appendix N Mine Terrestrial Ecology Report.

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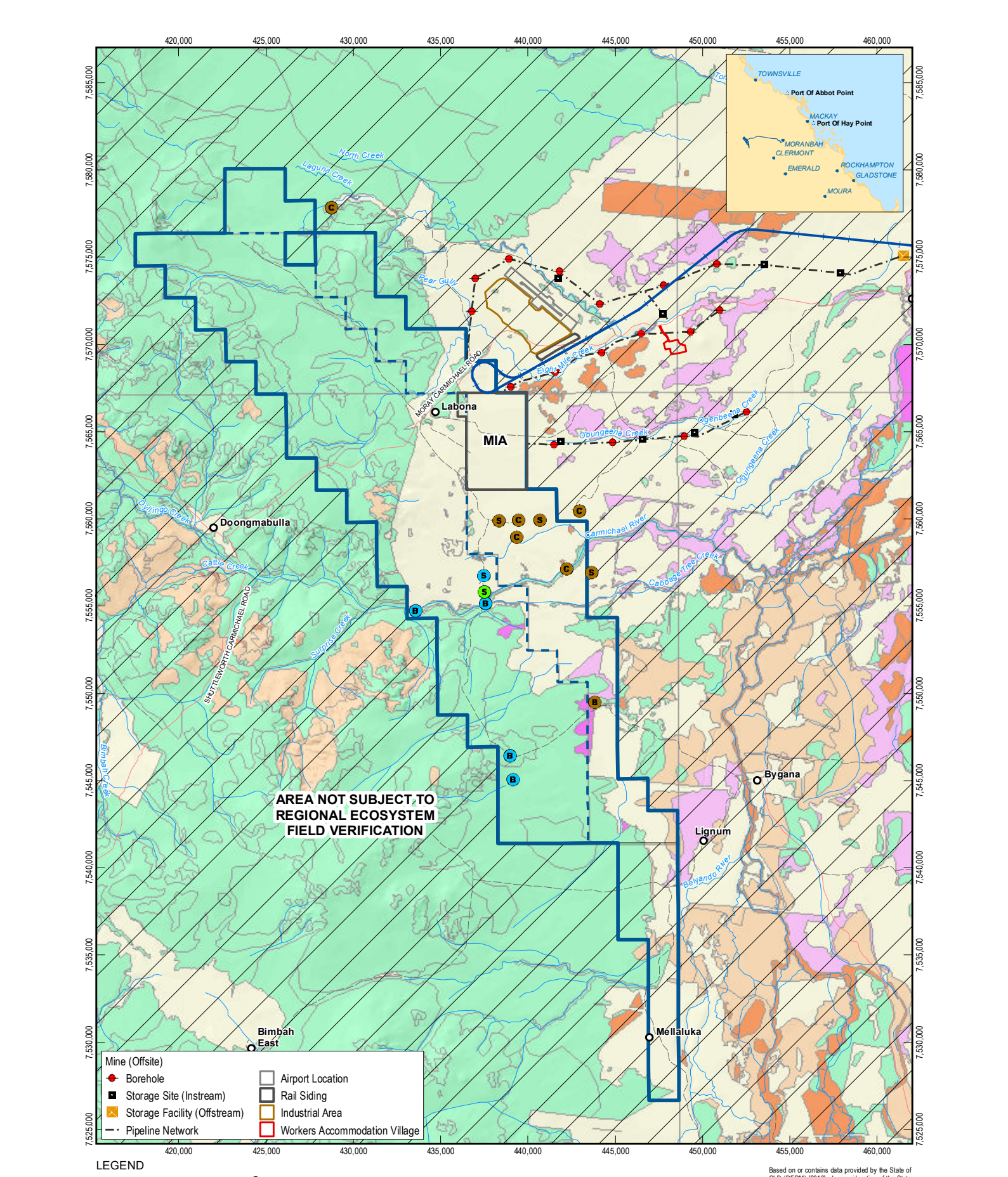

LEGEND

- Black-necked stork records - Spring 2010
- Black-necked stork records - Autumn 2011
- Black-necked stork records - Spring 2011
- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

Field Verified Regional Ecosystems

- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- Of Least Concern
- Non-remnant

1:275,000 (at A4)

0 1 2 3 4 5

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Location of State Listed Threatened Fauna Records - Project Area

Job Number 41-25215
Revision B
Date 14-11-2012

Figure 5-23

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Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DERM: Regional Ecosystems v6.1 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); GHD: Field Verified Regional Ecosystems (2011), Threatened Fauna Records (2010/2011). Created by: BW, CA

5.2.5 Aquatic Ecology

5.2.5.1 Aquatic Habitats

Aquatic habitats vary in size and geomorphology across the Study Area. They can be grouped into five broad water body types: lacustrine, palustrine, riverine, drainage lines and gilgais. Subterranean aquatic habitats are also present within the Study Area and these are discussed in Section 5.2.5.

Figure 5-24 shows the lacustrine, palustrine and riverine habitats across the site according to the DEHP water body mapping layer. The Carmichael River and Cabbage Tree Creek demonstrated the greatest diversity of aquatic habitats for aquatic fauna however macrophytes were observed only in the dams. Cabbage Tree Creek demonstrated the greatest diversity of habitat which was also reflected in the results of fish and crustacean sampling in this water body.

Lacustrine habitat is defined as wetland and deep water habitats located in a topographic depression or a damned river channel (DERM, 2010b). Lacustrine habitats also have vegetation (including trees, shrubs, persistent emergents, mosses or lichens) coverage less than 30 per cent (DERM, 2010b). Within the Study Area and offsite water infrastructure area habitats within this description are most commonly represented as damned watercourses north of the Carmichael River and sites along Obungeena Creek. Photographic example of this habitat type within the Study Area is shown in Plate 5-17.

Plate 5-17 Lacustrine Habitat: Four Mile Dam (November 2010); No. 1 Dam (May 2011)

Palustrine habitat describes water bodies that are dominated by vegetation (including trees, shrubs, persistent emergents, mosses or lichens) (DERM, 2010b). These are also represented by dams in the Study Area with the difference to lacustrine habitat being the greater presence of macrophytes or trees and shrubs (greater than 30 per cent cover). DEHP mapping (Figure 5-24) identifies 12 areas of this habitat category near the Carmichael River in the Study Area. One of these areas is a large dam (Site 15 Swamp Tank) with abundant floating, submerged and emergent macrophytes, and some inundation of fringing trees/shrubs when at water volume capacity. The palustrine habitat features were also observed in Cabbage Tree Creek (Site 13). The other two areas depicted on the map to the west of Swamp Tank and other smaller mapped areas in the west did not exhibit permanent standing water and are located in topographic depressions. They are vegetated by melaleuca and other species common to wetter areas, though demonstrated no aquatic habitat

values at the time of survey. Photographic examples of this habitat type within the Study Area are shown in Plate 5-18.

Plate 5-18 Palustrine Habitat: Cabbage Tree Creek (May 2011); Michael's Tank (May 2011)


Riverine habitats are those with a formed channel that periodically or continuously contain flowing water (DERM, 2011a). The Carmichael River, Belyando River, reaches of Cabbage Tree Creek (Site 12) and the eastern portion of North Creek can be classified as riverine. There are a number of drainage lines that have established stream banks and a formed channel, however, these lines provide limited long term aquatic habitat. The Carmichael River (5th order stream) represents the largest watercourse within the Study Area and maintains aquatic habitat throughout the year, even if in isolated pools. Cabbage Tree Creek also provides permanent aquatic habitat for flora and fauna within the Study Area. Photographic examples of this habitat type within the Study Area is shown in Plate 5-19.

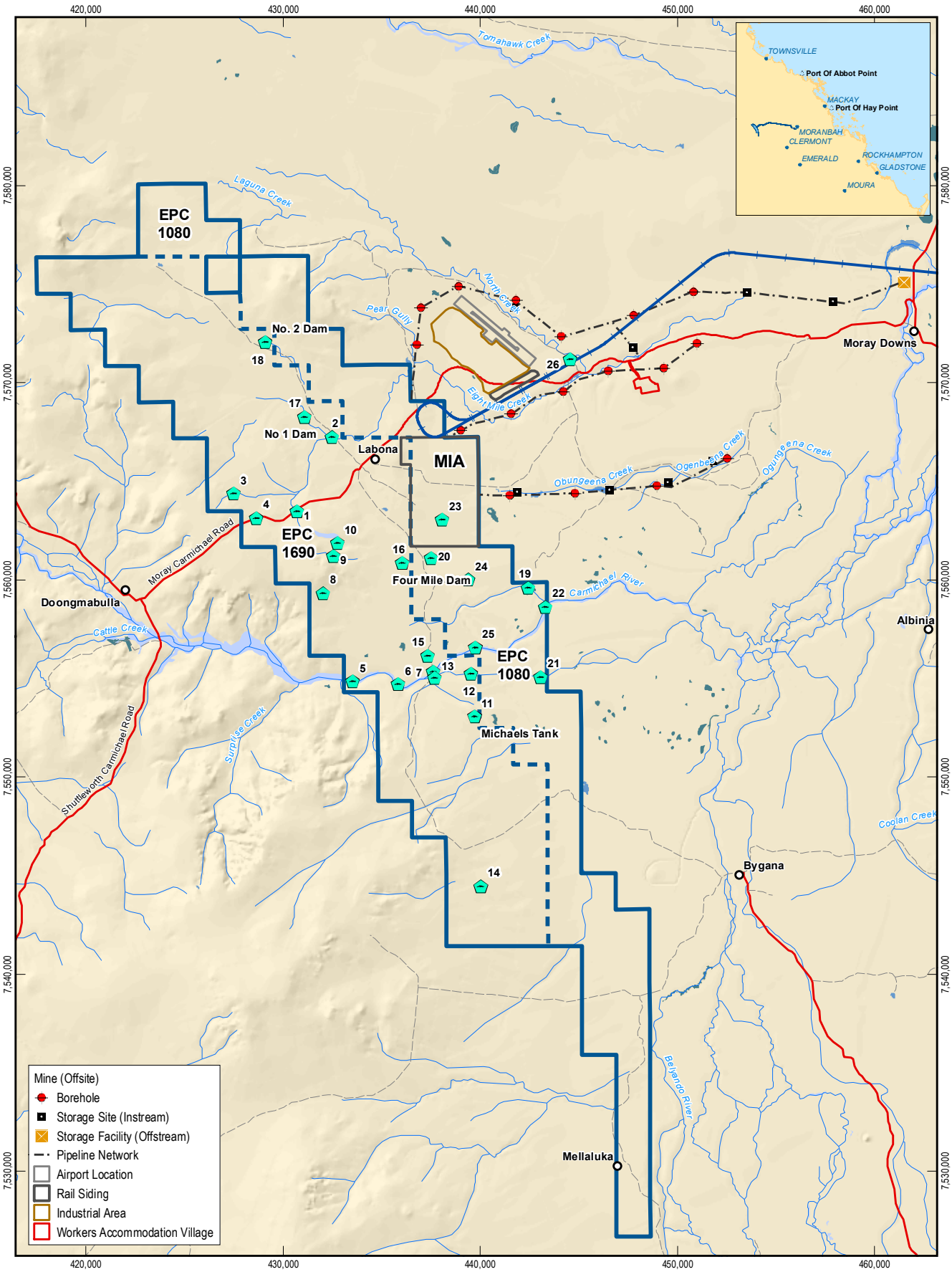
Plate 5-19 Riverine Habitat: Carmichael River (May 2011); Cabbage Tree Creek (May 2011)


Drainage lines are narrow drainage paths (often 1st order streams or not mapped) and occur at the top of stream catchments and meander in other areas of the Study Area. These paths do not have defined banks; rather they can be identified by a change in substrate from the adjacent area. Within the Study Area drainage lines often have a loose sandy substrate with adjacent geology being much more compact. These lines provide a pathway for runoff during high volume downpours and are not expected to accommodate long term flows or isolated pools. There is very little erosion observed in these shallow profile drainage lines. Photographic examples of this habitat type within the Study Area are shown in Plate 5-20.

Plate 5-20 Drainage Line: Eight Mile Creek (November 2010); Site 14 Drainage Line (May 2011)


Gilgais are distributed across the Study Area though are not necessarily related to the location of waterways. Gilgais are micro-relief land forms of mounds and depressions formed on shrink-swell and cracking clay soils where water can collect seasonally to form gilgai wetlands (DERM, 2011b). They are depressions in the landscape that can contain water and can attract a variety of reptiles, amphibians, birds, mammals and invertebrates (DERM, 2011b). The gilgais within the Study Area do not contain permanent water to support aquatic fauna though there is some evidence of water dependant plants persisting in these areas. The gilgais observed to have water were shallow, narrow (no greater than four metres across) and are not expected to be sustained throughout the dry season. Photographic examples of this habitat type within the Study Area are shown in Plate 5-21.

Plate 5-21 Gilgai Habitat: Site 20 Gilgai (November 2011)



LEGEND

- Homestead
- Aquatic Ecology
  - Habitat Assessment Site
- Local Road
- Track
- Watercourse
- Wetland Type
  - Lacustrine
  - Palustrine
  - Riverine
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Aquatic Ecology
Habitat Assessment Sites

Job Number	41-25215
Revision	D
Date	14-11-2012

Figure: 5-24

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DERM: Waterbody (2011), HYD Wetland (2009); GHD: Aquatic Ecology Assessment Site (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Road, Homestead, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); DME: EPC1690 (2010), EPC1080 (2011). Created by: BW.

5.2.5.2 Aquatic Dependant Flora

Review of the aquatic dependant native and exotic species listed for the Burdekin River catchment identified 150 native species and 20 exotic species previously recorded within the catchment. Of the 170 species, 37 native and 1 exotic have been previously recorded within 50 km of the Study Area (DEHP 2012). Of these 38 species previously recorded in the vicinity of the Study Area (refer to Volume 4 Appendix O Mine Aquatic Ecology Report), four are listed as endangered or vulnerable under the NC Act. However all 38 species were considered unlikely to occur in the Study Area based on habitat requirements.

Field assessments at the Study Area showed a low diversity and abundance of macrophytes especially within the Carmichael River. No macrophytes were observed at all but one of the survey locations on the Carmichael River where a small patch of submerged macrophytes was recorded. This is typical of riverine habitats that experience high flow events for short durations followed by extended dry periods. A number of common and widespread native macrophytes were confirmed present in the Study Area (refer to Volume 4 Appendix O Mine Aquatic Ecology Report).

5.2.5.3 Aquatic Fauna

Fish

Fish community structure and distribution within the Burdekin Catchment has been directly influenced by the Burdekin Falls in the lower end of the catchment, historically acting as a natural barrier to fish passage and preventing the colonisation of upstream habitats by downstream species that inhabit both fresh water and marine water (diadromous species). Artificial impoundments such as Burdekin Falls Dam and Clare Weir have further restricted the distribution of these diadromous species. The Burdekin Falls Dam, in place since 1985, may have inhibited populations of diadromous species from completing lifecycle processes. As such, fish species found in the Carmichael River and surrounding catchment are likely to be species that exclusively inhabit fresh water (potamodromous species).

A desktop assessment identified approximately 88 fish species within the Burdekin Catchment (Carter and Tait, 2008; DEHP Wildlife Online; Inglis and Howell, 2009). These include:

- Two freshwater fish species listed as vulnerable under the EPBC Act
  - freshwater sawfish (*Pristis microdon*), historically recorded in the Burdekin Catchment (Inglis and Howell, 2009)
  - Australian lungfish (*Neoceratodus forsteri*), recorded in the catchment in 1870 (DEHP Wildlife Online);
- Two endemic species,
  - soft-spined catfish (*Neosilurus mollespiculum*)
  - small-headed grunter (*Scortum parviceps*)
- golden perch (Macquaria ambigua), a translocated native species

Neither of the EPBC Act listed threatened fish species was considered likely to occur based on habitat requirements, distribution and influence of downstream barriers.

Searches of desktop databases (Wildlife Online and Queensland Museum) over the Study Area and a 50 km buffer area identified no records of fish species. Other desktop sources (published and grey

literature), previous studies and species profiles identified 17 species that may occur. None of the 17 species are threatened under the EPBC Act or NC Act.

Eleven of the 17 fish species predicted to occur within the Study Area were recorded during field surveys of three main water bodies representing riverine, palustrine and lacustrine habitats. All of the fish recorded are common freshwater species previously recorded in the upper Burdekin Catchment. No conservation significant species were detected during the field survey. Agassiz's glassfish (*Ambassis agassizii*) (Plate 5-22) and Midgley's carp gudgeon (*Hypseleotris species 1*) were the most commonly recorded species during field surveys. Other species captured included purple-spotted gudgeon (*Mogurnda adspersa*), sleepy cod (*Oxyeleotris lineolata*), eastern rainbowfish (*Melanotaenia splendida splendida*) (Plate 5-22 and Plate 5-23), Hyrtl's tandan (*Neosilurus hyrtlii*), spangled perch (*Leiopotherapon unicolor*), barred grunter (*Amniataba percoides*), fly speckled hardyhead (*Craterocephalus stercusmuscarum*), western carp gudgeon (*Hypseleotris klunzingeri*) and bony bream (*Nematalosa erebi*).

Plate 5-22 Agassiz glassfish (*Ambassis agassizii*)

Plate 5-23 Eastern rainbowfish (*Melanotaenia splendida splendida*)

The diversity of potamodromous fish species in the Study Area, as determined from literature and field surveys, is relatively low compared to other smaller catchments in northern Queensland (Pusey *et al*., 1998). This may be a result of a number of factors including:

Hydrology. High flows are generally short in duration and interspersed by long dry periods. This is likely to have reduced the ability of specialist species to colonise the catchment. Furthermore these prolonged dry conditions are likely to select against species with low tolerance to changing environmental conditions (Pusey *et al*., 1998).

The Study Area supports a low diversity of aquatic habitats and microhabitats with the system primarily characterised by open shallow water with a sandy/gravel substrate and limited in-stream debris and macrophytes (This Study; Pusey *et al*., 1998). This environment provides habitat for generalist species.

Degradation of aquatic habitats through land use practises has reduced the availability of habitat resources.

Pest Species

No pest fish species were detected during field surveys and no previous records were identified within a desktop assessment a 50 km buffer around the Study Area. The desktop assessment identified a

number of introduced species that are known to occur in the wider Burdekin Catchment, although these species are not present in the Belyando sub-catchment (Mozambique tilapia (Oreochromis mossambicus), spotted tilapia (Tilapia mariae), guppy (Poecilia reticulata) and mosquitofish (Gambusia holbrooki)) (Carter and Tait, 2008).

Reptiles

Desktop assessments for aquatic reptiles in the Burdekin Catchment identified two crocodile and five freshwater turtle species (Protected Matters Search; Cann, 1998; Cann, 2008). Field surveys were undertaken to assess the suitability of habitats for aquatic reptiles in the Study Area.

Identified crocodile species were the estuarine crocodile (*Crocodylus porosus*) and freshwater crocodile (*Crocodylus johnstoni*). Based on habitat requirements previous records in the catchment, the Study Area is not expected to provide important habitat for either species.

Identified fresh water turtle species were Cann's long-necked turtle (*Chelodina canni*), snake-necked turtle (*Chelodina longicollis*), Irwin's turtle (*Elseya irwini*), saw-shelled turtle (*Wollumbinia latisternum*) and Krefft's turtle (*Emydura macquarii krefftii*), none of which are conservation significant under the EPBC Act or NC Act.

Irwin's turtle is endemic to the catchment is listed as high priority under the DEHP 'Back on Track' framework for conservation management of Queensland's wildlife. Irwin's turtle generally prefers sandy riverine habitats with an abundance of macrophytes and in-stream debris (Cann, 1998; Cann, 2008). The sandy habitats within the Study Area were generally ephemeral or, in the case of the Carmichael River, recorded little or no macrophytes. For this reason the Study Area is not expected to provide habitat for the Irwin's turtle. The species is likely to be primarily restricted to the Bowen and potentially the Bogie River.

Mammals

Platypus (*Ornithorhynchus anatinus*) are listed as 'special least concern' wildlife under the NC Act and the known distribution of the species include the Burdekin catchment (Van Dyck, 2008). The species has not been recorded within a 50 km buffer of the Study Area (Wildlife Online) and field surveys did not detected suitable habitat within the Study Area, thus this species was considered unlikely to occur.

Invertebrates

Desktop assessment (Queensland Museum crustacean database) identified two crustacean species recorded within 50 km of the Study Area. Both species, *Daphniopsis pusilla* and *Moina baylyi*, were recorded near a salt lake, Lake Buchanan, which is outside the catchment basin containing the Carmichael River. These species inhabit halophilic waters of salinity of 3-60 g l^{-1} (Timms, 1987) and are unlikely to occur in the Study Area.

Trapping (bait traps) within surfacewaters during field surveys detected redclaw (*Cherax quadricarinatus*) (Plate 5-24) within the Carmichael River and Cabbage Tree Creek, though given the available habitats these crustaceans are expected to occur in other water bodies across the Study Area as well. Numerous freshwater crab shells from the Family Parathelphusidae were observed in the Study Area near all types of aquatic habitats and some gilgais implying these taxa are common across the sites surveyed.

Plate 5-24 Redclaw (*Cherax quadricarinatus*) Captured in Cabbage Tree Creek (Event 2: May)

Macroinvertebrate Communities

The highly variable and unpredictable environmental conditions of the river systems represented in the Burdekin Catchment are reflective of the relatively low macroinvertebrate diversity and community composition (Parsons Brinkerhoff, 2009).

Macroinvertebrate sampling was undertaken during the post wet season survey (Event 2 May) at three locations along the Carmichael River and during a pre-wet season survey (Event 3 November) at one location along the Carmichael River and one along Cabbage Tree Creek. A total of 230 individuals were collected from 41 families of aquatic macroinvertebrates across the five sites sampled.

Ephemeroptera, Plecoptera and Trichoptera (EPT) ratios for each site sampled were calculated. The EPT ratio is a widely used measure based on three macroinvertebrate families that have been identified as being sensitive to disturbance and pollutants, and therefore are considered good indicators of disturbance. High EPT ratios indicate a greater prevalence of taxa that are less tolerant to of disturbance (and can reflect higher habitat values). The EPT ratios for the sampled sites are low with the greatest recorded in Spring at a site on Cabbage Tree Creek (ratio 30 per cent). Full details on the community analysis undertaken is provided in Volume 4 Appendix O Mine Aquatic Ecology Report.

The dominant invertebrate taxa recorded varied between sites and seasons. Overall true bugs were recorded in greatest numbers, with Family Pleidae (pygmy backswimmers) recorded in greatest numbers. Family Dytiscidae (diving beetles) was also recorded in relatively greater numbers. No macrophytes were recorded in the sites sampled however trailing bank vegetation, detritus and root balls were well represented in the river habitats, providing habitat for these groups. These two dominant families were also the only two recorded at all sites sampled.

The uniform sandy substrate of the Carmichael River is expected to substantially influence the low macroinvertebrate community diversity at most sites. The species detected throughout the Study Area have habitat preferences including aquatic vegetation, woody debris, root balls and detritus. These characteristics were present though did not dominate in the Carmichael River. Cabbage Tree Creek displayed a relatively greater proportion of those features.

5.2.5.4 Subterranean Fauna

In Australia stygofauna are known from alluvial, limestone karst, fractured rock, and calcrete aquifers (Hancock *et al*., 2005; Humphreys, 2008). To be suitable for stygofauna, aquifers must have sufficient porosity of fractionation (connectivity) for adequate living space, and have sufficient organic matter and dissolved oxygen (Humphreys, 2008).

Few stygofauna species are known from coal seam aquifers. Eight taxa have been recorded by GHD (unpublished data) from coal seam aquifers in Queensland to date including species of harpacticoid copepod collected from central Queensland; a species of *Notobathynella* (Syncarida), a species of Trombidiidae (water mites) and two species of Pezidae (water mites) from a coal seam aquifer (89 m deep) in the Galilee Basin (current study), a species of Amphipoda and a species of Cyclopoid copepod from one bore from the northern Bowen Basin and a species of Astigmata (water mite) from a groundwater bore (75 m deep) from the Styx Basin located on the Central Queensland Coast.

In Queensland, diverse stygofauna communities have also been collected from alluvial aquifers of the Pioneer River, Burnett River, as well as Clermont, Nebo, Glenden, Collinsville, Rolleston, Marlborough, and Wondoan regions of the Bowen, Galilee, Styx and Surat Basins (GHD unpublished data). These communities were mostly collected from shallow alluvial aquifers of unconsolidated, heterogeneous sediments. Other significant stygofauna communities also appear common in alluvial aquifers, particularly where the aquifers are connected to rivers that flow for most of the year (Hancock and Boulton, 2008). This is because hydrological exchanges between surface and groundwater may be important sources of nutrients and oxygen to groundwater foodwebs (Hancock et al 2005, Boulton *et al.,* 2003).

A total of 19 groundwater bores were successfully sampled for stygofauna with analysis revealing the presence of stygofauna at two bores. Stygofauna groups identified include:

- *At bore C018P2 – Acarina, Trombidiidae, Pezidae sp1 and Pezidae sp2, and Syncarida, Notobathynella sp.*
- *At bore* C008P1 – Copepoda, Cyclopoida

Absence of stygofauna in the remaining bores sampled does not necessarily indicate that stygofauna are not present in these aquifers, rather, it may be due to unsuitable geological conditions (low porosity, low hydraulic conductivity), inadequate range of bores selected for sampling, poor groundwater quality, recent bore disturbance, or simply a low abundance of animals coupled with a heterogeneous distribution highlighting the basic need for replicated sampling covering different seasons and seasonal events.

Knowledge of stygofauna in the Galilee Basin is very limited at present as very few surveys have been conducted in this extensive region of Queensland. This sampling adds substantially to this body of knowledge. Given that only two of the 20 groundwater bores sampled recovered stygofauna across two comprehensive sampling events and that only five stygobitic taxa were recovered, it would seem reasonable to conclude that stygofauna are in low diversity and abundance from this locality. Recent multiple stygofauna surveys conducted by GHD in the southern Galilee Basin have also failed to identify significant stygofaunal communities which would suggest that stygofauna may be poorly represented in the wider geographic region.

5.3 Potential Impacts and Mitigation Measures – Construction

5.3.1 Introduction

This impact assessment has been structured to address impacts associated with the construction activities listed below. Full details about aspects of the construction phase of the Project are provided in Volume 2 Section 2 Description of the Project.

Broadly, the construction phase of the Project will involve the following activities:

- Development of Mine Infrastructure Area (MIA), including removal of farm dam
- Development of airport, air strip and land designated for industrial use
- Development of workers accommodations village
- Construction of a bridge across the Carmichael River
- Construction of offsite water supply infrastructure comprising:
  - Expansion of capacity of existing dams on North Creek and Obungeena Creek
  - Construction of two turkey nests (i.e. no catchment) water storage dams
  - Construction of bores and associated access tracks
  - Construction of in-stream extraction pumping infrastructure on Belyando River and North Creek
  - Development of water supply pipeline infrastructure for conveyance of water between all water supply sources
  - Facilities for treatment and storage of treated water

The locations of the MIA, airport and mine village are presented in Figure 5-26.

In terms of construction activities that may impact on the environment, it is understood that:

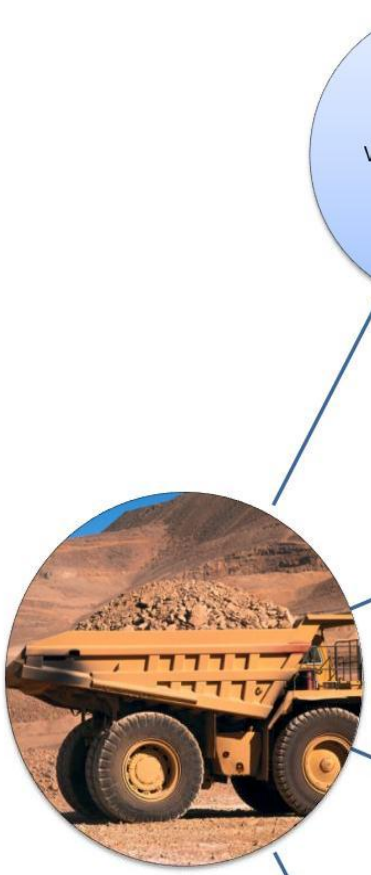
- All water leaving construction areas will be captured and treated prior to discharge/reuse
- Water required for construction will be sourced from a number of water supplies including offsite extraction from the Belyando River, North Creek and Obungeena Creek, Belyando River flood harvesting, in-stream storage and groundwater (Hyder Consulting, 2012).
- Sanitation for construction crew will be treated to A standard and discharged/reused onsite

The potential construction phase impacts to terrestrial and aquatic ecological values have been considered, and appropriate management and mitigation measures proposed, to ameliorate identified impacts. The potential construction phase impacts are set out below and shown in Figure 5-25.

- Vegetation clearing
  - Loss of vegetation and fauna habitat (including loss of roosting, foraging and breeding areas)
  - Fauna mortality
  - Habitat fragmentation
  - Habitat degradation through erosion of topsoils, dust deposition on plants and water resources
- Disturbance of surface watercourses
  - Loss of habitat and water resources for terrestrial species

  - Alteration/degradation of water resources that terrestrial species depend on
- Introduction or exacerbation of feral animal and weed species
  - Competition with native species, predation of native species, and habitat degradation (presence and prevalence of pest and weed species)
- Alteration to air quality and noise environments (i.e. altered exposure to disturbance)
  - Disturbance to breeding, roosting and foraging behaviours

Figure 5-25 Conceptual Diagram of Potential Construction Phase Impacts



Vegetation Clearing

- Loss of fauna habitat (including loss of roosting, foraging and breeding areas)
- Fauna mortality (i.e. due to vehicle strike whilst fleeing disturbance)
- Habitat fragmentation
- Habitat degradation (i.e. erosion of surface soils)

Disturbance of watercourses / water bodies

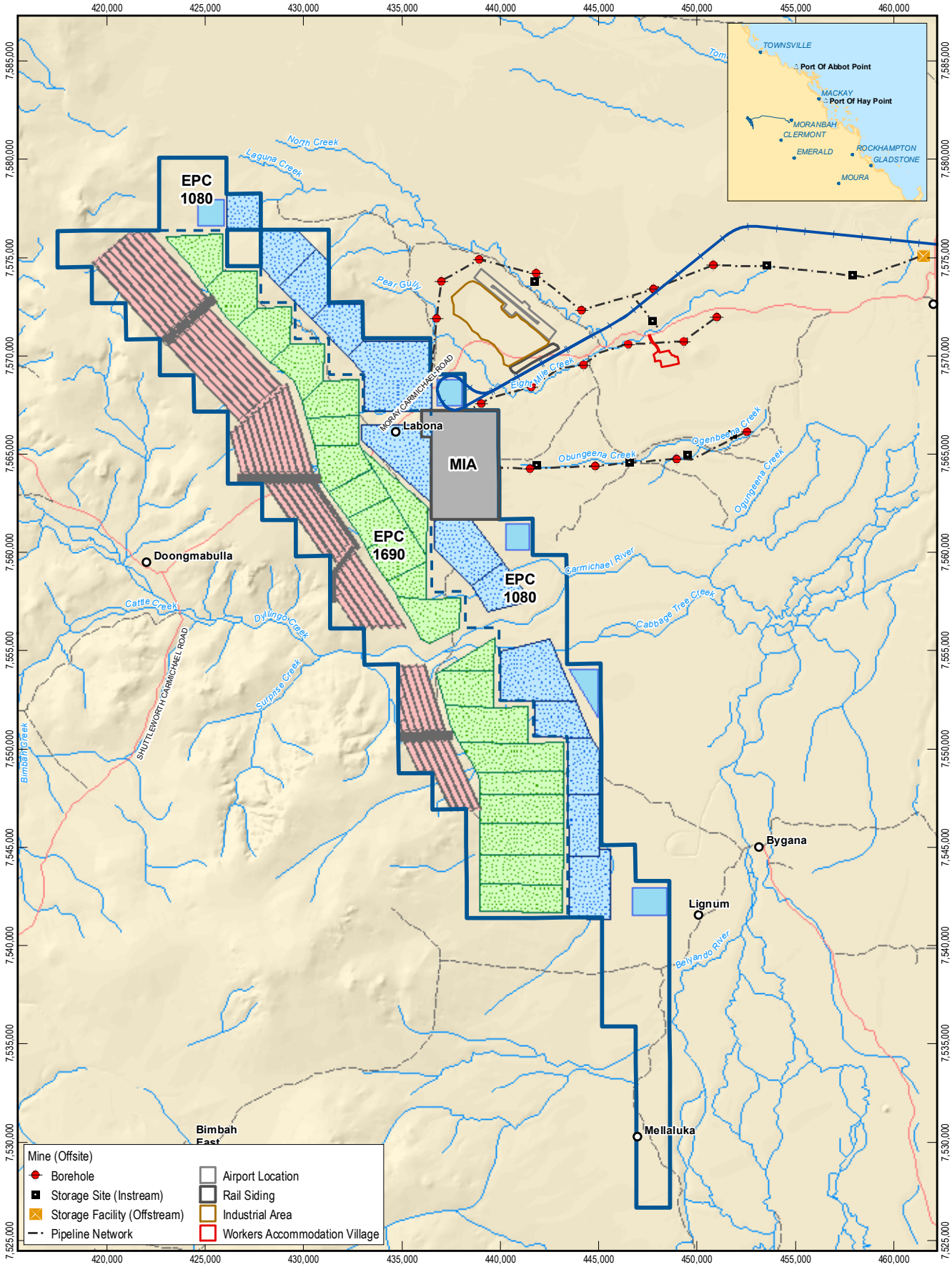
- Loss of habitat (water sources)
- Degradation of water quality
- Alteration of water quality

Introduction of feral species

- Competition with native species
- Predation of native species
- Presence and prevelance of pest and v species

Alteration to air quality and noise environs - increased disturbance

- Distrubance to roosting and foraging areas



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Construction Phase

Operation Phase

- Underground Mine Area
- Water Management Dams
- Underground Mine Plan
- Open Cut Blocks
- Out of Pit Waste Dumps

1:275,000 (at A4)

0 1 2 3 4 5

Kilometres

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

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Indicative Mine Plan - Areas of Impact

Job Number	41-25215
Revision	B
Date	14-11-2012

Figure 5-26

G:\41\25215\GIS\Maps\MXD\400_Ecology\41-25215_4001_rev_b.mxd

Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); Adani Pty Ltd: Indicative Mine Plan/Infrastructure (2012). Created by: BW, CA

5.3.2 Vegetation Clearing

5.3.2.1 Loss of Vegetation and Habitat for Terrestrial Species

Potential Impacts

Remnant and non-remnant vegetation is proposed to be cleared during the Project construction phase. Approximately 24 ha of remnant vegetation and 1,921 ha of non-remnant vegetation is proposed to be cleared for construction of the MIA, and approximately 86 ha of remnant vegetation and 3,227 ha of non-remnant vegetation (including 9 ha of high value regrowth vegetation) is proposed to be cleared for construction of the offsite infrastructure. Remnant vegetation located within the MIA to be impacted by construction comprises REs are classified as least concern (VM Act and biodiversity status) and do not form part of any TEC or Category B ESA. The RES include RE 10.3.6, RE 10.3.28 and RE 10.5.5.

The mapped remnant vegetation located within the MIA and offsite infrastructure areas to be impacted by construction comprises a number of mixed polygon REs within the Desert Uplands bioregion and the Brigalow Belt bioregion. REs located within the MIA have been field verified however, REs within the offsite infrastructure have not been verified through ground-truthing and therefore the extent of clearing for these RE types have been calculated based on DNRM's certified RE mapping (Version 6.1). Within the offsite infrastructure area, REs 10.4.3, 11.3.1, 11.4.5 and 11.4.9 (covering an area of 6 ha) are classified as Category B ESAs and RE 11.3.1 (covering an area < 1 ha) is a constituent RE of the Brigalow TEC. As the area of impact to these REs during the construction phase is minimal compared to impacts during the mine operation phase, further discussion of the impacts of clearing these vegetation types is contained within Section 5.4.2.

Approximately 9 ha of high value regrowth vegetation that is mapped within the offsite infrastructure area will be impacted by clearing for the construction phase of the Project. High value regrowth that is mapped within the offsite infrastructure areas are mapped as containing endangered REs. Within the workers accommodation village footprint, this regrowth vegetation (approximately 6 ha) comprises mixed polygon RE type 11.4.11/11.4.9/11.4.5. Within the water infrastructure areas, there are a number of small patches of regrowth vegetation (totalling approximately 3 ha) that represent mixed polygons containing RE types 11.3.3/11.3.1, 11.4.11/11.4.5 and 11.4.5/11.4.6/11.4.8.

Clearing of non-remnant vegetation on previously cleared land will reduce the localised extent of habitat for some animals including a range of common ground-dwelling reptiles, macropods and cleared land birds. The reduction in the extent of this habitat is considered to be of negligible significance due to its prevalence in the wider landscape as well as its low habitat value and extensive modification. Nevertheless, clearing should be minimised to the areas required for construction to minimise impacts on animals in this habitat, as well as to maintain a buffer between construction areas and areas of more significant habitat where possible.

Management and Mitigation

Where land clearing is required during construction, the following management and mitigation measures are recommended:

- The extent of land clearing is to be restricted to the minimal amount necessary for the construction of the MIA and offsite infrastructure and wherever possible, existing cleared areas are to be utilised. Where infrastructure must cross watercourses, locations where riparian

vegetation is already disturbed should be preferentially selected, or, if not possible, the construction footprint in these areas should be minimised and large habitat trees should be retained

- The extent of vegetation clearing must be clearly identified on construction plans and in the field. Areas that must not be cleared or damaged are to also be clearly identified on construction plans and in the field. Clearing extents are to be communicated to construction supervisors
- Any additional construction areas, such as site offices, construction stockpile locations, machinery/equipment laydown areas and storages, and construction camps are to be located where possible within existing cleared or disturbed areas
- As soon as possible after cleared areas such as laydown areas and site offices are no longer required and are not within the proposed mine footprint, rehabilitation will commence. This rehabilitation will involve vegetating disturbed areas to a state consistent with the adjacent landscape, in consideration of limitations associated with buffers relating to fire management. As these temporary construction disturbance areas will be sited in existing cleared areas (i.e. pasture), rehabilitation will involve revegetating using species that characterise the surrounding pasture
- Unavoidable loss of vegetation and fauna habitat will be offset in accordance with relevant Queensland and Commonwealth policies, as detailed in the Project Offset Strategy.

5.3.2.2 Loss Habitat for Listed Species

Potential Impacts

Clearing of remnant vegetation for the construction phase will result in the loss of areas of potentially suitable habitat for the following conservation significant species that have been confirmed present or are considered likely to occur within the Study Area:

- Black-throated finch (southern) (confirmed present at Study Area) – loss of approximately 24 ha of potential habitat within the MIA and 6 ha within the offsite infrastructure
- Squatter pigeon (southern) (confirmed present at Study Area) – loss of approximately 24 ha of potential habitat within the MIA and 6 ha within the offsite infrastructure
- Koala (confirmed present at Study Area) – loss of approximately 24 ha of potential habitat within the MIA and 6 ha within the offsite infrastructure
- Yakka skink (likely to occur at Study Area) – loss of approximately 24 ha of potential habitat in the MIA and 33 ha within the offsite infrastructure
- Ornamental snake (likely to occur at Study Area) – loss of approximately 0 ha of potential habitat within the MIA and 27 ha within the offsite infrastructure
- Little pied bat (confirmed present at Study Area) – loss of approximately 24 ha of potential habitat within the MIA and 33 ha within the offsite infrastructure
- Black-necked stork (confirmed present at Study Area) – loss of approximately 6 ha of potential habitat within the MIA and 0 ha within the offsite infrastructure
- Cotton pygmy-goose (confirmed present at Study Area) – loss of approximately 6 ha of potential habitat within the MIA and 0 ha within the offsite infrastructure

- Square-tailed kite (likely to occur at Study Area) – loss of approximately 24 ha of potential habitat within the MIA and 6 ha within the offsite infrastructure
- Black-chinned honeyeater (likely to occur at Study Area) – loss of approximately 24 ha of potential habitat within the MIA and 6 ha within the offsite infrastructure
- Echidna (confirmed present at Study Area) – loss of approximately 24 ha of potential habitat within the MIA and 33 ha within the offsite infrastructure
- Rainbow bee-eater (confirmed present at Study Area) – loss of approximately 1,945 ha of potential habitat within the MIA and 3,313 ha within the offsite infrastructure
- The eastern great egret and the satin flycatcher (confirmed present at Study Area) and nine additional migratory species (considered likely to occur at Study Area) have 0 ha of potential habitat impacted by the clearing of vegetation for the MIA and offsite infrastructure. Potential habitat for two predominantly aerial migratory birds that are likely to occur exists within the construction phase footprint:
  - Fork-tailed swift (likely to occur at Study Area) – loss of approximately 1,945 ha of potential habitat within the MIA and 3,313 ha within the offsite infrastructure; White-throated needletail (likely to occur at Study Area) – loss of approximately 1,945 ha of potential habitat within the MIA and 3,313 ha within the offsite infrastructure

Habitat loss will be localised during the construction phase, and will occur in a fragmented part of the local landscape. As larger areas of habitat for these species will be affected by the mine operations, further discussion of the impacts of the loss of these habitat types is provided in Section 5.4.2.

Management and Mitigation

- Pre-clearance surveys will be undertaken in areas identified as potential habitat for threatened species, prior to commencement of clearing. In areas where these surveys indicate the presence of habitat features observed to (or with the potential to) provide habitat for these species, a fauna-spotter catcher will be engaged to accompany clearing crews
- Unavoidable loss of vegetation and fauna habitat will be offset in accordance with relevant Queensland and Commonwealth policies, as detailed in the Project Offset Strategy.

As larger areas of habitat for these species will be affected by the mine operations, further discussion of the management and mitigation of the loss of these habitat types is provided in Section 5.4.2.

5.3.2.3 Mortality of Terrestrial Species

Potential Impacts

Potential mortality of terrestrial species as a result of vegetation clearing is discussed in Section 5.4.2.

Management and Mitigation

Management and mitigation measures for potential mortality of terrestrial species as a result of vegetation clearing are provided in Section 5.4.2.

5.3.2.4 Terrestrial Habitat Fragmentation

Potential Impacts

The MIA and offsite infrastructure are located in a locally fragmented landscape. Vegetation clearing at this localised scale may reduce the capacity of some less mobile fauna to move between habitats (including within cleared areas typified by non-remnant vegetation) that will be severed by the construction of facilities. This is particularly relevant to small, ground-dwelling fauna such as amphibians, reptiles and some arboreal mammals. Given that the construction of these facilities will occur in discrete footprints, and not represent a lengthy (linear) barrier between habitats, it is not considered likely that fauna movement at a landscape (regional) scale will be significantly affected.

Management and Mitigation

Management and mitigation measures to reduce the impact of habitat fragmentation to local fauna populations include:

- Landscape permeability will be retained where possible. Where fencing is required around cleared areas, it will be designed such that fauna can move through it (excluding those instances where fenced areas seek to protect fauna from threats such as trenches). Consideration will be given to avoiding the use of barbed wire on the top strand of wire fences
- Vegetation clearing will be undertaken in a sequential manner to allow more mobile fauna species the opportunity to disperse away from clearing areas

5.3.2.5 Terrestrial Habitat Degradation

Potential Impacts

Vegetation clearing has the potential to facilitate erosion (water and wind). This can have a localised impact on species and habitat suitability by reducing the quality and abundance of refuges, microhabitats and food availability through the smothering of native vegetation with sediment.

Earthworks will result in dust emissions. Excessive dust settling on vegetation could also suppress vegetation growth by limiting the photosynthesis potential of plants in close proximity to the construction area (Nanos and Ilias, 2007). Plants with dust on leaves may also be less palatable as a food source for animals. Dust deposition associated with earthwork activities will generally occur relatively close to areas of disturbance and hence, plants within 50 m – 100 m of construction activities may be affected by dust. As construction activities are temporary, effects will be short lived, and rainfall will generally remove dust from plants. Dust suppression will be used to control dust and this will reduce the extent of vegetation affected by dust.

Given that the construction phase activities will occur in a fragmented and disturbed part of the local landscape, edge effects are not expected to significantly detract from the value of habitats characterised by remnant vegetation that will be cleared.

Where vegetation clearing occurs on floodplains and near drainage lines, erosion may cause sedimentation of waterways, potentially degrading downstream aquatic and riparian habitats.

Management and Mitigation

Management of erosion and sedimentation in and adjacent to cleared areas will be undertaken in accordance with erosion and sediment controls set out in the construction environmental

management plan (offsite infrastructure) and Mine Environmental Management Plan (Volume 2, Chapter 13). This plan will identify all practices to be implemented prior to, during, and post-construction. The management approach to erosion and sediment control actions will include:

- Diversion of clean stormwater around disturbed areas, with scour protection as required to address any associated modifications in drainage paths
- Sediment fences and other sediment control devices, in particular in areas near earthworks, watercourses and key stormwater flow paths, will be installed and maintained
- All soil or mulch stockpiles will be located away from watercourses and key stormwater flow paths to limit potential for transport of these substances into the watercourses via runoff
- Design of stockpiles will consider soil properties to ensure side-slope stability and minimise susceptibility to failure due to erosion risk
- Dust suppression activities will be undertaken where appropriate and managed in accordance with the recommendations outlined in Volume 4 Appendix S Mine Air Quality Report
- Areas will be stabilised as soon as practicable after disturbance
- Stormwater control works to be installed as soon as practicable in the construction of onsite and offsite infrastructure

Even without erosion control, it is unlikely that the quantities of suspended solids that might enter surface waters would degrade water quality to the extent that it became unusable for terrestrial animals. Given the dynamic nature of the climate in the region, and modified state of some habitats in the landscape, it is likely that animals will have some degree of tolerance to water carrying elevated sediment loads during and after rainfall events. Additionally, there are a number of other farm dams and watercourses within the local area that provide alternative water resources for terrestrial animals.

5.3.2.6 Aquatic Habitat Degradation

Potential Impacts

The indirect impacts of clearing of land have the potential to degrade aquatic ecosystems by leading to changes in chemical (water quality) and physical (geomorphology and flow patterns) characteristics of the existing aquatic habitats within the construction footprint and downstream catchment. The direct loss of habitat as a result of construction is discussed in Section 5.3.3.3.

Specific to the construction phase, aquatic ecosystems at risk of degradation are those within the construction area and directly downstream of the dams (on North Creek and Obungeena Creek) and extraction locations on North Creek, Obungeena Creek and Belyando River, and pipeline crossing locations. Additionally, any areas receiving runoff flows from areas of land cleared for the MIA, workers accommodation village, industrial precinct and airport are likely to be impacted.

An infrastructure corridor, including a spanned bridge will be required to facilitate mining operations on the south side of the river. The crossing infrastructure will be designed such that no infrastructure will be placed in the bed of the Carmichael River. It is likely however that during construction vehicles may require access to the bed of the river; hence a temporary loss of habitat may result. Installation of the infrastructure across this watercourse will potentially result in a small loss of aquatic habitat, create a barrier to movement for native aquatic fauna species and/or alter hydrological flow. These

effects will however be temporary during construction and unlikely to have any medium or long term effects.

Physical changes in water quality have the potential to reduce the suitability of the aquatic environment for some aquatic flora and fauna species. The surface water quality of the Study Area is described in Volume 4 Appendix Q Mine Water Quality Report. The main sources of water quality changes are related to the mobilisation of sediments and pollutants. Water quality changes as a result of spills is discussed in Section 5.3.3.5.

Land clearing at the MIA, workers accommodation village, industrial precinct and airport will result in a local increase in exposed earth surfaces. The source of most suspended particulates (and in turn increase in turbidity), nutrients and other contaminants attached to particulates in waterways is mobilisation of soils through surface runoff , stream bank erosion and dust. Construction activities within or adjacent to watercourses for the offsite water supply infrastructure has the potential to disturb bed and bank substrates and lead to localised erosion and sediment transport to downstream habitats. Suspended particulates can influence the aquatic ecosystem when:

- In suspension – when in the water column particulates reduce light penetration and thus primary production as well as affecting gill function of fish
- Settling out – when settled sediments can smother organisms and their habitats (ANZECC, 2000)

Turbidity in streams in disturbed catchments is closely connected with rainfall and surface runoff with spikes in turbidity typically occurring after rain events, and then reduced turbidity levels as flows reduce and sediment is able to settle. The surface water quality assessment for the project identified that turbidity results were recorded above the nominated water quality objectives (WQO) on a number of occasions (Volume 4 Appendix Q Mine Water Quality Report). Although aquatic ecosystems in highly ephemeral systems are likely to be adapted to peaks in high turbidity during some periods, an increase in the magnitude or the frequency of these peaks of turbidity has the potential to have a detrimental effect on aquatic ecosystems.

Sediment movement can also mobilise nutrients and pollutants to aquatic habitats. Soils from the exposed areas, and potential pollutants, will be readily mobilised into local drainage lines and water bodies via erosion processes. The potential for mobilisation of soils and potential pollutants will be maximised after rain events and during high winds. Nutrient pollution has the potential to impact upon a system via the stimulation of growth of nuisance plants and cyanobacteria (ANZECC and ARMCANZ, 2000). Growth of these plants can lead to changes in the biological community composition as well as flow on affects to habitat suitability and aspects of water quality such as dissolved oxygen concentration which can impact upon aquatic fauna communities.

Within the Study Area concentrations of nutrients were generally higher in the still water bodies than in the Carmichael River. In the Carmichael River nutrient water quality sampling results were also detected to be linked to rainfall and surface runoff. Nutrient concentrations recorded higher (above WQOs) at the end of the wet season followed by a decrease during drier months and a gradual increase back to values above WQOs in September when wet season conditions begin. As with turbidity, aquatic ecosystems are adaptive to the existing seasonal variation in nutrients however increases in magnitude and frequency of peaks in this variable may have the potential to adversely impact ecosystems.

Management and Mitigation

Potential impacts on aquatic habitats as a result of clearing, can be largely avoided or mitigated through the implementation of construction specific management measures.

Mitigation measures will be detailed in the Mine and Offsite Environmental Management Plans, which will include erosion and sediment control requirements to be implemented and monitored throughout the construction phase of the Project.

To limit the degradation of downstream aquatic habitat during construction activities, mitigation and management will focus on reducing the potential mobilisation of sediments or pollutants, diversion of stormwater flows from disturbed areas and limiting sediment transport from exposed areas.

Controlling site runoff from all areas disturbed during construction and minimising bank disturbance will be important in limiting the degradation of habitats downstream of the construction footprints. The management and mitigation of the mobilisation of sediment and pollutants during construction is described in Volume 4 Appendix Q Mine Water Quality Report and these measures will assist in limiting the degradation of aquatic habitats. The measures identified include (but are not limited to):

- Avoiding clearing of vegetation and major earthworks during overland flow events.
- Installing stormwater diversion and collection systems as early as possible in the construction period.
- Developing and implementing erosion and sediment control plans. Further details on erosion and sediment control are provided in Environmental Management Plans (refer to Volume 2 Chapter 13 and Volume 2 Chapter 14)
- Maximising retention of surface cover by clearly delineating clearing areas and restricting activities to these areas.
- Locating soil or mulch stockpiles away from watercourses and key stormwater flow paths to limit potential for transport of these substances into the watercourses via runoff.
- Dust suppression activities to be undertaken where appropriate. Stabilisation of disturbed areas as soon as practicable after disturbance.
- Wherever possible, staging the clearing of vegetation as construction progresses and minimising the disturbance footprint at all times.
- Undertaking revegetation according to Rehabilitation Plan requirements.

The design of the MIA, workers accommodation village, industrial precinct and airport will incorporate stormwater management infrastructure and mechanisms to manage runoff.

Monitoring will include:

- Regular checks, including checks prior to forecast rain events, of erosion and sediment control devices to make sure these are in good working order
- Pre-rain checks of erosion and sediment control devices
- Inspections of streams for scouring and sediment deposition
- Ongoing water quality monitoring (refer to Volume 4 Appendix Q Mine Water Quality Report)

Summary

During the construction period it is expected that the aquatic ecology impacts associated with offsite water supply infrastructure will be localised and temporary. Impacts can be effectively managed through the implementation of management measures to minimise erosion and prevent the mobilisation and transport of sediments. Additionally, design measures have been adopted to condense and minimise the footprint of disturbance in the riparian zones. Monitoring requirements will be included in the Mine and Offsite Environmental Management Plans for both effectiveness of the management measures and the water quality conditions.

5.3.2.7 Loss of Riparian Vegetation

Potential Impacts

The loss of riparian habitats associated with the construction of pump sites and associated pipelines in the riparian zones of North Creek, Obungeena Creek, Eight Mile Creek and Belyando River will have highly localised impacts. Construction areas for water supply pipeline corridors, including laydown areas and stockpiles, will be located within the pipeline corridor, where possible, to minimise vegetation clearing related impacts. Additionally, the pipeline right of way within the riparian zone of Belyando River and North Creek will be reduced, where possible, to minimise impacts to vegetation communities. This habitat loss, in addition to any loss in the riparian zones of North Creek and Obungeena Creek where pipelines are proposed to intersect these waterways, is unlikely to represent a major impediment to movement of fauna along the riparian corridors along the affected waterways. The riparian vegetation along North Creek, Obungeena Creek and North Creek is not considered to represent a locally important corridor in this landscape.

The riparian zone plays an important role in the composition, function and protection of aquatic ecosystems. Established zones assist in stabilising soil, filtering toxicants and nutrients, provision of shade and as a source of large woody debris and organic matter for the functioning of aquatic ecosystems. Removal of riparian vegetation will be required for construction of the following offsite water supply infrastructure:

- In-stream dams on North Creek and Obungeena Creek
- In-stream extraction pumping infrastructure on the Belyando River and North Creek
- Pipeline crossing locations on North Creek (two locations), Obungeena Creek (one location) and Eight Mile Creek (one location)

The riparian zone of the Belyando River is characterised by a relatively consistent corridor of open forest and woodland dominated by *Eucalyptus coolabah* (coolabah) and *E. camaldulensis* (river red gum) canopy trees. The riparian zones of North Creek, Obungeena Creek and Eight Mile Creek are more fragmented.

Disturbance of riparian vegetation has the potential to lead to increased erosion and sediment transport to downstream habitats during flood and high flow runoff periods. The effect of increased erosion and sedimentation is discussed in Section 5.3.2.6.

The removal of a section of the riparian zone also exposes adjacent riparian communities to weed invasion. Discussion on the impacts of weed and pest species is in Section 5.4.5.

Management and Mitigation

Where unavoidable loss of the riparian zone for the construction phase will occur, sediment and erosion control measures will be implemented. The design and layout of the offsite water supply infrastructure will minimise the width of disturbance to the riparian zone. Sensitive areas in the vicinity of all construction will be clearly demarcated prior to construction to avoid accidental clearing or disturbance. A suitably qualified ecologist will be required to provide advice on the location of sensitive areas for demarcation.

These measures will be incorporated into the Mine and Offsite Environmental Management Plans to be prepared prior to any construction at the site. Management and mitigation of erosion and sedimentation is discussed in Section 5.3.2.6.

5.3.3 Disturbance of Water Resources

5.3.3.1 Overview

Construction activities, including the loss of a small farm dam approximately 6 ha in size (Brigalow Dam), have the potential to disturb to aquatic habitats associated with the ephemeral North Creek, Obungeena Creek and Eight Mile Creek. Existing farm dams on North Creek and Obungeena Creek will also be expanded which will result in temporary draining of these water storages. Disruption to these water resources has the potential to impact terrestrial ecological values through the localised reduction in availability and quality of drinking resources and foraging habitat, and potentially changes to riparian habitats in downstream watercourses due to changes in water quality and flow regimes. In particular, impacts realised from disturbance of water resources may include:

- Loss and disturbance of habitat for aquatic flora and fauna
- Mortality for aquatic fauna
- Change in or loss of aquatic habitat utilised by terrestrial species

5.3.3.2 Loss of Water Resource for Terrestrial Species

Potential Impacts

Construction of the MIA and offsite infrastructure, and specifically the water supply infrastructure, is proposed to result in the loss of Brigalow Dam and draining of several dams on ephemeral creeks so that these can be enlarged. These aquatic habitats are anthropogenic and occur in disturbed areas with minimal fringing vegetation. The main value of these dams for fauna is for drinking water and the dams may also be utilised by some threatened bird species including the black-throated finch (southern), squatter pigeon (southern) and black-necked stork as well as commonly occurring listed migratory species. As most natural waterbodies in the Study Area are ephemeral, farm dams can become important in dry periods.

The planning and concept design for offsite water supply infrastructure has aimed to avoid areas of high value aquatic habitat where possible by avoiding riparian habitat, referrable wetlands and gilgais.

There are a number of similar dams throughout the local area and the loss of one dam, and temporary loss of several other dams (while these are enlarged) is unlikely to cause any significant impact on native animals occurring in the region. With respect to the expansion of dams on North Creek and Obungeena Creek, habitat loss will only be of a temporary nature during the construction

phase and similar habitats that exist in the surrounding landscape that could provide temporary alternative water sources for these species.

Management and Mitigation

The loss of Brigalow Dam within the MIA footprint is an unavoidable impact of the construction phase of the Project but will be offset by construction of new water storage dams. Management of the removal of this water body and other management and mitigation strategies to minimise the impacts on aquatic environments are outlined in Volume 4 Appendix Q Mine Water Quality Report. The loss of dams on North and Obungeena Creek will be temporary whilst these are expanded during the construction phase, and will be negated by the wide availability of similar habitats in the surrounding landscape. In the event that there is a shortage of water resources in the landscape at the time of construction, temporary water tanks can be provided for native terrestrial species.

Summary

The impacts to terrestrial flora and fauna associated with changes to aquatic habitats are expected to be highly localised, temporary (notwithstanding permanent loss of Brigalow Dam), and in the landscape context, limited, post-mitigation.

5.3.3.3 Loss of Habitat for Aquatic Species

Brigalow Dam within the MIA footprint will be drained and in-filled to facilitate construction of the MIA. The farm dam is a low value lacustrine aquatic habitat. It is a farm dam with no connectivity to watercourses and exhibits disturbance from cattle and feral pigs. The water body water level was very low at the time of survey and the water present appeared highly turbid. The dam substrate is silt and clay and the margins consist of grasses only. The dam provides limited value for native aquatic flora and fauna, particularly as there is no in-water structure to provide for habitat variety, and no connectivity to the (surface) waterway system and hence little opportunity for recruitment of aquatic species. There will be a localised impact to resident native fish, crustaceans and turtle species in this dam when the water body is drained or filled with material.

Existing farm dams on North Creek and Obungeena Creek will be expanded to capture flood flows for the water supply. This process will require these dams to be temporarily drained so that the expansion can be undertaken. The temporary removal of these artificial aquatic habitats will result in localised, short-term impacts to non-conservation significant fish, macrophytes, crustaceans and turtles that are likely to be present; in the medium to longer term, this habitat will be restored when the water is returned.

North Creek and Obungeena Creek are ephemeral second order creek systems that play an important role in providing seasonal connectivity for aquatic fauna upstream and downstream in times of flow. This connectivity is important in maintaining gene flow and genetic diversity between periodically isolated populations. Additionally, these connecting waterways provide for recolonisation and/or population supplementation in the event of a population extinction or bottleneck. The expansion of the existing water supply dams on these creeks may create habitat fragmentation if flows are reduced due to larger volumes of water captured in the dams.

There is likely to be minimal impact to this aquatic habitat connectivity along watercourses from proposed dam expansions; however if creek diversions are proposed during construction, temporary loss of impacted sections of instream habitat may occur.

If flows occur in either waterway during construction, construction activities will probably preclude fish movement upstream. However, the construction period is short and impedance to movement over a single wet season is not likely to have any long term effects on fish populations. Impacts are also anticipated to be localised, with no aquatic species or habitats of conservation significance affected by the loss of habitat or impedance to movement during construction.

Construction of pump sites and associated pipelines in the riparian zones of North Creek and Belyando River will also impact on aquatic and riparian habitat. Construction of the offsite water supply infrastructure will also result in temporary disturbance of aquatic habitats while pipelines are installed across streams and drainage lines. These include ephemeral drainage lines; North Creek, Obungeena Creek and Eight Mile Creek.

Construction areas for water supply pipeline corridors, including laydown areas and stockpiles will be located within the pipeline corridor, where possible to minimise vegetation clearing related impacts. Additionally, the pipeline right of way within the riparian zone of Belyando River and North Creek will be reduced, where possible to minimise impacts to vegetation communities. The disturbance of the riparian zone may trigger erosion and sedimentation impacts and resulting degradation of adjacent and downstream habitats.

Management and Mitigation

The planning and concept design for offsite water supply infrastructure has aimed to avoid areas of high aquatic value where possible by avoiding riparian habitat, referrable wetlands and gilgais. The number of pipeline crossings of waterways have also been minimised and crossings have been located to reduce disturbance to the bed and banks of watercourses in the Study Area wherever possible.

Potential to further reduce disturbance to stream habitats by infrastructure will be reviewed in the detailed design phase, including consideration of:

- Selection of crossing locations to avoid or minimise disturbance to important areas of aquatic flora, waterholes, watercourse junctions and watercourses with steep banks
- Opportunities to use existing access tracks and other previously disturbed areas wherever possible
- Further opportunities to consolidate infrastructure alignments to minimise the number of crossings
- Design of pipeline crossings such that the level of the stream bed is not altered

While these design strategies will minimise the impacts on aquatic and riparian environments, some disturbance is expected to occur as a result of construction activities. Consequently, mitigation strategies will be required during construction to further reduce these impacts. Mitigation strategies will be based on compliance with the relevant DEHP *Guidelines for carrying out activities in a watercourse, lake or spring* and, if a riverine protection permit is required for any of the works, the conditions of this permit.

Mitigation strategies will include:

- In-stream works to be undertaken in nil or low flow conditions wherever possible
- Duration of in-stream works to be minimised through prior planning such that all equipment and materials are available to allow works to be completed as quickly as possible

- For dam raising sediment control measures to be installed where in-stream disturbance must be undertaken during flow conditions. This will most likely involve sediment weirs. If sediment weirs are installed, care will be taken to minimise effects of the sediment weirs on aquatic habitat
- Minimisation of disturbance area within streams and riparian areas. Equipment parking and laydown areas will be located outside these areas. The area of disturbance within streams and riparian zones will be the minimum area required for safe working and the area of disturbance for infrastructure installation clearly marked
- Prompt stabilisation of disturbed areas to prevent flow-related scouring of bed and banks of stream. Stabilisation is to use "soft" engineering solutions rather than concrete or similar
- Where existing dams are to be extended and/or the dam wall uplifted to increase storage capacity, works will be staged accordingly so as not interfere with the existing environment where practical.

5.3.3.4 Aquatic Fauna Mortality

Mortality or injury to resident native aquatic fauna can potentially occur when construction activities are undertaken within or adjacent to a water body. This usually arises as a result of vehicle/machinery strike or strike from falling vegetation or woody debris, but also as a result of fish and other aquatic fauna being stranded when the water is drained from waterways or dams. Fish, turtles and crustaceans were detected in aquatic habitats in the Study Area during surveys, and these species are likely to occur in the Brigalow Dam, Obungeena Creek and North Creek. Consequently, there are likely to be aquatic species that are at risk of mortality or injury.

The removal of Brigalow Dam through filling or draining the dam will result in the mortality of any resident aquatic communities present and the time of construction. Brigalow Dam is an isolated aquatic habitat, and as such, the fish and crustacean populations are not able to independently move to a refugial habitat. These communities are isolated populations likely to have been established as a result of stocking or incidental transfer by birds or the like. During wetter months this population is not likely to be connected to others hence will not contribute to the local biodiversity of the aquatic communities in the river and creek systems in the region. Though the community may not be important in the context of local biodiversity, all native species are protected under the NC Act and destruction of native species is prohibited without the required approvals. Approval conditions will include requirements to reduce the risk of fauna mortality when the dam is drained or in-filled.

Potential aquatic fauna mortality impacts with regard to construction of offsite water supply infrastructure are associated with construction activities within watercourses, such as pipeline crossings and draining of dams on Obungeena Creek and North Creek. Existing dams on North Creek and Obungeena Creek potentially contain commonly occurring native fish, crustaceans and turtles. Temporary draining of dams that are to be raised may therefore result in injury or mortality of some native species. Construction within riparian zones and within the bed and banks of ephemeral creeks such as North Creek, Obungeena Creek and Eight Mile Creek may also result in both direct and indirect aquatic fauna mortality. For example, direct mortality will occur in the event that an individual is struck by machinery or a falling object.

Indirect mortality may also occur in the event that a waterway is drained, or if there are significant and sudden changes in water quality and fish and other aquatic animals are unable to escape. For example, the removal of the riparian zone will reduce shading over the waterway. This will potentially result in an increase in surface water temperatures, a subsequent reduction in dissolved oxygen (as

warmer water has reduced oxygen holding capacity) and death of aquatic biota due to hypoxic conditions.

When in flow, North Creek, Obungeena Creek and Eight Mile Creek provide dispersal pathways for aquatic flora and fauna. Consequently, when construction is undertaken during flow conditions there is a risk of fauna mortality along these waterways. Although aquatic fauna species present are common and loss of individuals is not likely to have any significant impact on biodiversity of aquatic ecosystems, all native species are protected under the NC Act and destruction of native species is prohibited without the approval under the NC Act. Subsequently, all reasonable and practical measures will be undertaken to minimise the occurrence of such events.

Management and Mitigation

To avoid mortality of aquatic fauna during drainage of Brigalow Dam and the dams on North Creek and Obungeena Creek, fauna salvage and relocation may be required where there is water in the dams at the time of construction. This will involve:

- Survey of the dams immediately prior to draining to identify presence of fish and large crustacean species
- Depending on species identified, develop relocation techniques to capture species and identify appropriate locations for relocation
- Monitor during drainage of dams to check for stranding

To avoid potential mortality of aquatic fauna during construction within riparian zones and within the bed and banks of ephemeral creeks, construction activities will ideally be undertaken during dry or controlled conditions. Timing of construction in and adjacent to watercourses during dry conditions will assist in minimising potential indirect impacts to aquatic ecosystems at crossing sites and downstream.

5.3.3.5 Changes to Water Quality

Potential Impacts

Oils, fuel, lubricants and other substances containing chemicals will be required to operate construction machinery. Accidental spills or leaks anywhere within the catchment, including within the MIA, workers accommodation village, industrial precinct and airport have the potential to result in contaminants being transported to the aquatic environment via rainfall runoff. Commonly used substances contain elements that, at high concentrations, can be toxic to aquatic or terrestrial fauna.

Other potential sources of water contamination are:

- Untreated or partly treated sewage. Nutrients could cause eutrophication and algal outbreaks which may be toxic or unpalatable to animals and bacteria could cause animals to become sick. It is not proposed to discharge either untreated or treated sewage to any surface waters.
- Spills of hydrocarbons could make water unpalatable to terrestrial animals, and, depending on quantities, toxic. Controls proposed in relation to storage and handling of fuels, oils and other chemicals are detailed in Volume 2 Section 13 Mine Environmental Management Plan.

Increased turbidity due to vegetation clearing is discussed in 5.3.2.6.

Management and Mitigation

The management and mitigation of the mobilisation of sediment and pollutants during construction is described in Volume 4 Appendix Q Mine Water Quality Report and these measures will assist in limiting the degradation of aquatic habitats. The measures identified include (but are not limited to):

- Development of emergency response protocols and procedures for implementation in the event of a contaminant spill or leak and provision of spill response equipment.
- Storage of fuels, chemicals, wastes and other potentially environmentally hazardous substances in bunded or otherwise contained areas away from watercourses.
- Refuelling and in areas away from watercourses.
- Regularly checking vehicles and equipment for oil leaks.

The design of the MIA, workers accommodation village, industrial precinct and airport will incorporate stormwater management infrastructure and mechanisms to manage runoff. This may include holding tanks and/or gross pollutant traps (GPT) or other stormwater management techniques. Stormwater management mechanisms and monitoring requirements will be developed prior to any construction activities and incorporated in the Environmental Management Plan.

Monitoring will include:

- Regular checks of fuel, chemical and waste storage areas for leaks or improper storage
- Regular checks, including checks prior to forecast rain events, of erosion and sediment control devices to make sure these are in good working order
- Pre-rain checks of erosion and sediment control devices
- Inspections of streams for scouring and sediment deposition
- Ongoing water quality monitoring

Management of surface water quality during the construction of the MIA and offsite infrastructure is extensively detailed in Volume 4 Appendix Q Mine Water Quality Report.

5.3.3.6 Changes to Surface Flows and Geomorphology

Potential Impacts

Changing the direction or volume of runoff flows to watercourses and within watercourses has the potential to change the watercourse geomorphology as a result of scour and deposition. The mobilisation and subsequent deposition of sediments into watercourses has the potential to locally change bed and bank profiles. Such physical changes have the potential to reduce habitat suitability for existing communities and change the diversity and/or structure of the community by creating or removing microhabitat types to which the existing community has adapted.

The construction phase will result in a change to the current open grazing land with relatively permeable soils to compacted developed areas within the footprint. The resultant land use will have a relatively increased potential for runoff of rainfall to occur as the permeability of the soils is reduced within the footprint. As discussed in Volume 4 Appendix P Mine Hydrology Report, given the relatively small area of the catchment to be disturbed, it is unlikely that this increase in catchment permeability will substantially change runoff flow volume to the downstream catchment. Minor changes to topography will also occur as a result of construction which in turn may mean that flow

paths change. Again, the magnitude of change in the context of the catchment is unlikely to result in any significant changes to stream flows.

Alteration of volumes and flows in North Creek and Obungeena Creek associated with construction works to expand existing dams may result in changes to watercourse geomorphology.

Trenching of pipelines associated with waterway crossings at Obungeena, North and Eight Mile Creeks may also result in temporary localised impacts to geomorphology. These geomorphology impacts will mostly be due to the overland flow changes resulting from the buried pipeline 'crown' left on the soil surface. With rehabilitation of the pipeline right of way, this impact will be reduced as the right of way returns to a natural state with vegetation coverage.

Management and Mitigation

It is unlikely there will be a change in runoff flow volume such that it may significantly impact aquatic habitats. Management and mitigation to prevent erosion and runoff are discussed in Section 5.3.2.6.

5.3.4 Introduction and Proliferation of Weeds and Feral Species

Potential Impacts

Potential introduction and proliferation of terrestrial weeds is discussed in Section 5.4.5.1. Potential introduction and proliferation of aquatic weeds is discussed in Section 5.4.5.2.

Management and Mitigation

Management and mitigation of potential introduction and proliferation of terrestrial weeds is discussed in Section 5.4.5.1. Management and mitigation of potential introduction and proliferation of aquatic weeds is discussed in Section 5.4.5.2.

5.3.5 Behavioural Disruption Among Terrestrial Species

Potential Impacts

Construction activity at and near the construction zone associated with the MIA and offsite infrastructure may disrupt local fauna roosting, breeding and foraging activities, largely as a result of increased exposure to light, noise, dust, vehicles and people. Animals may also become more vulnerable to predation, because of increased light making it easier for predators to locate prey or noise levels making it harder for prey to detect approaching predators.

There is limited native habitat (i.e. remnant vegetation) in and around construction areas for native animals, and most animals occurring in the MIA and offsite infrastructure construction zones are common and generally tolerant to some disturbance. Furthermore, threatened species such as the black-throated finch (southern) and squatter pigeon (southern) are known to inhabit areas exposed to anthropogenic disturbance (peri-urban Townsville including directly adjacent to military training areas in the case of the former; numerous towns in central Queensland for the latter). Animals may exhibit initial fright behaviour, and will either adapt to the disturbance levels, or move away from the areas of activity into similar habitat that is extensively available in the adjacent landscape. Breeding activity is less likely to be associated with non-remnant vegetation; however, remnant areas will need to be checked as part of pre-clearing surveys.

Management and Mitigation

Management and mitigation for potential behavioural disruption among terrestrial species as a result of the construction of the Project (Mine) are consistent with those in Section 5.4.6.1.

5.4 Potential Impacts and Mitigation Measures – Operation

5.4.1 Introduction

This impact assessment has been structured to address impacts associated with the operation phase activities listed below. Full details about the staged operations of the proposed Mine are provided in Volume 2 Section 2 Description of the Project. It is important to note that some preliminary activities associated with the operation phase (i.e. stripping of vegetation prior to open-cut mining) will occur simultaneously with activities defined as occurring within the construction phase (as outlined in Section 5.3).

The operation phase of the Project (Mine) is proposed to involve the following activities:

- Underground mining through staged development with subsidence of mined areas of up to 8.3 m expected to occur
- Open cut mining through staged development and rehabilitation of pits over the duration of the Mine life
- Management of overburden through development and rehabilitation of waste areas over the duration of the Mine life
- Development and maintenance of clean water diversion drains through the mining lease to avoid mine affected area
- Establishment and maintenance of a 500 m buffer from each bank of the Carmichael River, with establishment of a flood levee bordering the outer edge of the 500 m buffer zone adjacent to the proposed open cut mines
- Establishment of sediment ponds (water management dams) to receive dirty water from mining operations
- Diversion of Eight Mile Creek
- Operation of the offsite infrastructure, comprising the operation of the workers accommodation village, airport, industrial area and offsite water supply infrastructure, including:
  - Pumping of water from North Creek and the Belyando River during peak flow periods
  - In-stream river extractions on North and Obungeena Creeks
  - Pumping of local groundwater reserves in the Moray Downs property, outside of the active mining leases

The indicative locations of the underground mining area, open cut mining area (blocks), out of pit waste dumps, water management dams, areas potentially exposed to subsidence (i.e. those areas above the underground Mine), and areas not to be subjected to operation phase activities, are presented in Figure 5-26.

It is understood that:

- Staged, non-sequential operation of the Mine is proposed to occur over 90 years, incorporating

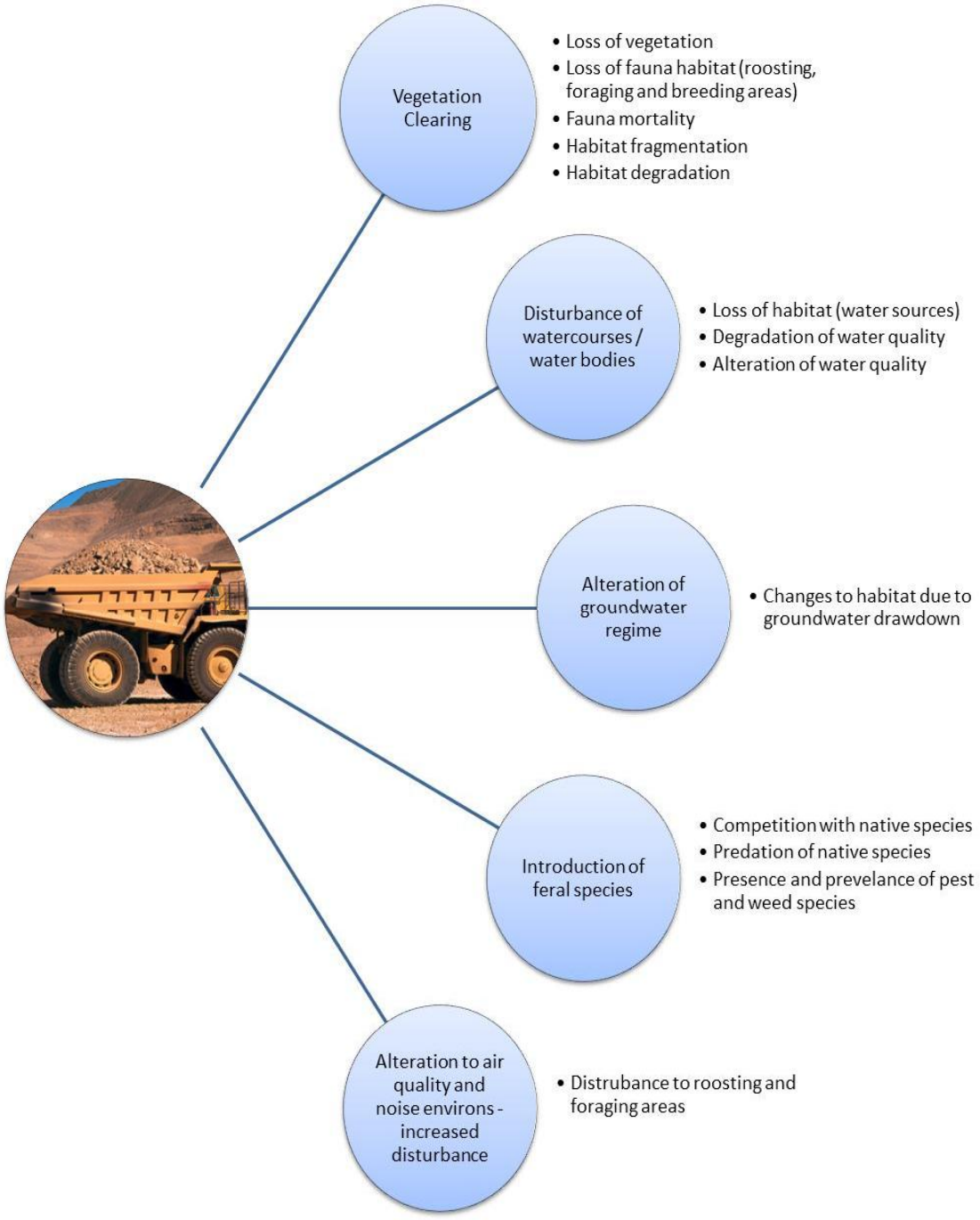
  - Underground mining in the west of the Study Area
  - Open cut mining in the middle of the Study Area
  - Overburden disposal (out of pit waste dumping) and water management dams in the east of the Study Area
- All clean water to be diverted to the Carmichael River will pass through sediment basins / traps prior to discharge
- Water management dams will be constructed and used for the variety of water treatment and storage requirements
- Discharges to surface water will occur under conditions of an environmental authority and will involve discharges from sediment ponds when rainfall exceeds the design capacity of those ponds and controlled discharges of mine affected water when sufficient dilution is available to address salinity levels.
- Access to the southern part of the Study Area will be achieved via one point, a spanned bridge across the Carmichael River
- All water runoff from the mine footprint will be captured, treated and reused
- No water will be extracted from the Carmichael River for operation of the mine
- Sewage waste from the operational workforce will be treated in a packaged plant to an A+ standard and all effluent will be recycled onsite

The potential operation phase impacts (as identified in Figure 5-27) to nature conservation values have been considered, and appropriate management and mitigation measures proposed, to ameliorate identified impacts, as listed below:

- Clearing of land (vegetation clearing)
  - Loss of vegetation
  - Loss of fauna habitat
  - Fauna mortality
  - Habitat fragmentation
  - Habitat degradation
- Disturbance of surface watercourses
  - Loss of water resources utilised by terrestrial species
  - Alteration/degradation of water quality in water resources utilised by terrestrial species
  - Degradation of aquatic habitat
- Alteration in groundwater regime
  - Changes to habitat due to groundwater drawdown
  - Potential indirect impacts to Doongmabulla Springs
  - Impact to stygofauna communities
- Proliferation of weeds and feral animals species
  - Competition with native species, predation of native species, and habitat degradation (presence and prevalence of pest and weed species)

- Increased disturbance to habitats
  - Disturbance to breeding, roosting and foraging areas and behaviours
  - Habitat alteration associated with subsidence

Figure 5-27 Conceptual Diagram of Potential Operation Phase Impacts



5.4.2 Vegetation Clearing

5.4.2.1 Loss of Vegetation

Potential Impacts

Potential impacts arising from vegetation clearing for mining operations are as follows:

- Loss of TECs

An approximate area of 267 ha of Brigalow TEC is located within the mining footprint. Of that, approximately 195 ha (73 per cent) of the TEC will be cleared. The TEC to be directly impacted represents 0.28 per cent of that available within the Belyando Downs subregion. The proportional loss of Brigalow TEC will be relatively small in the context of its subregional extent, and offsets will be secured and managed to maintain, protect and where possible enhance local biodiversity values. The localised loss of Brigalow TEC at the Study Area is not considered likely to adversely impact upon the biodiversity values of the region.

The 72 ha (27 per cent) of TEC remaining within the mining footprint is proposed to be retained and not cleared for mining operations, although some areas may be subject to subsidence from underground mining activities.

- Loss of Category B ESAs

Approximately 1,054 ha of area classified as Category B ESA is located within the mining footprint. Of that, approximately 820 ha (78 per cent) is proposed to be cleared for Mine operations. The Category B ESAs to be directly impacted represents 0.73 per cent of that available within the two subregions intersected by the Project (comprising the Alice Tableland subregion for the Desert Uplands REs, and the Belyando Downs subregion for the Brigalow Belt REs). The 234 ha (22 per cent) of Category B ESA remaining within the mining footprint is proposed to be retained and not be directly impacted by clearing activities for mining operations, although some areas may be subject to subsidence from underground mining activities.

- Loss of endangered REs

Approximately 267 ha of endangered (VM Act status) REs are located within the mining footprint. Of this area, approximately 195 ha (73 per cent) of the endangered REs located within the mining footprint are proposed to be cleared. The remaining 72 ha (27 per cent) is proposed to be retained and not be directly impacted by clearing activities for mining operations, although some areas may be subject to subsidence from underground mining activities.

The area to be cleared comprises three endangered RE types (11.3.1, 11.4.8 and 11.4.9) which are all located from the Brigalow Belt bioregion (Belyando Downs subregion) within the mining footprint of the Study Area. These endangered REs form brigalow vegetation communities and are constituents of the Brigalow TEC as well as Category B ESAs (discussed above). RE (11.4.8) covers an area of less than 1 ha within the Study Area and is proposed to be wholly removed by vegetation clearing for Mine operations.

- Loss of of concern REs

Approximately 345 ha of of concern (VM Act status) RE is located within the mining footprint. Approximately 169 ha (49 per cent) of the of concern (VM Act status) REs located within the mining footprint is proposed to be directly impacted through vegetation clearing. This area is made up of one

of concern RE from the Desert Uplands bioregion, RE 10.7.4, and two of concern REs from the Brigalow Belt bioregion, REs 11.3.3 and 11.4.6.

REs 11.4.6 and 11.7.4 are proposed to be most impacted by vegetation clearing for the operation of the Mine with 0.51 per cent and 0.40 per cent of the current extent of these REs within the subregion respectively being cleared. RE 10.7.4 has a current bioregional extent of less than 7,500 ha, of which 69 per cent of the total bioregional extent lies within the Alice Tableland subregion, where the Project is located.

- Loss of least concern REs

Approximately 28,029 ha of least concern remnant vegetation is located within the mining footprint. A total of 21 least concern RE types, 16 within the Desert Uplands bioregion and five in the Brigalow Belt bioregion, are proposed to be cleared for mining operations. This equates to a total removal of approximately 12,223 ha (44 per cent) of least concern RE within the mining (operation) footprint over the lifespan of the Mine. The loss of least concern vegetation for the operation of the Mine is proposed to occur sequentially over the lifespan of the Mine as new mining pits are developed and existing pits closed and rehabilitated.

Three least concern REs, 10.3.6, 10.3.28 and 10.5.5 within the Study Area are subject to the greatest impact from the loss of vegetation as all three REs are subject to a loss of 2,000 ha or more. RE 10.3.28 is proposed to be impacted the most with an approximate area of 4,020 ha to be cleared for Mine operation. These three RE types are broadly characterised as Eucalyptus brownii or Eucalyptus melanophloia open woodlands which are the dominant vegetation types within the Study Area. Vegetation loss of between 100 ha and 900 ha is proposed to occur in seven RE types. The remaining 11 RE types are proposed to be impacted by the removal of approximately 100 ha or less.

- Loss of high value regrowth

Of the 45 ha of high value regrowth vegetation that is mapped within the mining footprint, approximately 6 ha located within open cut blocks is proposed to be cleared. This regrowth vegetation is mapped as containing least concern REs, representing RE types 11.3.28a/11.3.6a. The 39 ha of high value regrowth remaining within the mining footprint is proposed to be retained and not be directly impacted by clearing activities for mining operations, although some areas may be subject to subsidence from underground mining activities.

- Loss of vegetation – Bygana West Nature Refuge

The Bygana West Nature Refuge covers an area of 1,487 ha and is wholly contained within the mining footprint. Vegetation clearing for mining operations within the Bygana West Nature Refuge will result in the direct loss of approximately 1,301 ha of the remnant vegetation in the nature refuge, an 88 per cent loss of its total vegetation coverage. The remaining 186 ha of the nature refuge within the Mine (operation) footprint may be exposed to subsidence as a result of underground mining activities.

- Loss of vegetation – flora species and habitat, including least concern species and species of conservation significance

The only flora species of conservation significance confirmed present during the field surveys, waxy cabbage palm, is restricted to the Carmichael River channel. A total of 17 ha of potentially suitable habitat within the fringing open forest/woodland vegetation community, in RE 11.3.25 will be subject to vegetation clearing. In addition, 2 ha of potentially suitable habitat located above the underground mine may be exposed to subsidence. The Carmichael River channel, which represents known

habitat for this species, will not be directly disturbed, nor will it be undermined, and a buffer is to be established. Therefore, there will be no clearing or loss of habitat for this species.

The footprint for mining operations may contain potentially suitable habitat for three flora species that may occur at the Study Area, as determined through the likelihood of occurrence assessment. None of these species were confirmed present during field surveys of the Study Area. The three species are:

- Acacia ramiflora (vulnerable EPBC Act; not listed NC Act) - may occur within Study Area
- Nesaea robertsii (not listed EPBC Act; endangered NC Act) – may occur within Study Area
- Peripleura *scabra* (not listed EPBC Act; near threatened NC Act) – may occur within Study Area

It is likely that potentially suitable habitat for these species will be removed through sequential vegetation clearing for the operation of the mine over the lifespan of the mine. Outcomes of the likelihood of occurrence assessment and potential habitat requirements for each species are detailed further within Sections 3.2.4 and Section 3.3.5.

Management and Mitigation

In response to unavoidable clearing of native vegetation, the following management and mitigation measures are recommended:

- Non-remnant areas within the Study Area that are to remain unmined should be rehabilitated and managed (including monitoring) with the objective being to gradually achieve regrowth and remnant status to vegetation communities that are associated with similar land zones in the local landscape. This active management should occur to contribute to the maintenance of ecological values of the local landscape in which the Study Area occurs, though it is recognised that cleared lands are generally seeded with exotic pastures and restoration of a native ground cover may be difficult to achieve, or a very long term outcome. Areas where such management could occur include along the Carmichael River corridor (north of the Carmichael River), in the eastern part of EPC 1080 (south and south east of the MIA), and at the southern part of EPC 1080 where no development is proposed to occur. A component of this active management should be the removal of cattle, or the implementation of ecologically sensitive grazing strategies
- The ecological values within the buffer area surrounding the Carmichael River are to be enhanced through a revegetation and active vegetation and habitat management program. The program should focus on providing habitat for key threatened species, and on providing east-west connectivity. A monitoring program should be implemented to monitor success of the revegetation and enhancement program as well as presence and utilisation by fauna, including threatened fauna. Results of monitoring of the revegetation program may be relevant to rehabilitation and also management of offset areas on Moray Downs and adjacent properties
- The extent of vegetation clearing is to be restricted to the minimal amount necessary for mining operations. Areas that must not be cleared or damaged are to be clearly identified on operation plans and in the field. Clearing extents are to be communicated to all necessary personnel involved
- During mining operations, sequential clearing will be adopted in order to minimise the ongoing total area of impact through clearing

- Vegetation clearing operations are to be supervised to monitor compliance of vegetation clearing with the defined clearing extents
- Unavoidable (staged) loss of vegetation will be offset in accordance with Commonwealth and Queensland policies, with the objective of maintaining, and where at all possible, enhancing local biodiversity values. Identification of offsets will seek to realise opportunities to enhance local and regional biodiversity values, for example, through the procurement and management of areas that contribute to corridors in the region. Furthermore, these areas should be identified with a view to achieving a 'no net loss' of local biodiversity values, in consideration of the types of vegetation that will be cleared, and the conservation status of those vegetation communities.
- As soon as possible after disturbed areas (cleared areas, open cut pits, out of pit waste dumps etc.) are no longer required, rehabilitation should commence. This is to include, but not be limited to, measures including the reinstatement of soil profiles, including topsoil, and revegetation using flora species of local provenance that are suitable for the reinstated soil and geomorphology. Management of previously disturbed land will occur in accordance with the Project Rehabilitation Management Plan. This plan will detail how disturbed land will be managed and rehabilitated, including (but not limited to) details about seed collection, flora regeneration and landscape architecture (i.e. topography), monitoring and adaptive management of rehabilitated areas. The objective of land rehabilitation should be to return disturbed areas to a vegetated state as quickly as possible after disturbance has ceased. In addition to monitoring and adaptive management of rehabilitated areas, opportunities for targeted rehabilitation activities that seek to enhance local biodiversity values should be identified and realised. These may include providing vegetated linkages across rehabilitation areas to larger areas of remnant vegetation, and provision of habitat resources for local fauna species
- The Rehabilitation Management Plan is to specify techniques for managing cleared vegetation and topsoil where this is to be used in rehabilitation.

5.4.2.2 Loss of Habitat for Terrestrial Species

Potential Impacts

Table 5-11 summarises habitat loss associated with this vegetation clearing, by fauna habitat type.

Table 5-11 Fauna Habitats – areas to be cleared of vegetation in Study Area

Fauna habitat type	Area to be cleared over life of mine			Total
	Open cut blocks	Out of pit waste dumps	Water management dams	
Ironbark-box grassy woodlands and open woodlands on grey sand plains 'Ironbark-box woodland'	7,196 ha	3,046 ha	350 ha	**10,592 ha**
Yellow jacket and rough leaved bloodwood shrubby low open woodland on red sand plains	61 ha	191 ha	0 ha	**252 ha**

Fauna habitat type	Area to be cleared over life of mine			Total
	Open cut blocks	Out of pit waste dumps	Water management dams	
'Shrubby low woodland'				
Tall mixed shrubland on red sand plains over ferricrete 'Tall mixed shrubland'	273 ha	34 ha	0 ha	**307 ha**
Gidgee and/or brigalow shrubby woodland and low woodland, sometimes with Dawson's gum emergents, on clay and clay loam plains 'Gidgee / brigalow shrubland'	659 ha	628 ha	64 ha	**1351 ha**
Open forest and woodland fringing watercourses and relict stream channels, and alluvial plains subject to flooding 'Fringing open forest / woodland'	3 ha	14 ha	0 ha	**17 ha**
Woodland and low open woodland associated with laterised sandstone rises and minor pediments 'Low woodland (sandstone rises)'	64 ha	3 ha	0 ha	**67 ha**
Open, previously cleared areas lacking native vegetative cover 'Open cleared land'	2,610 ha	4,155 ha	556 ha	**7,321 ha**

The staged loss of habitat, over the life of the mine, will reduce the local availability of foraging, breeding and shelter resources for a wide diversity of fauna species (approximately 44 per cent of remnant vegetation at Study Area). Mobile species may be able to disperse between similar habitats within the Study Area during staged mine operations, or disperse away from the Study Area to similar habitats in the landscape to the north, west and south of the Study Area. Habitat loss may diminish opportunities for movement of less mobile fauna (i.e. ground-dwelling reptiles, amphibians, small ground-dwelling mammals) in the local landscape.

It is important to note that large parts of the Study Area will to not be exposed to vegetation clearing during staged operations of the mine. Table 5-12 provides a summary of the fauna habitat areas that are not proposed to be affected by vegetation clearing. In total, 16,033 ha of land characterised by fauna habitats featuring remnant vegetation will not be cleared. In addition, 6829 ha of open cleared land (characterised by non-remnant vegetation) will to not be cleared during the mine's operation phase.

Table 5-12 Fauna Habitats - areas not to be cleared of remnant vegetation in Study Area

Fauna habitat type	Land not proposed to be cleared (outside of mine footprint)	Land not proposed to be cleared (above underground mine) – will be exposed to subsidence	Total
Ironbark-box grassy woodlands and open woodlands on grey sand plains 'Ironbark-box woodland'	6,182 ha	4,721 ha	**10,903 ha**
Yellow jacket and rough leaved bloodwood shrubby low open woodland on red sand plains 'Shrubby low woodland'	1,310 ha	987 ha	**2,297 ha**
Tall mixed shrubland on red sand plains over ferricrete 'Tall mixed shrubland'	275 ha	1039 ha	**1,313 ha**
Gidgee and/or brigalow shrubby woodland and low woodland, sometimes with Dawson's gum emergents, on clay and clay loam plains 'Gidgee / brigalow shrubland'	726 ha	157 ha	**883 ha**
Open forest and woodland fringing watercourses and relict stream channels, and alluvial plains subject to flooding 'Fringing open forest / woodland'	287 ha	2 ha	**289 ha**
Woodland and low open woodland associated with laterised sandstone rises and minor pediments 'Low woodland (sandstone rises)'	89 ha	258 ha	**347 ha**

Management and Mitigation

Where (staged) vegetation clearing is required for open cut blocks, out of pit waste dumps and water management dams, in accordance with staged development of the Mine, the following management and mitigation measures will be undertaken:

- Management of remnant vegetation at the Study Area on land that is yet to be mined, or is to remain unmined (including areas at the northern and southernmost parts of the Study Area), will be undertaken in accordance with the Project's overarching ecological management framework, to be embedded in the Project Environmental Management Plan. This framework will detail how land not subject to direct impacts (i.e. vegetation clearing) will be managed (including details relating to land use (cattle grazing), vegetation management, rehabilitation, weed and pest animal management, fencing and fire management), such that the terrestrial ecological values (including habitat quality and function) of such areas are maintained, and where possible, enhanced. This

strategy will make reference to the relevant environmental management actions outlined in the Project Environmental Management Plan

- Further to the above, suitable non-remnant areas within the Study Area that are to remain unmined through the life of this Project will be rehabilitated and managed as part of the overall offset strategy, with the objective being to gradually achieve remnant status that is consistent with the vegetation communities (and associated fauna habitats) that are associated with similar land zones in the local landscape. Areas where such management could occur include along the Carmichael River corridor (north of the Carmichael River), in the eastern part of EPC 1080 (south and south east of the MIA), and at the southern part of EPC 1080 where no development is proposed to occur
- The ecological values within the buffer area surrounding the Carmichael River are to be enhanced through a revegetation and active vegetation and habitat management program. The program should focus on providing habitat for key threatened species, and on providing east-west connectivity. A monitoring program should be implemented to monitor success of the revegetation and enhancement program as well as presence and utilisation by fauna, including threatened fauna. Results of monitoring of the revegetation program may be relevant to rehabilitation and also management of offset areas on adjacent properties
- Vegetation clearing for discrete phases of the Project operations should be undertaken in a manner that maximises the potential for fauna to disperse away from habitats within the clearing footprint, to adjacent areas, including onsite and offsite (offset) areas that are being actively managed for biodiversity outcomes. For example, prior to clearing, any opportunities to reduce the relative quality of habitats in a discrete clearing footprint whilst simultaneously enhancing the values of nearby habitats which may act as a sink for dispersing animals, should be realised. Such management may include gradually reducing the availability of surface water in the clearing footprint whilst simultaneously providing more of this resource in areas of (nearby) alternative habitat. The management of cattle (i.e. stocking rates) may also be considered for this purpose. Vegetation clearing within the clearing footprint should be undertaken sequentially, in a manner that encourages animals to disperse towards adjacent habitats that will remain intact. To facilitate this further, corridors between proposed clearing areas and habitats that will be managed for biodiversity should be maintained and enhanced, or where they do not occur, should be provided through targeted revegetation actions. The actual implementation of this recommended approach will need to be underpinned by onsite research, with its efficacy to be monitored and adaptively managed such that the overall objective of not-net-loss of regional biodiversity values is achieved
- The extent of vegetation clearing is to be restricted to the minimal amount necessary for the development of each applicable operational component of the Mine
- The extent of vegetation clearing is to be clearly identified on construction plans and in the field. Areas that must not be cleared or damaged are to also be clearly identified on construction plans and in the field. Clearing extents are to be communicated to all necessary construction supervisors
- Pre-clearance surveys will be undertaken in areas identified as potential habitat for threatened species, prior to commencement of clearing. In areas where these surveys indicate the presence of habitat features observed to (or with the potential to) provide habitat for these species, a fauna-spotter catcher will be engaged to accompany clearing crews. Habitat features identified during

the pre-clearance survey will be thoroughly checked by fauna spotter-catcher prior to clearing. Provision for the relocation of fauna will be made prior to the commencement of clearing

- Unavoidable (staged) loss of vegetation and the fauna habitat it provides will be offset in accordance with Commonwealth and Queensland policies, with the objective of maintaining, and where possible, enhancing the local biodiversity values identified in this baseline report such that local biodiversity values are not irreversibly affected in the long term. Identification of offsets should seek to realise opportunities to enhance local and regional biodiversity values, for example, through the procurement and management of areas that contribute to corridors in the region. Furthermore, these areas should be identified and managed with a view to achieving a 'no net loss' of local biodiversity values, in consideration of the types of vegetation that will be cleared and the conservation status of fauna species they provide habitat for. The management of these areas will seek to improve the quality and function of habitats, through identification and management of the threatening process with the potential to adversely affect fauna in these habitats, and should be undertaken in accordance with the Project's overarching ecological management framework, to be embedded in the Project Environmental Management Plan. This framework will detail how land not subject to direct impacts (i.e. vegetation clearing) including offset areas will be managed (including details relating to land use (cattle grazing), vegetation management, rehabilitation, weed and pest animal management, fencing and fire management), as well as what targeted research and monitoring is required to inform this management, such that the terrestrial ecological values of these areas are maintained, and where possible, enhanced. This strategy will make reference to the relevant environmental management actions outlined in the Project Environmental Management Plan
- As soon as possible after disturbed areas (cleared areas, open cut pits, out of pit waste dumps etc.) are no longer required, rehabilitation should commence. This is to include, but not be limited to, measures including the reinstatement of soil profiles, including topsoil, and revegetation using flora species of local provenance that are suitable for the reinstated soil and geomorphology. Management of previously disturbed land will occur in accordance with the Project Rehabilitation Management Plan. This plan will detail how disturbed land will be managed and rehabilitated, including (but not limited to) details about seed collection, flora regeneration, landscape architecture (i.e. topography), monitoring and adaptive management of rehabilitated areas. The objective of land rehabilitation should be to return disturbed areas to a vegetated state as quickly as possible after disturbance has ceased. In addition to monitoring and adaptive management of rehabilitated areas, opportunities for targeted rehabilitation activities that seek to enhance local biodiversity values should be identified and realised. These may include providing vegetated linkages across rehabilitation areas to larger areas of remnant vegetation, and provision of habitat resources within rehabilitated areas for local fauna species

5.4.2.3 Loss Habitat for Listed Fauna

Potential Impacts

The operation of the Project (Mine) has the potential to result in the loss of habitat for the following EPBC Act listed fauna species.

- Black-throated finch

Unavoidable vegetation clearing and resultant habitat loss (pre-management and mitigation) is considered to constitute a significant impact on the black-throated finch (southern), as a result of the (staged) loss of 9,862 ha of potential habitat within identified 'important areas' for the subspecies within the mining footprint.

- Squatter pigeon

The proposed mining footprint to be cleared over the life of Mine operations incorporates 12,391 ha of the 29,716 ha of identified as potential habitat for the squatter pigeon (southern). Based on the availability of similarly suitable habitat in the landscape surrounding the Study Area including grazing land characterised by open grassy woodlands, and the stable nature of the subspecies' population at present, it is not considered that the Study Area represents habitat critical to the survival of the (sub)species. Whilst local habitat availability will be reduced through staged mining operations, this loss is not considered to constitute a significant impact to an EPBC Act listed vulnerable species.

- Koala

The proposed mining footprint to be cleared over the life of Mine operations incorporates 10,609 ha of the 21,801 ha of identified as potential habitat for the koala (based on field verified REs). Based on the low estimated density of koalas within the Brigalow Belt and the availability of similarly suitable habitat in the landscape surrounding the Study Area, it is not considered that the Study Area represents habitat critical to the survival of the species. Whilst local habitat availability will be reduced through staged mining operations, this loss is not considered to constitute a significant impact to an EPBC Act listed vulnerable species.

- Yakka Skink

The mining footprint that is proposed to be cleared over the life of Mine operations incorporates 12,282 ha of the 27,027 ha of identified potential habitat for the yakka skink (based on field verified REs). Based on the fact that the species was not detected at the Study Area despite targeted surveys, and that similarly suitable habitat for the species is present in the landscape surrounding the Study Area, it is not considered that the Study Area represents habitat critical to the survival of the species for the yakka skink. Whilst local habitat availability will be reduced through staged mining operations, this loss is not considered to constitute a significant impact to an EPBC Act listed vulnerable species.

- Ornamental Snake

The mining footprint that is proposed to be cleared over the life of Mine operations incorporates 1,368 ha of the 2,540 ha of identified potential habitat for the ornamental snake (based on field verified REs). Based on the fact that the species was not detected at the Study Area despite targeted surveys, and that similarly suitable habitat for the species is present in the landscape surrounding the Study Area, it is not considered that the Study Area represents habitat critical to the survival of the species for the ornamental snake. Whilst local habitat availability will be reduced through staged mining operations, this loss is not considered to constitute a significant impact to an EPBC Act listed vulnerable species.

- Red goshawk, Australian painted snipe

The regional extent of potentially suitable habitat for red goshawk, Australian painted snipe, that may occur at the Study Area based on the presence of suitable habitat and known distribution, will be

reduced. Potentially suitable habitat for these species will still be present at the Study Area during the Mine's operation phase, and occurs in the surrounding landscape.

- Migratory birds

Land clearing for the Project's operation phase will reduce the local availability of habitat resources for the three EPBC Act listed migratory birds confirmed present at the Study Area, as follows.

  - Rainbow bee-eater – progressive loss of approximately 19,917 ha of potential habitat
  - Eastern great egret – progressive loss of approximately 34 ha of potential habitat
  - Satin flycatcher – progressive loss of approximately 17 ha of potential habitat

The eastern great egret, rainbow bee-eater and satin flycatcher are widely distributed species. Habitat at the Study Area is likely to be used on a temporary to permanent basis by these species. As these species are widespread, and suitable habitat is likely to occur over much of the surrounding landscape, habitat at the Study Area for the eastern great egret, rainbow bee-eater and satin flycatcher is not considered to constitute 'important habitat' as defined in the Significant Impact Guidelines (DEWHA, 2009c).

Eleven EPBC Act listed migratory birds that were not recorded at the Study Area but are considered likely to occur, as determined through the likelihood of occurrence assessment, are similarly widespread and abundant, with suitable habitat widely available in the landscape in which the Study Area occurs. The localised (staged) loss of potentially suitable habitat is not considered to constitute a significant impact to these species.

  - Common sandpiper – progressive loss of approximately 17 ha of potential habitat
  - Fork-tailed swift – progressive disturbance to approximately 19,917 ha of potential habitat – this species is predominantly aerial and thus habitat disturbance relates to overfly foraging habitat
  - Curlew sandpiper – progressive loss of approximately 17 ha of potential habitat
  - Latham's snipe – progressive loss of approximately 34 ha of potential habitat
  - White-bellied sea-eagle – progressive loss of approximately 34 ha of potential habitat
  - White-throated needletail (likely to occur at Study Area) – progressive disturbance to approximately 19,917 ha of potential habitat – this species is predominantly aerial and thus habitat disturbance relates to overfly foraging habitat
  - Caspian tern – progressive loss of approximately 17 ha of potential habitat
  - Black-tailed godwit – progressive loss of approximately 17 ha of potential habitat
  - Glossy ibis – progressive loss of approximately 17 ha of potential habitat
  - Common greenshank – progressive loss of approximately 17 ha of potential habitat
  - Marsh sandpiper – progressive loss of approximately 17 ha of potential habitat

The eleven migratory species that were not recorded at the Study Area but are considered likely to occur are similarly widespread and abundant, with suitable habitat widely available in the landscape in which the Study Area occurs. The localised (staged) loss of potentially suitable habitat is not considered to constitute a significant impact to these species.

- NC Act Listed Fauna

The operation of the Project (Mine) has the potential to result in the loss of the following habitat for NC Act listed fauna species confirmed present at the Study Area.

- Little pied-bat – progressive loss of approximately 12,562 ha of potential habitat
- Black-necked stork – progressive loss of approximately 45 ha of potential habitat
- Cotton pygmy-goose – progressive loss of approximately 45 ha of potential habitat
- Echidna – progressive loss of approximately 12,586 ha of potential habitat

The operation of the Project (Mine) has the potential to result in the loss of the following habitat for NC Act listed fauna species likely to occur at the Study Area, as determined through the likelihood of occurrence assessment.

- Square-tailed kite (likely to occur at Study Area) – progressive loss of approximately 10,609 ha of potential habitat
- Black-chinned honeyeater (likely to occur at Study Area) – progressive loss of approximately 10,609 ha of potential habitat

Management and Mitigation

It is proposed that additional field studies be undertaken to determine the presence of individuals, populations/colonies and/or important habitat areas for threatened species, including those species that are considered likely to occur at the Study Area that were not detected during baseline field surveys for the EIS (i.e. yakka skink, ornamental snake). Specific details of such studies regarding the black-throated finch (southern) are presented below. With respect to managing impacts in discrete clearing footprints during staged mining operations, targeted studies will be undertaken no more than one year prior to clearing, such that the management approaches are based upon information that is current.

The findings of such studies will be incorporated into Species Specific Management Plans for these animals (black-throated finch (southern), squatter pigeon (southern), koala, brigalow reptiles), and the outcomes will be directly linked to the overarching ecological management framework for the Project imbedded within the Project Environmental Management Plan, as well as the Project Offsets Strategy and the Project Rehabilitation Plan.

The Project Offset Strategy will address the unavoidable loss of habitat for conservation significant fauna resultant from Mine operations. This strategy will provide a framework for the identification of measures designed to maintain regional biodiversity values, where onsite impacts cannot be avoided. Such measures will include the identification and procurement of offsite land to be managed for conservation purposes, and investment in ecological research in the landscape in which the Study Area occurs.

Black-throated Finch (Southern)

Loss of habitat for the black-throated finch (southern) will occur in stages, in accordance with the staged development of the operational components of the Mine. Management actions will seek to maintain and where possible enhance habitats in unmined parts of the Study Area, as well as in offset areas, to encourage dispersal away from areas that will be cleared for staged mine operations. Offsets for black-throated finch (southern) habitat will be provided and an offsets strategy has been prepared that identifies suitable offsets on the Moray Downs property adjacent to the Study Area.

It is expected that, with active management of habitats, including removal of threatening processes and complementary habitat enhancement, the subspecies will disperse away from the developed parts of the Study Area, either to suitable habitat within other parts of the Study Area, or to potentially suitable habitat in the landscape to the north, west and south of the Study Area (see Figure 5-14), including areas procured and managed as offsets.

Further studies (discussed below) will be required prior to clearing to inform the identification and management of habitats that will be managed and conserved, such that the potential for successful dispersal is maximised. This dispersal to, and subsequent persistence at adjacent habitat areas will require targeted monitoring, such that the efficacy of the management of these areas, including their capacity to support and maintain displaced populations of animals including black-throated finches (southern) can be established.

Given uncertainties relating to the distribution, abundance and actual on-ground habitat characteristics of vegetation identified as potential habitat in the landscape surrounding the Study Area, targeted, long-term monitoring will be required to determine the efficacy of management actions in onsite and offsite (offset) areas. This will include research into population dynamics of black-throated finch (southern) in these habitats and the surrounding local landscape. Adaptive management will be applied to these managed habitats (onsite and at offset sites), with the results of monitoring studies incorporated into the measures implemented in these areas. Should this monitoring indicate that habitats being managed for local biodiversity are not be achieving desired outcomes (i.e. not providing habitat for displaced animals from the mine), additional actions will be undertaken to enhance offset habitat with a view to minimising long-term impacts to local fauna populations.

Onsite enhancement of the areas that currently do not provide suitable habitat for the black-throated finch (southern), such as the corridor adjacent to the northern bank of the Carmichael River may compensate for some of the habitat loss, and facilitate east-west dispersal of the subspecies. The provision of surface water in the eastern part of the Study Area (water management dams) may provide additional localised access to drinking water for the subspecies.

Management and monitoring of impacts to the black-throated finch (southern) will seek to contribute to the recovery of the subspecies, as per the objectives of the *National Recovery Plan for the Black-throated Finch Southern Subspecies* (Black-throated Finch Recovery Team, 2007). The onsite and offsite (offset areas) habitat management and complementary research program to be implemented will be informed by the *National Recovery Plan for the Black-throated Finch Southern Subspecies* (Black-throated Finch Recovery Team, 2007), and developed in consultation with relevant stakeholders (i.e. Black-throated Finch Recovery Team, Commonwealth and State governments, natural resource management groups, landholders etc.). Examples of recovery actions, documented in the *National Recovery Plan for the Black-throated Finch Southern Subspecies* (Black-throated Finch Recovery Team, 2007), to be incorporated into the Species Specific Management Plan (on and offsite (offset areas)) for the subspecies, may include:

- Investigate breeding requirements and threats to key breeding areas (Action 1.1)
- Investigate feeding and other habitat requirements (Action 1.2)
- Undertake targeted surveys (to identify habitat) (Action 2.4)
- Secure selected sites for conservation (Action 3.1)

- Address threats on grazing lands (Action 3.2)
- Monitor management effectiveness (Action 3.3)
- Determine suitability of birds in captivity for a reintroduction project (Action 4.1)

To inform the development of the black-throated finch (southern) Species Specific Management Plan, and contribute to the detailed design and implementation of management and mitigation measures (including management of offset areas) recommended here, it is proposed that the following be undertaken, such that the habitat values for the subspecies are maintained, and where possible enhanced, in the local landscape; and the management of areas for biodiversity onsite (in the Study Area) and offsite (in offset areas) contributes to the recovery actions for the black-throated finch (southern).

- Development and implement a long term monitoring program to gain a better understanding of the population size, seasonal movements and key habitat areas used by the black-throated finch (southern). The monitoring program and surveys will be developed and conducted by a combination of on-site environmental officers, consultants and research organisations. Monitoring should include surveys and data from surrounding properties and landscapes, and detailed information on water sources, vegetation composition and seasonal variation in habitat use. This can then refine the habitat mapping and models using more sophisticated and detailed spatial analysis methods. Such mapping would help refine the proposed Project Offset Strategy to ensure the best possible habitat is protected and maintained for the species
- Conduct further survey to identify whether there are breeding sites within the Study Area and broader landscape, as these will be the most important components of the black-throated-finch (southern) biology that will result in the persistence and conservation of the subspecies in any proposed onsite and offsite (offset) areas to be managed for biodiversity. Whilst no nests have been found to date it is considered likely that nesting occurs in the Study Area; these may consist of small pockets of suitable ephemeral wet season habitat such as sandy drainage lines and/or *Eucalyptus camaldulensis* / *Melaleuca* spp. complexes found embedded within REs 10.5.5, 10.3.6 and 10.5.1. If and where breeding sites are recorded from within proposed clearing footprints during surveys prior to the staged clearing of discrete parts of the Study Area, information obtained during studies on the breeding biology of the subspecies in the local landscape will be reviewed to inform when clearing should occur. Clearing should be undertaken as soon as possible after the completion of black-throated finch (southern) breeding (i.e. chick fledging), thus maximising the time between the commencement of clearing and the next breeding season (during which time birds would have dispersed away from the clearing footprint)
- Determine the context of the Study Area habitat and population within the broader landscape and regional population through survey and habitat assessments as per the Significant Impact Guidelines for the black-throated finch (southern). It is expected that the population is larger than currently identified and spread across the surrounding landscape to the north, west and south. A strategic assessment, i.e. Bioregional Plan, and/or a conservation plan for the Galilee Basin region would help achieve this, and though this is a responsibility for SEWPAC, such an exercise could be facilitated by Adani and other groups with adjacent mineral interests in the Galilee Basin

Furthermore, with specific regard to providing offsets for the loss of black-throated finch (southern) habitat, the following should be considered:

- The Project Offset Strategy will be based on securing “like for like” habitat. The Project Offset Strategy will include enhancement of habitat, and mitigation of any habitat loss via the careful conservation management of offset areas (i.e. reduced or no grazing, control of exotic pasture grass species, control of feral predators such as cats and foxes via innovative means such as reduced dingo control, raised watering troughs). This would be integrated with proposed research programs, where the most effective means to rehabilitate or enhance black-throated finch (southern) habitat are tested and used in on-going management
- The Project Offset Strategy will integrate at a landscape scale and form part of a network of landscape linkages across the eastern Desert Uplands region and to other known locations for black-throated finch (southern) populations and habitat. Project offsets will be of secure conservation land tenure, and will include programs for long term management and monitoring. Innovative options should be considered such as possible management partnerships of offset land through public and/or private partnership arrangements with well-established conservation organisations such as BirdLife Australia, Australian Wildlife Conservancy or Bush Heritage

Squatter Pigeon (Southern)

Conservation and survival of the squatter pigeon (southern) is identified as requiring a focus on maintenance and restoration of habitat and reducing predator related mortality (SEWPAC, 2011i). For the Project, the management of impacts to the subspecies will focus on maintenance and management of habitat for the species locally and regionally through the overarching ecological management strategy, inclusive of management of avoidable operation phase impacts, management of habitats onsite, procurement and management of offsets, and implementation of relevant measures detailed in the Project Environmental Management Plan.

In addition to the measures outlined above, species specific mitigation and management measures may include:

- Management of water sources created as part of the operation of the Project (water management dams) that may be suitable source of drinking water for the subspecies. If created water sources are not considered suitable for use by the species, compensatory water resources will be provided in nearby parts of the Study Area
- Monitoring of changes to the habitat values of the Carmichael River corridor to allow for adaptive management (i.e. enhancement, weed management) to maintain the function that the corridor provides for species dispersal and habitat resources
- Monitoring of fox and cat populations in the Study Area and implementation of an eradication program if necessary (applicable to all ground-dwelling fauna including black-throated finch (southern))

Koala

Habitat loss is considered a major impact to the koala (SEWPAC, 2012b). The Study Area occurs within Koala District C of the Queensland Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006—2016 EPA, 2006)). Little research has been conducted in this area and there is a lack of data relating to koala populations, habitats and the impacts of development (EPA, 2006). The management of impacts to the koala and loss of habitat as a result of Mine operations will seek to enhance species knowledge and conservation initiatives as per the National Koala Conservation and Management Strategy 2009-2014 (NRMMC, 2009) and future recovery plans for

the koala. Mitigation strategies will be guided by actions detailed within the National Koala Conservation and Management Strategy 2009-2014 and will focus on developing and implementing an onsite and offsite habitat management and research program in collaboration with relevant stakeholders (i.e. Commonwealth and State governments, natural resource management groups, landholders etc.). Species specific management and research items to be included in the Project Species Specific Management Plan (on and offsite) for the koala (under the overarching ecological management framework may include:

- Onsite and offsite research of koala populations, densities and habitats as this is a relatively unknown area for this species. Data gathered will be incorporated into the Commonwealth and State database of koala population distribution, density and habitat mapping data
- Development and implementation of ongoing monitoring programs of koala populations and habitats encompassing the Study Area and surrounding region, to research impacts of development on low density populations
- Onsite and offsite (offset areas) management of koala habitat in areas of preferred habitat types including ironbark-box grassy woodlands and fringing riparian vegetation communities. The aim is to improve the condition of habitats within and surrounding the Study Area, reduce fragmentation, and encourage connectivity and dispersal
- Monitoring of pest dog populations in the Study Area and implementation of a control program if necessary

Yakka Skink

Key threats for the yakka skink include habitat loss and degradation, and predation and destruction of habitat by feral species (in particular cats and foxes) (SEWPAC, 2011b). Additional field studies will be required to determine the presence of individuals and/or populations/colonies as the species was not detected during surveys, but is considered likely to occur. In the event the species is detected, a Species Specific Management Plan will be developed to manage impacts of the Project. The findings of the additional studies would inform the management approaches detailed in the Species Specific Management Plan, however, measures will focus on maintaining or enhancing suitable habitats (i.e. in offset areas) and managing the prevalence of predators in the area. Species specific mitigation and management measures may include:

- Establishment of microhabitat features preferred by the species (e.g. rock piles, logs) in actively managed onsite and offsite (offset) areas that have suitable core habitat features to enhance the values of existing potential habitat
- Identification of the locations of suitable microhabitats existing in actively managed onsite and offsite (offset) areas for the purposes of maintaining the habitat values for the species
- Monitoring of fox and cat populations in the Study Area and implementation of a control program if necessary
- Engaging a fauna spotter/catcher to check areas of suitable habitat identified through pre-clearance surveys immediately prior to ground disturbance. In the event individuals/colonies are detected, they will be relocated to suitable habitat in offset areas

Ornamental Snake

Factors that are considered likely to contribute to the decline of ornamental snake populations include habitat loss as a result of clearing, habitat degradation as a result of grazing and fragmentation, alteration of landscape hydrology associated with gilgai environments, alteration of water quality, predation by feral species and contact with cane toads (SEWPAC, 2011d). Additional targeted field studies will be required to determine the presence of individuals and/or populations/colonies as the species was not detected during EIS surveys. If detected, a Species Specific Management Plan will be developed to manage potential impacts. The findings of the studies will inform the management approaches in the Species Specific Management Plan, however, similar to the yakka skink, measures will focus of maintaining or enhancing suitable habitats and managing the prevalence of predators in the local area, namely within offset areas. Species specific mitigation and management measures may include:

- Identification of the locations of suitable microhabitats existing in in actively managed onsite and offsite (offset) areas for the purposes of maintaining the habitat values for the species throughout operation of the mine and providing potential areas for relocation, if individuals are found during pre-disturbance checks of mined areas
- Implementation of a sediment and erosion controls during operation of the mine
- Engaging a fauna spotter/catcher to check areas of suitable habitat identified through pre-clearance surveys immediately prior to ground disturbance. In the event individuals/colonies are detected, they will be relocated to suitable habitat in offset areas
- Monitoring of feral species populations in the Study Area and implementation of a control program if necessary
- Monitoring of gilgai areas within the Study Area and changes that may occur as a result of hydrological changes
- Implementation of a water quality monitoring program to assist in guiding erosion and sediment control during the operation of the mine

Migratory Birds and NC Act Listed Black-necked Stork and Cotton Pygmy-goose

For this Project, the management of impacts to the species will focus on maintenance and management of habitat for the species locally and regionally through the overarching ecological management strategy. Measures relating to management of impacts to migratory and other protected bird species include:

- Management of the water supply and raw water dams created during the operation of the mine such that migratory birds can utilise these habitats. If required, compensatory water resources will be provided in nearby parts of the Study Area
- Weed and pest animal monitoring and management within the Study Area
- Monitoring of species populations during breeding months to gain an understanding of the species' use of the area on a local scale. Further mitigation and management measures can be developed if important breeding activities are recorded

Little Pied Bat and Echidna

The overarching ecological management strategy will provide opportunity for enhancement of suitable habitats for these species. Specific to the little pied bat, monitoring and management of the

Carmichael River corridor will allow for adaptive management of the corridor that provides resources and facilitates dispersal of the species. Management will also include maintenance and enhancement of mature woodland areas occurring in actively managed onsite and offsite (offset) areas in order to provide ongoing habitat suitability.

5.4.2.4 Terrestrial Fauna Mortality

Potential Impacts

Vegetation clearing may result in the direct mortality of fauna. The scale of operational impacts as compared with those likely to occur during the construction phase is relatively greater, given the extent of the activities that will occur during the operation phase.

Vehicles and machinery used to undertake land clearing have the potential to lead to direct mortality of fauna in the event that individuals are struck. Those animals that are unable to disperse away from areas under active clearing are also susceptible to injury or death. This includes amphibians, reptiles, small ground-dwelling mammals, arboreal mammals and nocturnal species that are inactive during daylight hours. Other potential causes of mortality include animals becoming trapped in excavations, and carrion eaters (some raptors) being struck when feeding on road kill.

Mortality from haul trucks is likely to be minimal as these will be operating in open cut areas where animals are unlikely to be present. Coal is to be transported to the central MIA via a network of conveyors.

Fauna mortality will result in a local reduction in the abundance of some less mobile species. The habitat types that will be affected by operation phase activities, including those that will be cleared, support an array of common, widespread species, as well as potentially providing resources for a small number of conservation significant species. Given the landscape context in which the Project occurs, and in particular, the availability of similar habitat types in the local region, this loss is not considered likely to adversely affect the biodiversity values of this landscape. The management and mitigation measures outlined below will seek to reduce fauna mortality to the greatest extent possible. Furthermore, the management and mitigation measures proposed to address habitat loss, including management of habitats onsite and offsite for local biodiversity, will seek to alleviate potential impacts to animals dispersing away from clearing areas. In particular, enhancement of these areas (through identification and removal of threatening processes and provision of habitat resources) will seek to improve the quality and function of these habitats, such that they can act as a temporary or permanent sink for animals displaced from cleared areas.

Management and Mitigation

Management and mitigation measures to reduce the potential for fauna mortality as a result of operation phase activities include:

- Vegetation clearing for discrete phases of the Project operations should be undertaken in a manner that maximises the potential for fauna to disperse away from habitats within the clearing footprint, to adjacent areas, including onsite and offsite (offset) areas that are being actively managed for biodiversity outcomes. For example, prior to clearing, any opportunities to reduce the relative quality of habitats in a discrete clearing footprint whilst simultaneously enhancing the values of nearby habitats which may act as a sink for dispersing animals, should be realised. Such management may include gradually reducing the availability of surface water in the clearing footprint whilst simultaneously providing more of this resource in other areas. The management

of cattle (i.e. stocking rates) may also be considered for this purpose. Vegetation clearing within the clearing footprint should be undertaken sequentially, in a manner that encourages animals to disperse towards adjacent habitats that will remain intact. To facilitate this further, corridors between proposed clearing areas and habitats that will be managed for biodiversity should be maintained and enhanced, or where they do not occur, should be provided through targeted revegetation actions. The actual implementation of this recommended approach will need to be underpinned by onsite research, with its efficacy to be monitored and adaptively managed such that the overall objective of not-net-loss of regional biodiversity values is achieved

- Pre-clearance surveys will be undertaken in areas identified as potential habitat for threatened species, prior to commencement of clearing. In areas where these surveys indicate the presence of habitat features observed to (or with the potential to) provide habitat for these species, a fauna-spotter catcher will be engaged to accompany clearing crews. Pre-demarcated habitat features identified during the pre-clearance survey will be thoroughly checked by fauna spotter-catcher prior to clearing. Provision for the relocation of fauna will be made prior to the commencement of clearing
- Procedures in the event that an animal is injured will be developed. Given the distance to the nearest veterinary practitioner, this will most likely involve euthanasia. Adani will engage a suitably-qualified and licensed practitioner to be present on site to assess, and where necessary, euthanize injured animals
- Vehicles will be required to stay on pre-determined routes and not travel off-road
- All vehicles and plant will adhere to site rules relating to speed limits. Speed limits will be clearly signposted so as to minimise the potential for road kill. It is recommended that speed limits be set at 60 km/h during daylight hours, and 40 km/h at night
- Any road kill will be dragged to the edge of the road immediately and subsequently removed as quickly as practicable to reduce potential for scavengers to be struck
- Where practical, temporary fencing will be erected around excavations to exclude mobile animals from vegetation clearing areas
- Work areas will be checked for fauna that may have become trapped before work commences each day
- In instances where an animal/animals have entered active construction areas, the site environmental manager will be immediately informed. An assessment of whether the animal is at risk of harm and/or poses a threat to construction personnel will be made by the environmental manager (or their delegate). Where possible, the animal will be encouraged to disperse out of/away from the construction area. Where the animal is not able to disperse away, a professional fauna spotter-catcher will be engaged
- If any pits/trenches are to remain open after daily site works have been completed, they will be securely covered by an impenetrable barrier, if possible, or fauna ramps (e.g. log ramps or wooden planks) will be put in place to provide a potential means of escape for trapped fauna
- Site inductions are to include education regarding the local fauna of the site and protocols to be undertaken if fauna are encountered

5.4.2.5 Habitat Fragmentation

Potential Impacts

Given the approximately north-south orientation of the mine, and the length of the proposed footprint (approximately 45 km), the proposed mining activity has the potential to disrupt east-west flora and fauna movement in the landscape.

Large tracts of non-remnant vegetation occur over much of the central part of the Study Area between the Carmichael River and the Moray-Carmichael Road, and much of the eastern part of the Study Area (where the MIA, offsite infrastructure, some out of pit waste dumps and some water management dams are to be located). This cleared land extends beyond the Study Area – much of the landscape to the east of the Study Area is cleared land, featuring non-remnant vegetation. As such, the potential for east-west dispersal across the landscape through much of the central part of the Study Area, notwithstanding the narrow strip along the Carmichael River, is limited by the presence of large tracts of non-remnant land within and to the east of the Study Area.

A north east-to-west corridor, associated with connected tracts of remnant vegetation within and to the north east and west of the Study Area may be fragmented by staged mining operations at the northern part of the Study Area. Similarly, proposed mining operations in the southern part of the Study Area will disrupt a belt of remnant vegetation that extends from west of the Study Area, through the Study Area (at the Bygana West Nature Refuge) to the east towards the floodplain of the Belyando River.

Staged mining will also disrupt north-south movement through the Study Area. Remnant vegetation coverage is extensive in the landscape to the west, north west and south west of the Study Area, and so, north-south habitat fragmentation resultant from Mine operations will be less disruptive to landscape scale flora and fauna movement, as compared with east-west movement.

The barrier that will be created by operation activities associated with the mine has the potential to limit the ability of flora and fauna to disperse across the landscape. This is particularly applicable to habitats at the north and south of the Study Area, that retain some degree of connectivity to larger tracts of vegetation to the east and west in the adjacent landscape, as well as the narrow east-west strip of vegetation associated with the Carmichael River. Opportunities to alleviate the fragmentation caused by the mine will be realised through targeted onsite habitat management and the identification, procurement and management of offsite (offset) areas. The identification and management of these areas will seek to maintain and enhance local biodiversity values and will consider the function of these areas in the local landscape including how they contribute to connectivity.

Management and Mitigation

Management and mitigation measures to reduce the impact of habitat fragmentation to local fauna populations include:

- The ecological values within the buffer area surrounding the Carmichael River are to be enhanced through a revegetation and active vegetation and habitat management program. The program should focus on providing habitat for key threatened species, and on providing east-west connectivity. A monitoring program should be implemented to monitor success of the revegetation and enhancement program as well as presence and utilisation by fauna, including

threatened fauna. Results of monitoring of the revegetation program may be relevant to rehabilitation and also management of offset areas on adjacent properties

- Management of land within the Study Area (in consideration of the Project's staged operations, and including areas that are not within the mine footprint, unmined areas that will be mined at a later stage of operations, areas above the underground mine and rehabilitated areas) will be undertaken so as to maximise opportunities for localised flora and fauna dispersal in the Study Area. This will include the management and enhancement of existing areas that provide connectivity (where these do not occur within the mine footprint) within and beyond the Study Area, as well as the creation of corridors between habitats where this is possible
- The identification of offsets should take into consideration how these areas will contribute to landscape scale habitat function (including east-west connectivity). Given that east-west connectivity is likely to be disrupted at the north and south of the Study Area, the strategic procurement and subsequent management of offsets in the landscape adjacent to these parts of the Study Area may alleviate the barrier effect caused by mining operations. This will be achieved through managing and where possible enhancing these areas such that they provide a conduit for fauna movement 'around' the northern and southern parts of the Study Area, thereby allowing for east-west movement in the localities to be maintained. Whilst the connectivity between habitats adjacent to the northern and southern parts of the mine will be more circuitous (less direct) than it is currently, enhancement of habitats (such as provision of habitat resources, management of/removal of threatening processes) in strategically procured offset in these areas should contribute to the maintenance of east-west movement in these specific localities
- Where fencing is required around cleared areas or along the mine boundary, it will be designed to provide access to fauna around and/ or through the fencing, except where fenced areas seek to protect fauna from threats such as actively mined areas. Barbed wire will not be used on the top strand of wire fences unless necessary for security or to control cattle
- Post-disturbance rehabilitation should seek to identify and create conduits for movement within and beyond the Study Area. These corridors should link to existing areas that are likely to facilitate flora and fauna dispersal in the landscape

5.4.2.6 Terrestrial Habitat Degradation

Potential Impacts

The staged clearing of native vegetation throughout the Mine's operational life may result in the degradation of adjacent and downstream habitats. The potential impacts of habitat degradation, with respect to the Project's construction phase, are discussed in Section 5.3.2.Given the larger extent of land to be cleared as a result of mining operations, the spatial extent of potential degradation is relatively larger.

Edge effects may occur where remnant vegetation is exposed to a distinct ecotone associated with areas under active mining operations (or early stages of rehabilitation post-mining). Such effects may include increased exposure to noise, light, dust, wind, weeds and introduced animals. Exposure to any or some of these effects may alter habitat composition (i.e. reduced flora diversity and simplified flora structure) and quality (i.e. reduced availability of forage resources, increased exposure to predators) at the ecotone, thereby potentially changing species diversity in the altered habitat. Where

edge effects degrade or simplify habitat at the edge, it is possible the species diversity and habitat utilisation in this edge habitat will be reduced.

Earthworks will result in dust emissions. Excessive dust settling on vegetation could also suppress vegetation growth by limiting the photosynthesis potential of plants in close proximity to the construction area (Nanos and Ilias, 2007). Plants with dust on leaves may also be less palatable as a food source for animals. Dust deposition associated with earthworks activities will generally occur relatively close to areas of disturbance and hence, plants within 50 m – 100 m of construction activities may be affected by dust. As construction activities are temporary, effects will be short lived, and rainfall will generally remove dust from plants. Dust suppression will be used to control dust and this will reduce the extent of vegetation affected by dust. Dust emissions from vehicles and plant travelling on unsealed roads will have localised impacts on vegetation and water bodies near these transport routes. Dust suppression will be used to control dust on these roads.

Following extraction, coal will be processed and stockpiled in preparation for transport to port. Dust deposition may affect the physiology of plants as a result of increasing leaf temperatures and reducing photosynthesis (referenced in Chaston and Doley, 2006). Coal dust and overburden dust were found to affect plant functioning (leaf temperature) in an experimental situation where high dust loads were applied (Chaston and Doley, 2006). The experiment also indicated that the type of dust is related to impacts on leaf function, with fine dusts having impacts at much lower loads than dusts associated with mining activities where high dust loads are needed to cause an impact (Chaston and Doley, 2006). The authors concluded that dusts associated with mining activities will potentially impact plant physiology in instances where high dust loads may be deposited – typically within the immediate vicinity of the dust source (i.e. coal stockpile, overburden stockpile) (Chaston and Doley, 2006).

Impacts to flora from coal dust may occur where vegetation is growing immediately adjacent to stockpiles. Long term exposure to coal dust may result in changes to vegetation communities immediately adjacent to coal stockpiles, which may in turn alter habitat type and quality for fauna

Impacts to habitats adjacent to and downstream of clearing areas will be managed such that habitat degradation is limited in its extent and magnitude. This will largely be undertaken in accordance with management and monitoring protocols established in the Project Environmental Management Plan.

Management and Mitigation

The management and mitigation measures described for habitat degradation due to land clearing in the construction phase of the Project (i.e. construction of the MIA, airport and workers accommodation village) are largely applicable to land clearing and resultant habitat loss in the operation phase of the Project (refer to Section 5.3.2), and include:

- Management of erosion and sedimentation in and adjacent to cleared areas will be undertaken in accordance with protocols outlined in the Project Environmental Management Plan. This plan will include practices to be implemented prior to, during, and post-construction to minimise the potential for erosion to occur, including (but not limited to) timing of land clearing activities, sediment and erosion control measures to be implemented, performance criteria and corrective actions. Monitoring and reporting protocols will be detailed within this plan, and responsible parties for implementing the plan's actions should be identified

- Where land clearing occurs near or within ephemeral waterways, this will be primarily undertaken during low flow periods, to minimise the likelihood of erosion and sediment mobilisation during and after rainfall events
- A fundamental component of the management of onsite and offsite (offset) areas that are to be managed for biodiversity will relate to reducing exposure to, and minimising the impacts of habitat degradation including edge effects. This will be undertaken through implementation of weed and pest animal management, erosion management and dust management. These measures are included in the Project Environmental Management Plan. Further to this, consideration should be given to the creation of vegetated buffers around any critical habitat areas that are retained, where these areas occur directly adjacent to impact footprints. These buffers could comprise relatively fast growing trees of local provenance that could be strategically planted to provide a buffer between impact areas and managed habitat. Provisions for fauna movement through these buffers (i.e. from impact footprints, to adjacent habitat areas), would need to be factored into their design.

Further details relating to the management of erosion is presented in Volume 2 Chapter 4 Land. Further details relating to management of dust is presented in Volume 4 Appendix S Mine Air Quality Report.

5.4.2.7 Aquatic Habitat Degradation

Potential Impacts

Vegetation will be extensively cleared to facilitate the open cut mining pits and also to provide overburden disposal areas when required. The requirement for the clearing follows the progression of the coal extraction, that is, land will be cleared for the open cut pits and overburden storage areas when they become active throughout the life of the mining operation. Land will also be cleared to facilitate the offsite water infrastructure.

The mine operation area will remove 16,375 ha from the local river catchments, comprising 6,361 ha (29.9 per cent) from the Carmichael River catchment and 10,014 ha (12.9 per cent) from the Eight Mile Creek catchment . Surface runoff from these areas to creeks downstream of the disturbed areas may convey sediment and other contaminants, with consequent impacts on water quality and aquatic ecosystems.

As described in Section 5.3.2 land clearing will result in an increase in exposed earth surfaces and a reduction in vegetated buffer between the location of the activity and the watercourses not yet disturbed. These changes have the potential to change water quality of the aquatic ecosystems, subsequently degrading aquatic flora and fauna habitats. Works in creeks and drainage lines during clearing have the potential to disturb bed and bank substrates and lead to localised erosion and sediment transport to downstream habitats.

The potential impacts to aquatic ecosystems downstream of mine impact areas (dependant on stage in life of the mine) are consistent with those discussed in Section 5.3.2 though the extent of clearing is much greater. Sedimentation of water supplied downstream has the potential to degrade aquatic habitats in the downstream catchment as described in Section 5.3.2.

Acid mine drainage (AMD) can arise in coal seams where there is a high sulphur content. If this is the case, coal seams, when exposed to air and water can produce sulphuric acid (NSW Department of

Planning, 2005). Acidic runoff into a watercourse is likely to have adverse impacts to surface water quality and in turn aquatic habitat suitability. The potential for acid mine drainage and management measures proposed is discussed in Volume 2 Section 10 Waste.

Water treatment within the mining operation will consider the potential for AMD and will be designed such that discharge from the footprint of the mine and into any watercourses achieves the required WQO for the Project. WQO will be developed for the Study Area, including for all water to be released into the waterways of the area (refer to Volume 4, Appendix Q Mine Water Quality for further detail on WQO).

Management and Mitigation

The disturbance of land within the operation footprint is unavoidable. Protection of the aquatic ecosystems downstream of the Study Area is highly dependent on the management of the water quality of runoff and releases from the site.

The approach to managing water quality and runoff with respect to aquatic habitat is consistent with the construction phase measures, recognising the scale of the removal is much larger for operation. Runoff within the mine footprint will be managed via a number of management and engineering solutions including:

- Development and maintenance of clean water diversion drains to be established along the western boundary of the lease, and separating clean inflows from dirty water areas
- Management of clean water through sediment basins/traps prior to discharge
- Management of dirty water from operations through capture in sediment ponds for reuse
- Overflows of water from sediment ponds to nearest drainage line only to occur in accordance with environmental authority conditions (refer to Volume 4, Appendix Q Mine Water Quality Report)
- Sewage waste will be treated to A standard and recycled onsite/discharged.
- Contaminants that have the potential to cause environmental harm will not be released to the environment except under environmental authority permit conditions. Waters to be released to the environment must comply with the contaminant release limits which will be identified in a Receiving Environment Monitoring Program (refer to Volume 4, Appendix Q Mine Water Quality Report)
- Identifying and implementing enhancement opportunities in newly created aquatic habitats that may arise as a result of subsidence

As the mining operation, and hence habitat removal, will be staged, management and mitigation actions will correspond with activities of the time in order to protect areas not yet disturbed and the downstream catchment habitats. The Mine Environmental Management Plan (Volume 2, Section 13) will take into account the progression of the disturbance and identify areas to be managed in terms of erosion and sediment control and at what stage the required management must be applied. These measures focus on limiting sediment transport, risk of erosion and pollutants and are consistent with those identified in Section 5.3.2. There will also be the opportunity to incorporate lessons learnt and corrective actions into the Mine Environmental Management Plan (Volume 2, Section 13).

Aquatic ecosystem monitoring will be incorporated into the receiving environment monitoring program (REMP). The REMP will set out monitoring requirements, water quality targets, ecological indicators, corrective actions and reporting requirements. Further management and mitigation measures specific

to these aspects are detailed in Volume 4 Appendix P Mine Hydrology Report, Appendix R Mine Hydrogeology Report and Appendix Q Mine Water Quality Report.

5.4.3 Disturbance of Water Resources

5.4.3.1 Loss of Habitat for Aquatic Species

Potential Impacts

Aquatic habitat within the mining footprints that will be excavated or in-filled includes a minimum of 12 permanent farm dams, ephemeral watercourses (streams orders 1 and 2), drainage lines and gilgai areas). The mine plan incorporates a number of water management dams that will be created for water storage and collection and treatment of runoff from mining operational areas and these will potentially replace aquatic habitat loss from the farm dams (dependant on the habitat values that are established).

The majority of the watercourses within the footprint are ephemeral and many facilitate flow during heavy downpour or flooding events only, channelling runoff to the Carmichael River or Belyando River via Eight Mile Creek. Ephemeral habitat with intermittent base flow that is often reduced to unconnected waterholes is characteristic of the Burdekin Catchment (Negus *et al*., 2008); hence the habitat within the Study Area is considered characteristic and well represented on a regional scale. The removal of the habitat described at the site will reduce the availability of aquatic habitat on a local scale however; the loss of these habitats is not expected to have an impact to the aquatic biodiversity of the region as:

- The types of habitat are well represented within the Burdekin Catchment
- Much of the habitat is farm dams or ephemeral waterways that do not contribute to regional re-colonisation or connect permanent aquatic habitats
- Studies show that aquatic habitats in the study area support low to moderate diversity and do not support any aquatic species of conservation significance

The removal of the ephemeral watercourse reaches will be occur gradually throughout the entire mine operation (over 90 years). These watercourses are at the top of the Eight Mile Creek catchment or are 1st order streams draining to the Carmichael River and hence, diversion is not required.

Many of the farm dams, similar to Brigalow dam (discussed for removal during the construction phase), exhibit cattle and pig disturbance, have a silt and clay substrate with limited benthic microhabitat and have limited connectivity to watercourses that would facilitate aquatic species recruitment. Infilling or excavation of those dams will have a localised impact to native aquatic flora and fauna diversity and no impact on a regional scale. The water management dams to be (progressively) created during the mining operation have the potential to provide equivalent aquatic habitats provided that water quality is appropriately managed. These artificial water bodies have the potential to provide similar habitat values as the existing farm dams.

Overall, given the relatively low values of aquatic habitats to be destroyed, impacts on aquatic biodiversity are not expected. Loss of habitat will to some extent be offset during rehabilitation.

Along the Carmichael River, a 500 m wide strip of riparian vegetation on each bank will not be cleared. Impacts of groundwater drawdown have the potential reduce the complexity and/or extent of this zone; these are discussed in Section 5.4.4. An infrastructure corridor, including a spanned bridge

will be required in 2047 to facilitate mining operations on the south side of the river. The Carmichael River is the largest watercourse in the landscape and has more continual flow than other watercourses in the study area; this river provides the most connected aquatic habitat at the site. The crossing infrastructure will be designed such that no infrastructure will be placed in the bed of the Carmichael River. It is likely however that during construction vehicles may require access to the bed of the river; hence a temporary loss of habitat may result. Installation of the infrastructure across this watercourse will potentially result in a small loss of aquatic habitat, create a barrier to movement for native aquatic fauna species and/or alter hydrological flow. These effects will however be temporary during construction and unlikely to have any medium or long term effects.

Where temporary or permanent barriers to fish movement are proposed, there is the potential of a reduction in species abundance and distribution, localised extinction and a reduction in diversity. This restriction of access to habitat areas has the potential to reduce biodiversity of the Carmichael River within, upstream and downstream of the Study Area.

The expansion of existing dams on North and Obungeena Creeks and maintenance activities within pipeline easements may result in aquatic habitat fragmentation. However, these impacts are likely to be localised.

Management and Mitigation

The removal of the aquatic habitats of the farm dams and ephemeral, low stream order, watercourses within the mine operation footprints area is unavoidable. Although these habitats are not considered to be high value, many provide habitat for native aquatic species. In recognition of the staged approach to the mining it will be important to maintain the ecological values of watercourses in undisturbed states until scheduled for disturbance in order to limit indirect impacts to downstream habitats. Measures to manage undisturbed habitats include those already listed in Section 5.3.2.6 and are related to the management of erosion and runoff, wastes, clearing activities and the demarcation of sensitive and no-clear zones.

In addition to the management of indirect impacts to areas not planned for disturbance within the Study Area, rehabilitation of disturbed areas will provide opportunities to recreate aquatic habitat. This is discussed further in Section 5.5.

The enhancement of aquatic habitats created will be undertaken in accordance with a Rehabilitation Management Plan. The Rehabilitation Management Plan will incorporate measures relevant to the protection of downstream aquatic habitats as described above and measures to enhance aquatic habitats that may be created throughout the mining operation including:

- Establishing riparian zones with suitable native species adjacent to new flow paths created within and around the mined open cut pits and overburden stockpiles.
- Establishing aquatic habitat structure in areas that may provide temporary or permanent aquatic habitats, for example in permanent topographical voids remaining at mined open cut pits or other depressions. This may include woody debris or other suitable structure that will promote establishment of aquatic flora and fauna.
- Identifying and implementing enhancement opportunities in undisturbed areas or waterbodies that may form as a result of subsidence.

A 500 m wide strip on each bank of the Carmichael River will not be cleared of vegetation for operation of the project which will assist in protecting the riparian ecosystem from direct impacts of

mining operations. Management of the crossing will be required to limit the potential impact of this infrastructure on the aquatic ecosystems of the river at the crossing location and downstream. Measures to minimise the impact of the crossing of the Carmichael River include engineering solutions and management actions:

- Design and layout of the crossing will incorporate a bridge design that spans the watercourse bed and avoids construction within the banks as much as possible. Spanning the watercourse will avoid the removal of aquatic habitat, avoid installation of a barrier to movement by aquatic fauna and avoid alteration of hydrological flows locally.
- Design of the bridge crossing will consider fish passage requirements. Although the crossing will not be physically within the watercourse bed or banks, other non-physical factors can influence fish movement such as light availability. Guidelines are available that recommend minimum widths for light availability and design criteria for other factors that have the potential to influence movement.

Management of potential impacts associated with operation of the offsite water supply infrastructure will include:

- Undertake vegetation clearing associated with maintenance of pipeline easement in a sequential manner to allow more mobile species the opportunity to disperse away from clearing areas
- Operational rules will be developed with the purpose of maintaining watercourse flows during flood harvesting, to maintain the physical connectivity of aquatic habitats between upstream and downstream catchment areas

Potential indirect impacts to the riparian zone of the Carmichael River as a result of changes to the groundwater regime are discussed Section 5.4.4.

5.4.3.2 Aquatic Fauna Mortality

Potential Impacts

As described in Section 5.3.3.4 mortality or injury to aquatic fauna has the potential to occur when activities are undertaken within or adjacent to a water body. There will be a number of farm dams that will be removed during the operation of the mine. Each of the dams has the potential to contain native fish, crustaceans and turtles, all of which are protected under the NC Act and destruction of native species is prohibited without the required approval. .

With respect to the Carmichael River crossing, machinery and vehicles may be required to work within the watercourse to build the infrastructure. Although this habitat will not be removed there is potential for vehicle or machinery to strike aquatic fauna resulting in injury or mortality. The temporary habitat loss as a result of construction with the watercourse is discussed in Section 5.4.3.1. Once built, fauna mortality is not considered to be an impact as the bridge will elevate all vehicles out of the aquatic habitats.

Pumping of water from Belyando River, North Creek and Obungeena Creek may result in the entrainment of aquatic fauna species resulting in injury or death. Preventing entrainment at the point of water extraction presents the most suitable method of mitigating the effects of pumping systems on aquatic fauna. Draw down of water levels during periods of flood harvesting to the extent that dams are drained on Obungeena Creek and North Creek may also result in the mortality of resident aquatic species. To avoid this scenario, operating rules will govern the extraction, with the intent that no

water harvesting can occur below a set critical level. This approach will manage and maintain the water levels to this critical level. However, beyond this dams may also naturally dry during periods of drought.

Management and Mitigation

For the dam habitats , the required mitigation and management is consistent with that outlined for the construction phase in Section 5.3.3.4. Fauna salvage and relocation may be required which will involve similar management and mitigation approaches to those outlines in Section 5.3.3.4.

The management of potential fauna mortality as a result of offsite water supply infrastructure operation will include:

- Screen pump intakes with mesh to protect aquatic life
- Develop operational procedures for flood harvesting, to prevent dams on Obungeena and North Creek being pumped dry where practicable

5.4.3.3 Alteration of Surface Water Regime

Potential Impacts

Mine operations and the operation of the offsite water supply infrastructure will result in the sequential alteration to and loss of water courses (i.e. ephemeral creeks and associated riparian habitat) and water bodies (i.e. farm dams, pools and billabongs in and adjacent to water courses, cattle water points). This loss will affect terrestrial flora and fauna that utilise riparian and aquatic habitats, including riparian and aquatic vegetation, water birds, amphibians and terrestrial fauna that rely on surface water as a drinking resource.

Over staged development of the Mine, the local availability of surface water will be reduced, although new water sources are proposed to be created via water management dams at the eastern part of the Study Area. Also, areas overlying the proposed underground mining area are expected to be subject to subsidence. Water will accumulate in subsidence depressions, creating new surface water resources. Unless impacting on the safety of underground workings, these water resources will not be drained, but rather kept to support the ecological values of the system

Terrestrial habitats associated with aquatic systems (i.e. riparian vegetation) are proposed to be lost from some ephemeral creek lines within the mining footprint, although the riparian strip along the Carmichael River is proposed to be protected and enhanced.

With respect to the operation of the offsite water supply infrastructure, fluctuating or prolonged lowering of water levels within the constructed water supply dams and instream storages on Obungeena Creek and North Creek or during periods of flood harvesting may alter habitat availability for terrestrial species including conservation significant fauna species. Increased capacity of the existing water storage dams may mean that water is available for longer periods, although these dams will not necessarily be kept full as water is to be transferred to the mine raw water storage dam. As both North Creek and Obungeena Creek become unconfined channels downstream of the water harvesting area, loss of downstream pools due to the increased water extraction is not expected to be significant.

Impacts to surface water quality, including downstream impacts may occur where the geomorphology of waterways is altered, or where sediment and/or contaminants are mobilised during construction activities and enter waterways during and after rainfall.

With respect to terrestrial flora and fauna, loss and alteration of aquatic habitats will reduce the localised availability of habitat, including riparian areas for vegetation associated with water courses (and the fauna habitat these provide), as well as the drinking and foraging habitat provided by standing water bodies. The creation of water bodies associated with mine operations may compensate for this loss to some extent, whilst habitat alteration associated with subsidence may result in the creation of localised aquatic systems which would provide habitat for fauna and (aquatic) flora. The offset management approach will include provision of water resources in identified habitat areas.

The operation phase for water supply infrastructure will incorporate extraction of water from North Creek and the Belyando River (Moray Anabranch) during peak flow periods and in-stream river extractions on North and Obungeena Creeks. Water captured from the above-mentioned water supply sources will be stored, captured, treated (where required) to fulfil mine site water demands.

Both proposed flood harvesting and in-stream extraction have the potential to alter the surfacewater flow regime (volume and frequency) of these ephemeral systems. Watercourses in the area are ephemeral and hence aquatic communities present and downstream reflect the seasonal nature of water flow and volume. The extent of impact to the aquatic ecosystems will relate to the volume of water extracted from the watercourses and the timing of the extraction. Water resource modelling undertaken for the Project (Volume 2 Chapter 6 Water Resources) indicated that the proposed water extractions would have minimal impact against the Water Resource (Burdekin Basin) Plan 2007 environmental flows objectives. The plan defines hydrological characteristics of the connected water system that makes up the Burdekin Basin, including flow, velocities and flood extents at low, medium and high levels.

The fluctuating or prolonged lowering of water levels at the reservoirs on Obungeena and North Creeks may also adversely impact on habitat for aquatic species. Resident aquatic species, such as fish and crustaceans that reside in dams may be impacted where pumping results in draining of water from the dams. Species such as macrophytes may also be impacted by rising and falling water levels during periods of flood harvesting.

Alternatively, the proposed expansion of existing dams may result in the creation of additional habitat and resources for aquatic fauna species. Measures will be investigated to promote biodiversity values and improved habitat quality.

Potential impacts to water quality are addressed in the Volume 4 Appendix Q Mine Water Quality Report.

Management and Mitigation

Notwithstanding unavoidable impacts (i.e. loss of habitat where open cut blocks and out of pit waste dumps are to occur), a comprehensive suite of management actions will be implemented to reduce, and where possible, avoid adverse impacts to aquatic systems that may provide habitat values for terrestrial species. Volume 4 Appendix Q Mine Water Quality Report outlines the recommended strategies for managing impacts to water quality and surface waterways during the Project's operation phase. The management of areas onsite (outside the mine footprint) and offsite (offset areas) will

seek to maintain and enhance the values of habitats for flora and fauna, including aquatic systems and the resources they provide.

Management of potential impacts associated with operation of the offsite water supply infrastructure will include:

- Develop operational procedures for flood harvesting, to maintain a small volume of water in dams on Obungeena and North Creek being pumped dry
- Consider whether fringing vegetation can be established at some water storages created for the Project. This will depend on the ability to maintain raw water quality
- Identify strategic locations to provide additional water resources in offset areas

The Belyando River and North Creek flood harvesting will operate according to procedures that will be informed by the water modelling undertaken (Volume 2 Chapter 6 Water Resources). The flood harvesting will be undertaken such that small flows are largely unaffected. Pump will activate when a defined flood level is reached and in accordance with a Water Licence. All pipelines will include flow meters and all pumps will be controlled remotely to ensure that permitted extraction volumes are not exceeded.

The value of water bodies created as a result of mining activities and offsite water infrastructure (for aquatic flora and fauna will depend on the characteristics of the water body and its potential to provide habitat values. When new habitat (or potential habitat) is created with the expansion of the in-stream dams on North Creek, Obungeena Creek and the Belyando River an assessment on a case by case basis will be required to tailor management to the characteristics of the feature and opportunities for enhancement (see Section 5.4.3.1 for further discussion on the management of habitat creation opportunities). Riparian zone establishment and habitat structure establishment actions will assist in promoting colonisation by aquatic species. However, the utilisation of artificially created waterbodies by aquatic taxa is also dependent on the hydrological connectivity and persistence of the waterbody. A newly established waterbody will not be readily colonised by aquatic species if it remains disconnected from nearby waterways. In this situation, colonisation will only occur through chance dispersal via birds. This occurs when eggs, larvae or other small individuals are trapped on the feet and feathers of wading birds that then move to another waterbody. Furthermore, the persistence of aquatic communities depends on the persistence of the waterbody in which they reside. The Rehabilitation Management Plan for the Project will incorporate measures to enhance aquatic habitats that may be created throughout the mining operation, where suitable. This plan will be created in conjunction with the Ecological Management Plan for the operation of the Project and in coordination with relevant agencies and ecologists. These documents will be finalised prior to and construction or operation at the site and will require regular revision as the mining operations progress.

5.4.4 Alteration of Groundwater Regime

5.4.4.1 Changes to Groundwater Dependent Ecosystems

Potential Impact

The 30 to 60 m groundwater predicted model drawdown (unmitigated) will fluctuate seasonally as a result of mine requirements and seasonal weather conditions. Drawdown in itself does not indicate the degree of potential impact on the riparian ecosystem health, but rather it is the impact of the

drawdown on the baseflow of the watercourse. In the context of this project the groundwater model has identified that baseflow of the Carmichael River will be reduced by 7 per cent at the greatest operational/development extent of the mine. This baseflow reduction equates to a loss of approximately 1,000 m3/day in flow. It should be noted that baseflow does not include only visible surface flow, but includes the down gradient movement of water through the river bed.

The model has considered it unlikely that the mining workings will cause significant changes to the duration of zero flow and/or low flow periods in the Carmichael River owing to an existing disconnection between groundwater and river flow during the dry seasons. The existing riparian vegetation is characterised by species that are tolerant of periods of zero flow/low flow. While the riparian vegetation is tolerant of extended zero flow/low flow events, the reduction in baseflow by up to 7 per cent may extend the length of the zero flow events, and also reduce the number of low flow events, to a point at which even tolerant species will respond adversely. Reduced groundwater levels will have an impact on the duration and volumes of high flow connection between groundwater and river flows at other times of the year. These are the flow events that are critical to the maintenance of the waxy cabbage palm and important to riparian vegetation in general.

It would be expected that the most vulnerable species to short term adverse impacts would be the populations of waxy cabbage palm which are obligate dependent on a seasonal groundwater/surface connection to stimulate flowering, fruiting and thus general population maintenance. Unlike the other characterising species of the riparian areas (river red-gums and paperbarks), these palms have a root ball which does not extend more than several metres in diameter and are unable to access ground water that falls below this shallow zone. While though these species may persist for a number of years with no groundwater/surface connection, in the absence of any mitigation measures it must be considered that these species will be lost as part of the riparian landscape of the Carmichael River in the middle part of the operational life of the mine .

The maximum impact on baseflow is expected to occur well into the operational life of the mine with the most quantifiable impacts expected after approximately 60 years on other general riparian vegetation. The river red-gums have a marked propensity for persistence under drought conditions, but after prolonged years of baseflow reductions it is anticipated that visible mortality in mature trees will be apparent for certainly paperbarks (which are less drought tolerant than river red-gum) initially, and then river red-gums (from approximately 60 years onwards). This would not be an evenly distributed mortality in the riparian community as it has been indicated in the groundwater modelling that billabongs are still likely to persist along the Carmichael River and these areas will become refugial areas for the riparian vegetation that is currently typical of the river.

The cumulative impacts (without mitigation measures) of reduced base flow as a result of drawdown of the ground water table of groundwater dependent ecosystems include:

- Reductions and probably loss of the populations of the vulnerable (both EPBC Act and NCA) waxy cabbage palm ((*Livistona lanuginosa*) along the Carmichael River in the mid- term operational life of the mine (from 45 years onwards).
- Progressive mortality of characterising riparian species in the middle to latter parts of the operational life of the mine (after 60 years) beginning with less deeply rooted individuals (and species), and continuing to more persistent species such as river red-gums in the latter part of the mine life.

- Retreat of current characterising riparian vegetation to refugial areas such as billabongs and areas of runoff/drainage from mine pits where water is likely to persist as a result of anthropocentric drainage works.
- General reduction in river bank/watercourse stability in areas of riparian mortality with expected higher incidents of river bank slumping and general erosion during high flow flood events.
- Changes in riverbank vegetation composition as canopies are lost, creating conditions favourable to the introduction of grasses, forbs, a number of which may be weed species opportunistically recruiting into these areas.
- General alteration of environmental flow and instream conditions for aquatic macrophytes, with a high potential for reductions in the populations of these species.
- A general loss of breeding, roosting and foraging riparian habitat for fauna utilising the riparian community.
- Reduce or remove the base flow that currently provides the main water source to the river during the dry season and result in removal of the water source for aquatic habitats that provide refuge for aquatic flora and fauna. The result will be a reduction in aquatic habitat availability where the groundwater table is impacted
- Increase the duration of zero flow and/or low flow periods in the Carmichael River. No significant reduction in peak flows in the Carmichael River are anticipated as a result of the mine dewatering, given the peak flows are a result of direct rainfall and surface water runoff to the river in relation to rainfall. This anticipated change in the surface flow regime will reduce the temporal availability of aquatic habitat.

The groundwater modelling for the Project indicates that the GAB-fed Doongmabulla springs may have a maximum potential drawdown of approximately 0.12 m in 60 years into the operation of the mine.

In response to Coal Seam Gas (CSG) proposals, recent assessments of the potential for impacts of these operations on GAB springs have been carried out by DNRM and the Queensland Water Commission. These assessments have identified that drawdowns of over 0.2 m are considered to be potentially significant to the ecology and maintenance of the GAB springs. Predicted drawdowns at all springs in the Doongmabulla system are between 0.05m and 0.12 m, less than 0.2 m throughout the operational period with the majority of predicted impacts lower than 0.05 m. The predicted drawdown potential at the Doongmabulla springs is within this level considered to be potentially significant and will occur approximately 60 years into the life of the mine.

Given the current state of knowledge of the groundwater interactions and ecology of the springs, the level of impact in the short t to medium term is deemed to be insignificant. Monitoring of the springs and groundwater interactions in the initial development stages of the mine as a priority ongoing management action will enable better refinement and understanding of the relationship between the groundwater and mound springs ecology. In the longer term, while the predicted drawdowns are less than that currently regarded as having a potential adverse impact on GAB springs, management measures may be derived during the course of the monitoring program to enable any potential threat to ameliorated during the latter operational phases of the mine (i.e. beyond 60 years).

Drawdowns at the Mellaluka springs (a non GAB system) have been identified in the model at up to 0.8 m (approximately) at around 60 years into the life of the mine. These springs are approximately

10 km outside the mining lease area and are within a grazing area where these springs are used as stock watering points. Ecological survey of these springs has not been undertaken and the groundwater model is based on limited geological information in this area. Further investigations are therefore required to firstly assess the significance of this impact and then to determine appropriate mitigation and management measures. as mining does not occur in this area until the later stages of the proposed mine, adequate time is available to undertake this work.

Alteration of groundwater regimes may occur in association with water supply from bore fields in the Study Area. It is expected the bores will be drilled into the more productive Triassic to Quaternary aquifers. Based on preliminary modelling output and anticipated aquifer parameters, it is expected that after 10 years of extraction, the radius of influence of each bore would range between 3 and 5 km. Assuming a 10-year extraction period with cone of influence of 2 km radius, drawdown is expected to range between 0.5 and 2.5 m. This analysis is based on anticipated parameters and should be validated by aquifer testing and subsequent modelling. Once the proposed bores have been developed (exploration permit in application) with the required yield tests carried out, detailed groundwater surveys can be completed to verify the modelled estimates.

The Study Area and adjacent areas contain a number of ecosystems dependent upon the current groundwater regime. Changes to groundwater levels associated with pumping water from borefields could potentially impact on these values, which include:

- Groundwater dependent riparian vegetation communities in riparian areas of the Carmichael and Belyando Rivers reliant upon, in part groundwater base-flows.

Valenza (2012) found that the predicted cone of influence of the nearest bore to these spring systems does not extend beneath the GAB Doongmabulla Spring complex, and the Mellaluka Springs. For the Belyando River some of the bores have been positioned at distances ranging between 2 and 3 km from the river, resulting in some parts of the river being within the bore field's cone of influence Preliminary analysis undertaken by Valenza (2012) found that the impact on groundwater levels is likely to range between 0.5 and 2.5 m. This could potentially result in localised reductions in base-flows to the Belyando River system. Impacts to the Carmichael River will be minimal as the extraction boreholes are located away from the river system.

Further impacts are included within Volume 4 Appendix R Mine Hydrogeology Report.

Management and Mitigation

The primary impacts of the operation of the mine on general groundwater dependent ecosystems will not be possible to quantify until at least into the mid operational life of the mine, possibly up to 60 years. Some aspects, such as mortality of the waxy cabbage palm, may be more apparent earlier than this timeframe.

As these impacts are not predicted to occur until later in the proposed mine life, initial actions will be based on furthering understanding of the ecological and groundwater/surface water characteristics of the Carmichael River and springs. This in turn will allow refinement of impact predictions and development of more detailed management measures.

The following actions are therefore proposed to infill information gaps as identified above in the early phases of the proposed mine. These are primarily monitoring protocols that include:

- A detailed "ecological features" map will be made for the Carmichael River. This should identify the priority management areas including identifying the locations of waxy cabbage palms, riparian

composition and health, locations of billabongs (and their associated aquatic features), areas of connectivity/disconnection with the groundwater based on the modelling, gaining/losing areas of the river relative to the groundwater, as a minimum.

- Permanent CORVEG primary monitoring plots and transects (the latter over at least 100 m) should be established at regular intervals along the river for the purpose of establishing a riparian community health baseline. In the initial development/operational phases of the mine monitoring of the plots should be seasonal, reflecting high flow/low flow variability in the Carmichael River (twice annually). A minimum of 10 years of such monitoring would be used to identify the natural variability of the community. This monitoring should continue into the mid operational life of the mine, and increase to a quarterly frequency when the mine is at its fullest development/operational extent (60 years).
- Monitoring of the health of individual waxy cabbage palms should be undertaken on the same basis of the CORVEG plots. Cabbage palms are able to be transplanted, and where practical and feasible advice should be sought from the relevant agency at the time to transplant as many of these possible to other locations within the local provenance should there be evidence of stress that can be directly related to reductions in river base flows. If possible, this should be done in partnership with a university or the Queensland Herbarium.
- Vegetation monitoring should be undertaken having regard to groundwater monitoring/base flow monitoring. Locations for monitoring bores should be chosen with respect to selected environmental features along the Carmichael River (such as billabongs, particular riparian communities, areas with waxy cabbage palm) to enable more meaningful interpretation of potential direct interactions between these features and the groundwater.
- Monitoring the base river flow, including the establishment of gauging stations, should be undertaken in areas of particular ecological interest. Flow data should be monitored on an ongoing basis prior to construction, during operation and post operation upstream, downstream and within the Study Area.
- Additional investigations into the Doongmabulla spring are required to quantify the potential future impact on the spring of projected groundwater drawdown. These investigations should include detailed flora surveys, geological studies and development of an ongoing modelling and monitoring program.
- Any reintroduction of surface or groundwater back into the Carmichael River should be considered with respect to water quality, location of reintroduction, the priority environmental features for maintenance along the river (as per the “ecological features” map), channel porosity, etc. with the intent that should this water be introduced to the channel, it will be in a location where it will remain in the channel (and thus contribute to environmental flows downstream, and not be immediately lost to groundwater).
- Undertaking detailed monitoring of groundwater levels and surface water flows at the Carmichael and Belyando Rivers prior to construction, during operation and post operation upstream, downstream and within the Study Area to measure changes to groundwater and surface flows.
- Undertaking a continuous baseline monitoring program encompassing surface flow features both upstream and downstream of the borefield, in conjunction with nearby bore extraction yields and associated drawdown records.

It is proposed to position 17 bores within the Study Area with the following constraints:

- No bore would be placed inside the Great Artesian Basin (GAB) Water Resource Plan area
- The distance between the bores would be greater than 2 km to reduce cumulative drawdown
- The minimum sustainable distance would be maintained between the bores and the ecosystems at risk (Carmichael River, Doongmabulla springs, and Mellaluka springs). The sustainable distance is defined as the maximum expected radius of influence of the extraction bores, at peak extraction. Currently this is estimated as 10 km; however this value will be verified pending the modelling results.

Further management and mitigation measures are included within Volume 4 Appendix R Mine Hydrogeology Report.

5.4.4.2 Impacts to Stygofauna Communities

Potential Impact

Many species of stygofauna are restricted to small geographical areas. This means that any process that threatens the aquifer, potentially threatens an entire species and community. There is also a high degree of endemism in alluvial aquifers, even between adjacent systems (Hancock and Boulton, 2008).

Mining activities have the potential to impact stygofauna communities with respect to the extent of the proposed groundwater drawdown zone and the likely impacts on groundwater quality. Both these factors, over time, may cause prospective stygofauna habitat to be degraded or lost with the potential for significant impact on groundwater communities.

The Doongmabulla springs are located around eight kilometres west of the mining lease and are permanent artesian springs which provide base flow to the adjacent Carmichael River. The groundwater model predicted maximum drawdown impacts in the Clematis Sandstone which is thought to represent the source aquifer for these springs range from <0.05 to 0.12 m after 40-70 years at the two closest springs to the proposed mining area, i.e. the Little Moses spring to the north and the Doongmabulla Spring to the east.

The Mellaluka springs are located approximately ten kilometres south of the mining lease. Little is known about the Mellaluka spring system. The geology at the spring location is thought likely to comprise shallow near surface Quaternary and or Tertiary age strata overlying the older Permian units. Model results predict maximum drawdowns at the Mellaluka Springs of between 0.7 and 0.8 m.

Based on recent assessments of the potential for impacts on GAB springs, drawdowns of over 0.2 m are considered to be potentially significant (Queensland Water Commission 2012). Predicted drawdowns at all springs in the Doongmabulla system are less than 0.12 m throughout the operational period with the majority of predicted impacts lower than 0.05 m.

Further details regarding the groundwater modelling are reported in the Volume 4 Appendix R Mine Hydrogeology Report.

Mining activities of the proposed project have the potential to have direct effects on groundwater dependent ecosystems due to:

- Aquifer drawdown may have a detrimental impact on stygofauna. This may occur within and outside the operation area (for example at Mellaluka Springs and to a lesser extent the Doongmabulla Springs)
- Acid mine drainage and other geological or soil type influences to recharge have the potential to adversely impact stygofauna communities through changing groundwater quality. Section 5.4.2.7 describes impacts relating to acid mine drainage
- Excavation below the water table will result in groundwater drawdown around mine pits and changes to groundwater quality which can extend beyond the mine operation area. It will be important to assess the location and distribution of the stygofauna recovered against the aquifers from which they originated and the forecasted drawdown zone. As described the drawdown zone modelling will incorporate further fieldwork to refine model predictions such that the extent of impact can be identified.

The stygofauna collected from two bores within EPC 1690 have been identified as belonging to the Acarina Families, Trombiidae and Pexidae, the Syncarid Family, Parabathyneliidae and the Copepod Family, Cyclopoida. The level of taxanomic analysis undertaken in this study is in accordance with that specified by DEHP in the ToR. No stygofauna surveys have been carried out at Mellaluka Springs.

In Queensland, to satisfy the ToR, endemism needs to be disproved at the Family or Order level for stygofauna, in which cast the Acarina, Syncarid and Copepod Families are not endemic because the Families they belong to occur in all Australian States.

Management and Mitigation

Management and mitigation approaches will align with those identified to manage impacts to groundwater quality, quantity and interactions (Volume 2 Appendix R Mine Hydrogeology Report)

Specific to understanding the significance of impacts to the stygofauna community, the following management approaches are recommended:

- Build on and extend the existing baseline survey by conducting annual stygofauna surveys during mine construction, operation and closure phases in order to monitor and measure groundwater health and condition both within the Study Area and outside (i.e. the Doongmabulla and Mellaluka Springs)Extend the stygofauna sampling to the Mellaluka Springs to determine the presence to stygofauna and to identify if endemicity in the stygofauna community exists within the aquifer

5.4.5 Introduction and Proliferation of Weeds and Pest Species

5.4.5.1 Terrestrial Weeds and Pest Species

Potential Impacts

Increased movement of people, vehicles, machinery, vegetation waste and soil may facilitate the spread of weeds at and near the Study Area. Five WONS that are also declared plants under the LP Act are known to occur at the Study Area - parkinsonia (Parkinsonia aculeata), parthenium, prickly pear, velvety tree pear (Opuntia tomentosa) and rubber vine (Cryptostegia grandiflora). Despite the fact that 27 introduced plant species were recorded, weeds were not found to be abundant across much of the Study Area. Increasing the prevalence of weeds at the Study Area (and potentially

beyond to the surrounding landscape), may reduce the quality of habitats for some flora and fauna species, particularly by replacing native plants.

It is a characteristic of many weeds that seeds can rapidly germinate and plant growth is also rapid. Vegetation clearing and soil disturbance allows seeds present in soil to germinate. Germination and plant growth for weeds is typically faster than for native species and this can lead to increased weed levels in disturbed areas and affect the ability for native vegetation to re-establish.

There is also significant potential for weeds, either as seeds or other plant propagules, to be introduced to sites attached to dirty vehicles and equipment or to be contained in soil or seed mixes brought to the site. This can lead to increased levels of weeds already present on the site, or infestation by new weeds.

Food waste produced by human settlements may provide additional resources for feral animals such as pigs, rats, mice, cats and dogs. These animals, confirmed as present within the Study Area, may increase in abundance should easier access to forage resources be provided. Increased availability of water due to sediment ponds and water storages is beneficial to pest animals.

An increase in the prevalence of these animals may adversely impact native fauna in that it may lead to:

- Increased competition for resources
- Increased predation of native species by introduced animals
- Habitat degradation including pig damage of riparian areas and erosion caused by rabbit burrowing

There is also potential for pest animals such as ants to be introduced to sites through importation of vehicles, equipment, soils and similar media.

Management and Mitigation

Pest and feral species spread, and the potential for introduction of new feral species, will require management during the construction phase of the Project. An integrated suite of actions should be developed to manage pest species, including:

- Waste management measures incorporated into environmental management plans should include containment of food scraps in securely sealed containers
- Vegetation and soil waste should not be moved to areas of lower weed infestation
- Pest animal occurrence will be monitored during construction. If increased densities of pest animals are observed, or new pest animals are identified, humane pest controls will be implemented to manage numbers
- Weed mapping will be undertaken prior to commencement of construction. Mapping will cover the whole site but be particularly focused at high risk locations, such as areas of black soil so that weed hotspots can be identified. Baseline field surveys of identified hotspots within and near construction areas will be undertaken prior to commencement of construction. Weed control will be undertaken in areas that are very heavily infested or where WONS or Class 1 or 2 weeds declared under the LP Act are present prior to disturbance
- Weed levels will be monitored in areas adjacent to construction activities and any areas that are rehabilitated after construction. Monitoring will be undertaken annually during construction, with

results to be considered in terms of baseline information (collected prior to construction) and with reference to appropriate control (reference) sites. If significant infestations of any weeds occur, or if WONS or Class 1 or 2 weeds declared under the LP Act, weed control measures will be implemented. Weed control measures will be based on Queensland Department of Agriculture, Forestry and Fisheries and Isaac Regional Council advice. Ongoing monitoring of weed infestation associated with construction activities will occur through the operational weed management program

- All vehicles, equipment and materials brought on to the site will be certified as free of weeds and weed seeds and carry a weed hygiene declaration. Records are to be kept of compliance with this requirement
- Soil stripped and stockpiled from areas containing known weed infestations will be stored separately and are not to be moved to areas free of weeds
- Construction staff will not bring domestic animals to the Study Area

5.4.5.2 Aquatic Weeds and Pest Species

Potential Impacts

Soil disturbance and clearing of vegetation has the potential to result in the introduction and/or spread of aquatic weed and pest species. As discussed in Section 5.2.5.3 there are a number of pest fish species that occur in the Burdekin catchment. Although no pest species were recorded within the Study Area, pest species often flourish in disturbed habitats and in the event species are introduced (via translocation or stocking) or become prevalent closer to the Study Area, aquatic habitats may be susceptible. The introduction of these species can affect native fish communities through direct competition for resources (food and habitat), predation, habitat alteration and the introduction of diseases or parasites (DEEDI, 2011).

Aquatic weeds can also affect native communities by shading out native plants, reducing the quality of habitat for aquatic fauna communities and degrading water quality (DERM, 2011). Both weed and pest fauna species can be introduced when the numbers of people are visiting the area is increased. Weeds and weed seeds can be introduced in material (e.g. earth fill), water for water supply and vehicle (e.g. water trucks) vectors brought to the site during construction. The water supply plan for the Project incorporates the extraction of water from North Creek and the Belyando River outside the Study Area for use. In the event the water extraction location is in an area where aquatic weeds are present, seeds and propagules have the potential to be introduced.

Some terrestrial weed species and pest animals also have the potential to impact upon the aquatic environment directly and indirectly. Terrestrial weeds can invade riparian zones and aquatic habitats, whereby reducing aquatic habitat quality, diversity and availability. Pest animals such as pigs can have detrimental effects to watercourses by rooting 'ploughs' up to 20 m around a water body (DEEDI, 2010). This disturbance can lead to degradation of downstream water quality and habitat for aquatic species by creating erosion (DEEDI, 2010) destroying in-stream habitat and allowing opportunity for weed establishment rather than native riparian communities.

Introduction of pest and weed species locally has the potential to impact all aquatic habitats in the affected catchment if these species establish locally and spread to area with more permanent aquatic habitat such as the Carmichael River and Cabbage Tree Creek.

Management and Mitigation

Weed and pest species spread and the potential for their introduction will require management during the construction phase of the Project. An integrated suite of actions will be embedded in the Mine and Offsite Environmental Management Plans (Volume 2, Section 13 & 14) to manage both aquatic and terrestrial introduced species, including:

- Assessment of risk of aquatic weed transport at water supply extraction point such that filters or screens can be used to inhibit seeds and propagules or eggs being transferred to the Study Area
- Disposal of vegetation waste (in a manner that minimises potential for spread of weeds)
- Monitoring of weed levels and where increased weed levels occur, weed control programs
- Cleaning of vehicles, equipment and plant before entry to the site
- Regular weed and pest monitoring of the Study Area to confirm adequacy of management and mitigation approaches. Monitoring requirements and corrective actions will be clearly articulated in a Construction Management Plan.

Implementation of those measures will manage the impact to the aquatic ecosystems as well as terrestrial ecosystems.

5.4.6 Altered Exposure to Disturbance

5.4.6.1 Behavioural Disruption of Terrestrial Fauna

Potential Impacts

The higher intensity of land use at and near disturbed areas associated with Mine operations may disrupt local fauna behaviour, largely as a result of increased exposure to light, noise, dust, vehicles and people. Behavioural disruption may be direct (i.e. increased susceptibility to predation due to increased noise reducing prey vigilance, or increased light increasing prey detectability) or indirect (i.e. habitat degradation reducing local resource availability therefore increasing foraging dispersal distances for fauna). Given that the Study Area is currently exposed to some disturbance (as it is a working cattle property), the suite of species that occur exhibit a degree of disturbance tolerance. The black-throated finch (southern) and squatter pigeon (southern) are known to inhabit areas exposed to anthropogenic disturbance (peri-urban Townsville including directly adjacent to military training areas in the case of the former; numerous towns in central Queensland for the latter).

Animals may exhibit initial fright behaviour in response to the increased intensity of disturbance at the Study Area, and will either adapt to the disturbance levels, or move away from the areas of activity into similar habitat that is extensively available in the adjacent landscape. Dispersal will be facilitated by active management and where possible enhancement of habitats occurring onsite (outside the mine footprint) and offsite (offset areas).

Negative impacts to fauna from noise associated with operations of the Project are unlikely to occur (refer to Volume 4 Appendix U Mine Noise and Vibration Report).

Management and Mitigation

Management and mitigation measures to reduce disruption to fauna behaviour during Project (Mine) activities include:

- Pre-clearing surveys for active breeding sites

- Directional lighting will be used where possible to minimise light spill
- Restriction of movement of vehicles and humans to construction areas
- Dust suppression activities will be undertaken where appropriate and managed in accordance with the recommendations outlined in Volume 4 Appendix S Mine Air Quality Report.
- Regular maintenance of machinery and plant will be undertaken to minimise unnecessary noise

5.4.6.2 Changes to Fire Regime

Potential Impacts

Increased human activity may alter the fire regime of the local landscape, either deliberately through the need to manage bushfire risk, or through the accidental ignition of bushfires. Accidental or uncontrolled fires may have more pronounced impacts upon vegetation (and habitat) within and adjacent to the Study Area.

Management and Mitigation

Fire management strategies should be outlined in the Project Environmental Management Plan, and these should be implemented for all phases of the Project. As well as documenting protocols and actions for preventing accidentally-lit fires, the plan will outline how fuel loads will be monitored and maintained across the Study Area, as well as in offsite (offset) areas being managed for biodiversity. Ecological considerations should be incorporated into the development of this plan and response procedures developed.

Summary

Implementation of a fire management protocols should reduce the potential for destructive high intensity fires to disturb habitats at and near the Study Area.

5.4.7 Subsidence

Potential Impacts

Subsidence is predicted to occur above the underground mining area. This may alter the local topography above underground mining areas and, in the long term, alter surface hydrology patterns and vegetation assemblages. The areas of land to be potentially subject to the impacts of subsidence have been estimated by calculating those areas that sit directly beneath the underground mine area. In total, this equates to an area of 7765 ha.

Potential environmental impacts of subsidence include:

- Alterations in surface topography leading to changes in surface drainage patterns. For example, the bed profiles of streams may be affected by the subsidence profile. The underground mining footprint is traversed by minor ephemeral streams with small sub-catchments. Most of these flow roughly perpendicular to the longwall panel and subsidence trough orientation. As these streams are quite small and ephemeral, when flowing, the streams are likely to empty into the subsidence troughs and result in ponding at the surface, within some of the troughs. Higher points may become drier as surface water is diverted away from them.
- Alteration to below-ground geological profiles resulting in changes to sub-surface drainage patterns. The root zones of vegetation may be affected by the changes to sub-surface flow

conditions resulting from subsidence. Altered hydrology may result in areas of wetter or drier conditions for plants. Affected vegetation may fall over, become less stable, or more gradual impacts may occur in line with changes in water availability to root systems.

- Tension cracks may form in the ground surface. The width and depth of tension cracks will depend on the underlying geology and also the speed at which subsidence occurs. As subsidence will be staged, this may reduce the formation of tension cracking, but such cracking may further alter surface and/or sub-surface water flows and result in a direct loss of vegetation and/or pre-existing habitat features in some areas.

As a result of these effects, the nature of vegetation communities over underground mining areas may change over time. Taller trees may fall over (in areas of tension cracking for example), or gradually die due to the physical or hydrological changes. Shrubs and grasses are generally less likely to be affected by the physical changes of subsidence; however, changes in hydrology may lead to progressive changes in the nature of vegetation, as water tolerant species colonise the base of troughs and more drought tolerant species colonise the ridges above the pillars. During this transition, there will also be significant potential for weed invasion to occur, as weeds may be better able to take advantage of the changed conditions.

The surface topography within the Study Area consists of low-lying and gently sloping plains of generally less than 2 per cent gradient. The Carmichael River is the most significant watercourse in the area, in the southern part of the mining lease area, and the proposed longwalls have been set back from the River such that the closest longwall is approximately 215 m away.

Approximate areas subsidence by RE, habitat type, and habitat for conservation significant species is provided in Volume 4 Appendix N Terrestrial Ecology Report. It is considered that effects to individual REs will be unlikely to be significant in terms of their distribution and conservation status at a local or bioregional level, and whilst changes to habitat structure (such as areas of tree loss) and species compositions are likely to result from the levels of subsidence predicted, the general (overall) functionality of the fauna habitats present across the Study Area is unlikely to be significantly compromised.

For three of the six threatened species (black-throated finch (southern), squatter pigeon (southern) and yakka skink), the vast majority (79-86 per cent) of the overall area likely to be subject to subsidence represents potentially suitable habitat. These species utilise a wide range of grassland and open woodland habitats. For koala, over 60 per cent of the predicted impact area is potentially suitable habitat. Only very small areas of the predicted impact area represent potential habitat for ornamental snake and waxy cabbage palm. In the case of waxy cabbage palm, the species' restriction to the Carmichael River riparian corridor means that it is highly unlikely to occur in an area to be subject to subsidence.

While subsidence may occur over much, if not all, of the predicted subsidence area, the type and extent of subsidence will vary greatly in distribution and in magnitude of effect over time. Because the majority of the impact area represents known and potential habitat for four of these species, the effects of variable levels of subsidence across this area (and in turn variable impacts to the habitats upon which they rely) are likely to be reduced and result in impacts that could be locally significant, but unlikely to be significant at the wider, regional population level. The greatest impacts are likely to be those involving the loss of historical breeding sites, where there is a high fidelity to those sites amongst species; this may be the case for black-throated finch (southern) and yakka skink

(communal breeders), but is less likely to be applicable to the other threatened species present within the area.

Those species with a noted affiliation to water (black-throated finch (southern) and ornamental snake in particular) may be able to take advantage of the creation of additional ponded surface water areas as a result of subsidence. Black-throated finch (southern) requires an abundance of reliable water sources within its localised habitat ranges. Furthermore, they have been observed (during survey work) to drink from water sources in areas of cleared land or non-wooded vegetation and therefore any localised changes in habitat structure around existing or new water sources should not affect the subspecies' ability to use these water sources, so long as the requisite grassland and woodland habitats remain present within the nearby surrounds. Important habitats for ornamental snake comprise gilgais, melon-holes and/or fringing vegetation along watercourses, within brigalow or open woodland complexes. The same may apply to any increase in dead wood habitat created by fallen trees in areas of subsidence, which would be of potential benefit to species including yakka skink.

Subsidence has the potential to change existing topography via vertical shifts in the topography that influence the flow path and/or collection of water across the underground footprint. A number of potential impacts from underground mining have been documented in a Strategic Review of Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield (NSW Department of Planning, 2008) and in a report on Coal Mining Potential in the Upper Hunter Valley Strategic Assessment (NSW Department of Planning, 2005). Review of these has informed this assessment, taking into account operational activities specific to this Project. From this, the following impacts to watercourses have been identified as potentially impacting upon aquatic ecosystems across the Study Area:

- Reduction in surface flows and/or water levels which can increase the frequency, duration and magnitude of drying aquatic habitats
- Reduction of aquatic habitats as a result of complete drying of river pools
- Reduction in connectivity between river pools

These potential impacts will adversely affect aquatic habitat availability and suitability for aquatic flora and fauna. The area above the underground mining operation is drained by ephemeral watercourses and no permanent stream pools were observed during field survey, hence the potential for an impact to permanent habitat is avoided. Habitat values and diversity in these streams was low. The main potential adverse impact as a result of subsidence will be a reduction in connectivity between watercourse reaches in times of flow though the underground mining footprint mainly corresponds with the top area of the catchments and first order stream reaches that do not connect river pools.

There is potential for rainfall runoff to accumulate in subsidence depressions, creating new water bodies and habitats for aquatic flora and fauna, hence opportunity for a positive impact arises.

Management and Mitigation

Management and mitigation measures to reduce the impacts of subsidence to ecological features and resources will include:

- Implementation of the Subsidence Management Plan that has been produced for the Project, which allows for the offsetting of longwall panels between the seams (to reduce vertical displacement, tilt and curvature), the early diversion of small watercourses (where necessary), the

packing and backfilling of tension cracking, and the regular review of subsidence management in general

- Monitoring of the effects of subsidence on key species and habitats should also be carried out by suitably qualified ecologists, with monitoring events phased and scheduled following the cessation of excavations within each longwall panel (as well as the prior establishment of pre-impact benchmark sites as necessary). The monitoring should focus on documenting resulting changes to habitat types (using indicators such as vegetation cover and plant species diversity) and fauna species use of these areas (primarily the key threatened species listed above)
- Using the data from monitoring, specific rehabilitation plans should be produced and implemented, if necessary, to act upon any identified adverse impacts to habitats or features, where these are considered to pose a threat to key habitat communities and/or threatened species populations. Key performance indictors should be developed which, if not met, should result in corrective actions to directly address any functional loss in biodiversity
- It will most likely be preferable to adaptively manage evolving habitat changes rather than attempt to rehabilitate areas to their previous condition, which would be difficult to achieve. This would include retaining surface water within areas that become subject to ponding (rather than attempting to drain these), but as these new habitats evolve, there are also likely to be specific additional enhancements that can be made to these features, such as revegetation with native planting and the collection and aggregation of fallen woody material to create habitat piles

5.5 Potential Impacts and Mitigation Measures – Rehabilitation

The mining at the Study Area is scheduled to extend for approximately 90 years from 2013. There are a number of aspects of relevance to environmental management during progressive rehabilitation of the Project (Mine).

With respect to the potential impacts to the environment and associated mitigation for this phase, the decommissioning of the Mine will require detailed planning. Planning and subsequent development of a Project Decommissioning Environmental Management Plan should incorporate a phase of impact assessment that includes consideration of the potential impacts to the terrestrial ecosystems within, surrounding and downstream of the Study Area as they occur at the time of decommissioning, with reference to pre-mining state as described in Volume 4 Appendix N Mine Terrestrial Ecology Report.

The plan should consider (but not be limited to) incorporation of the following with respect to the management of habitats for nature conservation values.

- Rehabilitation and ongoing management of terrestrial systems disturbed at any stage of Mine operations to occur, with the objective of revegetating cleared areas as soon as possible after disturbance, and wherever possible, providing a suite of habitat resources for flora and fauna that replicates as closely as possible the resources available prior to the commencement of mining (as detailed in this baseline assessment of the existing terrestrial ecological values of the Study Area). A key aspect of this rehabilitation will be restoring and maintaining connectivity across the local landscape, particularly between intact habitats within and near the Study Area.
- Remediation and development of the final landform to consider drainage, erosion resistance and potential resultant change to vegetation communities (and thus fauna habitats), and surface water flows (direct and volume) in order to minimise changes to the aquatic habitats of the Carmichael River and downstream

- Rehabilitation requirements for any watercourse crossings
- Rehabilitation or re-establishment of riparian zones for watercourses
- Monitoring requirements for aquatic communities and water quality

5.6 Summary

The primary potential impacts of the Project (Mine) include:

- Vegetation clearing
- Direct disturbance of surface water courses and water bodies
- Degradation of downstream aquatic habitats as a result of sedimentation
- Fauna mortality during construction and operation
- Introduction of weeds and pest species
- Altered exposure of species to disturbance
- An alteration to the ground/surface water interaction in the vicinity of the Carmichael River

Impacts associated with a change in the relationship between surface and groundwater environments have the potential to substantially reduce the availability of aquatic habitats during dry periods when rainfall does not provide volumes to sustain isolated pools in the Carmichael River.

Groundwater modelling suggests there will be a water table drawdown of up to around 30 m in the vicinity of the Carmichael River under the post closure scenario and that groundwater discharges to local water courses, predominantly the Carmichael River, will be reduced by up to 1,000 m^3/d or 7 per cent of pre-development discharge during the operational phase.

Further details regarding the groundwater modelling are reported in the Volume 4 Appendix R Mine Hydrogeology Report.

The approach to mitigating and managing operation phase impacts will include a combination of prevention or reduction of all avoidable impacts to the greatest extent possible, active management to maintain and where possible enhance habitats that will not be impacted during staged operations, and active management of areas that will be disturbed during staged mining operations such that they retain their existing values until such time that they are disturbed. Research and monitoring will be a fundamental component of the impact management approach, with a dual objective of informing management of environmental impacts at and near the Study Area, as well as contributing to the understanding and protection of ecological values in the Galilee Basin. As unavoidable impacts are an inherent aspect of this Project, given that its operations are entirely related to the locality of the coal resource within the mining lease, offsets will form a substantial component of the impact management approach. Whilst all reasonable efforts will be made to minimise impacts to flora and fauna values within the operation phase footprint, vegetation loss, fauna habitat loss and fauna mortality will occur. The overarching objective of managing impacts during the operation phase will be to maintain and where at all possible enhance the ecological values that characterise the Study Area and the surrounding landscape, with a view to achieving no-net-loss of regional biodiversity values.