Adani Mining Pty Ltd

adani

Carmichael Coal Mine and Rail Project SEIS

Report for Matters of National Environmental Significance

6 November 2013

GHD

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Executive summary

Adani Mining Pty Ltd (Adani) is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal Mine in the north Galilee Basin approximately 160 kilometres (km) north-west of the town of Clermont, Central Queensland. All coal will be railed via a privately owned rail line connecting to the existing Goonyella rail system south of Moranbah, and shipped through coal terminal facilities at the Port of Abbot Point and/or the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (the Project) will have an operating life of approximately 60 years.

Project components are as follows:

- The Project (Mine): a greenfield coal Mine over EPC 1690 and the eastern portion of EPC 1080, which includes both open cut and underground mining, on Mine infrastructure and associated Mine processing facilities (the Mine), and the Mine (offsite) infrastructure including a workers accommodation village and associated facilities, an airport, an industrial area and water supply infrastructure.
- The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively including:
  - Rail (west): a 120 km dual gauge portion running from the Mine site (in the west) east to Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah.
  - Quarries: five local quarries to extract quarry materials for construction and operational purposes

The Project EIS was developed with the objective of avoiding or mitigating all potential adverse impacts to environmental, social and economic values and enhancing positive impacts. This report specifically addresses Section 9 of the Project Terms of Reference (ToR) addressing matters of national environmental significance (NES) of relevance to the Project that are protected by the EPBC Act.

The controlling provisions for the Project are:

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

Description of the environment and understanding of potential impacts from the Project has been supported by desktop review and conduct of field surveys. Temporally separated field surveys of direct relevance to matters of NES were conducted across the different geographies

of the Project to identify the existing terrestrial and aquatic biodiversity. Survey effort completed to date has enabled field verification of desktop assessments and habitat predictions. Data from surveys, in conjunction with desktop analysis, is considered adequate to describe the potential of the Project to affect matters of NES and inform potential mitigation and management measures.

Survey effort

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic flora	24 sites, 3 sites 24 sites, 1 site	Autumn: May 2011 Spring: September 2011
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Rail Study Area	Assessments for Property Maps of Assessable Vegetation	Various sites along corridor	Winter: June/July 2012
Mine Study Area (EPC 1690)	Terrestrial and aquatic flora	60 sites, 19 sites 168 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Mine Study Area (EPC1690)	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Offsite Infrastructure Area	Black-throated finch targeted surveys	9 water watch sites, 31 watch sites, 6 remote camera sites	Autumn: May 2012
Mine Study Area	Doongmabulla and Mellaluka Springs survey	Unstructured opportunistic survey effort	Autumn: May 2012
Post EIS			
Rail Study Area	Quarries matters of NES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Mine Study Area (EPC1690 / EPC1080)	Black-throated finch surveys	8 water body counts, 20 remote camera sites, 52 habitat and finch survey sites, 8 incidental observation sites	Autumn: May 2013
Mine Study Area	Doongmabulla and Mellaluka Springs survey	Unstructured opportunistic survey effort	Autumn: March/April 2013
Mine Study Area	Waxy Cabbage Palm survey	Population survey along 17.5 km of the Carmichael River	Autumn: April 2013
Offsite infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013
Offsite infrastructure Area	BioCondition	10 sites	Autumn: April/May 2013

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
Offsite infrastructure Area	Property vegetation management plans (PVMPs) and property maps of assessable vegetation (PMAV)	49 flora sites	Autumn: April/May 2013
Note: * Combination of rapid and comprehensive survey approaches were used across sites (defined in following sections)			

Data collected during field surveys and from desktop review of historical records has enabled potential habitat mapping to be completed for species of conservation significance. Recognising the geographical area of the Project, potential habitat mapping has been applied as a conservative measure to predict likelihood of species occurrence for impact understanding. Accordingly, if conservation significant species were not detected during survey, habitat availability is used as a proxy measure to inform likelihood of species occurrence and, therefore, potential to impact upon species.

In consideration of construction and operational activities of the Mine and rail components of the Project, potential impacts have been identified and described with respect to flora and fauna species which are matters of NES, their confirmed and potential habitat and vegetation communities that occur within (confirmed) or are considered likely to occur within the Study Area (as defined in Section 1.5).

Operation of the Mine will be staged across the 60 year life of the site. Operational Mine activity will occur approximately three years into the construction of the Mine. This will involve both underground and open cut mining works. Construction works for the Project will be progressive and will overlap with operational works from year three onwards.

Potential impacts arising from construction and operational works may include:

- Loss of remnant vegetation, flora habitat and vegetation community extents
- Loss of habitat (roosting, shelter, foraging, breeding) for native fauna including conservation significant fauna
- Degradation of terrestrial and aquatic habitat adjacent to and downstream of cleared areas
- Landscape fragmentation, reduction in connectivity and reduced capacity for fauna dispersal
- Fauna mortality

How these may affect matters of NES of relevance to the Project has been assessed in detail. Potential impacts have been considered with regard to whether an important population of protected species occurs at the site and whether impacts may be significant or not.

The significance of residual impacts, post-mitigation, was evaluated with consideration to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) significance criteria, which are provided in the Significant Impact Guidelines (DEWHA, 2009a).

In considering impact to listed taxa and communities, an assessment was also made to identify relevant matters for impact assessment in relation to the following:

- An important population – for listed vulnerable threatened species
- Habitat critical to survival – for listed threatened species
- Important habitat – for migratory species

Mitigation measures to avoid/minimise/offset impacts to identified matters of NES resulting from the construction and operational activities associated with the Project have been proposed and offset commitments have been identified. Findings of the assessment are summarised against the controlling provisions for the Project.

World Heritage Properties, National Heritage Places and the Great Barrier Reef Marine Park

The DSEWPaC Protected Matters Search Tool did not identify any world heritage properties or National Heritage Places of relevance to the Project. Assessment considered the nearest potential properties or Places which could be affected.

The Wet Tropics World Heritage Area is located over 270 km north of the Study Area with no direct terrestrial, aquatic or biodiversity links to the Study Area. No influences from the Project are predicted to occur on the Wet Tropics World Heritage Area and this area has not been considered further within this assessment.

The Tree of Knowledge and curtilage at Barcaldine is the closest National Heritage Place to the Study Area. It is located approximately 200 km south-west of the western extent of the Study Area. No direct or indirect influences on this Place will occur as a consequence of the Project and this Place has, therefore, not been considered further.

The Great Barrier Reef World Heritage Area (GBRWHA) is located over 300 km downstream of the Study Area and although connected hydrologically via watercourses, substantial hydrological barriers and other catchment land uses exist between the ocean and the Study Area, including the Burdekin River dam. The Mine Area contributes a small percent area (0.44 percent) to the Burdekin Falls dam catchment and significant controls will be established to manage onsite and offsite water and sediment quality impacts at the Mine Area. These measures will mitigate potential for impacts to aquatic values that could affect the downstream reefal environment. The distance from the GBR and the barriers would impede site conditions from having an influence on the values for which the reef is protected.

No impacts associated with the Project will result in a substantial and measurable change in the hydrological regime of the GBRWHA waters and, therefore, no effects on the GBRMP are predicted either. Accordingly, no impacts to the ecological, cultural or social values for which the GBR is recognised will occur as a result of the Project.

The Project will not impact upon any World Heritage Areas, National Heritage Places or the GBRMP.

Wetlands – Ramsar

The closest wetlands of international importance (Ramsar Wetland) are the Bowling Green Bay wetland, approximately 236 km northeast of the Study Area and the Shoalwater and Corio Bays Areas, approximately 380 km south-east of the Study Area. Although the Mine Area is not hydrologically connected to the Bowling Green Bay or Shoalwater and Corio Bay Ramsar wetlands, there is a chance of indirect impacts from Project runoff given it is hydrologically connected to the Burdekin River. So consideration has been given to whether any coastal inputs of terrigenously derived sediments could impact the Ramsar wetlands.

No areas of Ramsar wetland are predicted to be impacted by this Project. No areas of internationally important wetland will be lost, destroyed or substantially modified as a result of the Project nor will the hydrological regime of those distant wetlands be affected. None of the biodiversity values for which the Ramsar wetlands are recognised will be impacted by Project activities as the Project will not affect the geography of any Ramsar protected wetlands nor will it act to introduce invasive species to any wetland sites. Accordingly, no impacts to Ramsar wetlands are predicted to occur as a result of this Project.

The Project will not impact upon any internationally important wetland.

Listed threatened species and communities

The listed threatened species or ecological communities that could be affected by the Project, as determined by desktop studies and site assessments include:

- Threatened flora:
  - *Dichanthium queenslandicum* – vulnerable under the EPBC Act, may occur at the Study Area
  - Waxy cabbage palm (*Livistona lanuginosa*) – vulnerable under the EPBC Act; confirmed present at Mine Study Area and unlikely to occur at Rail Study Area
- Threatened fauna:
  - Black-throated finch (southern) (*Poephila cincta cincta*) – endangered EPBC Act; confirmed present at Mine and likely to occur at Rail Study Area
  - Squatter pigeon (southern) (*Geophaps scripta scripta*) – vulnerable EPBC Act; confirmed present across both Mine and Rail Study Areas
  - Ornamental snake (*Denisonia maculata*) – vulnerable EPBC Act; confirmed present across both Mine and Rail Study Areas
  - Yakka skink (*Egernia rugosa*) - vulnerable EPBC Act; likely to occur across Mine Study Area
- Threatened ecological communities:
  - Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered under EPBC Act; confirmed present in Study Area
  - The community of native species dependant on natural discharge of groundwater from the Great Artesian Basin (GAB) – endangered under EPBC Act; confirmed present west of Mine Study Area, may be subject to indirect impacts.

Given no representatives of *D. queenslandicum* were found on site, the Project is not expected to lead to a long-term decrease in the size of this vulnerable species population. As no representatives were detected, it is not considered that the Project could fragment any populations, adversely affect habitat critical to the survival of these species, including for reproduction, or reduce their area of occupancy.

The primary impacts (without mitigation measures) of reduced base flow as the result of drawdown of the groundwater table, reductions in base flow from upstream, and increases in the frequency of zero base flow events on this groundwater dependent ecosystem will result in a reduction in health, and probable mortality of waxy cabbage palm individuals (a vulnerable species under the EPBC Act) located in the eastern half of the Mine Area, including 9 adults and 160 juveniles.

Based on current knowledge, assessment indicates that the Project will likely have significant impacts to the following EPBC Act listed threatened species or ecological communities:

- Waxy cabbage palm
- Black-throated finch (southern)
- Brigalow TEC (locally significant impacts; regionally, impacts are not expected to be significant)

Waxy cabbage palm

Waxy cabbage palms have been identified occurring immediately west of the Mine site associated with the Moses Springs and also along the riparian corridor of the Carmichael River but were not detected during surveys of the Rail Area or Mine (Offsite) Area. Mine plan design has been optimised as far as possible to limit direct impact to approximately five individuals and 4 ha of potential habitat for the waxy cabbage palm.

As part of the proposed management measures detailed monitoring and research is proposed which will significantly increase the current level of information for the waxy cabbage palm particularly as the species has not previously been recorded within the locality.

A combination of mitigation and management measures to reduce impacts and offsets to address inevitable residual impacts to individuals of the species will be implemented to avoid significant impacts to the waxy cabbage palm.

Black-throated finch

The black-throated finch (southern) will be significantly impacted as a consequence of habitat losses due to vegetation clearing associated with the Project. Based on the currently available information (acquired from desktop and field studies) and in consideration of the Significant Impact Guidelines, (DEWHA, 2009a), it is considered that the Study Area, in particular the Mine Study Area, does support a ‘population’ of the black-throated finch (southern).

A total of 9730 ha of identified black-throated finch (southern) potential habitat are proposed to be impacted by vegetation clearing over the life of the Project. This represents 0.16 percent of the total potential habitat within these Desert Uplands and Brigalow Belt bioregions within which the Project occurs. This impact has been minimised through implementation of mine plan changes such that a reduction in direct impact of approximately 40 percent has been achieved.

The area of direct impact has been minimised as far as possible throughout the design and development of the mine plan. Through relocation of the out of pit stockpiles the area of direct impact was reduced by approximately 7,000 ha. This change to the mine plan resulted in an approximately 40 percent reduction in the potential area of direct impact.

Management and mitigation measures implemented in respect to indirectly impacted project areas, such as above underground mining areas with low subsidence impacts, will be undertaken in order to retain habitat that will maintain a viable population of black-throated finch (southern).

Offsets via direct land based and indirect research and monitoring have been identified to address residual impacts.

Habitat management, informed by ongoing research and monitoring, will occur during the life of the Project to minimise potential to realise an ongoing significant impact upon this species. Research works will contribute to the maintenance of this subspecies within this bioregion and therefore, in general, 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). Adani has committed to developing and implementing a Black-throated finch Management Plan which will also inform greater understanding of the species.

Brigalow TEC

The Brigalow TEC will be affected as a direct result of vegetation clearing. It is expected that 27 ha of this TEC will be cleared to facilitate the rail corridor infrastructure development. Within the Mine Study Area an extant patch of Brigalow TEC occurs south of the Carmichael River. In total, across the Mine Study Area, 554 ha of this TEC will be affected by vegetation clearing to facilitate mining and stockpiling works. Vegetation clearing is an unavoidable consequence of the Project. Where possible, the Project footprint has been located in existing cleared areas. However, where the clearing of remnant vegetation, including that protected under the EPBC Act, is unavoidable and cannot be satisfactorily avoided, managed and mitigated, offsets are likely to be provided in accordance with the relevant EPBC Act and State offset policy (refer SEIS Volume 4 Appendix F Revised Offsets Strategy).

It is not expected that the Project will significantly affect the prevalence of the Brigalow TEC regionally as management measures will be implemented to minimise habitat losses within the Study Area and to ensure that no losses of this TEC will be realised outside the Study Area (as is defined in Section 1.5).

Great artesian basin springs

The nearest GAB discharge spring is the Doongmabulla Springs complex. The Doongmabulla Springs complex comprises discrete pools and patches of grassland, sedgeland and woodland created by the outflow of artesian water from a cluster of spring groups (Joshua, Moses and Little Moses). Each spring group contains at least one spring – in the case of Moses, there are more than 65. Collectively, the spring groups are known as the Doongmabulla Springs complex. The Doongmabulla Springs complex is approximately 4.5 km in diameter, and is located approximately 9.8 km directly west of the western boundary of the Project Area. This wetland contains six flora species of conservation significance, including two species known to be endemic to the Doongmabulla Springs (the herb *Erygynium fontanum* and the grass *Sporobolus pamelae*).

The main threatening processes for this TEC are aquifer drawdown, excavation of springs, exotic flora and fauna invasion and stock damage, access by tourism, and impoundments (Fensham et al., 2010). This Project will realise a reduction in the pressure in the aquifer which has potential to impact upon this TEC. Conservative (i.e. worst case) modelling indicates the influence of Mine dewatering reaches the location of the Doongmabulla Springs with a maximum predicted reduction in pressure in the aquifer of between <0.05 and 0.12 m (operation phase) and <0.05 and 0.12 m (post-closure).

These reductions in pressure are expected to have a minor impact on the springs and associated wetlands, falling within the range of seasonal fluctuations to which the springs are already adapted. Therefore, it is thought that the reduction in flow will be within a tolerable range.

Listed migratory species

The desktop assessment indicated that a number of EPBC Act listed migratory species have been previously recorded or are predicted to occur within the Mine and Rail Study Areas. Of these, three were confirmed present during field surveys and eleven species are considered likely to occur while five species may occur. It is recognised that, in spite of the recommended management and mitigation measures, and the active rehabilitation of disturbed areas that will occur through the Project’s operational life, unavoidable loss of habitat for migratory species will occur.

Active, targeted management of habitats adjacent to the clearing footprint can improve their quality for migratory species. Establishing alternative habitats for migratory species adjacent to the Project through active management prior to clearing will encourage individuals to disperse from proposed clearing areas (or attract them to adjacent areas). This may include, but not be limited to, improving forage and nesting resources, increasing access to watering locations, and management of pest and weed species, to enhance the value of adjacent areas. This action will seek to minimise habitat loss (through replacement) and will also act to minimise potential for mortality by providing migratory species with habitat refugia within the operational landscape. The details for such management approaches and actions will consider the staged nature of operations, and will be detailed within Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C# Rail Applications and Offsite Infrastructure Species Management Plan) (under the overarching Project Land Management (Flora and Fauna) Plan).

The potential to realise a significant impact upon migratory species within the Study Area has been considered against criteria identified by DSEWPaC . Based on current knowledge the assessment identifies that the Project is not expected to have a significant impact upon any migratory species. This finding is on the basis that:

- The study area does not support an important population of any of these species
- The study area does not support an ecologically significant proportion of the population of a migratory species
- Measures identified in Sections 5.2 to 5.4 are expected to manage the potential to directly or indirectly impact these species
- The species are well represented in landscapes that surround the study area, where suitable alternative habitat is prevalent and will persist
- The species are not considered to be dependent upon any habitat within the study area for any particular lifecycle stages

As such, while large tracts of habitat suitable for these matters of NES will be affected, alternative habitat suitable for these species exists adjacent to the Study Area and within the region. Accordingly the Project is not predicted to adversely impact migratory species.

Water resources

The EPBC Act was recently amended to include water resources as a new matter of NES, protected under sections 24D and 24E. Whether or not the new matter of NES will be a controlling provision for the Project is not yet confirmed. This will in turn depend on a decision of the Commonwealth Environment Minister under section 23 of the *Environment Protection and Biodiversity Conservation Amendment Act 2013*, which has not been finalised at the time of publishing this report.

In any event, irrespective of whether or not sections 24D and 24E become controlling provisions for the Project, Adani has taken care in compiling the Project EIS and the SEIS to address any impacts on water resources. This has been a priority for a number of reasons, for example:

- The Project ToR requires detailed assessment of the impacts the Project is likely to have on water resource planning in the region, water resources, watercourses, and water interests held by third parties.
- Adani acknowledges the potential for the Project to impact on water resources, and the potential resulting impacts on other matters of NES, including for example nearby springs. In order to understand these potential impacts, the potential impacts on the water resource itself have been a core area of focus throughout the preparation of the Project EIS and the SEIS.
- The Interim Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IIESC) considered the Project in detail and made recommendations to DSEWPaC as to the necessary assessment. Adani has worked to meet those requirements. Relevantly, the ‘project advice’ function of the IESC covered in all material respects that of the IESC. This function was not limited to considering water resources impacts that also had secondary impacts on matters of NES.

The suite of documents presented as part of the Project EIS and the SEIS thoroughly assess the potential impacts of the Project on water resources.

Cumulative impacts

A cumulative impact assessment was completed. This assessment reviewed stated impacts from other relevant projects and, utilising a relevance factor, determined the significance of potential cumulative impacts. Assessment has identified that the potential cumulative impacts having a low risk relate to:

- Aquatic ecology
- Surface water
- Groundwater

The cumulative impact, which has a high risk, relates to:

- Terrestrial ecology

The potential to affect matters of NES as a result of cumulative loss of habitat, as well as a result of direct and indirect impacts associated with the Project, has been considered in defining offsets of relevance to the Project. Under implementation of the proposed Project offsets it is considered that the overall impact of the Project (direct, indirect and cumulatively) can be managed.

Offsets

The key Federal offsets policy, which applies to the Project, is the EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) which is applicable to Project (Mine) and Project (Rail).

Avoidance, mitigation and management measures have been proposed across the Project footprint in order to minimise the requirement for offsets.

However, a number of potential direct and indirect impacts have been identified within the Project footprint, including the direct loss of protected vegetation communities, habitat for threatened species and resources as a result of vegetation clearing. The delivery of offsets must meet the specific offset requirements outlined in all relevant environmental offset policies. In general there are two options for delivering offsets, these being either land-based offsets (direct or indirect) and/or offset payments.

The offset obligations associated with impacts to EPBC Act and State environmental values can be met through the delivery of a combined offset approach that addresses impacts to environmental values protected under both areas of legislative jurisdiction. Offset options that nominate a complementary approach will need to be agreed with the Department of Environment (formerly DSEWPaC), the Queensland Department of Environment and Heritage Protection (DEHP) and the Queensland Department of Natural Resources and Mines (DNRM) so that these options satisfy the requirements of both Federal and State offset policies. The Revised Project Offset Strategy is described in detail in the SEIS Volume 4, Appendix F.

Recommendations

In recognition of the nature and scale of impacts, and the impact previous land use has had on biodiversity in the Galilee Basin, a framework is proposed to manage these impacts and assist with biodiversity recovery over the life of Project operations. It is critically important that implementation of the framework becomes a collaboration between the proponent, land managers, research organisations and government so that the package of mitigation measures are able to meet the framework's objective.

The framework will provide detailed adaptive management strategies across a number of key elements that require mitigation. The framework will be underpinned by monitoring programs and on-going research such that management actions can be appropriately targeted, implemented, and where required, modified. This approach will need to be linked to the offsets strategy for the Project so that enhancement of biodiversity occurs at both local and regional scales.

The prevention/minimisation of impacts will be achieved through the implementation of the mitigation and management measures detailed within a number of project plans:

- Project Land Management (Flora and Fauna) Plan
- Project Vegetation Management Plan
- Project Species Specific Management Plan(s) (SEIS Volume 4, Appendix C3 Rail Applications)
- Project Environmental Management Plans
- Project Rehabilitation Management Plans
- Mins Subsidence Management Plan

- Project Weed and Pest Management Plan
- Project Erosion and Sediment Management Plan
- Project Waste and Resource Management Plan and Hazardous Substances Management Plan
- Project Bushfire Management Plan (SEIS Volume 4, Appendix S2 – Bushfire Management Plan)

Regular, standardised monitoring will be a core component of the successful implementation of these plans, and provide the means for adaptive management to maintain relevance of proposed actions across the life cycle of the Project.

A number of Project commitments have been identified as part of this assessment including:

- Provide additional baseline data pre-construction to:
  - Inform and refine the potential for impact upon specific environmental features such as the black-throated finch and groundwater draw-down potential
  - Inform offset requirements for specific environmental features
  - Establish site specific thresholds for application of effective monitoring of environmental receptors
  - Enable applicable management and mitigation measures to be developed
  - Confirm relevancy of findings from EIS studies immediately prior to construction work commencement to show currency of data at that time
- Achieve implementation of Project offset commitments
- Demonstrate efficacy of Project offset commitments during the life of the Project
- Achieve monitoring of specific environmental features to demonstrate management actions are effective during construction and operational works
- Enable feedback to improve and amend management and mitigation measures applied to construction and operational works as required to maintain efficacy of those measures in protecting the environment.

All Project Environmental Management Plans will be informed by monitoring works to be completed pre-construction and during delivery of the Project. They will be adaptable and include provision for revision and update based on monitoring feedback, changes in operational or construction work plans, changes in legislation and to maintain currency against political, social and environmental circumstances.

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Appendices

1. Introduction

1.1 Project overview

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

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

The Queensland Government's EIS process has been accredited for assessment under Part 8 of the EPBC Act in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland. The Proponent prepared an EIS in accordance with the Terms of Reference (ToR) issued by the Coordinator-General in May 2011 (Queensland Government, 2011). The EIS process is managed under section 26(1) (a) of the *State Development and Public Works Act 1971* (SDPWO Act), which is administered by the Department of State Development, Infrastructure and Planning (DSDIP).

The EIS, submitted in December 2012, assessed the environmental, social and economic impacts associated with developing a 60 million tonne (product) per annum (Mtpa) thermal coal Mine in the northern Galilee Basin, approximately 160 kilometres (km) north-west of Clermont, Central Queensland, Australia (Figure 1).Coal from the Project will be transported by rail to existing Goonyella and Newlands rail systems, operated by Aurizon Operations Limited (Aurizon). The coal will be exported via the Port of Hay Point and the Port of Abbot Point over the 60 year (90 years in the EIS) Mine life. The Carmichael Rail will be operational for a period of 90 years, catering for third party operations as identified in the Carmichael Coal Mine and Rail EIS.

Project components are as follows:

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

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

Figure 1 shows the Project location and Figure 2 shows the Project infrastructure layout.

LEGEND

- Town
- Major Port
- Other Rail Network
- Goonyella System
- Newlands System
- Local Road
- Watercourse
- Local Government Area

Project (Rail)

- Rail (West)
- Rail (East)
- Project (Mine)
- Mine (Offsite)
- Quarry

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision 2
Date 14-10-2013

Project Location

Figure 1

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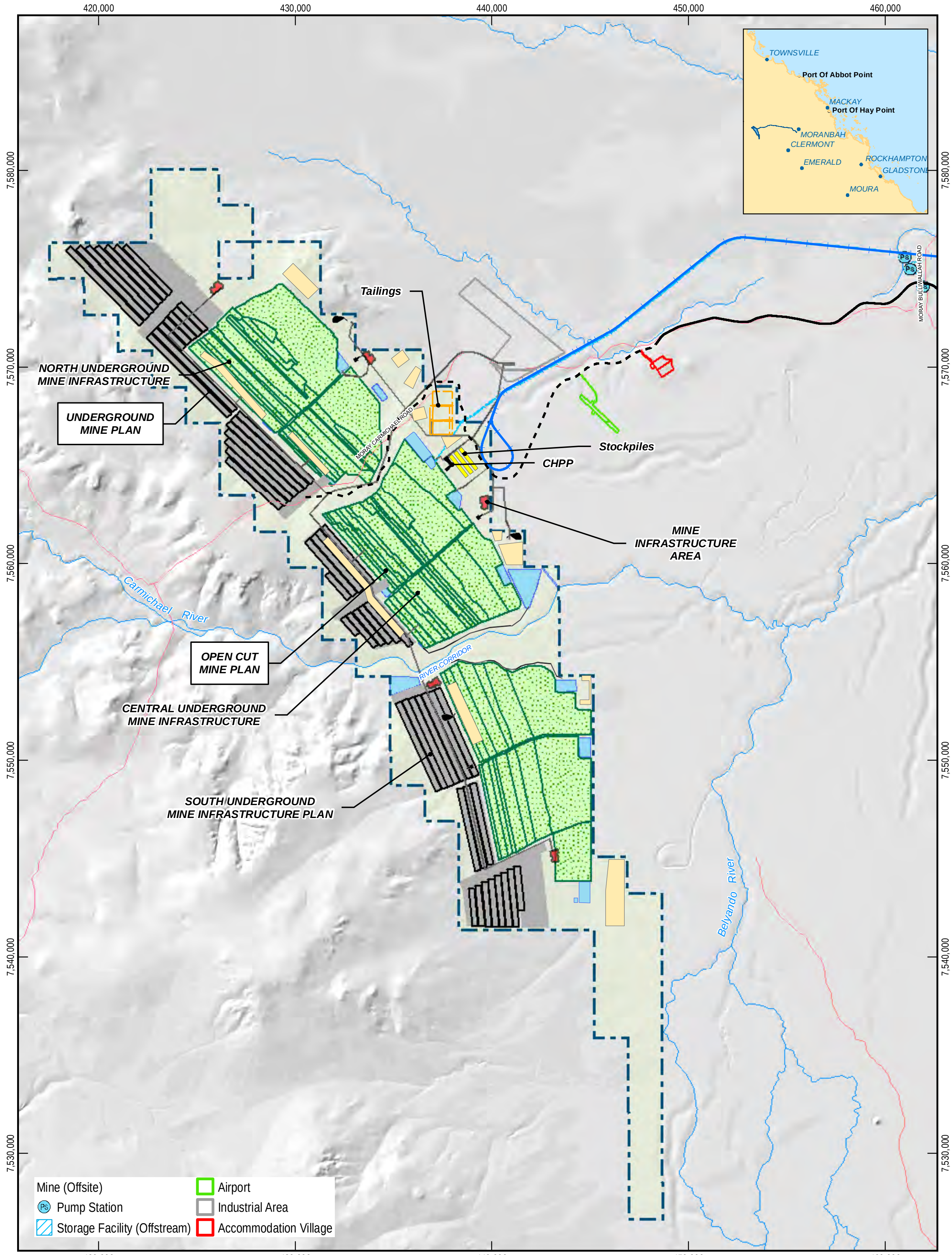
Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DNRM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008);
Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Offsite, Quarry (2013). Created by: MS



LEGEND

Local Road	Rail (West)	Open Cut Blocks	Mine Infrastructure
River / Watercourse	Mine (Onsite)	Out of Pit Waste Dumps	Stockpiles
Overland Conveyors		Water Management Dams	Tailings Cell
Road Corridor		Mine Infrastructure Area	Top Soil Storage
Road Corridor (Proposed)			

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision B
Date 25-10-2013

Project Infrastructure layout

Figure 2

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Alignment, Offsite(2013), Mine Layout / Infrastructure (2013); Created by: MS

1.2 Report scope

This report brings together assessments of impacts on matters of national environmental significance (NES) from the EIS and supplementary environmental impact statement (SEIS) technical reports (e.g. water resources, flora and fauna, cultural heritage and cumulative impacts etc.) to produce a stand-alone assessment in a format suited for assessment under the EPBC Act.

This report brings together the key baseline information contained within the following reports from the EIS and post-EIS components of the Project:

EIS

- EIS Volume 4, Appendix AA, Rail Ecology Report
- EIS Volume 4, Appendix AB – Rail Hydrology Report
- EIS Volume 4, Appendix AC – Rail Hydrogeology Report
- EIS Volume 4, Appendix J, MNES Report
- EIS Volume 4, Appendix N1, Mine Terrestrial Ecology Report
- EIS Volume 4, Appendix N2, Doongmabulla Springs Report
- EIS Volume 4, Appendix N3, Black-throated Finch Report
- EIS Volume 4, Appendix O1, Mine Aquatic Ecology Report
- EIS Volume 4, Appendix AB, Rail Hydrology Report
- EIS Volume 4, Appendix AC, Rail Hydrogeology Report
- EIS Volume 4, Appendix P1, Mine Hydrology Report
- EIS Volume 4, Appendix P2, Preliminary Water Balance
- EIS Volume 4, Appendix Q, Mine Water Quality Report
- EIS Volume 4, Appendix R, Mine Hydrogeology Report

Post-EIS

- SEIS Volume 4, Appendix C3, Rail Applications
- SEIS Volume 4, Appendix I2, Draft Subsidence Management Plan
- SEIS Volume 4, Appendix J1, Revised Ecological Assessment Report
- SEIS Volume 4, Appendix J2, Black-throated Finch Monitoring Report
- SEIS Volume 4, Appendix J3, Doongmabulla and Mellaluka Springs Report
- SEIS Volume 4, Appendix J4, Population Survey of Waxy Cabbage Palm Report
- SEIS Volume 4, Appendix J5, Offsite Infrastructure Ecological Assessment
- SEIS Volume 4, Appendix J6, Offsite Infrastructure BioCondition Report
- SEIS Volume 4, Appendix J7a, Offsite PMAV
- SEIS Volume 4, Appendix J7b, Offsite PVMP

- SEIS Volume 4, Appendix J8, Great Barrier Reef Wetland Protection Areas Report
- SEIS Volume 4, Appendix J9, Quarries EPBC Environmental Impact Assessment Review
- SEIS Volume 4, Appendix K1, Revised Mine Hydrogeology Report
- SEIS Volume 4, Appendix K2, Water Balance Report
- SEIS Volume 4, Appendix K3, Water Quality Report
- SEIS Volume 4, Appendix K4, Flood Mitigation and Creek Diversion Design
- SEIS Volume 4, Appendix K5, Revised Mine Hydrology Report
- SEIS Volume 4, Appendix K6 Groundwater Assessment Addendum

This report is specifically aimed at addressing those matters of NES present within the Study Area, including the Mine and the Rail, which are further described in Section 1.5.

1.3 Limitations and assumptions

Desktop data was a valuable resource in characterising ecological values and how they relate to matters of NES. Given the size of the Project footprint (i.e. the Study Area, as defined in Section 1.5), and the seasonal variations in both climate and species presence, it was imperative to incorporate additional sources of information into the assessment to provide the most accurate ecological understanding of matters of NES, and the potential impacts that may arise from the Project. However, the accuracy of these additional data sources may be limited where ground-truthing of historical data or mapping could not be carried out (e.g. where the presence of a given species or community was not verified).

Limitations and assumptions of the Report include:

- The requirements of the Project ToR have been supported by substantial desktop research in combination with field surveys.
- Habitat assessments and desktop species information have been used to provide an understanding of the variation in flora and fauna communities across seasonal variation.
- Where uncertainties exist in determining the likelihood of occurrence of a species within the Study Area, the more conservative of the options under consideration was adopted.
- Habitat assessments conducted during spring 2010, spring 2011, autumn 2011, autumn 2012 and autumn 2013 in conjunction with desktop species information, are considered suitable to describe the existing environment and seasonal character as it relates to potential for the Project to impact upon matters of NES.
- Amendments have been made to the location and extent of the Mine, offsite infrastructure, rail corridor, camps and rail infrastructure. These changes remain within the targeted Rail Study Area and Mine Study Area (Study Areas are defined in Section 1.5). The buffers incorporated into desktop database queries are considered sufficient to capture ecological information, in the event that small changes to the Project footprint were required. Rail field assessments are considered suitable to describe the existing environment and seasonal character as it relates to potential for the Project to impact upon matters of NES.

- The habitat mapping method was underpinned by a number of assumptions due to the large area over which predictive mapping was undertaken, and in some cases the lack of fine-scaled and species-specific habitat data.

1.4 Relationship to other actions

The Project is located within the Galilee Basin and as such, is closely related to other projects within the Galilee Basin currently under investigation or expected to commence investigations in the next five years. The following projects have been identified as having particular relevance in terms of potential cumulative impacts associated with project development, offering the opportunity for co-location of infrastructure, and/or providing necessary supporting infrastructure for the export of coal. The information provided here is summarised from details provided in EIS Volume 1 Section 1 Introduction and Section 11 Cumulative Impacts and updated to reflect ongoing consultation with the DSDIP.

The following projects currently under assessment and have been included in this assessment, as they are relevant in terms of potential cumulative impacts associated with the Project:

- Alpha Coal Project (EPBC 2008/4648, 2008/4647): Mine element
- Kevin's Corner Project (EPBC 2009/5033)
- China First Coal Project (also known as Galilee Coal Project (Northern Export Facility)) (EPBC 2009/4737): Mine element
- South Galilee Coal Project (EPBC 2010/5496)

Adani is also aware of the following proposals within the Galilee Basin; however, insufficient information is available at the time of writing (July 2013) to enable inclusion in the cumulative assessment:

- China Stone Coal Project (MacMines): development of two open cut and two underground mines with ultimate production for export of 30 Mtpa via a rail spur line linking into the proposed Project (Rail) corridor to export coal through the Port of Abbot Point. The Terms of Reference for the project was released in January 2013, and the EIS for this project is currently under preparation; as such, no further publicly available information is currently available to enable the cumulative impacts to be understood.
- Alpha West Coal Project (GVK Hancock Coal Pty Ltd): a proposed 24 Mtpa capacity underground mine located immediately to the west of the Alpha Coal Project. A concept study has been completed for this project; however, no publicly available information is currently available.
- Alpha North Coal Project (Waratah Coal): proposed coal mines located north of the proposed Alpha West Coal Project. Feasibility studies have commenced for the project; however, no publicly available information is currently available.
- Carmichael East Coal Project (Waratah Coal): located to the north of the Alpha North Coal Project within the western portion of EPC 1080, which is immediately adjacent to the western boundary of the Mine Project Area. No publicly available information is currently available for this project.

The following projects are relevant as they offer the opportunity for co-location of infrastructure:

- China First Coal Project (also known as Galilee Coal Project (Northern Export Facility)) (EPBC 2009/4737): Rail element
- Alpha Coal Project (EPBC 2008/4648, 2008/4647): Rail element
- Goonyella to Abbot Point Rail Project (EPBC 2011/6082)
- Aurizon Central Queensland Integrated Rail Project (EPBC 2012/6321)
- North Galilee Basin Rail (Adani Mining Pty Ltd): Located from Mistake Creek west of Moranbah to the Port of Abbot Point (near Bowen). The draft Terms of Reference for the project are currently undergoing public consultation and as such, have not been finalised.

The following projects are relevant as they provide necessary supporting infrastructure for the export of coal:

- Abbot Point Terminal 0 Project (EPBC 2011/6194)
- Port of Hay Point (Dudgeon Point Coal Terminals) (EPBC 2012/6240)

1.5 Project description

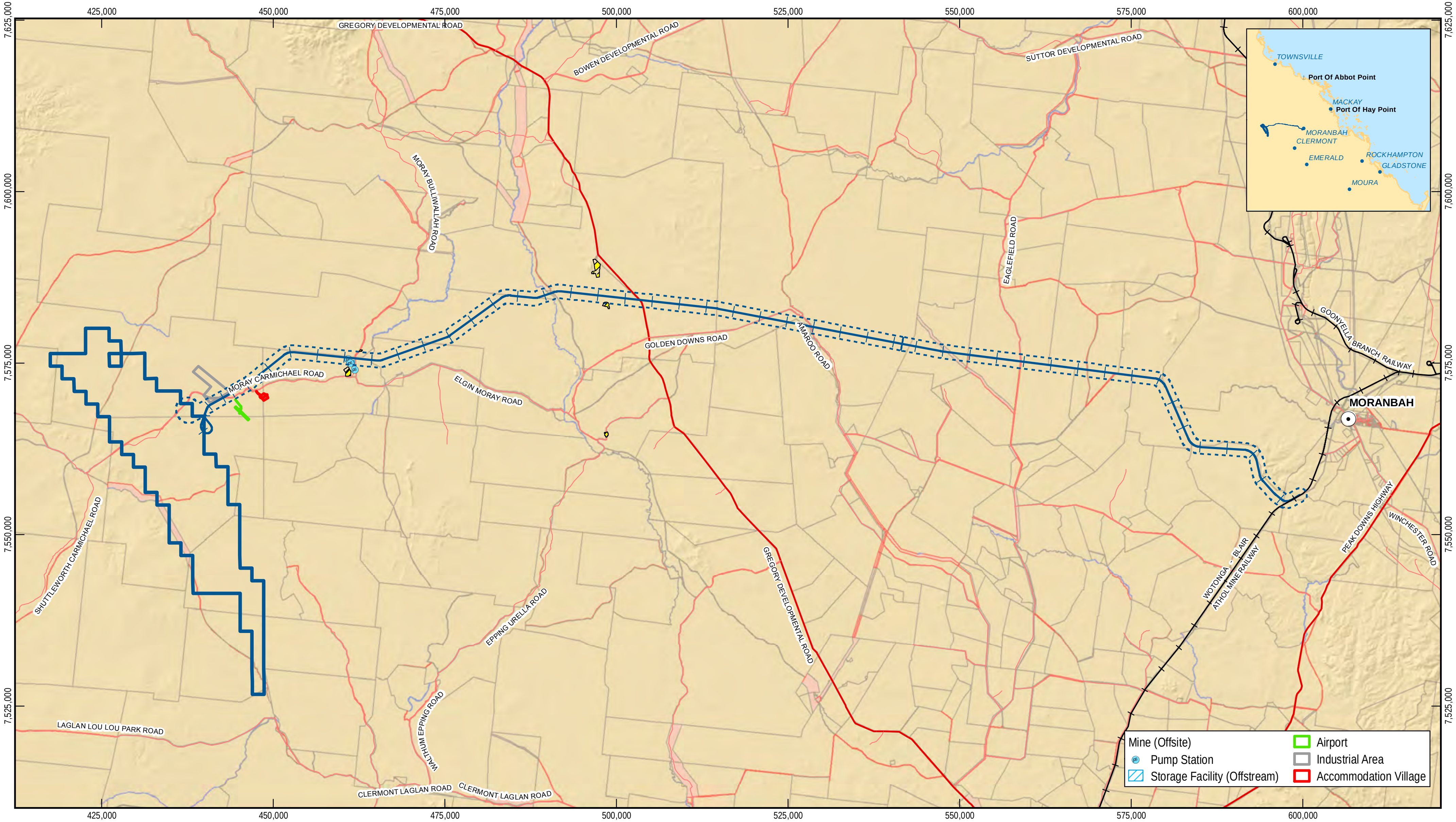
1.5.1 Overview

The EIS Volume 1 Section 1 Introduction provides detailed consideration of feasible alternatives to the Project, including project planning and locality alternatives to the Project, as well as discussion of the consequences of not proceeding with the project. The interdependencies of the Project (Mine) and Project (Rail) components are explained with regard to how each of any infrastructure requirements relate to the viability of the Project. The Study Area for this report includes the Project (Mine) and Project (Rail) Areas described below (Figure 3). Information is summarised here.

1.5.2 Project Mine

The Project (Mine) is located approximately 160 km northwest of the town of Clermont in the northern extent of the Galilee Basin in central Queensland. The Mine will be developed over EPC1690 and the eastern and northern portion of EPC1080. The Project (Mine) has access to an estimated 7.8 billion tonnes of indicated plus inferred resource. The Project (Mine) plan is based on achieving the production objective of 60 Mtpa (product) as quickly as possible and then maintaining a relatively steady rate of production over the life of the Mine. A combination of both open cut and underground mining methods are proposed to extract the coal (Figure 2). Adani has investigated potential sources of coal that meet its specific resource quantum and delivery timeframe requirements and has not identified any viable alternatives.

The Project (Mine) onsite infrastructure includes all infrastructure located within the boundary of EPC1690 and part of EPC1080. This includes (in addition to open cut and underground mining areas) a coal handling and processing plant (CHPP), tailing and reject disposal areas, power supply infrastructure and water management infrastructure (including raw water, Mine affected water, sediment affected water and process water). Planning for above ground infrastructure has been dictated by the location of the coal resource and environmental site conditions to minimise as far as possible sterilisation of the available resource or impacts to sensitive ecological values.



1:750,000 (at A4)

0 5 10 15 20 25

Kilometres

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

N

LEGEND

- Town
- State Road
- Local Road
- Other Railway
- Cadastral Parcel
- Road Reserve
- Watercourse Reserve
- Study Area
- Project (Rail)
- Project (Mine)
- Quarry

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	C
Date	17-10-2013

Mine and Rail Study Areas

Figure 3

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), DCDB (2010); DME: EPC1690 (2010)/EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013). Created by: BW, CA

The Project (Mine) offsite infrastructure includes a workers accommodation village and associated facilities, a permanent airport site, an industrial area and offsite water supply infrastructure. Offsite water supply will include:

- An off-stream storage near the Belyando River, including a ‘turkey nest’ style dam
- Pipelines connecting the water supply to the off-site infrastructure area and demand points within the proposed Mine

Since the EIS was submitted, Adani has continued to progress resource definition and Mine planning for the Project. The SEIS Volume 4, Appendix B Updated Mine Project Description includes a detailed assessment of technological alternatives for economic mining methods, and some consequential changes to the Project design since the EIS submission. Specifically the investigation had considered open cut versus underground operations and options for best utilisation of the resource with least environmental impacts. Additionally, there has been a review of infrastructure placement in order to avoid wherever possible, impacts to matters of NES and other environmental values. For example, top soil storage locations have been located to minimise environmental disturbance whilst still providing an operationally acceptable solution.

1.5.3 Project Rail

In October 2010, Adani undertook a high level desk-top assessment to identify possible rail alignments addressing the environmental, hydrological, geotechnical and civil constraints associated with four nominated west-east alignments between EPC 1690 and a connection point to the Goonyella rail system at approximately 14 km south-west of Moranbah (Figure 3).

Environmental considerations included:

- River and waterway crossings
- Wetlands, in particular those triggered under State Planning Policy 4/11 Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments, water bodies, dams, etc.
- Topography and landforms
- Regional ecosystems (REs), in particular endangered and of concern REs, high value regrowth vegetation and Essential Habitat
- The location and extent of Biodiversity Planning Assessment areas
- Indigenous cultural heritage and Native Title claims
- Environmental features such as restricted area, nature refuges and reserves
- The presence of other infrastructure (including homesteads and settlements), mining and exploration lease and permit boundaries, coal resource areas, roads, power lines and pipelines
- Strategic Cropping Land

The hydrology assessment considered constraints associated with surface water flows, specifically: waterway crossings (Belyando River, Mistake Creek, Middle Creek and Diamond Creek as well as additional major tributaries); flood prone areas; topography; distance to ‘sensitive objects’; riparian zones; and the direction of crossings.

The geotechnical assessment considered criteria that had the potential to affect the railway embankment details and soil treatments. This included the extent of black soils or reactive soils, the extent of wet or low strength soils, the extent of basalt and the extent of hard rock.

Results were considered at an Options Framing Workshop through a multi-criteria analysis (MCA). The objectives set for the Options Framing Workshop were:

- To minimise the length of waterway and wetland crossings
- Avoiding significant earthworks features
- To avoid homesteads and sensitive environmental areas
- Avoiding black soil areas as much as possible
- Keeping the total length of the corridor to a minimum
- Improve the Goonyella rail system (Moranbah Junction) approach
- Minimise impact on REs
- Provide a smoother geometry

The preferred alignment was used to initiate discussions with landowners potentially directly impacted by the alignment. A dedicated and independent Land Liaison Officer was appointed to undertake these discussions. Based on feedback received from landowners, further refinement of the alignment was undertaken. Realignment considered the placement of the preferred alignment along cadastral boundaries as far as is practicable, and the minimisation of impact on existing infrastructure, considering all constraints.

A 500 m investigation corridor was established in association with the preferred alignment and used for the assessment of impacts to inform the EIS. Through the EIS process, development of concept design and on-going liaison with potentially directly impacted landowners (as willing) the 500 m investigation corridor was reduced to a defined (though nominal) 95 m Project (Rail) alignment.

The Project (Rail) is a greenfield rail line, connecting the Mine to the existing Goonyella and Newlands rail systems, with an operational capacity of 100 Mtpa and a life of 90 years. The Project (Rail) is comprised of a 120 km, standard gauge west portion and a 69 km, narrow gauge east portion, and includes four construction camps (one combined with the Project (Mine) workers accommodation village).

It was understood that quarry and borrow pits would be required near the alignment of the Project (Rail). The EIS reflected preliminary work undertaken to identify potential quarry and borrow locations. The locations are now identified in the SEIS.

The following amendments have been made to the description of the Project (Rail) assessed in the preparation of this report for their potential impacts on matters of NES:

- Realignment of the balloon loop approximately 2 km south east, necessitating
  - Removal of the concrete batching plant at Chainage 182.500 km
  - Reorientation of the bridge laydown area at Chainage 175.500 km
  - Relocation of the turning circle at Chainage 176.000, 400 m east
  - Relocation of the turning circle at Chainage 175.400, 375 m south east

- Realignment of the rail corridor approximately 300 m north at Goodoowada and Elgin Downs properties, to sit on the boundary of Lot 637 PH1980, necessitating
  - Realignment of bridge laydown at Chainage 128.100
  - Relocation of track laydown at Chainage 126.000, 200 m north
  - Relocation of turning circle and Chainage 124.000, 200 m north
  - Relocation of bridge laydown at Chainage 123.000, 125 m north
- Relocation of Construction Camp 2 approximately 2.9 km west
- Relocation of Construction Camp 3 approximately 2 km west
- Relocation of various bridge and laydown areas to minimise impact to landholders and optimise construction of the Project (Rail)
- Relocation of the Construction Depot on Lot 4 SP116046 approximately 9 km west
- Inclusion of five quarries at:
  - Disney (Lot 4 SP116046)
  - Borrow 7 (Lot 3235 PH752)
  - North Creek (Lot 3235 PH752)
  - Moray (Lot 662 PH1491)
  - South Back Creek (Lot 656 PH138788)

Ancillary facilities associated with the quarries include:

- Crushing and screening plant (Borrow 7, Moray and South Back Creek)
- Stockpile areas
- Demountable site buildings
- Fuel storage and treatment facilities
- Water storage and treatment facilities
- Internal and external access roads

Further information on the proposed quarries is provided in SEIS Volume 4, Appendix C5 – Quarry Applications and Volume 4, Appendix J9, Quarries EPBC Environmental Impact Assessment Review.

1.5.4 Mine and Rail interdependencies

The Galilee Basin is not currently serviced by any rail infrastructure which would enable export of coal product from the proposed Mine. As such, the Project comprises both the Mine development and Rail development. However, Adani has identified the opportunity to link to current and proposed rail infrastructure to minimise the potential environment and social impacts of linear infrastructure within the rural environs. However, the two Project elements are inextricably linked and could not proceed as separable developments.

1.5.5 No action option

Adani has no other access to coal mining within Australia. A no action option, that is, that Adani does not develop the Project, would likely lead to Adani's demand for coal being met from outside of Australia.

The no action option for the Project (Mine) would see significant capital investment in Queensland/Australia totalling approximately $21.5 billion foregone. The Project (Rail) is expected to require capital expenditure totalling $1.2 billion over a three year period. The benefits of this investment will not be realised to the Queensland and national economy if the Project is not developed. Similarly, approximately 3,800 jobs directly associated with operation of the Project (Mine) and approximately 120 associated with the Project (Rail) would be foregone.

1.6 Matters of national environmental significance

The matters of NES assessed as controlling provisions for the Project are summarised in Table 1. A copy of the Protected Matters Search is included in Appendix A.

Table 1 Matters of national environmental significance of relevance to the Study Area

Significance classification	Summary
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.
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.
Wetlands (Ramsar) (section 16 & 17B)	No Ramsar wetlands within or of relevance to Study Area. Bowling Green Bay is approximately 230 km northeast of the Study Area. Shoalwater and Corio Bay is approximately 380 km southeast of the Study Area. Coongie Lakes is approximately 800 km south-west of the Study Area.
Listed threatened species and communities (sections 18 & 18a)	Nine EPBC Act listed threatened flora species previously recorded in Study Area and five identified in the Project ToR for consideration. Four EPBC Act listed threatened fauna species previously recorded in Study Area and one identified in the Project ToR for consideration. Four EPBC Act listed threatened ecological communities (TECs) with potential to occur in Study Area.
Listed migratory species (section 20 & 20A)	Eighteen EPBC Act listed migratory species predicted to occur in Study Area and one identified in the Project ToR for consideration.
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.

Significance classification	Summary
Water resources (section 24D & 24E) (Note: to be determined by Federal Environment Minister)	A number of water resources including in rivers, streams, wetlands, lakes and aquifers occur in the Study Area.

1.7 Legislative framework for matters of NES assessment

The Federal Minister for the Environment determined the Project to be a 'controlled action' under the EPBC Act on 6 January 2011, due to the potential for the Project to impact upon matters of NES. Accordingly, the Project has been carefully assessed in terms of its potential impacts on the determined controlled provisions.

The Project is required to avoid, manage and mitigate impacts as far as practical. However, if residual impacts are predicted, environmental offsets (direct or indirect) are a mechanism of last resort to compensate for adverse significant impacts of developments on matters of NES protected by the EPBC Act.

The EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) outlines the Australian Government's position on the use of environmental offsets under the EPBC Act. While offsets may not necessarily ameliorate 'onsite' impacts to matters of NES, they seek to provide a net environmental gain through targeted actions (on or offsite).

Under the EPBC Act, environmental offsets can be used to maintain or enhance the health, diversity and productivity of the environment as it relates to matters of NES protected by the Act. However, environmental offsets are not applicable to all approvals under the EPBC Act. Environmental offsets should not be applied where the impacts of a development are considered to be minor in nature or could reasonably be avoided or mitigated.

Although the State government offset policies may have the capacity to deliver offsets that will satisfy DSEWPaC's policy and the requirements of the EPBC Act, it should not be assumed that an offset, which satisfies State requirements, would automatically satisfy the requirements of the EPBC Act. As such, the offset options will need to be agreed with DSEWPaC and the relevant State government agencies on a suitable outcome that satisfies both EPBC Act and State offset policy.

1.8 Methodology of assessment

1.8.1 Overview

Predictions of the extent of impact to matters of NES and the benefits of any mitigation measures proposed should be based on sound science and quantified where possible. The areas of investigation referred to and defined in the following sections include:

- Project (Mine) Study Area: EPC 1690, EPC 1080 and the Mine offsite infrastructure
- Project (Rail) Study Area: a 500 m wide investigation area that encapsulates the Project (Rail) infrastructure corridors over the length of approximately 189 km between the Carmichael Mine and Moranbah Area, and five quarry areas.

This report considers both the Rail and Mine components of the Project; therefore, the Study Area for this report is defined to include both the Rail and Mine Study Areas (see Section 1.5

and Figure 3), unless otherwise specified. A description of the existing environmental 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, database searches and existing technical reports. Field studies were conducted to obtain information for all relevant matters of NES for the Project and to ground-truth results from desktop assessments. Scientific and common names for flora and fauna described are consistent with those used in published sources described in SEIS Volume 2, Section 5 Mine Nature Conservation and SEIS Volume 3, Section 5 Rail Nature Conservation.

1.8.2 Desktop assessment

Information relating to the terrestrial and aquatic ecological values of the Study Area was obtained from a variety of literature and database sources, including numerous state databases. These have been used to understand values of relevance to matters of NES protected under State legislation, which are not identified by the Protected Matters Search Tool, but have been previously recorded in the Study Area. Details of the sources of relevance to matters of NES protected under the EPBC Act are provided in Table 2. The data sources used for the Population Survey of Waxy Cabbage Palm Report focussed on Australian herbaria records and a range of peer-reviewed scientific literature (for the full reference list, please refer to SEIS Volume 4, Appendix J4 Population Survey of Waxy Cabbage Palm Report).

Table 2 Summary of desktop sources

Source and name	Description of information source	Desktop Search extent	Limitations of use
DSEWPaC Protected Matters Search Tool and Environmental Reporting Tool	The DSEWPaC Protected Matters Search Tool identifies matters of NES and other matters of NES protected by the EPBC Act that may occur within or relate to the Study Area. The tool predicts the potential presence of a species/ecological community in an area based on bioclimatic modelling, known distribution and habitat preferences. The DSEWPaC Environmental Reporting Tool was also queried to provide information on invasive species that have the potential to occur, and nationally and internationally important wetlands within or near the Study Area.	Rail Study Area searches (approximating with the centrelines of the rail corridors of the Study Area (-22.01, 146.37 – western extent; -22.10, 147.96 – eastern extent) with 10 km buffers were undertaken. For the quarries, a 10 km radius search centred on each quarry site was used. Mine and Mine (offsite) Study Area, a point search (approximating with the centre of the Mine Study Area (-22.041, 146.364) with a 50 km buffer was searched. For the Doongmabulla and Mellaluka Springs, a point search at approximately the centre of the Study Area (-22.083, 146.247 for the Doongmabulla wetland; -22.317, 146.482 for the Mellaluka wetland) with a 5 km buffer was searched.	This is a predictive tool only – it does not necessarily indicate that a species/ecological community occurs in a defined area. In predicting species/community presence, it allows for field survey efforts to be targeted.
DSEWPaC Directory of Important Wetlands	The Directory identifies nationally and internationally important wetlands. The DSEWPaC Protected Matters Search Tool (see above) lists nationally and internationally important wetlands occurring within or related to prescribed search extents.	Rail Study Area searches (approximating with the centrelines of the rail corridors of the Study Area (-22.01, 146.37 – western extent; -22.10, 147.96 – eastern extent) with 10 km buffers were undertaken. Point searches using central coordinates of each quarry area, each with a 2 km buffer, were undertaken. Mine and Mine (offsite) Study Area, a point search (approximating with the centre of the Mine Study Area (-22.041, 146.364) with a 50 km buffer was searched via the DSEWPaC Environmental Reporting Tool. For the Doongmabulla and Mellaluka Springs, a point search at approximately the centre of the Study Area (-22.083, 146.247 for the	This mapping identifies the location of wetlands that satisfy at least one criterion agreed upon by the Australian and New Zealand Environment and Conservation Council (ANZECC) Wetlands Network in 1994. The mapping may be limited by the currency and quality of available data.

Source and name	Description of information source	Desktop Search extent	Limitations of use
		Doongmabulla wetland; -22.317, 146.482 for the Mellaluka wetland) with a 5 km buffer was searched.	
Birds Australia Bird Atlas Data	Birds Australia maintains a database of bird records from across Australia. This database includes species of NES.	Rail Study Area a rectangular area was searched, approximating with the centreline of the Rail Study Area (-22.01, 146.37 – western extent; -22.10, 147.96 – eastern extent) with a 10 km buffer. Mine and Mine (offsite) Study Area a rectangular area was searched, such that the diagonal extending from the approximate centre of the Mine Study Area (-22.041, 146.364) to each corner was 50 km. The co-ordinates of the search were between latitudes -21.598 and -22.512, and longitudes 145.865 and 146.837. For the Doongmabulla and Mellaluka Springs, a one degree square containing the point 146.23717, -22.32246 was searched.	This database catalogues known records of species in a defined area. The age and lack of spatial precision of species records may limit their value for inclusion in current studies in some instances.
Queensland Department of Natural Resources and Mines (DNRM) Regional ecosystem (RE) mapping	The Queensland DNRM maps remnant vegetation using the RE classification system (DERM, 2010a). REs are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil (Sattler and Williams, 1999). REs are classified under the Queensland *Vegetation Management Act 1999* as being endangered, of concern or least concern. REs were used to define potential habitat for threatened species, ecological communities and migratory species.	Mapping was obtained for the Study Area and the adjacent landscape in an electronic data layer for analysis in a Geographic Information System (GIS).	RE mapping is informed by interpretation of landform, substrate, photo/satellite imagery and where available, field data. The mapping has undergone little or no ground-truthing in many parts of Queensland. Because of this, and the scale at which the mapping is created, RE mapping does not always accurately depict vegetation assemblages on the ground.

Source and name	Description of information source	Desktop Search extent	Limitations of use
DNRM Essential habitat mapping	Essential habitat is defined as 'vegetation in which a species that is endangered, vulnerable or near threatened under the NC Act has been known to occur' (DERM, 2011a). DNRM maps Essential Habitat (and Essential Regrowth Habitat) in conjunction with remnant and regrowth vegetation mapping (DERM, 2010b).	Mapping obtained for the Study Area and adjacent landscape in an electronic data layer for GIS analysis.	As Essential Habitat and Essential Regrowth Habitat mapping is underpinned by RE/regrowth mapping, the constraints associated with mapping scale and lack of ground-truthing of REs are applicable to this information source.
Department of Environment and Heritage Protection (DEHP) Wetland mapping	Various mapping layers produced by DEHP (including Wetland Protection Areas).	Mapping obtained for the Study Area and adjacent landscape in an electronic data layer for GIS analysis.	Wetlands are identified using the DEHP AquaBAMM Methodology – the on-ground values of individual wetlands identified through this methodology have not necessarily been assessed, as designation is primarily based on existing literature and expert opinion. As such, designation does confirm the value of these systems for local flora and fauna.
DEHP Biodiversity Planning Assessment (BPA) mapping – Brigalow Belt bioregion and Desert Uplands bioregion and Biodiversity Planning Assessment expert panel reports	Identifies landscape scale biodiversity features at varying levels of significance (local, regional, state). The mapping methodology is underpinned by DNRM's remnant vegetation (i.e. RE) mapping. Expert panel reports provide information on the landscape-scale values of bioregions, and in some instances identify bioregional priority taxa.	Mapping obtained for the Study Area and adjacent landscape in an electronic data layer for GIS analysis.	As BPA mapping is underpinned by RE mapping, the constraints associated with mapping scale and lack of ground-truthing of REs is applicable to this information source.

Source and name	Description of information source	Desktop Search extent	Limitations of use
DEHP Burdekin Natural Resource Management Region Back on Track Actions for Biodiversity report (DERM, 2010c)	This document identifies priority species in the Burdekin Natural Resource Management (NRM) region, details the regional threatening processes impacting upon these species, and proposes a range of actions to address regional threats. Priority taxa are identified through the DEHP Back on Track species prioritisation framework, in consultation with a range of stakeholders from the region. The document seeks to guide priority species conservation in the region over the next five years.	The document covers the entire Burdekin NRM region (in which a large portion of 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.
DEHP Wildlife Online database	The DEHP Wildlife Online database (DERM, 2011b) maintains a catalogue of animal and plant species records from specific localities across Queensland. As well as common species, records of animals and plants listed as threatened under the NC Act are contained within the database.	A rectangular area was searched, approximating with the centreline of the Study Area (-22.01, 146.37 – western extent; -22.10, 147.96 – eastern extent) with a 10 km buffer was undertaken. For the Mine (offsite) Area, a point search approximating the centre of the Mine (offsite) Area (-22.041, 146.364) with a 50 km buffer was used. For the Doongmabulla and Mellaluka Springs, a point search at approximately the centre of the Study Area (-22.083, 146.247 for the Doongmabulla wetland; -22.317, 146.482 for the Mellaluka wetland) with a 5 km buffer was searched. For the quarries, a 50 km search radius around the approximate centre of Project Area was used (CDM Smith, 2013).	This database catalogues known records of species in a defined area. DEHP recommend that independent verification of records should be undertaken to inform the accuracy and completeness of information catalogued within this database (i.e. field surveys).

Source and name	Description of information source	Desktop Search extent	Limitations of use
DEHP (Queensland Herbarium) HERBRECS specimen database	The HERBRECS database catalogues flora specimen records obtained throughout Queensland.	A rectangular area was searched, approximating with the centreline of the Study Area (-22.01, 146.37 – western extent; -22.10, 147.96 – eastern extent) with a 20 km buffer. For the Mine (offsite) Area and Springs, a rectangular area was searched, such that the diagonal extending from the approximate centre of the Mine (offsite) Area (-22.041, 146.364) to each corner was 50 km.	This database catalogues known records of species in a defined area. The age and lack of spatial precision of species records may limit their value for inclusion in current studies in some instances.
Queensland Museum Queensland Museum Data Search	The Queensland Museum catalogues vertebrate fauna specimen records obtained throughout Queensland.	A rectangular area was searched, approximating with the centreline of the Study Area (-22.01, 146.37 – western extent; -22.10, 147.96 – eastern extent) with a 10 km buffer. For the Mine (offsite) Area, a rectangular area was searched, such that the diagonal extending from the approximate centre of the Mine (offsite) Area (-22.041, 146.364) to each corner was 50 km. For the Doongmabulla and Mellaluka Springs, a rectangular area was searched, such that the diagonal extending from the approximate centre of the Study Area (−22.083, 146.247) to each corner was 5 km. The co-ordinates of the search were between -22.032 and -22.124 south and 146.192 and 146.296 east.	This database catalogues known records of species in a defined area. The age and lack of spatial precision of species records may limit their value for inclusion in current studies in some instances.
Global Biodiversity Information Facility Atlas of Living Australia	The Atlas of Living Australia is an aggregation of information on Australian species, as provided by museums, herbaria, community groups, government departments, individuals and universities.	A search undertaken for each of the five quarry locations.	This database catalogues known records of species in a defined area. The age and lack of spatial precision of species records may limit their value for inclusion in current studies in some instances. Unverified observations are also presented by members of the public.

Source and name	Description of information source	Desktop Search extent	Limitations of use
Burdekin Dry Tropics & Australian Government (Carter and Tait 2008) Freshwater Fish of Burdekin Dry Tropics Natural Resource Management (NRM) Region	The report documents the diversity and distribution of freshwater fish species within the Burdekin Dry Tropics NRM Region.	The document covers the entire Burdekin Dry Tropics NRM region (in which the Study Area occurs).	Some species listed in this document are not relevant to the Study Area, as the Burdekin Dry Tropics NRM region encompasses a large area of central Queensland. Species distributions are described in terms of sub-catchments and distribution maps are useful to identify species with potential to occur in the Study Area.
DEHP (Natural Resources and Environment Division) Expert Panel Reports: Burdekin Region (DERM, 2009a, b, 2011c)	These three reports; aquatic fauna, aquatic flora and aquatic ecosystems, are part of the Aquatic Conservation Assessment for riverine and non-riverine wetlands in the Great Barrier Reef (GBR) catchment. The reports identify rare and threatened, priority and exotic species, species richness, and priority ecosystems and special features of the 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.

1.8.3 Field surveys

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

EIS Volume 2, Section 5 Mine Nature Conservation and Volume 3, Section 5 Rail Nature Conservation describe in detail the approaches completed for field surveys. Additional surveys were carried out post EIS in 2013 including:

- Black-throated finch surveys
- Doongmabulla and Mellaluka Springs survey
- Waxy Cabbage Palm survey
- Mine Offsite Infrastructure Area survey
- Quarries matters of NES survey

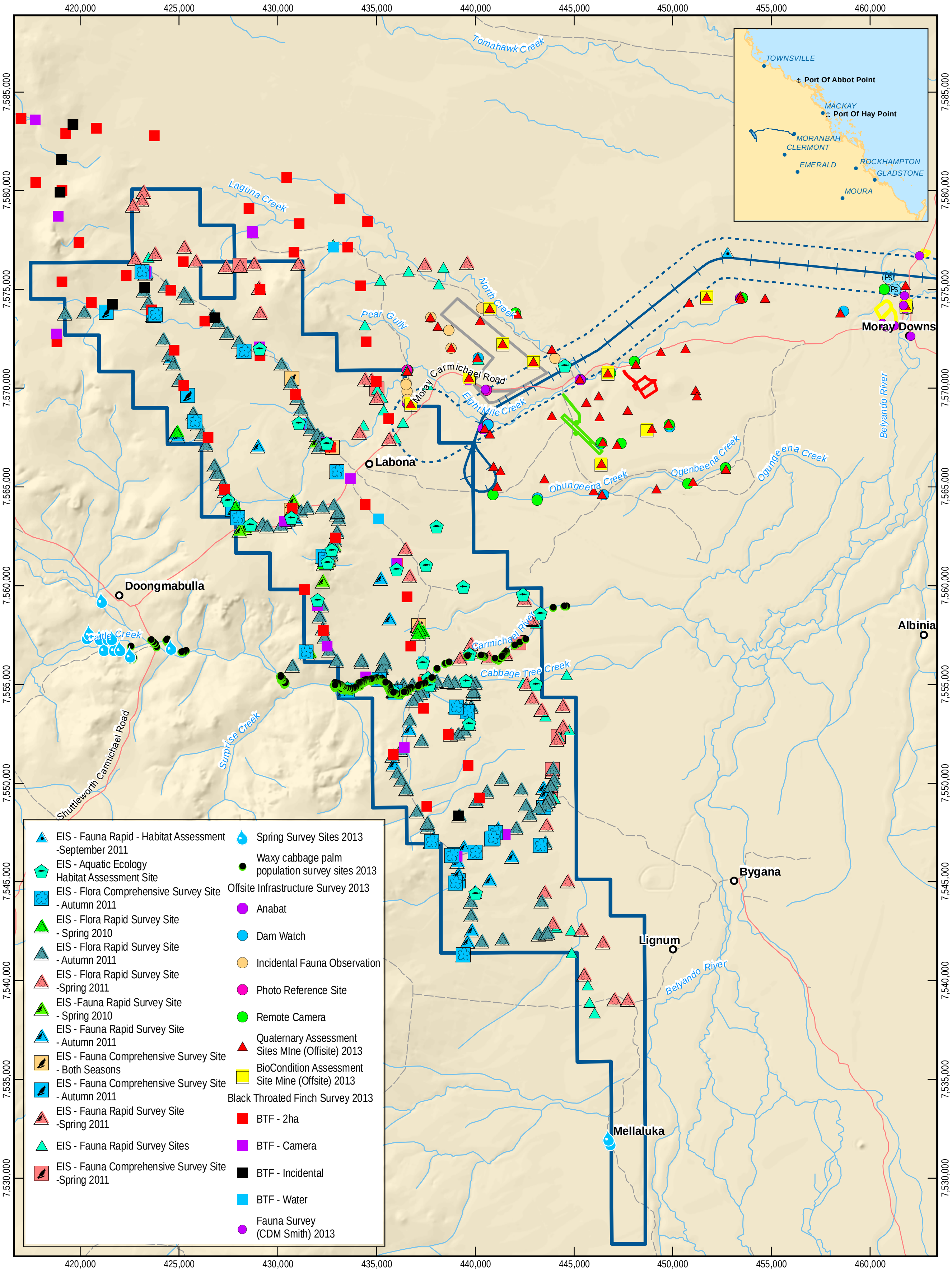
Temporally separated field surveys of direct relevance to matters of NES (refer Table 3) were conducted across the different geographies of the Project to identify the existing terrestrial and aquatic biodiversity values. Figure 4 depicts the survey effort that was completed across the Project geography.

Table 3 Survey effort

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic flora	24 sites, 3 sites 24 sites, 1 site	Autumn: May 2011 Spring: September 2011
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Rail Study Area	Assessments for Property Maps of Assessable Vegetation	Various sites along corridor	Winter: June/July 2012
Mine Study Area	Terrestrial and aquatic flora	60 sites, 19 sites 168 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Mine Study Area	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Mine Study Area	Doongmabulla and Mellaluka Springs survey	Unstructured opportunistic survey effort	Autumn: May 2012

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Offsite Infrastructure Area	Black-throated finch targeted surveys	9 water watch sites, 31 watch sites, 6 remote camera sites	Autumn: May 2012
Post EIS			
Rail Study Area	Quarries matters of NES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Mine Study Area	Black-throated finch surveys	8 water body counts, 20 remote camera sites, 52 habitat and finch survey sites, 8 incidental observation sites	Autumn: May 2013
Mine Study Area	Doongmabulla and Mellaluka Springs survey	Unstructured opportunistic survey effort	Autumn: May 2012 Autumn: March/April 2013
Mine Study Area	Waxy Cabbage Palm survey	Population survey along 17.5 km of the Carmichael River	Autumn: April 2013
Offsite infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013
Offsite infrastructure Area	BioCondition	10 sites	Autumn: April/May 2013
Offsite infrastructure Area	PVMP and PMAV	49 flora sites	Autumn: April/May 2013

Note: *a combination of rapid and comprehensive survey approaches were used across sites (defined in following sections)



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Study Area
- Project (Rail)
- Project (Mine)
- Quarry
- Mine (Offsite)
- Pump Station
- Storage Facility (Offstream)
- Airport
- Industrial Area
- 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

GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Terrestrial and Aquatic Field Survey Sites

Job Number	41-26422
Revision	C
Date	17-10-2013

Figure 4
Sheet 1 of 5

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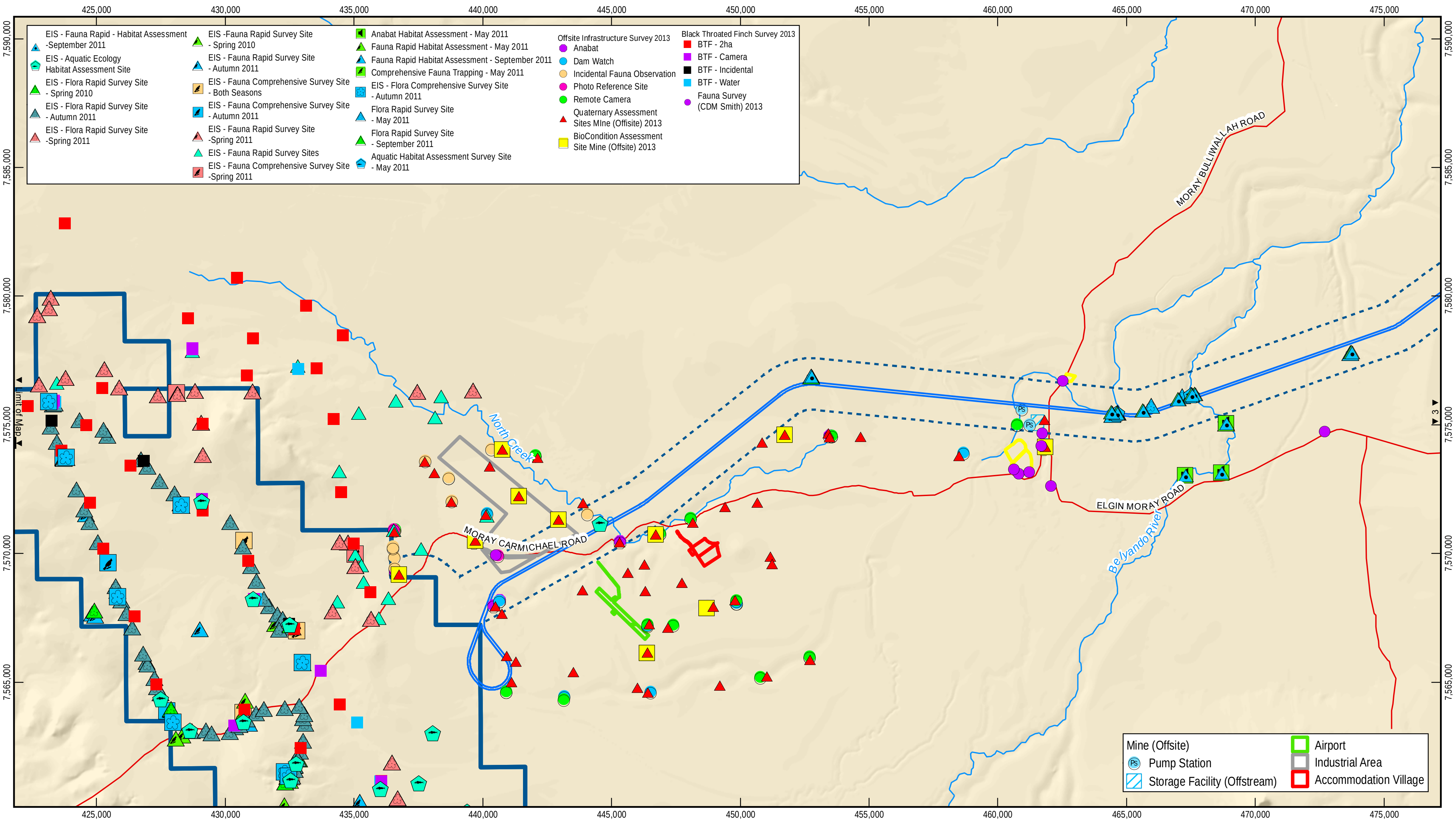
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GHD: Fauna Survey Sites (2010), Study Area, Fauna Survey Sites (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Road, Homestead, Watercourse (2007); DME: EPC 1690 (2010)/EPC 1080 (2011); CDM Smith: Fauna Survey (2013); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013). Created by: BW, MS



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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

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Quarry
- Rail (West)
- Rail (East)
- Project (Mine)

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Terrestrial and Aquatic Field Survey Sites

Job Number	41-26422
Revision	B
Date	17-10-2013

Figure 4
Sheet 2 of 5

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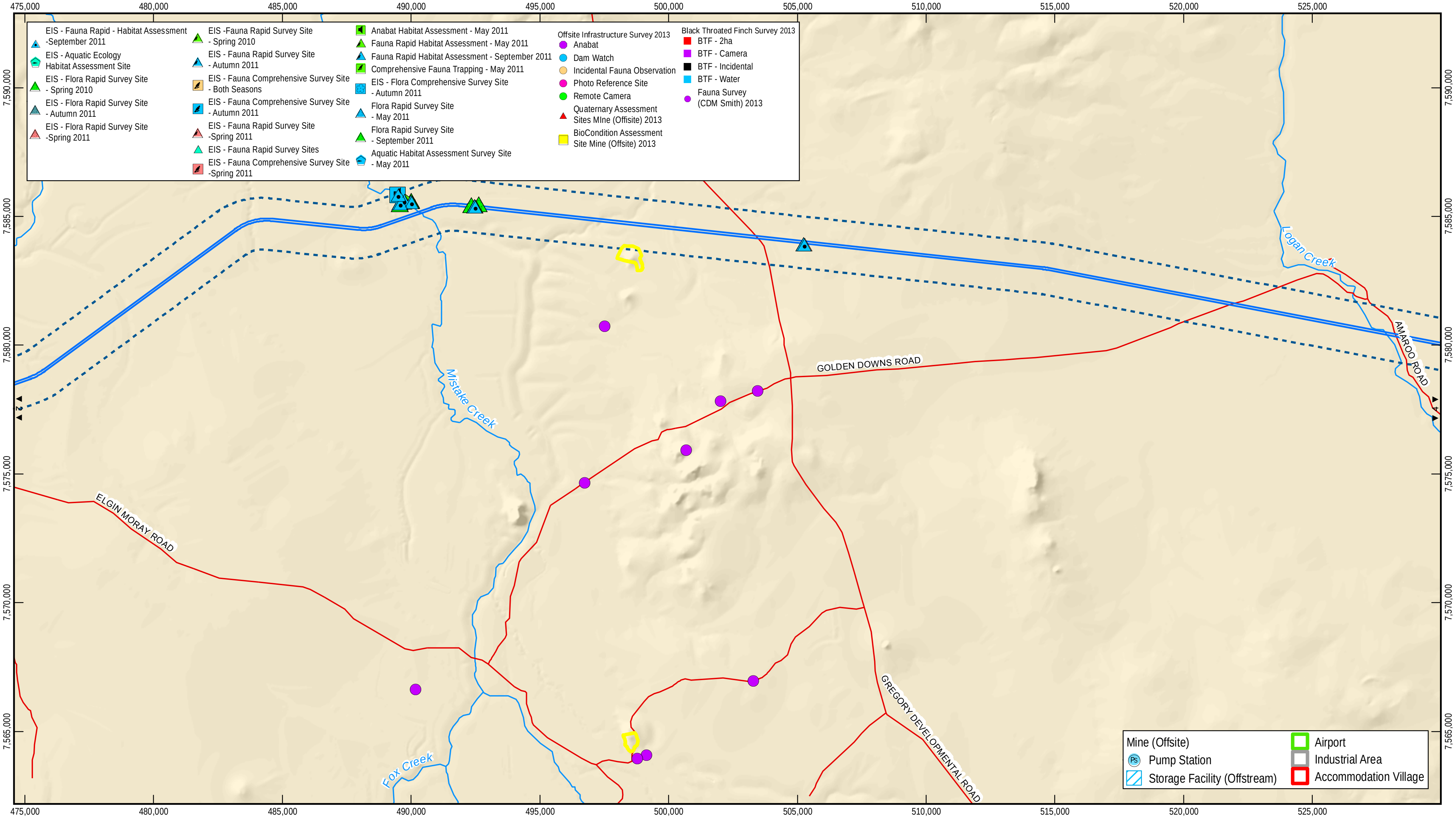
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Squatter Pigeon Habitat (2012); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Sightings (2012);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011); GHD/CDM Smith: Survey Sites (Various Years). Created by: MS



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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

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Quarry
- Rail (West)
- Rail (East)
- Project (Mine)

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Terrestrial and Aquatic Field Survey Sites

Job Number	41-26422
Revision	B
Date	17-10-2013

Figure 4
Sheet 3 of 5

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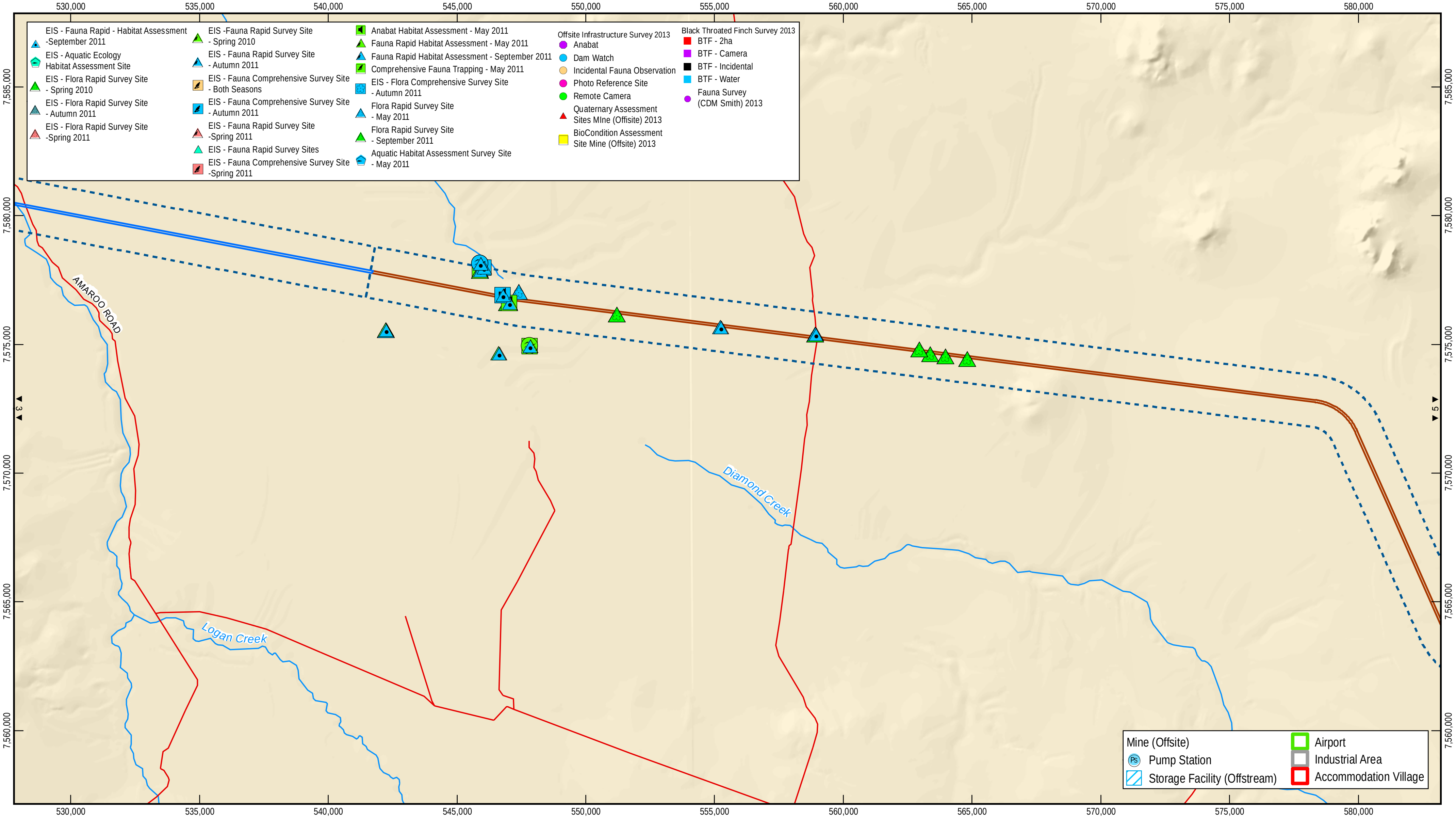
Data source: DNRM: DEM (2008), Potential Squatter Pigeon Habitat (2012); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Sightings (2012); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011); GHD/CDM Smith: Survey Sites (Various Years). Created by: MS



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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

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Quarry
- Rail (West)
- Rail (East)
- Project (Mine)

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Terrestrial and Aquatic Field Survey Sites

Job Number	41-26422
Revision	B
Date	17-10-2013

Figure 4
Sheet 4 of 5

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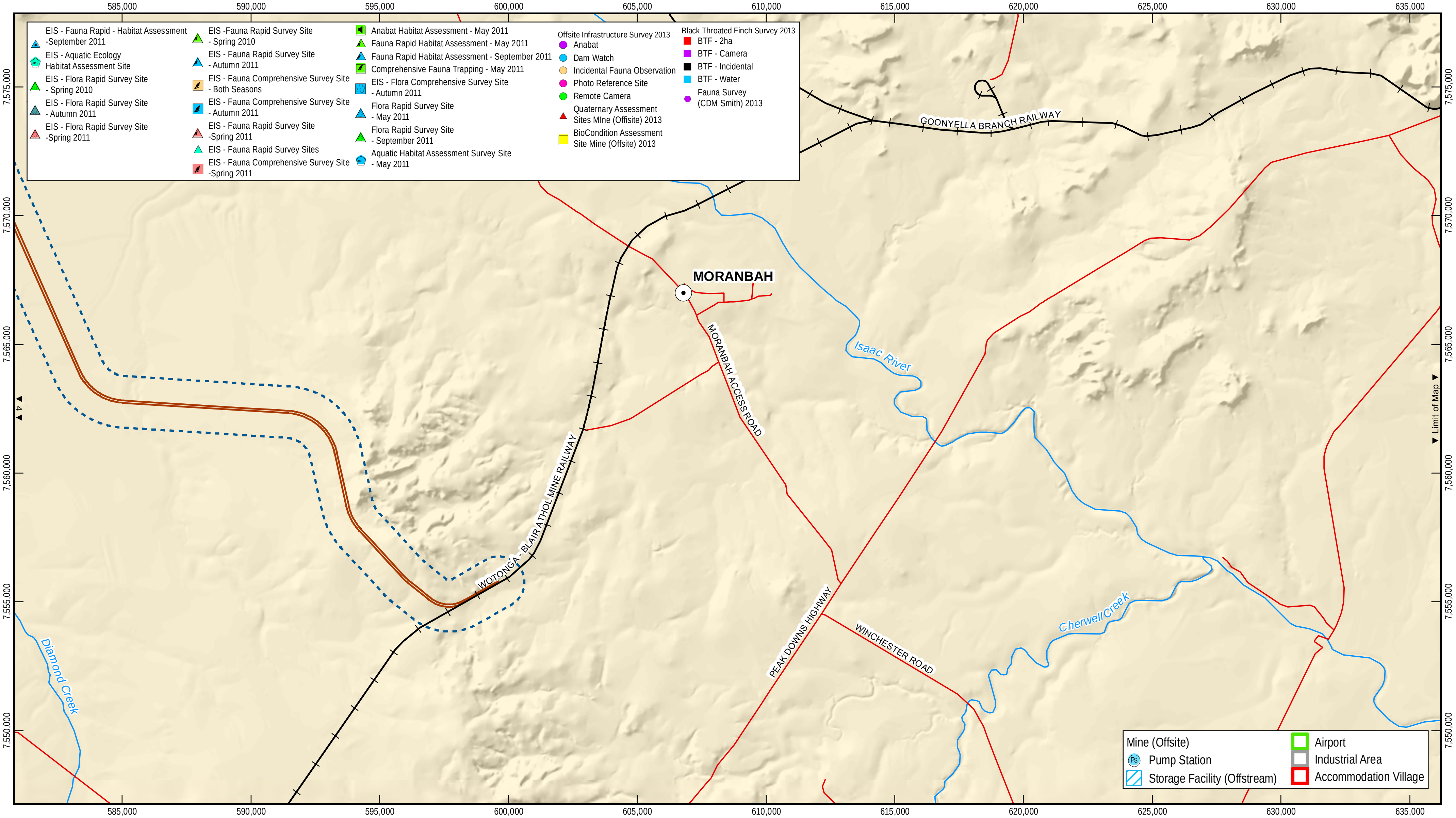
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Squatter Pigeon Habitat (2012); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Sightings (2012);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011); GHD/CDM Smith: Survey Sites (Various Years). Created by: MS



1:200,000 (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

LEGEND

Town
Road
Other Railway
Watercourse
Study Area
Quarry
Rail (West)
Rail (East)
Project (Mine)

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Terrestrial and Aquatic Field Survey Sites

Job Number	41-26422
Revision	B
Date	17-10-2013

Figure 4
Sheet 5 of 5

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Squatter Pigeon Habitat (2012); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Sightings (2012); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011); GHD/CDM Smith: Survey Sites (Various Years). Created by: MS

1.8.3.1 *Terrestrial flora survey techniques*

Flora survey efforts employed standardised approaches recognised by regulatory agencies for describing the existing floristic environment and to inform the presence of any protected species. The assessments conducted identified whether EPBC Act protected taxa were present, and whether mapped threatened ecological communities (TECs) at a Queensland Regional Ecosystem (RE) occurred. A summary of various flora survey methods used during the Project is provided in Table 4.

Table 4 Summary of terrestrial flora survey methods

Comprehensive survey sites	Rapid survey sites	Targeted and random meander searches
• CORVEG secondary site methodology used • Quadrat sampling (500 m^2) • Complete site lists of woody and non-woody flora species • Three measures of abundance collected for woody species, non-woody species relative abundance measured • RE verification • General site description with notes recorded on landform, geology, soils, past disturbance & weeds • All sites photographed extensively	• Equates to a quaternary CORVEG site • Plotless sampling technique • Level of detail collected varies – at all sites, dominant species recorded • Extensive species lists generated at a number of sites • RE verification • Brief notes recorded on landform, geology, soils, weeds	• Literature review conducted to determine habitat requirements of rare and threatened species • Targeted searches conducted onsite based on habitat requirements • Random meander searches were also utilised

Floristic surveys were conducted using CORVEG methodologies defined by the Queensland Herbarium (Neldner et al., 2005), with the objective to investigate the suite of vegetation types occurring within the Study Area. Field surveys were conducted in areas of remnant vegetation including mapped REs. Flora sampling methods included:

- 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

1.8.3.2 *Terrestrial fauna survey techniques*

For the purposes of this assessment, terrestrial fauna are defined as animals that only spend limited periods of time in aquatic environments. This includes amphibians and semi-aquatic species such as water birds. Species considered as aquatic fauna include obligate aquatic species (fish, freshwater turtles and aquatic macroinvertebrates).

Terrestrial fauna survey methods used for comprehensive and rapid surveys during the Project are summarised in Table 5.

Table 5 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) • Remote cameras set for a series of night monitoring events • Habitat assessment • Opportunistic search for wildlife traces • Standardised (20 minute) bird surveys • Active searches for herpetofauna • Ultrasonic bat detection (Anabat) • Standardised spotlighting for nocturnal fauna • Call-playback for owls and frogs	Completed at all rapid assessment sites: • Habitat assessment Completed at some rapid assessment sites: • Opportunistic search for wildlife traces • Standardised (20 minute) bird surveys • Active searches for herpetofauna • Ultrasonic bat detection (Anabat) • Standardised spotlighting for nocturnal fauna • Call-playback for owls and frogs • Remote cameras set for a series of night monitoring events • Waterbody watches	• Remote cameras set for a series of night monitoring events • Waterbody watches • Opportunistic wildlife records

Fauna habitat assessments (rapid assessments) were undertaken at each of the different vegetation communities encountered within the Study Area. Where possible, these sites coincided with the locations of rapid flora assessments. Habitat assessments were also undertaken at comprehensive survey sites. Habitat assessments provided information on vegetation characteristics, microhabitats, adjacent land uses, connectivity, evidence of faunal presence, and overall inferred value of habitat for fauna species.

The following parameters were recorded during habitat assessments:

- 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)

In general, targeted surveys for threatened species were incorporated into the sampling methodologies outlined in Table 5 (i.e. ground-trapping and opportunistic searches for threatened reptiles, Anabat detection for threatened bats). Survey guidelines for threatened species prepared by the Australian Government were reviewed for those threatened species considered likely to occur, or confirmed present in the Study Area, including black-throated finch (southern) (*Poephila cincta cincta*), squatter pigeon (southern) (*Geophaps scripta scripta*), ornamental snake (*Denisonia maculata*) and yakka skink (*Egernia rugosa).*

It should be noted that at the time field surveys for the Project were undertaken, the koala was not a listed threatened species (Federal). As such, targeted surveys for this species were not undertaken although fauna surveys conducted, including habitat assessments, scat searches and spotlighting, provide information relating to this species.

A targeted black-throated finch (southern) survey was undertaken in May 2012 and May 2013. A summary of the targeted black-throated finch (southern) survey effort is provided below and full details are presented in EIS Volume 4 Appendix N3 Black-throated Finch Report and SEIS Volume 4 Appendix J2 Black-throated Finch Monitoring Report. A combination of three survey methods was used based on the recommended methods within the Significant Impact Guidelines for the Black-throated Finch (southern) (*Poephila cincta cincta*) (hereafter, the 'Black-throated Finch (southern) Significant Impact Guidelines') (DEWHA, 2009b). These methods comprised water source watches, 2 ha counts and remote fauna cameras.

Water source watches were undertaken within and adjacent to the Study Area following the recommended methods outlined in the 'Background Paper' to the Black-throated Finch (southern) Significant Impact Guidelines (DEWHA, 2009b)[1]. Water source watches were conducted at nine different water sources for close to 28 person hours.

Standardised bird surveys were undertaken at each assessment site using the methods recommended for surveys by Birds Australia. This involved a timed 20-minute (minimum) survey of a 2 ha search area by one ecologist, recording the number of birds seen or heard calling, and the presence and composition of any mixed flocks. A total of 31 searches with a total of 21 person hours were dedicated to bird surveys within the Study Area.

Remote fauna surveillance camera surveys involved the use of un-manned motion-sensing cameras that were set up and left *in situ* to detect fauna over an extended period. Nine cameras were installed at six different water sources where water source watches were also performed.

1.8.3.3 Aquatic ecosystems and flora survey techniques

Aquatic habitat assessments were undertaken at sites within the Study Area to characterise water bodies with respect to ecological values for aquatic flora and fauna. Although not all sites held water during all survey events seasonal assessment was completed across the Study Area to confirm the presence or absence of aquatic habitat temporally. Figure 4 shows the aquatic survey sites.

An assessment site is defined as a 100 m reach for water bodies and includes bed and banks. The assessment considers all the habitats within this area. 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. This was

[1]Note: DSEWPaC indicated on 4 July 2011 that black-throated finch (southern) surveys conducted as part of EIS studies satisfied its requirements for presence/absence surveys for the subspecies(meeting between DSEWPaC and GHD).

achieved using a standardised pro-forma approach modelled on the Queensland Australian River Assessment System (AusRivAs) assessment protocols.

Aquatic flora (macrophyte) assessment was undertaken in conjunction with habitat assessments. Riparian vegetation assessment was conducted across the Study Area as part of the dedicated terrestrial flora assessments (refer Section 4).

1.8.3.4 Aquatic fauna assessment

In field aquatic assessments were used to supplement desktop information on fauna in the region and provide information specific to the Study Area. Given the highly variable flow regime of watercourses in the catchment, desktop information is valuable for providing data that cannot be captured during all seasonal conditions.

During 2011, surveys for fish and crustaceans were undertaken within water bodies that provided adequate habitat for trapping using box and opera house traps. Given the drier conditions on the earlier survey event trapping generally occurred during the May survey event. The sites selected for fauna assessment are 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, which are considered to have lower habitat values. 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.

Aquatic macroinvertebrate sampling was undertaken in accordance with the Queensland AusRivAS assessment protocols (DNRM, 2001). The assessments were undertaken using field sampling and live pick procedures, laboratory analysis and community data analysis. Sampling of macroinvertebrate taxa not considered by AusRivAS (e.g. crabs) was also completed.

Desktop searches indicate one threatened aquatic species, the freshwater sawfish (*Pristis microdon*) has been historically recorded in the Burdekin Catchment adjacent to the Study Area; however, it is highly unlikely to occur within the Study Area (unsuitable habitat, barriers to movement) and accordingly dedicated searches for this taxa were not required.

1.8.4 Likelihood of occurrence assessment

The information acquired through the desktop and field assessments described above was used to characterise the existing terrestrial and aquatic ecological values of the Study Area, as relevant to matters of NES. All potential impacts to each matter of NES identified as a controlling provision for the Project has then be considered and assessed. For conservation significant flora and fauna species, a likelihood of occurrence assessment was undertaken to filter listed threatened or migratory species that could potentially occur at the site to focus assessment on those taxa that are known, likely or may occur at the site. This was used to inform the impact identification process.

Determination of likelihood of occurrence considered information relating to:

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

- The occurrence of suitable habitat at the Study Area based on field observations
- The confirmed presence of conservation significant species at the Study Area

A likelihood of occurrence ranking was attributed to each conservation significant species, based on the following framework:

- **Unlikely to occur**: species has not been recorded in the region (no records from desktop searches) **AND/OR** current known distribution does not encompass Study Area **AND/OR** suitable habitat is generally lacking from the Study Area.
- **May occur**: species has not been recorded in the region (desktop searches) although species' distribution incorporates Study Area **AND** potentially suitable habitat occurs at the Study Area.
- **Likely to occur**: species has been recorded in the region (desktop searches) **AND** suitable habitat is present at the Study Area.
- **Confirmed present**: species recorded during field surveys at the Study Area.

For other matters of NES, impact identification and assessment was undertaken based on existing literature, desktop research and field data where available. Extensive modelling in relation to water resources has been carried out during the Project EIS and SEIS, which has informed the impact identification and assessment for a number of specific matters of NES.

1.8.5 Potential habitat mapping for threatened species and communities

In consideration of the extensive size of the Study Area and the inability to access many parts during the field surveys a mapping methodology has been adopted whereby potential habitat for threatened species and communities is mapped within the Study Area and in the adjacent wider landscape. Threatened species and communities that are mapped through this process are those that are confirmed present and considered as likely to occur within the Study Area based on the likelihood of occurrence assessment outlined above.

Currently, the mapping methodology has taken into consideration the known distribution, ecology and preferred habitat characteristics of each species and TEC to which it has been applied. The species and communities that have been mapped according to this methodology comprise:

- Black-throated finch (southern)
- Squatter pigeon (southern)
- Reptiles of the brigalow belt, including ornamental snake and yakka skink
- Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC
- The community of native species dependant on natural discharge of groundwater from the Great Artesian Basin (GAB)

In regard to the black-throated finch a process of mapping high and low habitat was undertaken to reflect the more detailed information available on site for this species.

Potential habitat has been mapped at a regional scale to enable consideration of regional impacts and potential cumulative impacts.

1.8.6 World heritage values

To understand potential of the Project to impact upon the Great Barrier Reef World Heritage Area, and related values, conceptual modelling of Project impacts and offsite effects was completed. This was coupled with desktop analysis to identify those values for which the Great Barrier Reef is recognised of relevance to the project as well as analyse the influence of the existing catchment within which the project occurs on downstream catchments, including coastal waters. Information from each was reviewed with regard to known and predicted Project impacts, the potential they have to influence coastal habitats and water quality of the Great Barrier Reef. This informed potential for the Project to impact directly or indirectly upon the values for which the World Heritage Area is recognised or the existing ecological processes that support the functionality of the Great Barrier Reef.

1.8.7 Water resources

As part of the SEIS, and in addition to the body of work done in preparation of the EIS, several studies were either updated or prepared as part of the assessment of water resources, including:

1. Revised groundwater modelling and impact assessment (SEIS Volume 4 Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum). The groundwater modelling was redone on the amended Mine plan.
2. Water balance study (SEIS Volume 4 Appendix K2 Water Balance Report). While the water balance model for the EIS was developed with Microsoft Excel, the SEIS water balance makes use of GoldSim modelling software, allowing for a better understanding of water movements on site. In addition, a salt balance was developed within the GoldSim environment.
3. Water quality study (SEIS Volume 4 Appendix K3 Water Quality Report). A combination of desktop and field assessments were undertaken to describe the existing surface water resources that may be affected by the Project (Mine) in the context of environmental values (EVs).
4. Updated flood modelling (SEIS Volume 4 Appendix K4 Preliminary Flood Mitigation and Creek Diversion Design Report). The study done as part of the EIS was updated to better represent the Mine plan presented in the project description. In addition, the proposed creek diversions have been detailed.
5. Updated modelling of rail flooding (SEIS Volume 4 Appendix S1 Rail Flood Modelling Report). Flooding modelling was revised based on additional design information.

1.8.8 Impact assessment and mitigation – threatened species, TEC's and migratory birds

In consideration of construction and operational activities of the Mine and Rail components of the Project, potential impacts have been identified and described with respect to flora and fauna species, their confirmed and potential habitat, and vegetation confirmed present and considered as likely to occur within the Study Area (as per the criteria nominated under Section 1.8.4). Mitigation measures to avoid/minimise/offset impacts to identified matters of NES resulting from the construction and operational activities associated with the Project have been proposed.

The significance of residual impacts, post-mitigation, was evaluated with consideration to the DSEWPaC significance criteria, which are provided in *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (hereafter, the 'Significant Impact Guidelines') (DEWHA 2009a).

In considering impact to listed taxa and communities, assessment was also made to identify relevant matters for impact assessment in relation to the following:

- An important population – for listed vulnerable threatened species
- Habitat critical to survival – for listed threatened species
- Important habitat – for migratory species

These are defined in the following sections.

1.8.8.1 Important population

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include 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
- Populations that are near the limit of the species range

1.8.8.2 Habitat critical to the survival of a species or ecological community

Areas that are necessary for:

- Activities such as foraging, breeding, roosting, or dispersal
- The long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- Maintenance of genetic diversity and long-term evolutionary development
- The reintroduction of populations or recovery of the species or ecological community

Such habitat may be, but is not limited to habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/ or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

1.8.8.3 Important habitat

An 'important habitat' for migratory species is considered to be one or more of the following:

- Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- Habitat that is of critical importance to the species at particular life-cycle stages
- Habitat utilised by a migratory species which is at the limit of the species range
- Habitat within an area where the species is declining

In addition, any species that are categorised as critically endangered, endangered, vulnerable or extinct in the wild are considered matters of NES and trigger the EPBC Act. Section 179 of the EPBC Act defines these categories as stated below.

- A native species is eligible to be included in the **extinct in the wild** category at a particular time if, at that time:
  - (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range
  - (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
- A native species is eligible to be included in the **critically endangered** category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
- A native species is eligible to be included in the **endangered category** at a particular time if, at that time:
  - (a) it is not critically endangered
  - (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
- A native species is eligible to be included in the **vulnerable category** at a particular time if, at that time:
  - (a) it is not critically endangered or endangered
  - (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.

1.8.9 Project activities relevant to impact assessment and mitigation

The Project will require the development of both permanent and temporary infrastructure. To achieve a conservative assessment, it has been assumed that temporary impacts will remain for 10 years and operational impacts are considered to be permanent unless otherwise defined.

The construction phase of the Project (Mine and Rail) will involve the following activities:

- Development of offsite infrastructure including a workers accommodation village and temporary construction camps, an industrial area, a permanent airport and water supply infrastructure
- Establishment of five quarries (refer to Section 1.5.3) to provide material for Project (Rail) embankments, sub-base, select, fill, rail ballast and road base.
- Construction of a 95 m wide rail corridor and temporary construction infrastructure, including track and bridge laydown areas, turning circles and concrete batching plants.
- Construction of a rolling stock maintenance yard, maintenance roads, and infrastructure at a passing loop for operational requirements (including sub-stations for electrification and signalling and power supply rooms)
- Construction of temporary construction camps – footprint includes some remnant vegetation
- Construction of depot (comprising flash butt welding plant, concrete batch plants, ballast stacking and casting yard for bridge structures, sewage treatment plant and chemical storage)

The operational phase of the Project (Mine and Rail) will involve the following activities:

- Construction of the Mine infrastructure areas
- Operation of Project (Mine) offsite infrastructure, including the workers accommodation village, industrial area, permanent airport and water supply infrastructure
- Underground mining staged through development with subsidence of mined areas expected to occur
- Open cut mining staged through 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 to be established along the boundary of the Mine Area, and separating clean inflows from dirty water areas
- Spanning of the Carmichael River at one site to achieve access to the southern part of the Study Area
- Use of a rail corridor (95 m wide) (fenced and inclusive of maintenance/service road, passing loops and bad order sidings)
- Use and maintenance of rolling stock maintenance yard, maintenance roads, and infrastructure at a passing loop for operational requirements

The Mine will be operational for approximately 60 years with staged development of the open cut and underground pits. Site rehabilitation following construction and completion of mining activities at each phase of the project will also be staged over the duration of the Mine life. The Project (Rail) will be operational for 90 years.

Site works across the construction phase of the project, and during Mine operations, will require the clearing of remnant vegetation, spanning or removal of watercourses and/or standing water bodies, and fragmentation of the landscape, amongst other impacts. These will result in impacts across the site of:

- Clearing and fragmentation of lands
- Removal of water resources and alteration of groundwater from drawdown, due to the following:
  - Floodwater harvesting on the Belyando River
- Water required for construction and operational purposes will be sourced from onsite dams or from offsite sources with watercourse diversions established early in the Project lifecycle.
- Alteration of topography associated with subsidence over underground mining pits and mounding of spoil
- Potential introduction of weeds and exotic pests

Each of these impacts has the potential to reduce local biodiversity and may potentially affect regional biodiversity; consideration has been given to the significance of these impacts as they relate to matters of NES.

Habitats and species that are likely to be permanently affected as a result of habitat losses or groundwater influences will require offsetting. SEIS Volume 4 Appendix F Revised Offset Strategy provides a considered offset strategy for the Project. In addressing offsets for the Project, consideration has been given to relevant offset policy requirements.

1.9 Report structure

To facilitate review and assessment of how the Project may impact matters of NES, findings are reported in the following sections structured against the provisions of the EPBC Act for which the Project is controlled. As such, a description of the environmental values of relevance to each controlling provision and how these may be impacted by the project is provided. The report is structured as follows:

Section 2 – World Heritage Areas, National Heritage Places and the Great Barrier Reef Marine Park

Section 3 – Wetlands of international importance

Section 4 – Listed threatened species and ecological communities

Section 5 – Potential impacts on listed migratory species

Section 6 – Potential impacts on water resources

Section 7 – Cumulative and consequential impacts

Section 8 – Offsets

Section 9 – Framework for impact and offset management, monitoring and reporting

Section 10 – Conclusions and recommendations

2. World Heritage Areas, National Heritage Places and the Great Barrier Reef Marine Park

2.1 Introduction

A number of geographies within Queensland provide unique environmental, cultural or heritage features. In recognition, these areas have been afforded legislative protection. Any project that may interfere with the values for which any protected site has been recognised must ascertain the potential for impact and identify mitigation measures. To understand whether values of protected sites will be affected by the Project, an assessment of impacts of the Project has been completed. These have been supported by desktop and field assessment studies, which describe the existing terrestrial and aquatic ecological values of the Study Area.

2.2 Description of environmental values

2.2.1 Habitats within the Study Area

The Study Area occurs in central Queensland within the Burdekin Basin, approximately 320 km upstream of the Great Barrier Reef World Heritage Area (GBRWHA) and the Great Barrier Reef Marine Park (GBRMP). The vast majority of the Study Area is within the Brigalow Belt bioregion except for the extreme western extent of the Study Area, which captures the boundary of the Desert Uplands bioregion. Land use 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.

The dominant riverine environment, the Carmichael River, bisects the proposed Mine site and flows east for approximately 20 km to its juncture with the Belyando River. From this point, the Belyando River flows in a northerly direction for approximately 90 km where it joins the Suttor River. Beyond its juncture with the Belyando River, the Suttor River flows north (approximately 50 km) to the Burdekin Falls Dam (Lake Dalrymple). The Burdekin River downstream of Burdekin Falls Dam flows for approximately 160 km to its mouth at Upstart Bay within the GBRWHA near Ayr (Figure 5).

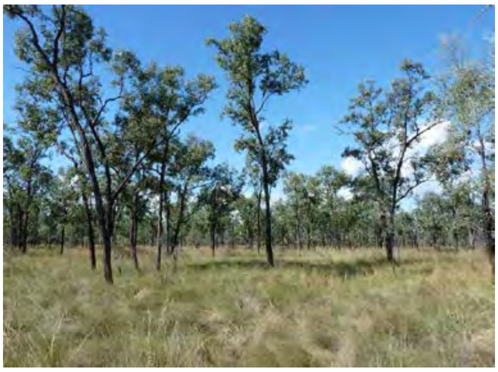
Aquatic habitats vary in size and geomorphology across the Study Area. They include lacustrine, palustrine and riverine habitats (Plate 1). A number of dams are scattered across the Study Area and streams and seasonal drainage channels direct flows into the more permanent water bodies. Dams have little overhanging or emergent vegetation; however, other water bodies support riparian corridors of varying diversity and width.

As a result of the high location in the catchment and seasonality in rainfall, flows within the Study Area are restricted to the wetter months, November to March, with many streams and drainage channels drying entirely and larger rivers sustaining only pools or low flows by the winter months (June/July). The Burdekin River Gorge and falls and the Burdekin Falls Dam have influenced the ecology of the catchment by restricting aquatic fauna movement from the eastern coastal area to the upper catchment areas (Pearson et al., 2010).

Three areas within the Mine Area are mapped as GBR WPAs under the Queensland State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments. The GBR WPAs within the Mine Area are consistent with the Queensland wetland classification of a semi-arid grass, sedge and herb swamp. Semi-arid swamps are mostly situated in alluvial plains and are typically subject to temporary inundation. They may be inundated annually or less regularly; some may be inundated once every three years at most. Further details of these wetlands are provided in SEIS Volume 4, Appendix J9 GBR Wetland Protection Areas Report.

The GBR WPAs are often dry for years and may only be wet for a short period (i.e. ephemerally). This makes their identification difficult. The local 10 year Average Recurrence Interval (ARI) flood model indicates a 10 percent chance of flooding to the north of the Carmichael River every year, with 0.08 – 1.00 m of water inundating each GBR WPA. One of the GBR WPAs covers a mapped 1st order tributary of the Carmichael River, which may suggest that this GBR WPA will frequently be inundated. The 100-year ARI flood event modelling suggests that the GBR WPAs are inundated with 1 – 2 m of water during these events.

Plate 1 Terrestrial and aquatic habitats found in the Study Area



Open woodland

Cleared land

Eucalypt and Acacia woodland

Woodland with grassy understorey

Belyando River (riverine habitat)

Permanent dam (lacustrine habitat)

Ephemeral stream (riverine habitat)

Gilgai (palustrine habitat)

Figure 5 Conceptual model of the flow path to the coast

2.2.2 World Heritage Areas

The DSEWPaC Protected Matters Search Tool did not identify any world heritage properties or National Heritage Places of relevance to the Project. The two closest world heritage properties to the Study Area are the GBRWHA and the Wet Tropics WHA.

The Study Area is located approximately 272 km south of the Wet Tropics WHA. The Wet Tropics WHA has no direct terrestrial, aquatic or biodiversity links to the Study Area. No influences from the Project are predicted to occur on the Wet Tropics WHA and this area has not been considered further within this assessment. The Study Area is also located over 200 km due west and approximately 320 km upstream of the GBRWHA and the GBRMP. The Carmichael River bisects the proposed Mine site and joins a network of river systems, which eventually enter the coastal waters of Queensland (Figure 5).

The GBR is a unique reefal mosaic that spans more than 348,000 km^2 of the continental shelf of Queensland. The GBR is recognised globally for its biodiversity, size, prevalence of endemic species, aesthetic and cultural values (DSEWPaC, 2012b). In 1981 it was inscribed on the World Heritage List against the following criteria:

- Outstanding example representing a major stage of the earth's evolutionary history given the GBR is the largest single collection of coral reefs in the world
- Outstanding example representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment given the GBR represents a mature system which has been in existence for millions of years
- Containing unique, rare and superlative natural phenomena, formations and features and areas of exceptional natural beauty
- Providing habitats where populations of rare and endangered species of plants and animals survive

The GBR is by far the largest single collection of coral reefs in the world. The World Heritage Values of the property include: coral reefs, coral cays and continental islands, reef morphologies reflecting historical and on-going geomorphic and oceanographic processes. Biologically, the GBR supports the most diverse ecosystem known to man. Its enormous diversity is thought to reflect the maturity of an ecosystem that has evolved over millions of years on the northeast continental shelf of Australia (DSEWPaC, 2012b).

The GBR is of Indigenous cultural importance for Aboriginal and Torres Strait Islanders. Non-Indigenous heritage values are also represented and include mapped historic shipwrecks, which occur throughout the reef mosaic. These, along with its biological diversity, represent features that are of outstanding national heritage value to Australia, which led to the GBR being registered as a place of National Heritage in May 2007.

Prior to inscription upon the World Heritage or National Heritage registers the GBR was recognised as an environment requiring special management to provide sustainable use with appropriate protection. In 1975, the GBRMP was designated and the GBR Marine Park Authority established and chartered with the responsibility of sustainably managing activities within the GBRMP. The GBRMP covers more than 344,400 km^2 of the GBRWHA, extends 2,300 km along the Queensland coast, and encompasses most of the waters from low water mark on the mainland coast (Hutchings et al., 2008). A number of coastal areas, namely operational port environments that occur within the WHA, are excluded from the GBRMP. This provides opportunity for targeted, intensive management of those environments against the activities, which are conducted within those areas, responsibility for which rests with the various port management agencies operating in Queensland.

The GBR is a multiple use jurisdiction managed with an overriding conservation objective to maintain the values of the reef. In this regard the Marine Park Authority works with the Queensland Government, its agencies and port authorities to achieve effective management of the GBR. Given the alignment of the values for which the GBR is designated as a Marine Park, a WHA and a National Heritage Place, assessment of each these matters is considered collectively within this section.

The main physical, chemical and ecological processes of the GBR ecosystem influenced by land-based activities within catchments are primarily freshwater inflows, sediment transport and nutrient cycling. Inflow of freshwater and sediments into the GBR lagoon occurs naturally from seasonal rainfall processes, which transport nutrients to the GBR lagoon. Dissolved nutrients and sediments are important components of the biogeochemical cycles of the GBR (Brodie et al., 2011; Furnas et al., 2005). There is, therefore, potential to influence the ecology of the GBR by affecting these inputs.

While freshwater inflows are a natural occurrence, anthropogenic changes to catchments have altered the amount, the pattern and the quality of water inflows that reach the estuaries and marine environments associated with the GBR (Scheltinga et al., 2006). Subsequently, catchment activities have the potential to influence the ongoing health of the GBR.

Terrestrial inputs to coastal waters can occur year round. However, significant pulse inputs occur during the wet season. In particular, flood plumes are significant conduits of sediment and contaminants from land based activities/catchments to the GBR (Connolly et al., 2005). Anthropogenic changes of land use in the GBR catchments mean there are higher than previous levels of sediments within the flood plumes, and associated increases in contaminants. The sediment within flood plumes impacts aquatic flora and fauna. The nutrients carried by the flood plume may stimulate the growth of pelagic and benthic algae and phytoplankton, which can disrupt the natural trophic relationships (or 'food webs') of the marine community (Connolly et al., 2005) and cause algal blooms.

There can also be physical impacts on aquatic flora and fauna when sediments clog and damage fish and invertebrate gills, or smother or obstruct photosynthesis in aquatic flora and fauna. This means sediment loads can influence the productivity and trophic relationships of aquatic communities (Kelley et al., 2006). Suspended sediments can also affect feeding success of visual predators, scavengers and grazers (for example fish or turtles).

Over the past 150 years, sediment inflow into the GBR has increased, primarily due to historical land management practices, including extensive forest clearing (especially the clearing of lowland rainforests and wetlands for sugarcane) and the clearing of dry land forest for cattle. The removal of riparian and terrestrial vegetation for cropping and grazing has resulted in the destabilisation of banks, increased susceptibility to gully erosion and increased land surface erosion through wind and rain.

Land use activities of the Project may have potential to influence the health and ecology of the GBR given the Mine Area is hydrologically connected to the coastal habitats via the Carmichael and Belyando Rivers entering the GBR lagoon at Upstart Bay (Figure 5).

The marine environment at Upstart Bay at the mouth of the Burdekin River (within the GBRWHA) is characterised by:

- Open water and lower intertidal areas with dense and extensive seagrass beds
- Higher intertidal and supra-tidal flats that are largely unvegetated
- Beaches and beach ridges which support low vine forest
- Mangroves (approximately 20 mangrove species have been recorded on the Burdekin River delta)
- Freshwater impoundments and associated swamps

The delta at the mouth of the Burdekin River forms a continuous, complex wetland aggregation, composed of mangrove lined estuaries fed by distributary channels and backed by permanent and seasonal floodplain water bodies. The delta forms a continuous, complex wetland aggregation composed of beaches, bars, spits, islets, intertidal flats, mangrove lined estuaries and permanent and seasonal freshwater bodies. The aggregation is comprised entirely of unconsolidated sediments.

Mangroves line approximately 50 percent of the banks of the Burdekin River delta and southern Upstart Bay, with approximately 20 mangrove species recorded. This diversity is only exceeded in Australia by mangroves growing in wet tropical areas (DSEWPaC, 2013a; 2013b).

Despite the variable and occasionally relatively high turbidity and sediment loads, seagrass occurs throughout most of marine environment within Upstart Bay at densities, which vary seasonally, and temporally (McKenna et al., 2008). The Bay and its seagrass meadows is considered to have high fisheries value (McKenna et al., 2008).

Upstart Bay has also been observed to support a resident marine turtle population and dugong and dolphin species on a semi-permanent basis (GHD, 2010). The near-shore coastal environments are known to exhibit a high degree of temporal variability and to a lesser degree, spatial variability in water quality parameters, given the marked influence of waves, currents and local discharges from rivers and creeks within shallow coastal environments (De’ath, 2007; De’ath and Fabricius, 2008).

Within Upstart Bay there are General Use, Habitat Protection, Conservation Park (Cape Upstart Conservation Area) and Marine National Park (Cape Upstart Marine NP) zones. The Burdekin fish habitat area, which includes Upstart Bay, and the Upstart Bay dugong protection area provide foraging habitat for a number of fauna species, including a marine turtle population and dugong and dolphin species. Upstart Bay and the values, which support the GBR’s status as a WHA and National Heritage Place, are located 320 km downstream of the Study Area. As described in Figure 5, flows between the Study Area and the GBRWHA are influenced by dams, weirs and inputs from other catchments.

2.2.3 Other protected places

The Tree of Knowledge and curtilage at Barcaldine is the closest National Heritage Place to the Study Area. It is located approximately 200 km south-west of the western extent of the Study Area. In April 2006, the Tree of Knowledge was poisoned and did not recover. It was felled on 29 July 2007 but the site remains an important place of National Heritage. No direct or indirect influences on this Place will occur as a consequence of the Project and this Place has therefore not been considered further.

2.3 Potential impacts

2.3.1 Overview

The Project will require the construction of a 189 km long rail corridor (95 m width) in conjunction with open cut and underground mining operation across 39,143 ha. As described in the Updated Mine Project Description (SEIS Volume 4, Appendix B), to facilitate Mine operation permanent Mine offsite infrastructure will be established, including a workers accommodation village and a permanent airport (Figure 2). In addition, a rail corridor will bisect the landscape crossing watercourses and floodplains. In particular, site development will result in the sequential loss of watercourses, catchment area and water bodies and diversion of catchment runoff around the Project site.

The project will have no direct impact on the values of the WHA, National Heritage Place or Marine Park. Potential indirect impacts have been assessed in terms of:

- Aesthetic values
- Downstream water quality

2.3.2 Aesthetic values

The Project does not directly connect with or influence the GBR (see Section 2.2.1). The Study Area does not bound the coast, it is located 320 km inland of the coast. The Study Area is, therefore, physically and visually disconnected by mountain ranges and expanses of terrestrial habitat. It does not contribute to the aesthetic values for which the GBR is protected. Nor will construction or operational activities associated with the Project detract or influence upon the aesthetic values of the Reef. Accordingly, the Project will not have any influence on those values.

2.3.3 Downstream water quality

The Project falls within the dry tropics in central Queensland within the Burdekin Basin (see Section 2.2.1). The Basin is known to provide a significant input of terrestrial sediment and nutrients to the GBR as a result of wet season discharge via the Burdekin River (Bainbridge et al., 2012). This influences the functioning biodiversity of the GBR.

Construction and operational works associated with the Project will potentially affect watercourses that are hydrologically connected to the coast. Potential impacts from site construction and operation are described in detail in SEIS Volume 4 Appendix J1 Revised Mine Ecological Assessment Report. Activities that have relevance to the GBR are those that have potential to influence the quality and quantity of water entering the downstream catchment system as a result of:

- Loss of catchment area
- Erosion or runoff of stormwater
- Extraction of water resources for use on site
- Release of mine affected water (MAW) from site

2.3.3.1 Loss of catchment area

The construction and operational works for the Mine will occur within the catchment of the Carmichael River and will progressively reduce the size of catchment area. The pre-development Mine catchment area will be reduced by 25 percent as a consequence of operational activities. The post-development Mine catchment area will be 503 km^2. This area will no longer drain to the Carmichael River, resulting in a 20 percent decrease of the Carmichael River catchment (2,505 km^2).

The Carmichael River catchment is part of the larger Belyando River catchment. In turn, the Belyando River catchment is part of the Burdekin River Basin, which discharges to the coast at Upstart Bay within the GBRWHA. This affected Mine catchment area makes up 1.4 percent of the Belyando River catchment and 0.44 percent of the Burdekin Basin (see Figure 6).

2.3.3.2 Erosion or runoff of stormwater

The Project will potentially affect the water quality and quantity of the Carmichael River catchment due to erosion or runoff of stormwater. Understanding the movement of water to the coast and the contribution of the Carmichael River catchment to the larger Burdekin River Basin is important for understanding potential for the Project to impact upon the Reef.

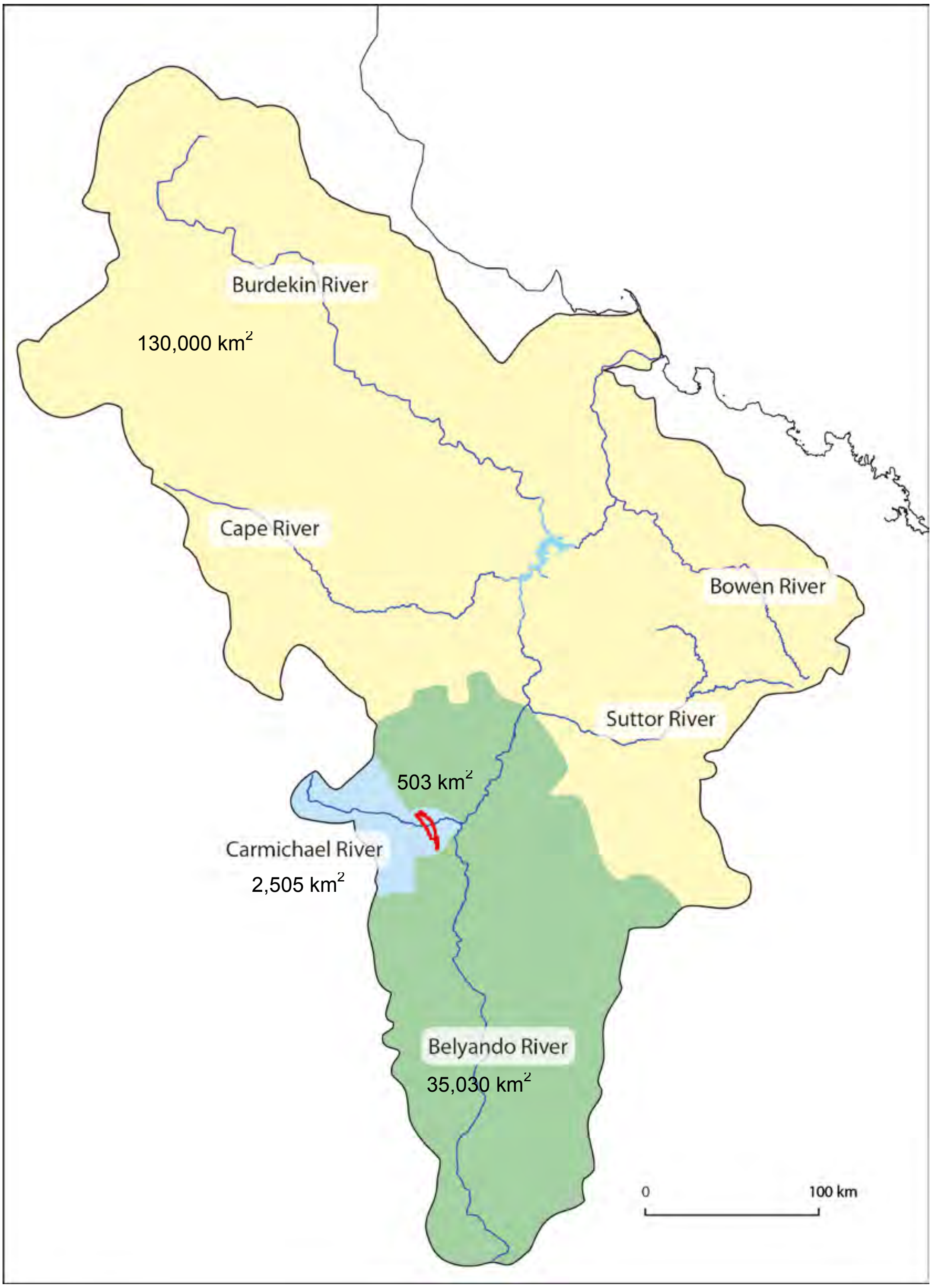
Kroon et al. (2012) identify that the Burdekin River Basin is the largest contributor of sediment to the Great Barrier Reef. The largest contribution of total suspended sediment loads from the Burdekin River Basin to the GBR is derived from grazing lands (DPC, 2011). The removal of riparian vegetation also has the potential to contribute to bank erosion and suspended sediment loads in watercourses and lead to degradation of aquatic habitats. By minimising the disturbance required for construction, implementing erosion and sediment control measures and weed management measures, any impact to riparian vegetation and aquatic habitats from activities in the riparian zone will be reduced.

The majority of the Burdekin River Basin runoff (over 80 percent), including the Carmichael River catchment is regulated by Lake Dalrymple and the Burdekin Falls Dam. The dam catchment captures inputs from the Belyando and Suttor rivers associated with the Study Area as well as inputs from the Cape River and the upper Burdekin River catchments.

As conceptually described in Figure 5, significant distance, catchment area and natural and artificial barriers to aquatic connectivity exist between the Study Area and the GBRWHA. Dams, weirs and floodplains may trap sediment and prevent it from flowing downstream. This is confirmed by studies completed by Lewis et al., (2013), Bainbridge et al., (2012) as well as others (e.g. Pearson et al., (2010)). These studies also confirm that these barriers affect potential for site based activities to impact upon the values for which the Reef is protected. Lewis et al., (2013) has examined the efficiency of the Burdekin Falls Dam at trapping sediments and throughput from upstream catchments. The study took account of water and sediment load transport through the dam from upstream to downstream of the dam across five years of monitoring under different seasonal rainfall conditions. This study provides information about the catchment contributions to the Burdekin River Basin and therefore informs connectivity with coastal habitats.

The contributions of the catchment within which the Project is located to downstream flows to the GBR are markedly far less than other catchments, and as the Project will affect a very minor proportion of the catchment it is unlikely that material change in these flows will be detectable. The Belyando River catchment, of which the Mine Area makes up 1.4 percent, contributes less than or equal to 11 percent of the sediment loads to the Burdekin Falls Dam and sediment loads attributed to this river were less 1 percent in some years. Lewis et al. (2013) determined that sediment loads delivered to the Burdekin Falls Dam were predominantly sourced from the upper Burdekin River (70 – 94 percent).

Figure 6 Burdekin Basin (yellow), Belyando River catchment (green), Carmichael River catchment (blue) and Mine Area (red)



Water for use on site will principally be sourced from pit dewatering (groundwater) and floodwater harvesting (surface water). The influence of the Project on the groundwater across the Study Area is described in detail in the SEIS Volume 4, Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum. Impacts to the flow, direction of flow and volumes of groundwater within the Study Area will occur. Review of that information has informed how groundwater drawdown may influence water flows on/off site and, therefore, influence downstream aquatic environments connected to the GBR.

Groundwater model predictions suggest that mining induced drawdown will increase the rate of base flow loss across the Mine Area. The model predictions suggest water table drawdowns of less than 1 m along most of the Carmichael River corridor, although impacts of up to approximately 4 m in the river closest to the proposed open cut pits are predicted (see SEIS Volume 4, Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum).

Total impacts through a combination of reduced base flow upstream and increased base flow losses in the Carmichael River across the Mine Area are predicted to be around 1000 m^3/d (33 percent of the pre-development base flow) at the end of the Mine life and 950 m^3/d (31 percent of the pre-development base flow) post closure. No significant impacts on flows and/or levels are expected in any other local watercourses, including the Cabbage Tree Creek, since these creeks are ephemeral in nature and not thought to currently receive any substantial discharges from groundwater.

Water for site operation will also be sourced from flood harvesting of the Belyando River. A review of the hydrological modelling undertaken for the Project (SEIS Volume 4, Appendix K5 Revised Mine Hydrology Report) indicated that the proposed water extractions would have minimal impact against the Water Resource (Burdekin Basin) Plan 2007 environmental flows objectives. A pump and inlet constructed on the bank of the Belyando River will pump water to a 5 GL storage dam only once flood flows exceed established criteria (200 ML/day).

Previous studies have clarified that the groundwater systems that will be impacted by the Project are not hydrologically linked to those associated with the GBRWHA waters. The groundwater systems that feed the GBR are located more coastally than the catchment within which the Project is located. Significant catchment area and groundwater recharge systems occur between the Study Area and the coast and these are not dependent on the groundwater systems of catchment of the Study Area. Therefore, while impacts to groundwater will occur as a result of the Project, these will not result in measurable change in the hydrological regime of the GBRWHA waters. Therefore, no effects on the GBRMP (or its recognised values) resulting from altered groundwater are predicted.

2.3.3.3 Release of Mine affected water (MAW) from site

Drainage runoff from the Mine site will be considered as sediment affected water (SAW) or MAW, depending on the location. Drains will channel runoff into sediment ponds located onsite. Sediment ponds will be left to evaporate or alternatively, be pumped to MAW storages where required. Water balance estimates indicate, due to the significant use of water on site for dust management and other activities, site based runoff will be reused on site during all except extreme wet season events. During wet season inundation Mine waters will be moved between dams to minimise risk of overflow. Under such a scenario, all spillway discharge will be diverted along a drain separate to the clean water system and discharged from site.

2.4 Management and mitigation measures

2.4.1 Management measures

2.4.1.1 Loss of Catchment Area

Lewis et al., (2013) concluded in their study that very fine suspended sediment largely passes through the dam and the management of this fraction is important for the export of sediment to the Reef lagoon. Therefore, management intended to reduce bulk suspended sediment delivery to the Burdekin Falls Dam for improved water quality inputs to the GBR lagoon should focus remedial efforts on the upper Burdekin River catchment (Lewis et al., 2013). This study also concludes.

The project activities have been planned with regard to management of potential for offsite impacts such that site design and erosion, sediment and water control provisions have been established to mitigate potential for environmental impacts. The various management strategies will apply during construction and operational works to minimise potential for affecting quantity and quality of water flows downstream of the Study Area. In particular, controls to mitigate release of any contaminants or suspended solids from site to avoid affecting quality of waters entering Lake Dalrymple, thereby mitigating potential to affect quality of waters entering the GBR.

2.4.1.2 Erosion or runoff of stormwater

To limit the degradation of downstream aquatic habitat mitigation and management will focus on limiting sediment transport from exposed areas, minimising the risk of increased erosion and managing potential mobilisation or introduction of pollutants. 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 Mine Area. Mitigation measures are identified in detail within the Environmental Management Plans (EMPs) (SEIS Volume 4, Appendix Q1 and Q2) and include (but are not limited to):

- Clearing of vegetation is not to be undertaken during overland flow events
- Construction activities that affect stormwater flow paths to commence only after suitable stormwater management infrastructure has been established
- Requirement to construct across Carmichael River during dry conditions to limit localised erosion at construction areas
- Installation and maintenance standards for sediment fences and other sediment control devices, in particular for areas near earthworks, watercourses and key stormwater flow paths
- Location of all 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
- Stabilisation of disturbed areas to be undertaken as soon as practicable after disturbance. If appropriate, clearing of vegetation to be undertaken in a staged manner as construction progresses, minimising the disturbance footprint at all times. Revegetation of applicable areas to be undertaken as soon as practicable, using native flora appropriate for local conditions.

- Emergency response protocols and procedures for implementation in the event of a contaminant spill or leak to be clearly articulated in the site EMPs (construction and operation). Contaminated materials are to be removed from site by a licenced waste collector and transport company, and disposed of at a licenced facility.
- Spill kits to be located at regular intervals across the construction phase footprint to allow for timely response to uncontained spills. All staff to be familiar with their use.
- Requirement for the use of vehicles and machinery in good working order to limit potential for hydrocarbon leaks
- All waste management measures, including appropriate storage locations and disposal procedures for domestic and construction waste to be clearly articulated in a Waste and Resource Management Plan
- Regular water quality monitoring of nearby resources to confirm adequacy of management and mitigation measures. Monitoring requirements, water quality targets, corrective actions and reporting requirements to be clearly articulated in a Water Quality Management Plan, embedded within the EMPs (construction and operation).

2.4.1.3 Release of Mine Affected Water Mine Affected Water

The design, engineering and understanding of onsite environmental conditions at the Mine Area have informed development of measures proposed to mitigate the potential impacts from sediment and Mine affected water from the Mine Area. Details are provided in Volume 4, Appendix K5 – Revised Mine Hydrology Report. Measures principally relate to controlling movement of water around and across site, trapping and treating waters affected by site works and release of treated waters back into streams. To facilitate this, dedicated water management structures and systems will be established as a priority during construction works. These include diversion drains, sediment ponds, dams for storage of waters from site and scour protection measures for any surfaces that may be exposed to water runoff and have potential to mobilise sediments into the adjacent waterways (see SEIS Volume 4, Appendix K5 Revised Mine Hydrology Report).

Diversion drains will be constructed to divert clean water from upstream catchments around the proposed Mine infrastructure. Clean water will be discharged into existing gullies and creeks downstream. The diversion drains are to be designed for 100 year ARI flood capacity, and where required, flood protection levees will be provided along the sides of the drains to provide pit shells with 1,000 year ARI immunity plus an additional 600 mm freeboard. These drains will enable catchment runoff from lands adjacent to the Mine to continue to flow into downstream waterways without needing to be treated. Drains will be constructed to minimise risk of erosion or scour to manage and mitigate mobilisation of sediments.

Drainage runoff from the Mine site will be considered as sediment affected water (SAW) or mine affected water (MAW), depending on the location. Drains will channel runoff into sediment ponds located onsite. Sediment ponds will be left to evaporate or alternatively, be pumped to MAW storages where required. Water balance estimates indicate, due to the significant use of water on site for dust management and other activities, site based runoff will be reused on site during all except extreme wet season events. During wet season inundation Mine waters will be moved between dams to minimise risk of overflow. Treatment of MAW may occur if there is risk of overtopping. Under such a scenario, all spillway discharge will be diverted along a drain separate to the clean water system and discharged from site. Site releases will only be

permitted to occur in accordance with strict project licence conditions, issued through an Environmental Authority by the Qld Department of Environment and Heritage Protection (DEHP) and compliance monitoring will be required to demonstrate efficacy of applied management controls.Scour protection will be provided for spillways and diversion drains and will be designed in accordance with Queensland Urban Drainage Manual / Austroads Waterways Design – A Guide to the Hydraulic Design of Bridges, Culverts and Floodways, where appropriate.

2.4.2 Environmental conditions

In addition to the mitigation measures outlined above, activities within the mining lease require an Environmental Authority (EA), which contains general conditions regarding prevention of environmental harm. Discharge and overflow events from the water management infrastructure on the mining lease are undertaken in accordance with the relevant conditions under an EA issued by EHP. Activities may not commence within the mining lease until an EA is approved, and must then take place in accordance with conditions of the EA.

By agreement between the EHP and the Department of Energy and Water Supply, dams on a mining lease that contain hazardous substances are administered by EHP and are included in the EA (Mining Lease). These may include:

- Mine affected water storages
- Tailings management dams
- Some sediment affected water dams

While there are no formal legislative requirements in relation to erosion and sediment control, the EP Act specifically makes it an offence to deposit contaminants into surface waters, and to place contaminants in such a way as the contaminant may be reasonably expected to enter surface waters.

The Project EMPs have been prepared to support the environmental impact assessment process for the Carmichael Coal Project under the EPBC Act and SDPWO Act. As such, the EMPs reflect the findings and recommendations of studies undertaken for the EIS and SEIS, and provides a framework for management of identified impacts and implementation of recommendations made.

The EMPs will be updated to incorporate conditions of the EA once it has been approved and to achieve compliance with conditions of approvals obtained. The EP Act also imposes a ‘General Environmental Duty’ requiring all individuals and organisations to take all reasonable and practical measures to avoid environmental harm.

2.5 Summary

The DSEWPaC Protected Matters Search Tool did not identify any world heritage properties or National Heritage Places of relevance to the Project.

The Wet Tropics WHA is located over 270 km north of the Study Area with no direct terrestrial, aquatic or biodiversity links to the Study Area. No influences from the Project are predicted to occur on the Wet Tropics WHA. The GBRWHA is located over 300 km downstream of the Study Area and although connected hydrologically via watercourses, substantial hydrological barriers and other catchment land uses exist between the ocean and the Study Area, including the

Burdekin River Dam. The catchment within which the Project is situated provides little contribution to flows that influence the coast from this region and onsite control measures will manage potential for offsite impacts. Localised impacts within the immediate Project catchment are expected but these are not considered to have connectivity to coastal habitats. The Mine catchment area is 0.44 percent of the Burdekin Falls Dam catchment and the majority of the sediment loads delivered to the Burdekin Falls Dam are predominantly sourced from the upper Burdekin River (70 – 94 percent) (Lewis et al., 2013).

The number of hydrological barriers and catchment land uses between the Mine Area and the coast influence the quality and quantity of water that flows into Upstart Bay within the GBRWHA. Given the distance, barriers, mitigation and management measures and conditions that will be imposed as part of the environmental authority for the Project, no onsite impacts are expected to detrimentally affect the values for which the GBR is recognised. No impacts associated with the Project are expected to result in a substantial and measurable change in the hydrological regime of the GBRWHA waters or systems that feed those waters and, therefore, no effects on the GBRMP are predicted to occur. Accordingly, no impacts to the ecological, cultural or social values for which the GBR is recognised will occur as a result of the Project. The Project EMPs will be updated to incorporate conditions of the EA once it has been approved to achieve compliance with conditions of approvals obtained.

The Tree of Knowledge and curtilage at Barcaldine is the closest National Heritage Place to the Study Area. It is located approximately 200 km south-west of the western extent of the Study Area. No direct or indirect influences on this Place will occur as a consequence of the Project.

The Project is not predicted to impact upon any World Heritage Areas, National Heritage Places or the GBRMP.

3. Wetlands of international importance

3.1 Introduction

Wetlands that are representative, rare or unique with regard to their biodiversity, size, geomorphology or location for the conservation of biodiversity are recognised under the EPBC Act as a matter of NES. A number of different water body types are recognised as wetlands, including permanent water bodies, seasonal or intermittent lakes, human-made and subterranean hydrological systems. Listed and protected wetlands have met criteria to be afforded Ramsar status and any action that may influence the values for which the wetland has been recognised must be assessed to ascertain the potential for impact and identify mitigation measures. Protected wetlands that may be impacted by the Project are considered within this section with regard to the values for which the wetland is recognised and the potential for the project to impact upon those values.

3.2 Description of environmental values

3.2.1 Coongie Lakes

The DSEWPaC Protected Matters Search Tool indicated that the Coongie Lakes Ramsar site in South Australia (located approximately 800 km south-west of the Study Area) is of relevance to the Project. The Study Area occurs near the extreme north-east of the Cooper Creek Catchment, which drains in a south westerly direction towards north-east South Australia and the Coongie Lakes.

The Coongie Lakes is a complex and extensive ephemeral and semi-permanent freshwater wetland system in an arid zone, comprising channels, waterholes, lakes, internal deltas and numerous shallow flood out plains, interdune corridors and swamps. Several vegetation communities, including river red gum and coolabah woodlands and saltbush occur along the channels, in the claypans and on the dunes. Eighty-three species of waterbirds been recorded in Coongie Lakes.

The Study Area lies within the Burdekin River Basin and the basin discharges to the coast at Upstart Bay. Therefore, no surface waters from the Study Area flow into the Cooper Creek Catchment (Figure 7). Accordingly, the Coongie Lakes Ramsar site is not hydrologically connected to the Study Area.The closest wetlands of international importance (Ramsar Wetland) are the Bowling Green Bay wetland, approximately 236 km northeast of the Study Area and the Shoalwater and Corio Bays Areas, approximately 380 km south-east of the Study Area (Figure 7).

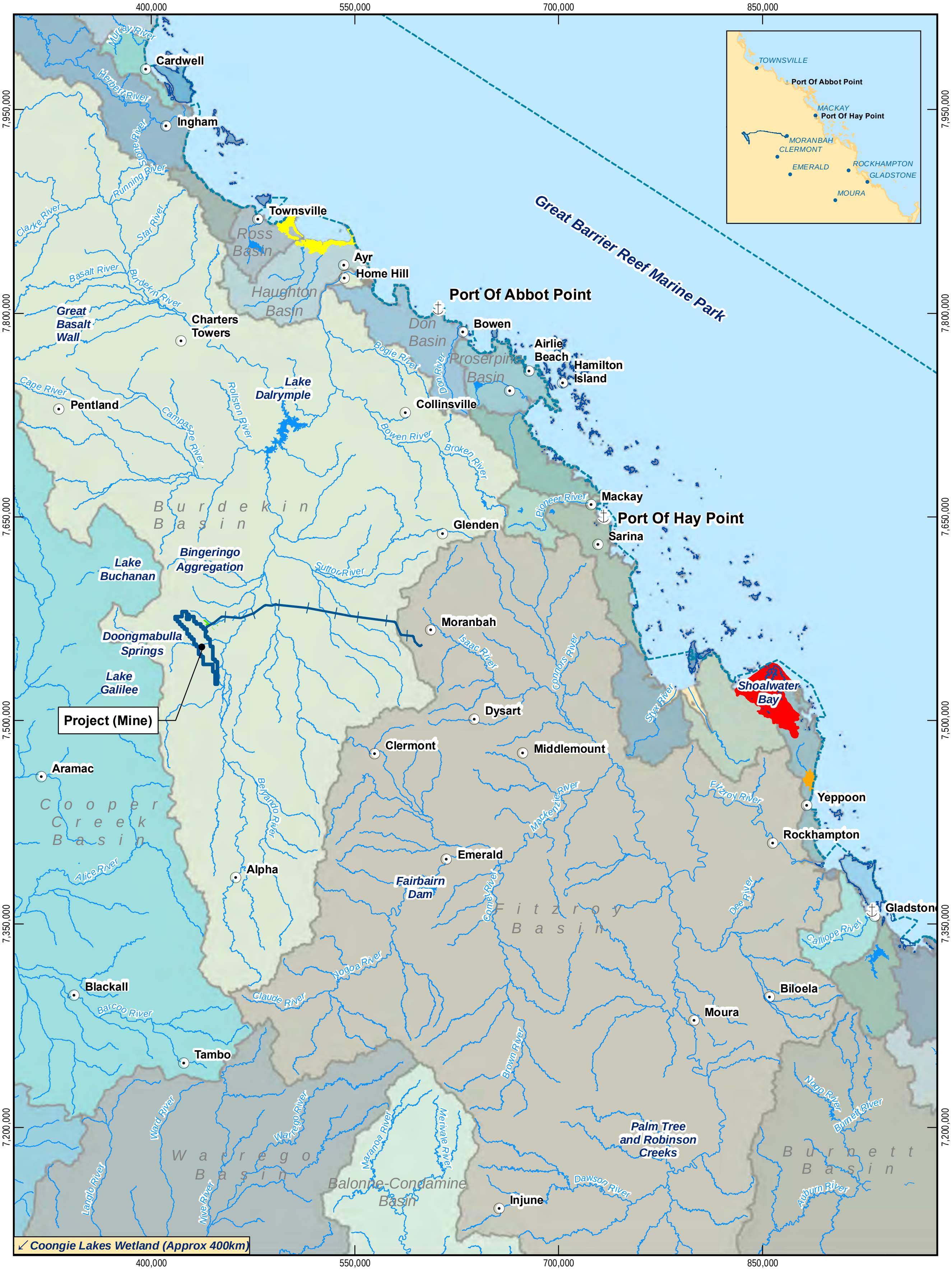
3.2.2 Bowling Green Bay and Shoalwater and Corio Bays

Bowling Green Bay wetland is within the Haughton and Ross River Basins and 40 km north of Upstart Bay. The Shoalwater and Corio Bays Area is within the Water Park Creek Basin and 500 km south of Upstart Bay.

Bowling Green Bay contains a diverse coastal wetland system including inter-tidal seagrass beds, mangrove woodlands and saline saltpan communities, and brackish to freshwater wetlands inland. The Haughton River and many creeks feed into the wetland system. The site is an important habitat for approximately 50 percent of the migratory species listed on international conservation agreements. The intertidal and subtidal seagrass beds provide feeding habitat for the threatened green turtle and dugong.

The Shoalwater and Corio Bays Areas contains a wide diversity of landscape types including undulating lowlands and hills, riverine plains, freshwater lagoons, swamps, estuarine inlets, dunes, sand beaches, and intertidal sand and mudflats. Nationally threatened species that occur at the site include the green turtle, hawksbill turtle, flatback turtle, loggerhead turtle, honey blue-eye fish and Oxleyan pygmy perch. A number of listed migratory bird species have been recorded at the site. The site has been identified as being of international importance to the migratory eastern curlew, whimbrel and great knot.

These Ramsar wetlands are not hydrologically connected to the Burdekin River Basin or the Study Area and, as such, no aquatic ecological connection between the Study Area and the Ramsar wetlands exist.



LEGEND

- Town
- Major Port
- Watercourse

Directory of Important Wetlands (Includes RAMSAR Sites)

- Great Barrier Reef Marine Park
- Bowling Green Bay
- Corio Bay Wetlands
- Shoalwater Bay

- Project (Rail)
- Project (Mine)
- Mine (Offsite)

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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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

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	B
Date	17-10-2013

Ramsar sites

Figure 7

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DNRM: DOI Wetlands, Drainage Basins (2009); GA: Towns, Watercourses, Mainlands (2007); DME: Carmichael Mine Site (2011); GHD: Major Ports (2010); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013). Created by: BW.

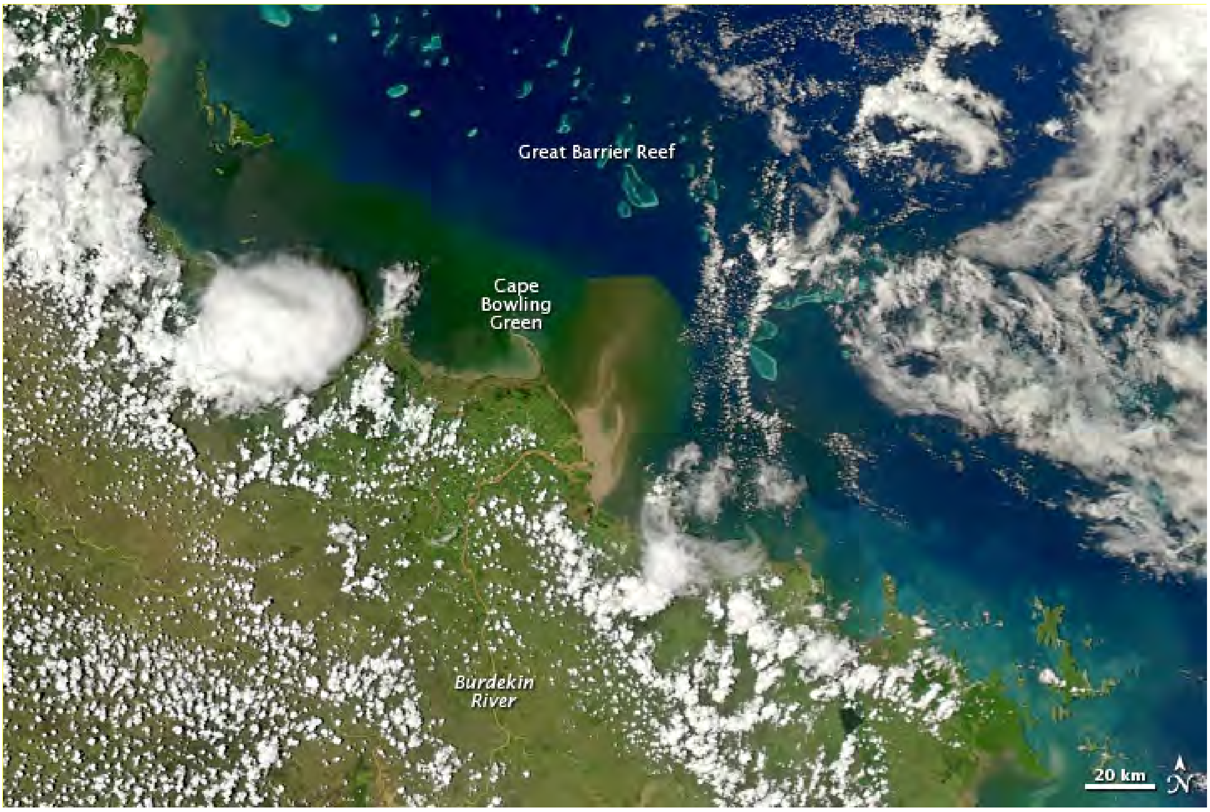
3.3 Potential impacts

Although the Mine Site is not hydrologically connected to the Bowling Green Bay or Shoalwater and Corio Bay Ramsar wetlands, there is a chance of indirect impacts from Project runoff given it is hydrologically connected to the Burdekin River. Therefore, consideration has been given to whether any coastal inputs of terrigenously derived sediments could impact the Ramsar wetlands. The impact from sediment plumes from recent flood events to the Ramsar wetlands was assessed.

During the December 2010 and January 2011 floods in Queensland, the rivers carried large sediment loads to the coast. On January 4, 2011, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite captured the natural-colour image of the Queensland coast (Figure 8).

Figure 8 shows the sediment plume created from water discharged from the Burdekin River. The waters around the Bowling Green Bay Ramsar site also showed a sediment plume from the adjacent land. The sediment plume from the Burdekin River does not reach the Bowling Green Bay Ramsar site instead, it moves further out to sea. This provides further evidence that the sediment loads from the Burdekin Basin do not reach Bowling Green Bay or Shoalwater and Corio Bay Ramsar wetlands.

Figure 8 Satellite imagery of the Burdekin River sediment plume (4 January 2011)



Source: http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=48438

3.4 Management and mitigation measures

A number of mitigation measures at the Mine Site will control any sediment runoff, however, there may be a risk during flood events if the sediment dams on site overtop. Mitigation measures are identified in detail within the Environmental Management Plans (EMPs) (SEIS Volume 4, Appendix Q1 and Q2) and include (but are not limited to):

- Clearing of vegetation is not to be undertaken during overland flow events
- Construction activities that affect stormwater flow paths to commence only after suitable stormwater management infrastructure has been established
- Requirement to construct across Carmichael River during dry conditions to limit localised erosion at construction areas
- Installation and maintenance standards for sediment fences and other sediment control devices, in particular for areas near earthworks, watercourses and key stormwater flow paths
- Location of all 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
- Stabilisation of disturbed areas to be undertaken as soon as practicable after disturbance. If appropriate, clearing of vegetation to be undertaken in a staged manner as construction progresses, minimising the disturbance footprint at all times. Revegetation of applicable areas to be undertaken as soon as practicable, using native flora appropriate for local conditions.
- Emergency response protocols and procedures for implementation in the event of a contaminant spill or leak to be clearly articulated in the site EMPs (construction and operation). Contaminated materials are to be removed from site by a licenced waste collector and transport company, and disposed of at a licenced facility.
- Spill kits to be located at regular intervals across the construction phase footprint to allow for timely response to uncontained spills. All staff to be familiar with their use.
- Requirement for the use of vehicles and machinery in good working order to limit potential for hydrocarbon leaks
- All waste management measures, including appropriate storage locations and disposal procedures for domestic and construction waste to be clearly articulated in a Waste and Resource Management Plan
- Regular water quality monitoring of nearby resources to confirm adequacy of management and mitigation measures. Monitoring requirements, water quality targets, corrective actions and reporting requirements to be clearly articulated in a Water Quality Management Plan, embedded within the EMPs (construction and operation).

The Project EMPs have been prepared to support the environmental impact assessment process for the Carmichael Coal Project under the EPBC Act and SDPWO Act. As such, the EMPs reflect the findings and recommendations of studies undertaken for the EIS and SEIS, and provides a framework for management of identified impacts and implementation of recommendations made.

The EMPs will be updated to incorporate conditions of the EA once it has been approved and to achieve compliance with conditions of approvals obtained. The EP Act also imposes a 'General Environmental Duty' requiring all individuals and organisations to take all reasonable and practical measures to avoid environmental harm.

3.5 Summary

The Project is not hydrologically or ecologically connected to any Ramsar wetland. The Study Area is connected aquatically to the Burdekin River but flood plumes from this system do not move northwards to influence Bowling Green Bay, instead they flow offshore. Proposed mitigation measures to manage offsite impacts will be implemented and form conditions for the environmental authority for the Project.

Accordingly, no areas of Ramsar wetland are predicted to be impacted by this Project. No areas of internationally important wetland will be lost, destroyed or substantially modified as a result of the Project nor will the hydrological regime of those distant wetlands be affected. None of the biodiversity for which the Ramsar wetlands are recognised will be impacted by Project activities as the Project will not affect the geography of any Ramsar protected wetlands nor will it act to introduce invasive species to any wetland sites. Accordingly, no impacts to Ramsar wetlands are predicted to occur as a result of this Project.

4. Listed threatened species and ecological communities

4.1 Overview

4.1.1 Species and communities confirmed or likely to occur

Australia supports a high percentage of endemic species and communities. Development, urbanisation, clearing of land for grazing or agricultural purposes and other activities have affected the prevalence and distribution of these species historically. Some are now considered to be threatened or endangered.

Ecological communities are naturally occurring biological assemblages that comprise a particular habitat type. Threatened ecological communities (TECs) are ecological communities that have been assessed under the EPBC Act and assigned to one of five categories related to the status of the threat to the community i.e. conservation dependant, vulnerable, endangered, critically endangered and extinct in the wild.

The EPBC Act offers protection for threatened species and ecological communities to preserve the naturally occurring biodiversity of the Australian landscape. Projects that are at risk of affecting the prevalence or distribution of any listed taxa require assessment under the EPBC Act.

Desktop research and field surveys have been used to describe the threatened species and communities confirmed present or likely to occur within the Study Area, which could, therefore, be affected by the Project.

In total, one listed threatened flora species, four listed threatened fauna species and two listed TECs have been confirmed present or assessed as likely to occur within the Study Area, as outlined in Table 6. Each is dealt with separately within subsequent sections.

Table 6 Threatened species and communities present or likely to occur

MNES Classification	Name	Presence	Section
Listed threatened flora	Waxy cabbage palm	Confirmed present	4.2
Listed threatened fauna	Squatter pigeon (southern)	Confirmed present	4.3
	Black-throated finch (southern)	Confirmed present	4.4
	Yakka skink	Likely to occur	4.5
	Ornamental snake	Confirmed present	4.6
Listed threatened ecological community	Brigalow	Confirmed present	0
	GAB springs	Confirmed present	4.8

4.1.2 Direct impacts associated with the project

During development of the Project and preparation of the EIS and SEIS, substantial consideration was given to minimising the potential impacts on matters of NES, including minimising the Project footprint, setback options and construction staging. These measures have been adopted such that the impacts identified in this chapter are those which could not reasonably be avoided or minimised through design changes and refinements.

To assess the potential impacts of the Project on matters of NES, the Rail and Mine components of the Project are addressed separately. The potential impacts from the Rail and Mine components will be realised across different time frames and will impact matters of NES in different ways. Therefore, to accurately assess the impacts on matters of NES, the construction and operational phases for the Rail and Mine component have been assessed independently. However, collective or cumulative impacts as a result of both aspects of the Project progressing simultaneously are noted where appropriate. Table 7 provides a summary of the key Project components and potential associated environmental impacts.

Table 7 Key Project components and potential environmental impacts

Project component	Potential environmental impacts
Mine lease area	
Open cut pits	Habitat loss Habitat fragmentation and degradation Changes to hydrology (groundwater and surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk
Underground mining area	Habitat alteration through subsidence Changes to hydrology (groundwater and surface water)
Overburden disposal (out of pit waste dumping), water management dams and flood levee	Habitat loss Habitat fragmentation and degradation Changes to hydrology (groundwater and surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk
Off-lease infrastructure area	
Workers accommodation village and associated facilities, permanent airport site, industrial area and water supply infrastructure	Habitat loss Habitat fragmentation and degradation Changes to hydrology (surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk
Rail	
Rail corridor (95 m wide) including rail line, maintenance road, passing loops and bad order sidings	Habitat loss Habitat fragmentation and degradation Changes to hydrology (surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk

Project component	Potential environmental impacts
Rolling stock maintenance yard, ballast and material stockpiles, Borrow 7	Habitat loss Habitat fragmentation and degradation Changes to hydrology (groundwater or surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk

4.1.2.1 Rail construction

Description of activities

Construction of the Project (Rail) will involve the following activities:

- Site preparation including site clearance, construction camp establishment, installation of temporary and permanent fencing, installation of drainage and water management controls and construction of site access
- Civil works including bulk earthworks, black soil treatment, construction of cuts and embankments, installation of permanent drainage controls, construction of temporary haul roads, establishment of concrete batching plants, bridge and water course crossing construction and development of quarries and borrow areas
- Track works including installation of the rail, signalling infrastructure and maintenance infrastructure

Collectively the temporary and permanent infrastructure comprises the Project footprint for the construction phase of the Project. The extent of the Project footprint is presented in Figure 2.

Potential impacts

Construction of the rail infrastructure will require clearing a permanent 95 m wide rail corridor to allow rail infrastructure to be established. Clearing will also be necessary for temporary construction infrastructure outside the 95 m corridor, including track and bridge laydown areas, turning circles and concrete batching plants, as well the permanent maintenance facility. Clearing will also be required for construction of the five quarries that will provide materials during construction.

Potential impacts arising from vegetation clearing during the construction of the Rail (Project) may include:

- Loss of remnant vegetation in the form of REs, flora habitat and vegetation community extents
- Loss of habitat (roosting, shelter, foraging, breeding) for native fauna including conservation significant fauna
- Landscape fragmentation, reduction in connectivity and reduced capacity for fauna dispersal
- Degradation of terrestrial and aquatic habitat adjacent to and downstream of cleared areas
- Fauna mortality during clearance, earthworks and/or general construction activities

These are discussed in more detail below.

Habitat loss

The total area of potential TECs to be cleared from within the Project (Rail) footprint includes 26.6 ha of REs potentially consistent with the brigalow (*Acacia harpophylla* dominant and co-dominant) TEC. In addition to the brigalow TEC (and associated fauna habitat types), two dams (based on DERM's water bodies mapping layer, 2010) and a number of watercourse habitats will be disturbed by the construction activities. In total, it is predicted that 12 major watercourse crossings and approximately 76 minor watercourse crossings (including unmapped ephemeral drainage lines) may be affected. The majority of the watercourses intersected by the Project (Rail) footprint are ephemeral streams that provide limited aquatic habitat and therefore disturbance impacts will be limited at these locations. However, cattle water troughs also provide a source of water to avian fauna and are common throughout the construction footprint. Consequentially, construction activities will reduce local availability of habitats associated with natural and artificial water bodies.

Habitat fragmentation and degradation

Clearing of vegetation and construction activities within the Project (Rail) footprint will cause fragmentation of adjacent habitat. In addition to fragmentation, clearing and construction activities will result in temporary localised increases in noise, vibration and light disturbance. Habitat degradation may also occur due to increased exposure to dust, wind, weeds and introduced animals. Exposure to any of these effects may alter habitat composition and quality 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 altered and the diversity of native species reduced.

Vegetation clearing also has the potential to facilitate erosion (water and wind) particularly on soil types with a high erosion potential and on high gradient slopes. Where vegetation clearing occurs on floodplains and near drainage lines, erosion may cause sedimentation of waterways, potentially degrading downstream aquatic and riparian habitats.

Changes to hydrology

Construction of the Project (Rail) will include construction of embankments and watercourse crossings which has the potential to change 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.

Injury or mortality of species

Injury or mortality to individuals may occur during construction as a result of interaction with construction vehicles or equipment. It is anticipated that fauna mortality will occur, particularly for those cryptic and/or less mobile animals that may not be detected by the fauna spotter-catcher prior to or during vegetation clearing activities. This may therefore affect ornamental snake, which is cryptic and may be more vulnerable if in torpor at the time of clearance or where located underground

Disturbance and displacement of species

Individuals and/or populations of some matters of NES species recorded in the terrestrial and aquatic environments across the Study Area will be lost from the local environment due to clearing and watercourse disturbance associated with construction of the Project (Rail). Increased anthropogenic disturbance in the Study Area also has potential to alter fauna behaviour, primarily as a result of increased exposure to light, noise, dust, vehicles and people.

Weeds, pests and fire risk

Increased movement of people, vehicles, machinery, vegetation waste and soil may facilitate the spread of weeds within the construction area. Pest and feral species may disrupt ecosystems by outcompeting and replacing native species and increasing predation pressures, thus altering ecosystem diversity and potentially disrupting ecosystem function.

Pest and feral species may disrupt ecosystems by outcompeting and replacing native species and increasing predation pressures, thus altering ecosystem diversity and potentially disrupting ecosystem function. Eleven introduced plants were detected within the Rail Study Area, of which, three are ‘declared plants’ under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act). Increasing the prevalence of weeds within the construction footprint and the potential for weed spread beyond to the surrounding landscape may reduce the quality of habitats for some fauna species locally.

Mitigation and management measures

Mitigation and management measures associated with construction of the Project (Rail) are detailed in the EIS Volume 3, Section 5 and identified within the Rail EMP (SEIS Volume 4, Appendix W) and the Rail and Offsite Infrastructure Threatened Species Management Plans (SEIS Volume 4, Appendix C3). Key management and mitigation measures that will be implemented to minimise impacts to matters of NES are summarised here.

Habitat loss

The total extent of vegetation clearing, and in particular remnant vegetation, required for the rail construction phase has been minimised in the design phase of the Project (Rail) through avoidance. The Project (Rail) alignment has as far as is practicable (and in consideration of other environmental, social and technical constraints) been located in areas that have been previously cleared or degraded by both past and current land use practices (refer EIS Volume 1 Section 1 Introduction for discussion on Project alternatives).

Detailed design and layout for construction will further consider opportunities to avoid sensitive habitat, including aquatic habitat, and make use of non-remnant/cleared land. Clearance extent will be restricted to only that necessary for the Project.

Habitat fragmentation and degradation

Habitat fragmentation and degradation will be avoided through minimising human and vehicle access to river and creek bed and banks. Construction of dedicated river/watercourse crossings (as far as practical) will reduce the need for personnel, equipment, machinery and plant to traverse the river/watercourse and limit disturbance to bed and banks. A Project Erosion and Sediment Management Control Plan will be implemented to limit degradation of downstream aquatic habitat.

Where temporary stream or channel diversions are required to facilitate activities in wet periods, stream flow will be maintained to provide connectivity between aquatic habitats and facilitate aquatic fauna passage.

Design will incorporate stormwater management infrastructure and mechanisms to minimise the change in flow regime of watercourses where appropriate and mitigate potential scour. This may include holding tanks and/or gross pollutant traps.

Disturbance and displacement of species

Vegetation clearing will be undertaken in a sequential manner to allow mobile fauna to disperse away from clearing areas. Prior to clearing, all demarcated habitat features will be checked for fauna by a fauna spotter-catcher and at risk, species will be relocated. A Fauna Species Relocation and Salvage Plan (part of the Rail and Offsite Infrastructure Threatened Species Management Plans (SEIS Volume 4, Appendix C3)) will be developed to facilitate relocation of fauna individuals according to species requirements (particularly if conservation significant fauna species are encountered during clearing activities). A fauna mortality register will be maintained to document the location and frequency of mortality and the fauna species most susceptible to injury and death, to enable on-going modifications to fauna conservation management strategies where necessary.

Rehabilitation of cleared areas will occur as soon as practicable after cleared areas are no longer required. Areas to be cleared will be demarcated onsite and clearance operations will be supervised by a suitably experienced ecologist to monitor compliance with clearance extents and for avoidance of impacts to fauna.

Weeds, pests and fire risk

Fauna fencing, speed limits, fire controls, light spill controls, dust suppression, pest and weed controls will be utilised onsite to minimise direct or indirect impacts to fauna.

4.1.2.2 Rail operation

Description of activities

The operational footprint of the rail infrastructure includes the 95 m wide rail corridor and permanent infrastructure, including:

- Rail corridor (95 m wide) (fenced and inclusive of maintenance/service road, passing loops and bad order sidings)
- Rolling stock maintenance yard (western end of the Project)
- Ballast and material stockpiles
- Borrow 7

Operation of the Project (Rail) will enable transportation of up to 100 Mtpa to port. Rail operation will occur 24 hours, 7 days a week, for a period of up to 90 years. No clearing of vegetation is expected to occur within the operation phase of the Project (Rail) other than that required for maintenance of infrastructure and access tracks.

Potential impacts

Habitat fragmentation and degradation

The rail infrastructure will create a permanent linear barrier across the landscape for fauna movement. This will be established during the construction phase. This fragmentation impact will be realised for the operational life of the rail is expected to have a localised effect on fauna movements; however, at a regional scale it is unlikely that this fragmentation will result in adverse impacts given that the environment is pre-adapted and currently functions as a fragmented landscape (the existing fragmented nature of the surrounding landscape from historical clearing and grazing practices).

Changes to hydrology

Changes in aquatic habitats used by fauna may occur as a result of rail operation. This may be from runoff carrying contaminants that degrade water or sediment quality, or as a result of an altered catchment landscape from infrastructure creating a barrier to flows and realising a change in the floodplain hydrology. This could reduce availability of water resources through degradation or impeded movement of aquatic fauna within and between habitats during flood periods. Reduction of localised biodiversity may be realised if such potential impacts are not controlled.

Injury or mortality of species

Operation of the Project (Rail) represents an increased risk to fauna from train and maintenance vehicle strikes. The risk to fauna posed by vehicular traffic is significantly less than the risk posed throughout the construction phase of the Project (Rail) as vehicular traffic will be lower than that during the construction phase. Vehicles movements will be controlled by enforced speed limits and the rail corridor will be fenced with fauna passage facilitated at designated points. Therefore, it is not considered likely that adverse impacts on fauna will result as a consequence of train or vehicle strikes during operation.

Disturbance and displacement of species

The higher intensity of activity at and near disturbed areas associated with the Project (Rail) 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).

Weeds, pests and fire risk

Increased movement of people, vehicles, machinery, vegetation waste and soil may facilitate the spread of weeds within the operational area. Pest and feral species may disrupt ecosystems by outcompeting and replacing native species and increasing predation pressures, thus altering ecosystem diversity and potentially disrupting ecosystem function. Eleven introduced plants were detected within the Study Area, of which, three are 'declared plants' under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act). Increasing the prevalence of weeds within the operation footprint and the potential for weed spread beyond to the surrounding landscape may reduce the quality of habitats for some fauna species locally.

The introduction of weeds and pests as well as indirect impacts to vegetation (e.g. dust settlement) can influence foraging and other fauna behaviours. These anthropogenic influences can therefore result in increased mortality potential, including potential consequence of a change in the fire regime of the site.

Mitigation and management measures

Habitat fragmentation and degradation

Operation of the rail infrastructure will result in landscape fragmentation on a local scale. Design of the Project (Rail) aimed to minimise impacts as far as practical by avoiding fragmenting habitat and incorporating suitable watercourse crossings and fauna passages.

Other measures that will be implemented during operation of the Project (Rail) to mitigate and ameliorate potential habitat fragmentation and degradation will include:

- The height of the rail corridor above watercourses will be optimised to accommodate the movement of wildlife underneath the infrastructure and reduce potential interference with aquatic fauna movements.
- Sediment traps will be established at strategic locations to protect water bodies from sediment and pollutants
- Fauna corridors will include revegetation, fencing and grids/gaps to promote fauna use. Consideration will be given to fauna/fish passage requirements and design will adopt criteria, which promote fauna use.
- Fauna underpasses within important habitat areas will be incorporated into the design of the rail corridor. Appropriate fencing and revegetation will be used to encourage use by fauna species.

Changes to hydrology

Sufficient spanning of watercourses will be achieved to not interfere with the floodplain hydraulics. Protective vegetative drains and dams will be established to manage stormwater runoff and sediment erosion potential to buffer sensitive flora and fauna and provide alternative water resources.

Injury or mortality of species

Incidents of fauna strike and mortality will be monitored during operation. Dead carcases will be disposed of away from the rail corridor to reduce the occurrence of predators, such as raptors and pest fauna, also being struck by moving trains.

The rail will be fenced to restrict the ability of fauna to move across the rail line

Disturbance or displacement of species

The railway infrastructure will not be lit, with the exception of the balloon loop and maintenance facility. This will mitigate lighting impacts on fauna behaviour for the majority of the length of the corridor.

Weeds, pests and fire risk

Fencing, fire controls, pest and weed controls will be incorporated into the EMP (operation) to minimise direct or indirect impacts to flora or fauna.

4.1.2.3 Mine construction

Description of activities

Construction of the Project (Mine) will include development of the Mine and Mine (offsite) infrastructure, including a workers accommodation village, an industrial area, a permanent airport and water supply infrastructure.

Construction of the Project (Mine) will be progressive with a timeframe that achieves peak production within 10 years. There is an initial intense construction phase (first three years) to realise first Mine activity. Rehabilitation and progressive development will occur throughout the life of the Project (Mine).

Potential impacts

Potential impacts arising from construction of the Mine (onsite and offsite infrastructure) may include:

- Loss of vegetation and fauna habitat (including roosting, foraging and breeding areas)
- Landscape fragmentation, reduction in connectivity and reduced capacity for fauna dispersal
- Degradation of terrestrial and aquatic habitat adjacent to and downstream of cleared areas, including erosion of surface soils
- Fauna mortality

Habitat loss

The existing cleared land that dominates the Project (Mine) construction area has relatively low terrestrial ecological value, and supports a lower diversity of flora and fauna species than more complex habitats featuring remnant vegetation. During various field surveys, these cleared areas were generally not found to provide a suite of habitat resources for conservation significant terrestrial ecological values (i.e. threatened species, migratory species, TECs), although black-throated finch (southern) and squatter pigeon (southern) sightings were made at water bodies surrounded by non-remnant vegetation. In addition to conservation significant species, vegetation communities provide habitat features for a variety of common woodland bird, reptile and mammal species.

One small farm dam (approximately 6 ha in size) will be lost as a result of construction of the Mine infrastructure. This dam is a shallow scrape that has a seasonally fluctuating water level, and does not feature aquatic or riparian vegetation. While the dam is likely to represent a localised water source for fauna, potentially including threatened species such as the black-throated finch (southern) and squatter pigeon (southern), water is readily available from other farm dams throughout the surrounding agricultural landscape.

Individuals and/or populations of some of the species of NES recorded from the terrestrial and aquatic environments across the Mine Area will be lost from the local environment due to clearing and watercourse disturbance during construction of the Project (Mine).

Changes to hydrology

There are no mapped water bodies within the workers accommodation village or industrial precinct and permanent airport. However, construction of the offsite water supply infrastructure will result in temporary disturbance of aquatic habitats while pipelines are buried under streams and drainage lines, including barriers to flow, temporary diversions, disconnection of the floodplain and changes to surface flows.

Due to the temporary nature of construction at any one location, 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.

The disturbance of the riparian zone may trigger erosion and sedimentation impacts and resulting degradation of adjacent and downstream habitats. Management measures will be implemented during construction to mitigate potential impacts to downstream water bodies that could influence matters of NES. These would include changes in water quality as a result of erosion, introduction of contaminants, wastes or other pollutants.

Alteration of the topography of the landscape to achieve development of the Mine infrastructure will result in changes to surface flows and geomorphology. The existing open grazing land will be compacted and developed and, as such, the resultant land will have a higher potential for runoff. Appropriate stormwater management, including use of water storage dams, will be required to manage potential for erosion and scouring from runoff to manage risk of contaminants entering watercourses.

Injury or mortality of species

Injury and mortality may occur where animals are struck by vehicles or plant, or where animals become entrapped in active construction areas (pits, trenches, building sites etc.).

Disturbance and displacement of species

Behavioural disruption may also arise as a result of increased vehicular activity and a change in disturbance types at the Study Area, such as increased dust mobilisation and increased exposure to noise, light and vibration.

Weeds, pests and fire risk

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. Introduction and/or spread of weeds and pest species may occur from construction works. In particular, rubbish and wastes associated with the workers accommodation village may attract feral animals such as pigs and dogs, which would adversely affect native biodiversity. Measures will be required to manage pests, weeds and wastes to minimise potential impacts from weeds and pests on the ecological integrity and functioning of non-disturbed lands and waterways.

Mitigation and management measures

Habitat loss

Detailed design will aim minimise the extent of land to be cleared for the construction of the Mine and Mine (offsite) infrastructure. Where land clearing is required, the following management and mitigation measures will be implemented to minimise impacts:

- The extent of vegetation clearing will be identified on construction plans and in the field. Areas that are not to be cleared or damaged will be identified on construction plans and in the field. Clearing extents will communicated to all necessary construction personnel and clearing activities will be supervised by an ecologist to monitor compliance of vegetation clearing with the defined clearing extents.
- Each water supply storage facility (offsite infrastructure) will include an associated storage area, which will be located, where possible, within existing cleared, non-remnant or disturbed areas.
- Management of land disturbed as a result of construction works will occur in accordance with the Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2). 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). The objective of land rehabilitation will be to provide habitat resources for those localised flora and fauna assemblages identified in EIS Volume 2, Section 5 Mine Nature Conservation.
- Vegetation clearing will be undertaken in a sequential manner to allow mobile fauna to disperse away from clearing areas. Prior to clearing, all demarcated habitat features will be checked for fauna by a fauna spotter-catcher and at-risk species will be relocated. A Fauna Relocation Plan (a component of the Land Management (Flora and Fauna) Plan) will be developed to facilitate relocation of fauna individuals according to species requirements (particularly if conservation significant fauna species are encountered during clearing activities). A fauna mortality register will be maintained to document the location and frequency of mortality and the fauna species most susceptible to injury and death, to enable on-going modifications to fauna conservation management strategies where necessary.

Habitat fragmentation and degradation

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 should be given to not using barbed wire on the top strand of wire fences.

Changes to hydrology

Detailed design will incorporate stormwater management infrastructure and mechanisms to minimise the change in flow regime of watercourses where appropriate and mitigate potential pollution. This may include holding tanks and/or gross pollutant traps.

Existing access tracks will be used where possible and new tracks will align to traverse previously disturbed areas. Where watercourse crossings are required, crossing locations will be selected to avoid or minimise disturbance to aquatic flora, waterholes, watercourse junctions and watercourses with steep banks.

A Project Erosion and Sediment Control Plan will be implemented to limit degradation of downstream aquatic habitat.

If temporary stream or channel diversions are required to facilitate activities in wet periods, stream flow will be maintained to provide connectivity between aquatic habitats and facilitate aquatic fauna passage.

Weeds, pests and fire risk

Waste management, fire controls, pest and weed controls will be utilised onsite to minimise direct or indirect impacts to fauna or flora due to weeds, pests and fire. All environmental controls will be documented within the EMP (construction).

4.1.2.4 Mine operation

Description of activities

The operation phase of the Project (Mine) will involve the following activities:

- Underground mining staged through development with subsidence of mined areas
- Open cut mining staged through development and rehabilitation of pits over the duration of the Mine life
- Management of overburden through disposal (out of pit waste dumping) and development and rehabilitation of waste areas over the duration of the Mine life
- Development and maintenance of clean water diversion drains to be established along the boundary of the Study Area, and separating clean inflows from dirty water areas
- Operation of offsite water supply infrastructure
- Operation of a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure
- Establishment of sediment ponds to receive water from mining operations
- Development and maintenance of a 500 m buffer from the centre of the Carmichael River, with establishment of a flood levee bordering the 500 m buffer zone adjacent to the Carmichael River

The staged, non-sequential operation of the Mine is proposed to occur over 60 years and will include:

- Underground mining in the west of the Project (Mine) Area
- Open cut mining in the centre of the Project (Mine) Area
- Overburden disposal (out of pit waste dumping) and water management dams in the east of the Project (Mine) Area

Potential impacts

Potential impacts to ecological values due to operation of the Project (Mine) will include:

- Habitat loss resulting from vegetation clearing and changes to topography and the resultant potential for fauna mortality
- Habitat fragmentation and degradation (i.e. erosion of surface soils, degradation of water quality)
- Changes to hydrology resulting from disturbance of surface watercourses and removal of watercourses/water bodies leading to:
  - Aquatic fauna mortality
  - Loss of habitat for species
  - Alteration/degradation of water quality
- Changes to hydrology resulting from an alteration in the groundwater regime leading to:
  - A reduction in pressure within the aquifer and therefore potential impacts to springs
  - Drawdown of the groundwater table and impacts to groundwater-dependent ecosystems
- Introduction of pest and weed species:
  - Competition with native species, predation of native species
  - Habitat degradation (presence and prevalence of pest and weed species) and reduction in resource availability
- Altered exposure to noise, light and dust disturbances, causing:
  - Disturbance to roosting and foraging areas
  - Habitat degradation from dust settling

Habitat loss

Mine operations will require extensive vegetation clearing and will follow the progression of coal extraction. Subsequently, vegetation clearing is proposed to not occur across the entire mining footprint (i.e. areas associated with open cut mining, out of pit waste dumps and water management dams) in a single event, but rather is proposed to be staged to correspond with the sequential development of coal extraction.

The staged loss of habitats, over the life of the Mine, will reduce the local availability of foraging, breeding and shelter resources for a wide diversity of fauna species. 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.

Vegetation clearing may also result in the direct mortality of fauna. Animals that are unable to disperse away from areas under active clearing are particularly susceptible to injury or death. This includes amphibians, reptiles, small ground-dwelling mammals and nocturnal species that are inactive during daylight hours.

Generally, the staged yet permanent loss of remnant vegetation for mining operations will have an acceptable impact on the REs located within the operational footprint of the Mine. Less than one percent of the current (2006) subregional RE extent for all endangered and of concern REs impacted by the Project is proposed to be lost as a result of vegetation clearing (SEIS Volume 4, Appendix J1 Revised Ecological Assessment Report).

The loss of vegetation, resulting in a loss of flora species and habitat, is a considerable impact of the Project. The EPBC Act and State offset policy will be addressed in terms of the offsetting requirements, including:

- EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a)
- DERM – Queensland Biodiversity Offset Policy (DERM, 2011d), a specific-issue offsets policy under the Queensland Government Environmental Offset Policy

Additional information regarding offset requirements for the Project is provided in Section 8.

Habitat fragmentation and degradation

Mine operations may reduce the ability for fauna to disperse across the landscape by fragmenting the landscape, either as a result of land clearing or facility construction, thereby reducing fauna corridors. This is more likely in the northern and southern parts of the Study Area where potential north east-to-west/east-to-west fauna movement may occur through the Study Area.

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. Vegetation clearing also has the potential to facilitate erosion. A levee will be constructed on either side of the Carmichael River, both to protect the channel and riparian vegetation, and to provide flood mitigation for the proposed pits to the immediate north and south of the river.

Altered geomorphology may also affect erosion or sedimentation potential across the landscape, particularly associated with offsite water supply infrastructure where dams may act as sources of sediment if appropriate bank stabilisation strategies are not properly implemented.

Historical land use practises have resulted in a landscape, which includes large tracts of cleared land featuring non-remnant vegetation. As such, the potential for long-distance west-to-east fauna dispersal across the landscape through much of the Study Area is currently limited. A wildlife corridor, associated with tracts of remnant vegetation within and to the north-east and west of the Project (Mine) Area may be fragmented by staged mining operations at the northern part of the Project (Mine) Area. Similarly, proposed mining operations in the southern part of the Project (Mine) Area will disrupt a belt of remnant vegetation that extends from west of the Project (Mine) Area, through the Project (Mine) Area (at the Bygana West Nature Refuge) to the east towards the floodplain of the Belyando River. Habitat fragmentation will restrict opportunities for localised fauna movement, with impacts more pronounced on small, less mobile animals such as frogs, reptiles and small ground-dwelling and arboreal mammals. Perimeter fencing around the Mine site may also inhibit fauna movement.

Mine operation requires substantial excavation and movement of earth from and around the Study Area, which will contribute to a change in topography across the Study Area. Overburden stockpiles will reach a maximum of 140 m in height. The impacted landscape will be engineered to manage erosion potential and overland flows will be channelled into staging dams for management of stormwater runoff water quality. Subsidence of 2 to 5.5 m is expected to occur across the area subject to underground mining, which will influence the topography of the landscape and influence habitat connectivity.

Changes to hydrology: surface water

Staged clearing of the land within creek catchments and creation of dams associated with offsite water supply infrastructure has the potential to disturb bed and bank substrates and lead to localised erosion and sediment transport to downstream habitats.

The primary impact to aquatic ecosystems will relate to mobilisation of sediments and other contaminants into the aquatic environment, which will require stringent erosion and sediment control management. The removal of aquatic habitat 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 Basin
- Much of the habitat comprises farm dams or ephemeral waterways that do not contribute to regional re-colonisation or connect permanent aquatic habitats

Within the Study Area, the watercourse pathways to be disturbed by open cut pits or overburden stockpiles are generally ephemeral reaches at the top of a catchment rather than reaches that connect permanent aquatic habitat areas. Removal of these watercourse reaches will be temporally distributed throughout the entire Mine operation (over 60 years).

Acidic runoff into a watercourse is likely to have adverse impacts to surface water quality and in turn aquatic habitat suitability and faunal use of the environment. Results of testing undertaken as part of the assessment for potential acid Mine drainage (see EIS Volume 2 Section 10 and SEIS Volume 4 Appendix O1 Mine Waste Characterisation Report) indicate that the majority of the overburden and interburden materials (not immediately adjacent to the coal seams) and roof and floor wastes are not likely to be a source of acid immediately after mining. Nor would most of these materials be expected to an immediate source of salinity. Nevertheless, 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 water quality objectives for the Project. Water quality objectives have been proposed for the Study Area, including for all discharges to local receiving waters (refer to SEIS Volume 4, Appendix K3 Water Quality Report for further detail on water quality objectives).

In general, it is expected that over staged development of the Mine, the local availability of surface water is proposed to be reduced by up to 25 percent. Areas overlying the underground mining area are proposed to be subject to subsidence. Subsidence depths across the Mine Area are predicted to range between 2 and 5.5 m. Water will accumulate in subsidence depressions for up to approximately 24 hrs, for around 60 percent of time events. This may alter the local topography above underground mining areas and, in the long-term, alter surface hydrology patterns and vegetation assemblages. The area of land potentially subject to the impacts of subsidence is 7,922 ha.

Whilst flow from upstream within the catchment is proposed to be diverted away from this area, it is expected that some flow will occur in this area as a result of localised rainfall. There is potential for this water to accumulate in subsidence depressions, creating new surface water resources. These water resources may not be drained, but rather kept to support the ecological values of the system. Design of the underground Mine plan should seek to minimise the potential for alteration to surface topography (and overland flows), such that impacts to vegetation communities and fauna habitats in these areas are minimised.

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 post-rainfall.

The removal of the aquatic habitats of farm dams and ephemeral, low stream order, watercourses within the Mine operation footprints area is unavoidable. Although the habitats to be affected are not considered to be high value, many provide habitat for native fauna. 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. Watercourses will be affected both directly and indirectly from land clearing and operational works and may result in alteration/degradation of water quality in downstream environs.

Changes to hydrology: groundwater

Impact of pressure reduction on springs

Changes to groundwater hydrology have the potential to occur as a result of the operational phase of the Project (Mine). Impacts to groundwater and base flow in the Carmichael River are discussed in SEIS Volume 4 Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum.

Further detail regarding the modelling predictions for pressure reduction in the aquifers at the Doongmabulla and Mellaluka spring groups from the Revised Mine Hydrogeology Report (SEIS Volume 4 Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum) is provided in Section 4.8.7.

The results show that a 19 cm reduction in pressure in the aquifer supplying the Joshua Spring is likely to result in a negligible reduction in flow. The threatened species found at the Joshua Spring wetland, *M. artesium* and *S. partimpatens*, are unlikely to be impacted, as the water supply to the wetland in which they occur is not likely to be reduced to an extent that will affect these species.

At Moses Spring, a total of 65 active springs were counted, of which 56 had a recognisable mound, five were ‘small artesian seeps’ and the other four springs were ‘non-mounding artesian springs’ (springs that had a pool but no mound). Spring morphologies observed during surveys are discussed in more detail in the springs technical report, Volume 4 Appendix J3 of the SEIS. Twelve of the mounds were less than 20 cm high, 24 were 20 – 50 cm high, and 20 were higher than 50 cm. The highest mounds were approximately 1 – 1.5 m tall (that is, 1.5 m above the level of the surrounding plain).

The threatened species associated with the Moses Springs are generally present on or immediately adjacent to the mounds, seeps or pools. Most mounds are separated from other mounds by bare sections of plain. The majority of the population of endemic and/or threatened species at Moses are located within wetland areas fed by seepage from the springs. These wetlands generally form sedgeland or grassland, rarely with trees (weeping paperbark clumps or individual waxy cabbage palms).

The predicted reduction in pressure at Moses Spring group is generally less than 0.08 m. These reductions in pressure are expected to have a minor impact on the springs and associated wetlands, falling within the range of seasonal fluctuations to which the springs are already adapted. Therefore, it is thought that the reduction in flow will be within a tolerable range.

Groundwater modelling predicts that reduction in pressure in the Little Moses Spring will be less than 0.05 m. This would result in the pond level dropping by 0.05 m, and it is expected this would represent a negligible impact on the ecology of the spring and the sedgeland that fills most of its surface area.

Mellaluka spring group is located near the south western corner of the eastern section of the Mine Area, on Mellaluka Station. It is not believed to be fed by a GAB aquifer and therefore, does not meet the criteria for TEC designation.

Impact of drawdown of the groundwater table on GDEs

For around 3 km upstream of the western boundary of the Mine Area, the predicted pre-development modelled long-term average base flow is approximately 4,150 m^3/day. Model results suggest the Carmichael River predominantly upstream of the western boundary of the Mine Area is ‘gaining’ (see Figure 9) which is consistent with groundwater level and surface water flow observations at the site. This section corresponds to the location of a dense cluster of waxy cabbage palms.

From a point some few hundred metres east of the western boundary of the Mine Area, pre-development groundwater flow modelling results suggest that the Carmichael River switches from generally gaining flow to losing flow (Figure 10) which is consistent with groundwater level and surface water flow observations at the site. Between that location and the eastern Mine Area boundary, predicted pre-development long-term average base flow gradually reduces to around 3,150 m^3/day and groundwater levels have been measured around 4.5 m below the channel bed.

It is important to note that base flow to the river will naturally vary, is seasonally affected and that current model predictions are effectively long-term averages. It is normal for base flow to fluctuate and for many sections of the river to have periods of zero base flow – for example, late in the dry season, or during droughts. Zero base flow periods pre-development are predicted to occur approximately 30 percent of the time at the eastern Mine Area boundary.

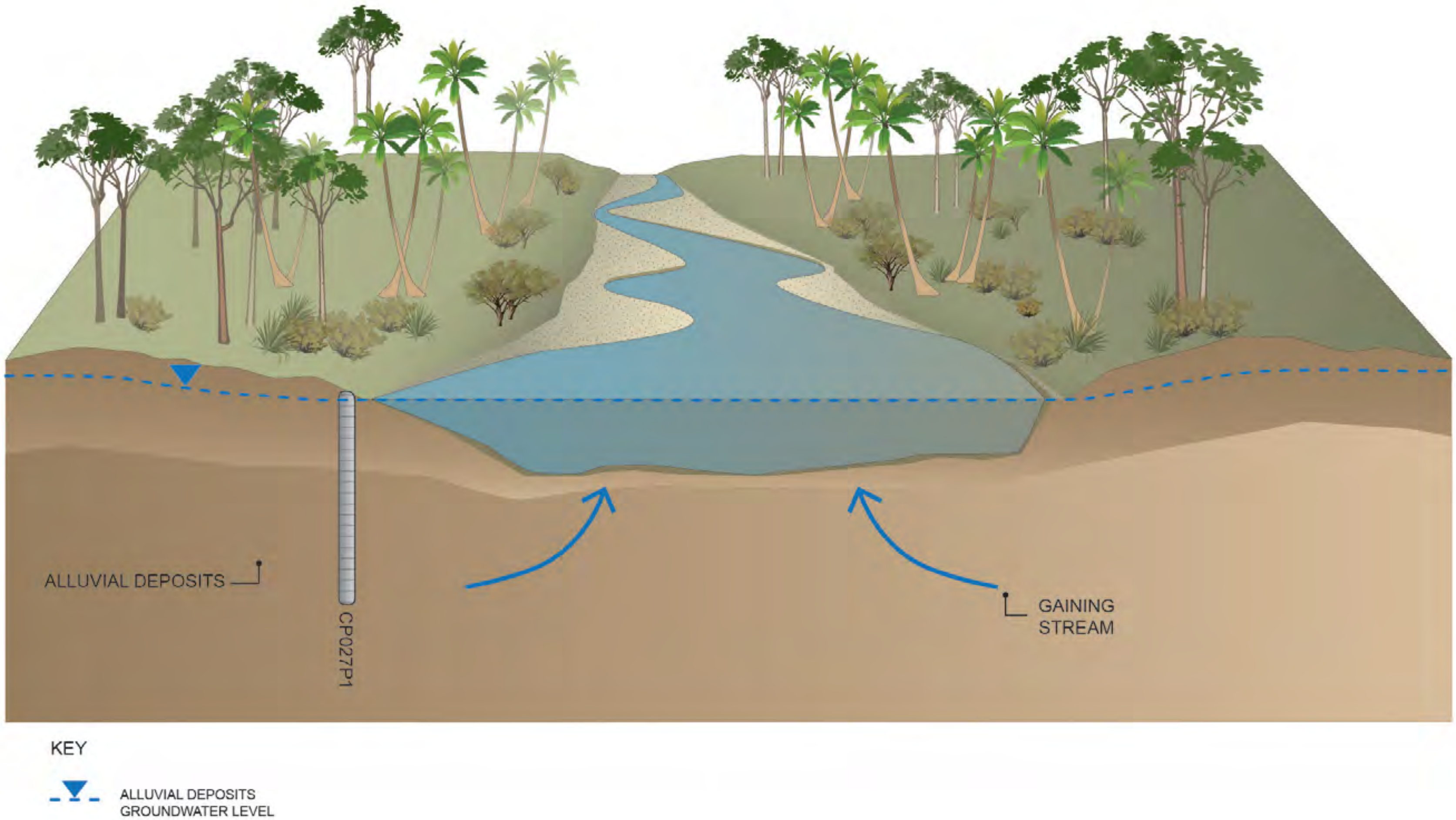


Figure 9 Conceptual river profile model of a ‘gaining’ river section

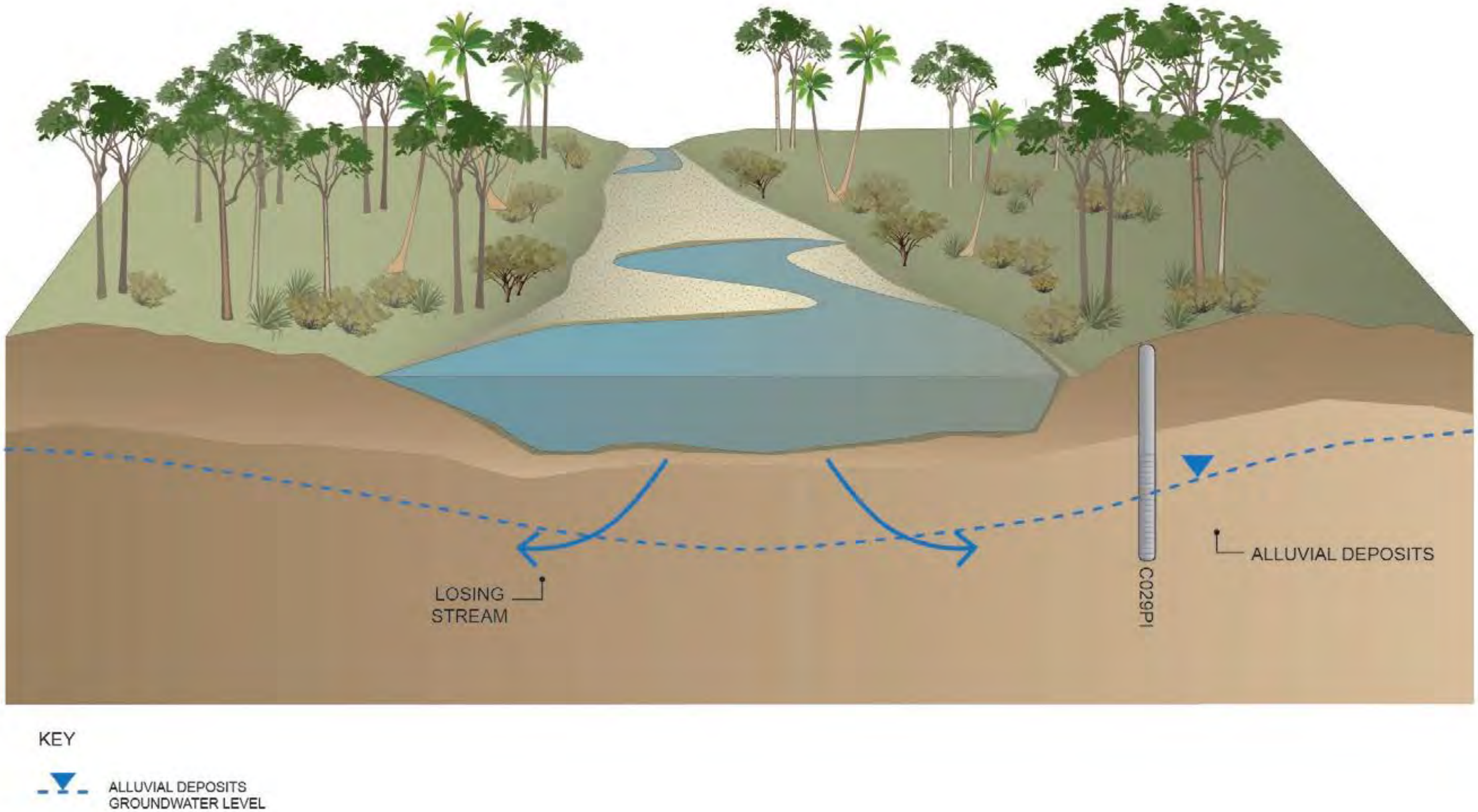


Figure 10 Conceptual river profile model of a 'losing' river section

Predicted impacts on the current water table based on groundwater modelling results suggest that:

- Near the western boundary of the Mine Area, drawdown will be around 1 m and zero flow periods will increase to approximately 5 percent of the time, from zero percent currently
- In general, drawdown of the water table along the Carmichael River is greatest near the middle of the Mine Area, at approximately 4 m, and decreases gradually towards both the western and eastern boundaries
- At the eastern Mine Area boundary, base flow will be reduced by around 1,000 m^3/day (33 percent of pre-development base flow) during the operational phase, falling slightly to approximately 950 m^3/day reduction (31 percent of pre-development base flow) post-closure
- Zero flow periods at the eastern Mine Area boundary will increase by 30 percent to 60 percent of the time during operation and post closure

Drawdown of the water table is predicted to reduce the volume of base flow to the Carmichael River and cause the point of zero-base flow to migrate upstream (i.e. to lengthen so it is closer to the eastern boundary of the Mine Area). These reductions are predicted to cause the point at which base flow in the Carmichael River is reduced to zero (through leakage to the ground in ‘losing’ sections of the river) to migrate 10 km upstream, from 25 km downstream of the eastern Mine Area boundary pre-development, to 15 km downstream post-development.

Injury or mortality of species

Vegetation clearing for Mine operation may also result in the direct mortality of fauna. Those animals that are unable to disperse away from areas under active clearing are particularly susceptible to injury or death. This includes amphibians, reptiles, small ground-dwelling mammals and nocturnal species that are inactive during daylight hours. Management and mitigation measures to reduce the potential for fauna mortality as a result of land clearing activities during Mine operations are largely analogous to those described for the construction phase of the Project.

Disturbance and displacement of species

Habitat degradation, behavioural disruption and injury/mortality may arise as a result of increased vehicular activity and a change in disturbance types at the Study Area. These processes will potentially impacts fauna species listed as matters of NES. Habitat degradation and associated behavioural disruption may result from increased dust mobilisation and increased exposure to noise, light and vibration. Injury and mortality may occur where animals are struck by vehicles or plant, or where animals become entrapped in active construction areas (pits, trenches, building sites etc.). Increased human activity may also alter the fire regime of the landscape, which could affect vegetation and fauna.

Weeds, pests and fire risk

Pest and weed management is important to mitigate potential indirect impacts on certain matters of NES, such as the effects of pig damage or aquatic weeds on germination of waxy cabbage palm, or the effects of dog and cat population densities on mortality of migratory birds. To manage risk and potential for pest and feral species spread, and the potential for introduction of new feral species, during operation of the Project (Mine) an integrated suite of actions will be implemented.

Mitigation and management measures

Habitat loss

Where native vegetation clearing is required, the following management and mitigation measures will be implemented:

- The extent of vegetation clearing will be restricted to the minimal amount necessary for mining operations. During initial mining operations, only mining areas subject to the first stage of sequential clearing will be impacted. Vegetation clearing or the disturbance of areas that are not subject to mining will be minimised prior to their operational dates.
- The extent of vegetation clearing for each stage of mining operation will be identified on construction plans and in the field. Areas that must not be cleared or damaged will also be identified on construction plans and in the field. Clearing extents will be communicated to all necessary construction personnel involved.
- Remnant (including TEC) vegetation not subject to initial clearing will be demarcated in the field and all staff are to be educated that these areas are environmental protection areas up until the time when they need to be cleared. Vegetation clearing operations are to be supervised by an ecologist to monitor compliance of vegetation clearing within the defined clearing extents.
- Prior to clearing of any remnant vegetation, the non-remnant areas that will remain unmined should be revegetated and managed to reach remnant status (to match pre-clearing extent). This will be detailed in the Project Land Management (Flora and Fauna) Plan.
- Where land clearing occurs near or within ephemeral waterways, this will be undertaken during dry conditions to minimise the likelihood of erosion and sediment mobilisation during and after rainfall events.
- Prior to construction and mining operation, baseline field surveys to identify initial weed populations and ongoing monitoring of these populations and for any new occurrences are to be undertaken. Any weed populations identified are to be actively managed with the goal to reduce the spread of and eradicate weed species from the Study Area. This will be detailed in the Project Weed and Pest 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 to strive to achieve a ‘no net loss of vegetation and watercourse’ approach. This is to include, but not be limited to, measures including the reinstatement of drainage channels, riparian vegetation, and soil profiles to the pre-mining extent, using flora species of local provenance and undertaking revegetation activities. Management of previously disturbed land will occur in accordance with the Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2). This plan will detail how disturbed land (including watercourses) will be managed and rehabilitated, including (but not limited to) details about seed collection, flora regeneration and landscape architecture (i.e. topography). The objective of land

rehabilitation should be to provide habitat resources for localised flora and fauna assemblages.

Habitat fragmentation and degradation

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

- Staged Mine development will seek to maintain east-west connectivity where possible throughout the Mine's operational life. The strip of land to be protected on either side of the Carmichael River will be managed so as to maintain and provide biodiversity values.
- Work areas will be checked regularly for fauna that may have entered the work area or become trapped, any fauna found will be relocated. All vehicles and plant will adhere to designated tracks/roads to avoid unnecessary habitat impacts and will adhere to site rules relating to speed limits to minimise potential for road kill.
- Vegetation clearing will be undertaken in a sequential manner to allow more mobile fauna species the opportunity to disperse away from clearing areas. Employees will be made aware of environmental management requirements for vegetation clearing and fauna management and all employees will adhere to requirements at all times.
- Management of land that is yet to be mined, or is to remain unmined, will be undertaken in accordance with a Project Land Management (Flora and Fauna) Plan. This plan will detail how land not subject to direct impacts (i.e. vegetation clearing) should be managed (including details relating to land use (cattle grazing) and fire management), such that the terrestrial ecological values, including connectivity, of such areas are maintained, and where possible, enhanced. This plan will be implemented in conjunction with its component sub-plans relating to the maintenance/enhancement of terrestrial ecological values of undeveloped parts of the Study Area (i.e. Project Species Specific Management Plan(s) (SEIS Volume 4, Appendix C3 Rail Applications).

Changes to hydrology: surface water

Management actions to mitigate risks to aquatic habitats are identified as follows:

- Design and sequencing of site use to incorporate stormwater management infrastructure and mechanisms to manage runoff. Stormwater management mechanisms and monitoring requirements will be developed prior to any operational activities for each operational area of the Study Area (as it is progressively developed) and incorporated in the Water Quality Management Plan.
- Activities that affect watercourse path, including stormwater flow paths or creation of dams, are not to commence until suitable diversion and management of flows is achieved to avoid unnecessary interruption of flows, erosion and water quality degradation.
- Vegetation clearing activities will, where possible, seek to avoid alteration to waterways such that the impacts to water quality and downstream flows are minimised to the greatest extent possible.
- Dust suppression activities to be undertaken where appropriate.
- Management of erosion and sedimentation will be undertaken in accordance with a Project Erosion and Sediment Management Plan. This plan will identify all 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 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.

- Management of potential contaminant or waste release, or emergency response to such, to be documented within the EMP (operation). Regular water quality monitoring to be completed to confirm adequacy of management and mitigation measures. Monitoring requirements, water quality targets, corrective actions and reporting requirements to be clearly articulated in an Operational Water Quality Management Plan, embedded within the EMP (operation).
- Natural attributes of any aquatic habitats created throughout the mining operation will be enhanced. This will be achieved using measures including establishment of riparian zones with suitable native species and 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. Rehabilitation of, or enhancement of, previously disturbed habitat at surface water courses and the creation of fringing habitat for terrestrial species adjacent to constructed water storages and dams will include a requirement for woody debris or other suitable structures that will promote establishment of aquatic flora and fauna. In addition, works will seek to identify and implement enhancement opportunities in newly created aquatic habitats that may arise as a result of subsidence. These measures will be identified within the Draft Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Draft Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2).
- No water will be sourced from the Carmichael River
- Sewage will be treated to Class A standard such that value and quality of aquatic habitats is not adversely impacted

Changes to hydrology: groundwater

Proposed mitigation and management measures for Doongmabulla and Mellaluka Springs include:

- Flow monitoring of the outlet at Joshua spring to monitor changes in output, and in the Carmichael River immediately adjacent to Joshua spring, to monitor contributions to surface water flow and seasonal changes.
- Mapping and measurement (using GPS equipment capable of sub-metre accuracy) of the 'vegetated area' perimeter of the main wetland areas at the Moses Spring group quarterly (there are five main wetland areas).
- Mapping and measurement (using GPS equipment capable of sub-metre accuracy) of selected isolated mound springs (those discrete mounds outside the wetland areas) at Moses Spring group should be conducted on a seasonal basis by a suitably qualified botanist prior to and during the predicted drawdown impact. At least 10 should be selected over the entire spring group (these same 10 to then be resurveyed at each repeat survey), focussing on differing sized mounds and gaining a good geographic spread over the entire group. This should include a complete species list of the mound

vegetation, a photographic record (taken from at least two locations consistently), diameter, height and perimeter measurements (diameter taken from the same places each time), and flow measurements. If a mound should disappear during the Mine life, a nearest neighbour replacement should be selected.

- Ecological studies of the two threatened species listed under the EPBC Act that occur at Moses Spring – blue devil and salt pipewort – should be conducted annually. This should be done in consultation with the Queensland Herbarium using an appropriate survey method for small herbs (the latter of which is a clumping species). Consideration should be given to changing the frequency of surveys if population changes are noted.
- A baseline survey of aquatic invertebrates at Moses Spring conducted by a suitably qualified ecologist/entomologist prior to mining operations commencing, to determine the presence of endemic species.
- A baseline water level will be established at a reference location for the springs, and water levels should be measured against this baseline on a quarterly basis during mining operations.
- These monitoring events will commence at least one year before mining operations (in order to continue a baseline understanding of existing conditions), and continue for at least two years after mining operations are completed.
- At the conclusion of baseline surveys (after at least one year of surveys prior to commencement of mining operations) a Baseline Ecological Condition report will be prepared for the springs.
- An annual report on the spring condition, including statistical comparison to baseline condition, will be provided including reporting on any change from baseline conditions and planned actions.
- These surveys will utilise data gained from studies into groundwater levels conducted by the Mine.
- Ongoing monitoring of Mellaluka Springs will be focused on groundwater studies and is outlined in the Mine Hydrogeology Report (GHD, 2013r).
- Adani will provide a Draft Groundwater Dependant Ecosystem (GDE) Management Plan for approval prior to the commencement of construction. This plan will address impacts to the following GDE's:
  - Doongmabulla Springs Complex
  - Mellaluka Springs Complex
  - Carmichael River, particularly the Waxy Cabbage Palm

  The Plan will include the following:
  - A management framework that aligns with the other project management plans
  - Clear statements regarding the intent, approval requirements, objectives and actions
  - Details of how the management plan will be applied across the project phases – pre construction / construction / operation / post operations, offset areas
  - Details of any proposed adaptive monitoring program to support the plan objectives.

- Details of how experts will be used in a review capacity to inform ongoing monitoring and management
- Incorporates all proposed management and mitigation measures, including reference to relevant State and Federal Guidelines of relevance to these GDE's.
- Specific performance targets and how these will be measured and reported

All surveys and other works will be conducted in consultation with the Doongmabulla and Mellaluka property owners.

Proposed mitigation and management measures for the Carmichael River include:

- Water recycling to supplement base flows in the Carmichael River during dry periods will be conducted in accordance with procedures outlined in the Water Balance Report (SEIS Volume 4 Appendix K2). This will see excess and treated water reintroduced to the river near the western Mine Area boundary, with due consideration to water quality. The intent is that this water will be introduced to the channel in a 'gaining' section of the river, where it will remain in the channel and thus contribute to base flows downstream.
- A detailed 'ecological features' map will be made for the Carmichael River to assist in dieback and river health monitoring, identifying priority management areas including the locations of waxy cabbage palms, rubber vine infestations, riparian composition and health, 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 transects will 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 will be seasonal, reflecting high flow/low flow variability in the Carmichael River (twice annually). This monitoring should continue into the mid operational life of the Mine, and increase to a quarterly frequency when drawdown is at its maximum. If possible, depth to groundwater data should be incorporated.
- 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 deep pools, 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 Mine Area.
- 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 Mine 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 bore field, in conjunction with nearby bore extraction yields and associated drawdown records.

Injury or mortality of species

Management measures to reduce the potential impact of injury or mortality to individual animals, includes:

- Vegetation clearing will be undertaken in a sequential manner to allow more mobile fauna species the opportunity to disperse away from clearing areas. All vegetation clearing will be undertaken in the presence of a qualified fauna spotter-catcher. Pre-demarcated habitat features should be thoroughly checked by a fauna spotter-catcher prior to clearing. Provisions for the relocation of fauna should be made prior to the commencement of clearing.
- All vehicles and plant associated with vegetation clearing will adhere to site rules relating to speed limits. Speed limits will be developed, and clearly signposted so as to minimise the potential for road kill.
- Site inductions are to include education regarding the local fauna of the site and identification of protocols to be undertaken if fauna are encountered.

Weeds, pests and fire risk

To minimise the risk and potential for pest and feral species spread, and the potential for introduction of new feral species during operation, mitigation and management measures will include:

- A Project Waste and Resources Management Plan and Hazardous Substances Management Plan will be implemented, and include waste management and disposal protocols and procedures. This plan will incorporate protocols relating to the:
  - disposal of vegetation waste (in a manner that minimises potential for spread of weeds)
  - disposal of food scraps and the like (to minimise potential for pest animals to access food wastes).
- Monitoring for and management of introduced animals in and adjacent to cleared areas to occur in accordance with a Project Weed and Pest Management Plan. This plan will include details relating to the monitoring, management and where necessary eradication of pest animals.
- Management of weeds in and adjacent to cleared areas to occur in accordance with a Project Weed and Pest Management Plan. This plan will include details relating to the monitoring, management and where necessary eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols.
- Weed audits of areas to be developed (during staged mining operations) will be conducted at a suitable time of the year when growing conditions and identification of weed species are optimal. These audits should cover the applicable development area with a particular focus on high risk locations, such as areas of black soil so that appropriate scale weed mapping can be undertaken to identify weed hotspots, for incorporation into the Project Weed and Pest Management Plan.
- All construction machinery and materials brought onto site will be certified as free of weeds and weed seeds. Records are to be kept of compliance with this requirement.

- Soil stripped and stockpiled from areas containing known weed infestations are to 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.

Disturbance and displacement of species

Management and mitigation measures relevant to these potential impacts include:

- Directional lighting will be used where lighting is required in construction areas.
- Dust suppression actions will be undertaken in all cleared areas, at stockpiles and on all unsealed roads at suitably regular intervals.
- Frequent maintenance of machinery and plant will be undertaken to minimise unnecessary noise and risk of sparks or other creating a fire hazard.
- Implement a Project Bushfire Management Plan (SEIS Volume 4, Appendix S2 Bushfire Management Plan) to document protocols and actions for preventing accidental fires, including how fuel loads are to be stored and maintained across the Study Area.
- Speed restrictions, adherence to roads and use of trained fauna spotters are required to minimise mortality risk to fauna from increased vehicular activity at site.

4.2 Waxy cabbage palm

4.2.1 Ecology and legislation

The waxy cabbage palm is listed as vulnerable under the EPBC Act. The waxy cabbage palm grows to approximately 20 m tall. Its leaves are broadly circular, reaching up to 190 centimetres (cm) in width. Leaf stems grow up to 200 cm long, and have protruding sharp thorns (Rodd, 1998). The species is distinctive for the long woolly hairs on the stems of the leaves and the flower stalks.

In general, there is a shortage of records in Australian herbaria for the waxy cabbage palm (relative to other plant groups). All records of collections lodged with Australian herbaria are for palms located in tributaries of the Burdekin River, primarily upstream and within 130 km of Lake Dalrymple. The main river systems from which Australian herbaria records exist are the Cape and Campaspe rivers and their tributaries (CHAH, 2013). However, this species has also been recorded from Doongmabulla and the Carmichael River. In addition, Dowe (2007) reports other known populations from the lower Suttor and Belyando River catchments, approximately 70 km north-east of the Study Area. However, the waxy cabbage palm does not appear to be present in the actual Burdekin, Suttor or Belyando Rivers (Dowe, 2007; DSEWPaC, 2013c). Based on surveys conducted in 2002 by Dowe and Pettit, it was estimated that the total adult population of the species (at that time) was less than 1000 individuals (Pettit and Dowe, 2003, quoted in DSEWPaC, 2013c).

All known populations of waxy cabbage palm are growing on sandy, ephemeral watercourses or their floodplains. These watercourses are often braided or anastomosed systems, although populations do occur on single channel streams (Dowe, 2010; Rodd, 1998; DSEWPaC, 2013c).

At some sites, palms have been located growing on the floodplain, and these have been associated with a high water table (Dowe, 2009). Individuals are usually located within or adjacent to the stream channel, where they can form an important component of the riparian canopy (Pettit and Dowe, 2003). Riparian canopy vegetation recorded as associated with the waxy cabbage palm includes *Eucalyptus camaldulensis* var. *obtusa* (river red gum), *E. tereticornis*, *E. platyphylla, Melaleuca leucadendra* (weeping paperbark), *M. fluviatilis* (narrow-leaved paperbark)*, Casuarina cunninghamiana*, and *Corymbia brachycarpa* (Queensland Herbarium, 2013; Rodd, 1998; DSEWPaC, 2013a).

4.2.2 Desktop results

Waxy cabbage palm was not predicted to occur by the Protected Matters Search Tool. It was subsequently confirmed present within the Mine Area during investigations for the EIS at the Carmichael River and at Moses Spring on Doongmabulla Station (Plate 2).

4.2.3 Field survey methodology

Surveys of Doongmabulla and Mellaluka Springs were carried out on two occasions, in May 2012 and March/April 2013.

An additional population survey of waxy cabbage palm was carried out at the time of the second Springs survey, in March/April 2013, to further map the location and extent of this species within and adjacent to the Moses and Little Moses Springs (upstream of the Mine Area) and within the Mine Area. This survey was conducted to seek confirmation of the specific extent of occurrence of waxy cabbage palm within the Study Area, to enable a full understanding of potential impacts and the ability to eliminate impacts wherever possible. Areas surveyed where palms were found to be growing were either beside Moses or Little Moses Springs, or in the Carmichael River and fluvial landforms immediately adjacent to it, or its tributaries.

Each survey area within the Carmichael River was divided into 500 m linear plots (i.e. 500 m as measured parallel with the river's direction of travel, replicating the survey method of Petit and Dowe (2003) to allow for direct comparison to the Burdekin Basin populations of waxy cabbage palm. There are no other specific survey guidelines for the species. A total of 35 plots, each 500 m long were surveyed.

The survey consisted of two GHD ecologists walking the length of each 500 m plot, one on each side of the river, logging on hand held GPS:

- the coordinates of palm individuals or clusters (a cluster being where more than one palm was located within a 5 m radius of at least one other palm)
- the estimated height of each palm (in cases where clusters made measuring each palm difficult, an average was recorded)
- the location of each palm in terms of fluvial land form elements

Moses Spring was searched and only one cluster was located, growing within an area of approximately 2 ha in open woodland and grassland on the periphery of the spring. Individuals were photographed, mapped with a GPS, and the height was recorded (they were all on the same land form).

4.2.4 Field survey results

The 2013 field surveys identified a total of 831 palms, with 19 of these individuals counted at Moses Spring, and the remainder in the Carmichael River (Figure 11 and Figure 12). The majority of individuals were situated in two areas of high population density (of 479 palms and 155 palms, respectively). Adult palms accounted for only 11 percent of this population.

Vouchered specimens of adult waxy cabbage palms were submitted to the Queensland Herbarium from Moses Spring (voucher identification: SFDanielsen1870) and the Carmichael River within the Project Area (voucher identification: SFDanielsen1880). These specimens were confirmed as waxy cabbage palm and the samples were incorporated into the Herbarium collection.

Detailed survey information is contained within SEIS Volume 4, Appendix J4, Population Survey of Waxy Cabbage Palm Report, but findings are summarised below.

Plate 2 Waxy cabbage palms at Moses Spring (left); waxy cabbage palms on Carmichael River channel bench (April, 2013)

At Moses Spring, the palms are located at the interface between two vegetation communities – a *Sporobolus pamalae* grassland, and a river red gum (variety *obtusa*) and weeping paperbark woodland/open woodland, which comprises much of the vegetation adjoining the south-eastern edge of the Moses Spring.

All waxy cabbage palms at Moses Spring are located within 100 m of a central point, generally within the river red gum/weeping paperbark community on the outskirts of the spring wetland, with a core population of 16 palms located within a 50 m radius. Although the palms at Moses Spring are situated in the Carmichael River catchment, their location in a GAB spring wetland is unique for this species (based on current Australian herbaria records (CHAH, 2013) and the DSEWPaC website (DSEWPaC, 2013c)), and so this group are treated for the purpose of this report as a separate population.

1:5,500 Paper Size A4

0 25 50 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Homestead
- Waxy cabbage palm (Moses)
- Local Road
- Track
- Watercourse
- Moses Spring
- Study Area
- Project (Mine)

*Note: Some points represent clusters of 2 or 3 individuals

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision A
Date 23 Oct 2013

Location of waxy cabbage palm population associated with the Mine Study Area: Moses Spring

Figure 11

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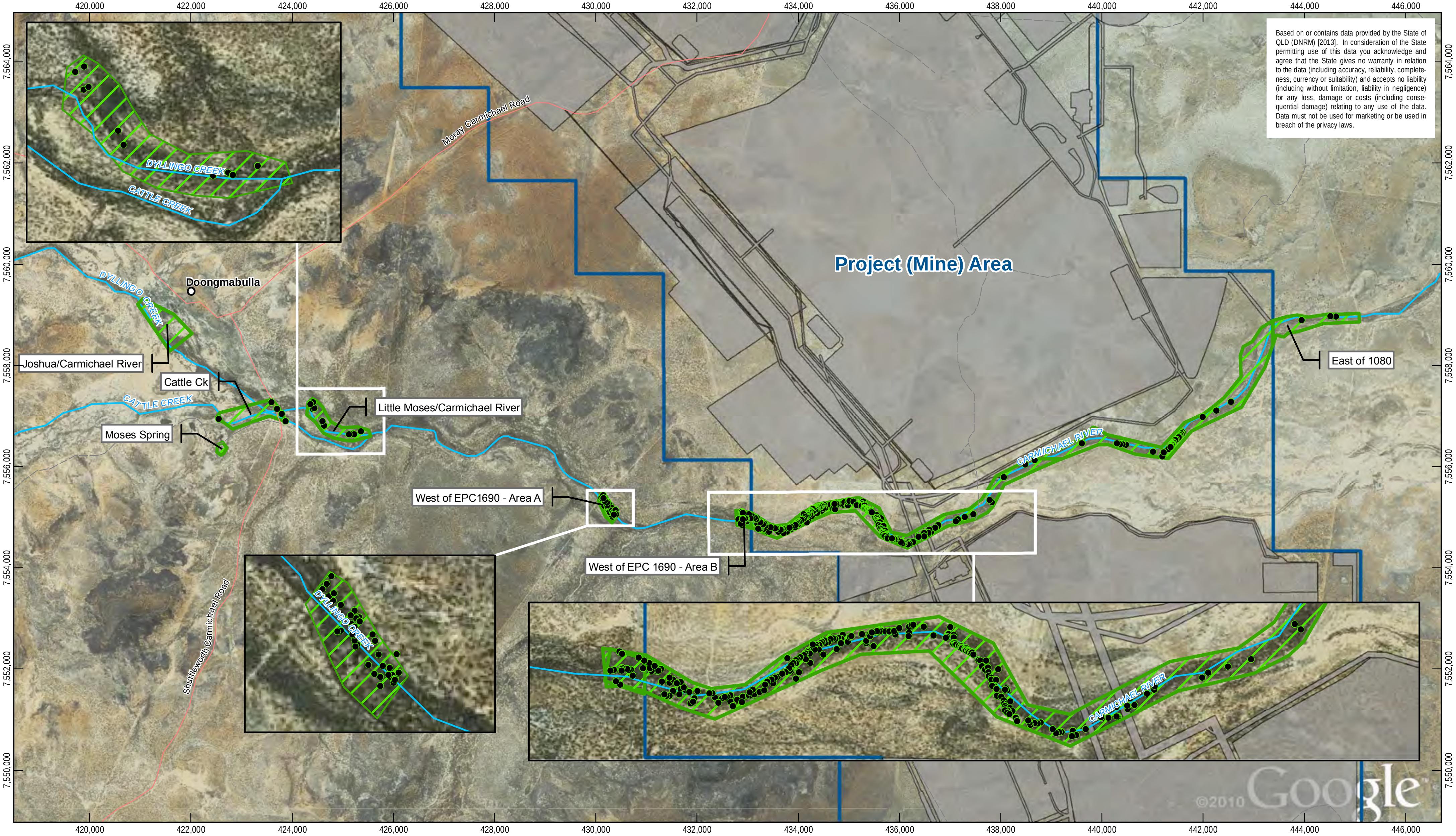
Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: Road (2010); DME: EPC1690 (2010), EPC1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Watercourse (2007);
GHD: Moses Spring, WCP Location (2013); Google Earth Pro: Image (2004). Created by: MS



1:100,000 Paper Size A4

0 0.5 1 2

Kilometres

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

N

LEGEND

- Homestead
- Waxy cabbage palm population
- Local Road
- Track
- Watercourse
- Study Area
- Project (Mine)
- Mine (Onsite)

GHD adani

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Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	A
Date	23 Oct 2013

Location of waxy cabbage palm population associated with the Study Area: Carmichael River

Figure 12

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Level 9, 145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: Roads (2010); DME: EPC1690 (2010), EPC1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Watercourse (2007);
Adani: Mine (Onsite) (2013); GHD: Survey Area, Population WCP (2013); Google Earth Pro - Image (2004). Created by: MS

Within the Carmichael River, waxy cabbage palms were recorded on the banks of the river channel and within the adjacent floodplain. The habitat where the species was encountered is characterised by an open forest with a canopy from 20 – 25 m tall dominated primarily by river red gums, some up to 10 m in circumference, frequently with weeping paperbark and narrow leaved paperbark dominating or co-dominating in places. Waxy cabbage palm constitutes a sub-canopy where it is present, but elsewhere there is a negligible to absent lower tree and shrub layer. The ground layer is generally dense, and is dominated by mat rush, with *Juncus continuus* growing in the channel beds and grasses including kangaroo grass (*Themeda triandra*), golden beard grass (*Chrysopogon fallax*), Queensland blue grass (*Dichanthium sericeum*), *Eragrostis elongata* and *Bothriochloa bladhii*.

The 2013 survey findings indicate that the population is not spread evenly along the Carmichael River. Furthermore, the waxy cabbage palm population structure differs between the Moses Spring (which is much smaller, located in atypical habitat, and relatively isolated) and Carmichael River (which has a high level of internal connectivity and is located in more typical habitat for the species) populations. The Carmichael River populations have considerably higher numbers of seedlings than in the sub-adult or adult stages, and no other sub-population trends upwards as sharply or permanently as age increases.

Waxy cabbage palms within the Study Area are currently subject to impacts from cattle grazing, including trampling of seedlings, trampling of watercourse bed and banks and grazing of foliage. The area is also subject to impacts from feral pigs.

4.2.5 Status in project area

Waxy cabbage palms were found within the Mine Area, but were not detected during surveys of the Rail Area or Mine (Offsite) Area. The likelihood of occurrence assessment for the Mine (Offsite) Area identified this species as may occur due to limited potential suitable habitat being available. It is noted that desktop studies did not predict this species as occurring within the Project Area and that the individuals identified represent a new extension of this species extent and an increase the regional coverage of the species.

Based on the currently available information acquired from desktop and field studies, and in consideration of the Significant Impact Guidelines (DEWHA, 2009a), it is considered that the Study Area supports an ‘important population’ of the waxy cabbage palm, noting that an important population of an (EPBC Act) vulnerable species is defined in the Significant Impact Guidelines as 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
- Populations that are near the limit of the species range (DEWHA, 2009a)

Furthermore, habitat for this species within the Carmichael River and Moses Spring is considered ‘habitat critical to the survival of the species’, as defined in the Significant Impact Guidelines (DEWHA, 2009a).

4.2.6 Threatening processes

Threatening processes listed for the waxy cabbage palm by DSEWPaC (2013c) are:

- Inappropriate or modified fire regimes
- Changes to hydrology including building dams and barriers
- Weeds and pests through direct competition or habitat degradation
- Restricted geographic distribution
- Grazing pressure - stock will browse seedling leaves (Dowe, 2007)
- Grazing pressure - trampling seedlings and disturbing the hydrology of its habitat
- Clearing and fragmentation for agriculture

The waxy cabbage palm itself is believed to be somewhat fire resistant (Pettit and Dowe, 2003; Dowe, 2010). However, frequent fires combined with continuous grazing may overcome this resistance (Pettit and Dowe, 2003). In particular, Pettit and Dowe (2003) stressed the threats to the species from frequent fires, heavy weed infestations, and grazing (mostly associated with trampling, not just of seedlings but also through damage to riverbeds and banks, which form habitat for the species). These authors considered that these threats together with ‘its limited geographic range and the small isolated population size makes it vulnerable to rapid decline given unfavourable natural conditions such as extended drought periods’ (Pettit and Dowe, 2003).

During the 2013 survey, four threatening processes were noted: weed infestation, feral pigs, cattle and bush fire. Rubber vine is established at various points along the Carmichael River, from Joshua Spring (and likely upstream) to the furthest downstream point surveyed, 2.5 km east of the Study Area.

4.2.7 Potential impacts

Impacts to mapped potential habitat for waxy cabbage palm species are provided in Table 8.

Table 8 Impacts to waxy cabbage palm habitat

Project Area/Phase	Direct clearing (ha)	Indirect subsidence (ha)
Rail construction	-	-
Rail impact area	-	-
Mine construction	-	-
Mine operation	4.0	-
Off-site construction	-	-
Mine impact area	4.0	-
Project impact area	4.0	-
Note: Waxy cabbage palm potential habitat is mapped based on REs mapped within the Carmichael River corridor		

Habitat loss

Direct impact to areas of mapped habitat includes less than 4 ha of direct clearing associated with the construction of the haul road across the Carmichael River. Based on current survey results this constitutes five individual plants. This area of direct impact has been minimised through design, including the location of the Carmichael River buffer, and the location of the haul road.

Changes to hydrology

For around 3 km upstream of the western boundary of the Mine Area, the predicted predevelopment modelled long-term average base flow is approximately 4,150 m^3/day. Model results suggest the Carmichael River predominantly upstream of the western boundary of the Mine Area is 'gaining' (see Figure 9), which is consistent with groundwater level and surface water flow observations at the site. This section corresponds to the location of a dense cluster of waxy cabbage palms.

From a point some few hundred metres east of the western boundary of the Mine Area, predevelopment groundwater flow modelling results suggest that the Carmichael River switches from generally gaining flow to losing flow (see Figure 10), which is consistent with groundwater level and surface water flow observations at the site. Between that location and the eastern Mine Area boundary, predicted pre-development long-term average base flow gradually reduces to around 3,150 m^3/day and groundwater levels have been measured around 4.5 m below the channel bed.

Waxy cabbage palms are present along the Carmichael River and become progressively less common from west to east. However, apart from the reduced presence of waxy cabbage palms, there is no discernible difference in riparian vegetation along the river.

It is important to note that base flow to the river will naturally vary, is seasonally affected and that current model predictions are effectively long-term averages. It is normal for base flow to fluctuate and for many sections of the river to have periods of zero base flow – for example, late in the dry season, or during droughts. Zero base flow periods pre-development are predicted to occur approximately 30 percent of the time at the eastern Mine Area boundary.

Predicted impacts on the current water table based on groundwater modelling results suggest that:

- Near the western boundary of the Mine Area, drawdown will be around 1 m and zero flow periods will increase to approximately 5 percent of the time, from zero percent currently
- In general, drawdown of the water table along the Carmichael River is greatest near the middle of the Mine Area, at approximately 4 m, and decreases gradually towards both the western and eastern boundaries
- At the eastern Mine Area boundary, base flow will be reduced by around 1,000 m^3/day (33 percent of pre-development base flow) during the operational phase, falling slightly to approximately 950 m^3/day reduction (31 percent of pre-development base flow) post closure
- Zero flow periods at the eastern Mine Area boundary will increase by 30 percent to 60 percent of the time during operation and post closure

Drawdown of the water table is predicted to reduce the volume of base flow to the Carmichael River and cause the point of zero-base flow to migrate upstream (i.e. to lengthen so it is closer to the eastern boundary of the Mine Area). These reductions are predicted to cause the point at which base flow in the Carmichael River is reduced to zero (through leakage to the ground in 'losing' sections of the river) to migrate 10 km upstream, from 25 km downstream of the eastern Mine Area boundary pre-development, to 15 km downstream post-development.

The observed existing downward gradient from the Carmichael River to the underlying groundwater table (i.e. losing conditions) which has been modelled across the majority of the

Mine Area suggests that existing riparian vegetation appears to be tolerant of a range of base flow/groundwater conditions. The riparian community species composition is consistent over the entire length of the Carmichael River within the Mine Area, with the exception of the dense cluster of waxy cabbage palms in the vicinity of the western Mine Area boundary (where an upward hydraulic gradient has been observed suggesting that the river may be generally gaining flow from groundwater in this area.

The waxy cabbage palm is the species likely to be the most vulnerable to increased drawdown combined with reduced base flow volume and increased periods of zero base flow. This species is dependent on a seasonal recharging of soil water, which includes pockets and lenses that store water and which palms in arid watercourses often rely on (Paul Forster, Queensland Herbarium, pers. comm., 21.09.2012). Unlike the other characteristic riparian species (river red gums and paperbarks), these palms have a root ball which does not extend more than several metres in diameter. The 2013 survey found waxy cabbage palms growing primarily in sandy alluvial soil on channel benches, channel bars, and in the bed of the Carmichael River, in situations where groundwater is likely to be closest to the surface, and clustered along a section of the river, which may be ‘gaining’ flow.

In sections of the river further downstream which appear to be ‘losing’ flow, the palms were recorded in much lower densities. This suggests the species does not favour areas where groundwater is less accessible. However, it should also be noted that waxy cabbage palms occur in relatively arid areas (relative to most other Livistonas), and are able to persist through drought periods when recharge is infrequent.

The majority of waxy cabbage palms (including most of the adults) are located within the western half of the Mine Area and, in this section, are considered likely to persist despite the predicted changes, together with other species in the riparian zone.

While the dominant riparian vegetation in the Carmichael River is tolerant of extended zero/low flow events, a predicted reduction in base flow volume, and a predicted increase in zero flow periods is likely to stress palms in locations where groundwater is predicted to be drawn down by up to around 4 m in the near vicinity of the river.

Potential reductions in health, leading to stress and mortality of the dominant riparian species (river red gums and paperbarks) in the eastern half of the Mine Area where drawdown is predicted to be up to 4 m. Potential impacts may commence with less deeply rooted paperbarks and smaller trees, and continue to more persistent species such as river red gums (this latter stage may take decades). This dieback is expected to approach 100 percent of the canopy where drawdown will potentially reach 4 m (an 800 m stretch of the river near the centre), but may also occur (albeit not to as great an extent) in the eastern half of the eastern Mine Area section.

In particular, the waxy cabbage palm is unlikely to be able to tolerate such a combined reduction in access to base flow and groundwater, although the population survey counted only two juvenile palms in this section of the river.

The predicted declines in base flow combined with increased zero base flow events are thought likely to result in stress to the 169 waxy cabbage palms (including nine adults) recorded in the eastern section of the Mine Area, with stress levels increasing with proximity to the eastern boundary (and beyond, for waxy cabbage palm that are located downstream (east) of the Mine Area eastern boundary).

The relatively low percentage of adults in this section of the river is likely to be indicative of the existing difficulties seedlings and sub-adults experience to become established where groundwater is deep, base flow volume is low, and zero baseline flow events are more common than upstream. It is not clear how many of the large number of juveniles in this section of the river will survive under existing conditions – based on the low relative number of adults present, high mortality rates are expected. However, all waxy cabbage palms (juveniles, sub-adults and adults) are expected to be challenged by the likely changes predicted by the modelling.

As the eastern section of the Carmichael River within the Mine Area is mostly predicted to experience reductions in base flow than increases in depth to the water table, it is likely that only the waxy cabbage palm will be impacted significantly in this section of the river. The maximum impact on base flow is expected to occur approximately 20 years into the operational life of the Mine.

The primary impacts (without mitigation measures) to the waxy cabbage palm are of reduced base flow as the result of drawdown of the groundwater table, reductions in base flow from upstream, and increases in the frequency of zero base flow events. These impacts will result in:

- Reductions in health, leading to stress and potential mortality of waxy cabbage palm individuals (a vulnerable species under the EPBC Act) located in the eastern half of the Mine Area, including 9 adults and 160 juveniles.
- Potential reductions in health, leading to stress and mortality of the dominant riparian species (river red gums and paperbarks) in the eastern half of the Mine Area where drawdown is predicted to be up to 4 m. Potential impacts may commence with less deeply rooted paperbarks and smaller trees, and continue to more persistent species such as river red gums (this latter stage may take decades). This dieback is expected to approach 100 percent of the canopy where drawdown will potentially reach 4 m (an 800 m stretch of the river near the centre), but may also occur (albeit not to as great an extent) in the eastern half of the eastern Mine Area section.
- Removal of an important water source providing habitats for aquatic flora and fauna, with consequent reductions in aquatic habitat diversity.

In summary, in the eastern half of the Mine Area, the river habitat for the waxy cabbage palm will be significantly impacted by groundwater drawdown within the Carmichael River channel. Where dieback of some or all of the trees in the canopy occurs:

- Loss of the open forest canopy will let in more light, favouring weeds and shrubs. In particular, rubber vine (*Cryptostegia grandiflora* – a class two declared weed) infestations currently in the Carmichael River within the Mine Area will increase in height, area and density, with the capability to render the watercourse inaccessible to humans and large animals. Other weeds such as parkinsonia (*Parkinsonia aculeata* - another class two declared weed) and noogoora burr may also flourish.
- These weeds will increase the quantity of seed moved downstream to other sections of the Carmichael and Belyando Rivers.
- Such weed infestations provide havens for feral pigs, which damage waxy cabbage palm seedlings and exacerbate erosion and bank damage.

- Increasing weeds can lead to a consequent reduction in species diversity and ecosystem complexity, reducing the ability of the watercourse to host a diverse range of species and life forms.
- Loss of the large trees growing in banks and channel bars will result in increased instability of those banks and channel bars. High flow events in future will result in increasing bank and channel erosion, and bank slumping.
- Increased erosion leads to increased sedimentation downstream, with consequent declines in water quality.
- Loss of the forest canopy alters environmental conditions (humidity, dappled shade/sun, temperature gradients in pools, etc.) that are important for in stream aquatic macrophytes and invertebrates, with a high potential for reduction in the populations of these species.
- A general loss of breeding, roosting and foraging riparian habitat for fauna utilising the riparian community.

4.2.8 Management and mitigation measures

Proposed mitigation and management measures for the waxy cabbage palm and broader Carmichael River corridor include:

Habitat fragmentation and degradation

Management of land that is yet to be mined, or is to remain unmined, will be undertaken in accordance with a Project Land Management (Flora and Fauna) Plan. This plan will detail how land not subject to direct impacts (i.e. vegetation clearing) should be managed (including details relating to land use (cattle grazing) and fire management), such that the terrestrial ecological values, including connectivity, of such areas are maintained, and where possible, enhanced. This plan will be implemented in conjunction with its component sub-plans relating to the maintenance/enhancement of terrestrial ecological values of undeveloped parts of the Study Area (i.e. Project Species Specific Management Plan(s) (SEIS Volume 4, Appendix C3, Rail Applications)). This represents a positive measure for areas of waxy cabbage palm currently subject to impact from grazing that will be subject to improved management and potential increased habitat values associated with a reduction in habitat impact.

Changes to hydrology

Water recycling to supplement base flows in the Carmichael River during dry periods will be conducted in accordance with procedures outlined in the Water Balance Report (SEIS Volume 4 Appendix K2). This will see excess and treated water reintroduced to the river near the western Mine Area boundary, with due consideration to water quality. The intent is that this water will be introduced to the channel in a 'gaining' section of the river, where it will remain in the channel and thus contribute to base flows downstream.

Weeds, pests and fire risk

Existing weed infestations, rubber vine present within the river bed (that is still at a manageable stage) will be managed in order to reduce the likelihood that canopy dieback will result in the excessive growth of weeds. This will safeguard existing populations of waxy cabbage palm, it is recommended that the infestation of is removed and that ongoing management measures are implemented to monitor any resurgence. In addition, the existing pig population, which is damaging waxy cabbage palm habitat and seedlings, should be controlled, resulting in a potential increase in habitat values in the managed areas.

A Project Waste and Resources Management Plan and Hazardous Substances Management Plan will be implemented, and include waste management and disposal protocols and procedures. This plan should incorporate protocols relating to the:

- disposal of vegetation waste (in a manner that minimises potential for spread of weeds)
- disposal of food scraps and the like (to minimise potential for pest animals to access food wastes)

Monitoring and management will be undertaken for weeds and pest species:

- Monitoring for and management of introduced animals in and adjacent to cleared areas to occur in accordance with a Project Weed and Pest Management Plan. This plan should include details relating to the monitoring, management and where necessary eradication of pest animals.
- Management of weeds in and adjacent to cleared areas to occur in accordance with a Project Weed and Pest Management Plan. This plan should include details relating to the monitoring, management and where necessary eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols.
- All construction machinery and materials brought onto site will be certified as free of weeds and weed seeds. Records are to be kept of compliance with this requirement.
- Soil stripped and stockpiled from areas containing known weed infestations are to 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.

Weed audits of areas to be developed (during staged mining operations) will be conducted at a suitable time of the year when growing conditions and identification of weed species are optimal. These audits should cover the applicable development area with a particular focus on high risk locations, such as areas of black soil so that appropriate scale weed mapping can be undertaken to identify weed hotspots, for incorporation into the Project Weed and Pest Management Plan.

Research and monitoring

Much of the focus of mitigation for the waxy cabbage palm will be on monitoring to allow for adaptive management in addressing inevitable indirect impacts of groundwater drawdown, as follows:

- A detailed 'ecological features' map will be made for the Carmichael River to assist in dieback and river health monitoring, identifying priority management areas including the locations of waxy cabbage palms, rubber vine infestations, riparian composition and health, 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 transects will 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 will be seasonal, reflecting high flow/low flow variability in the Carmichael River (twice annually).

This monitoring should continue into the mid operational life of the Mine, and increase to a quarterly frequency when drawdown is at its maximum. If possible, depth to groundwater data should be incorporated.

- Monitoring of the health of the waxy cabbage palm population should be undertaken on a bi-annual basis, preferably at the start of the wet season and the start of the dry season (December and May). Cabbage palms are able to be transplanted, and where practical and feasible (given that large machinery is required, gaining access may do more damage to the river than is practical), advice should be sought from the relevant agency at the time to transplant as many of these as possible to other locations, 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.
- The relationship between waxy cabbage palm and groundwater is poorly understood, as is the reaction of this species to drawdown (this lack of knowledge extends to most of the *Livistona* genus). This Project (Mine) provides a unique opportunity to learn more about these subjects. It is recommended that long-term research be conducted, preferably in partnership with a university, on the population on the Carmichael River and its response to observed changes in groundwater depth and base flow volume and frequency. This should include long-term flow monitoring and measurements of groundwater depth changes at least three locations along the river where adult waxy cabbage palms are located (preferably, chosen to contrast different change regimes). Complete mapping of the Carmichael River waxy cabbage palm population (particularly downstream of the Mine Area, where base flow reductions will have an impact) is also recommended.
- 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 deep pools, 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 Mine Area.
- 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 Mine 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 bore field, in conjunction with nearby bore extraction yields and associated drawdown records. Pest and weed management is important to mitigate potential indirect impacts on certain matters of NES, such as the effects of pig damage or aquatic weeds on germination of waxy cabbage palm, or the effects of dog population densities on mortality of migratory birds. To manage risk and potential for pest and feral species spread, and the potential for introduction of new feral

species, during the operations an integrated suite of actions should be developed to manage pest species

Management plan

Adani will provide a Draft Groundwater Dependant Ecosystem (GDE) Management Plan for approval prior to the commencement of construction.

This plan will address impacts to the following GDE's:

- Doongmabulla Springs Complex
- Mellaluka Springs Complex
- Carmichael River , particularly the Waxy Cabbage Palm

The Plan will include the following:

- A management framework that aligns with the other project management plans
- Clear statements regarding the intent, approval requirements, objectives and actions
- Details of how the management plan will be applied across the project phases – pre construction / construction / operation / post operations, offset areas
- Details of any proposed adaptive monitoring program to support the plan objectives.
- Details of how experts will be used in a review capacity to inform ongoing monitoring and management
- Incorporates all proposed management and mitigation measures, including reference to relevant State and Federal Guidelines of relevance to these GDE's
- Specific performance targets and how these will be measured and reported

4.2.9 Recovery plans, conservation advice and threat abatement plans

No recovery plan exists for the waxy cabbage palm, but the Project's mitigation and management actions focusing on ameliorating weed and pest impacts through removal and management and providing additional base flows to the Carmichael River are consistent with addressing acknowledged threats to the species.

The approved Commonwealth conservation advice for waxy cabbage palm (TSSC 2008agj) includes research priorities for designing and implementing monitoring programs and more precisely assessing population sizes, distribution, ecological requirements and the relative impacts of threatening processes. The specific detail of the monitoring programs to be undertaken will be designed with this advice in mind and in consultation with the appropriate experts and organisations at that time. This monitoring will then contribute to the achievement of these priorities and existing knowledge and understanding of the species.

4.2.10 Residual impacts and impact significance

Assessment against EPBC Act criteria indicates that there may be an important population of this species across the Study Area. There is no information available on the wider regional extents of or potential habitat for the species at a broader, landscape scale beyond the study area.

The 2013 survey found waxy cabbage palms growing primarily in sandy alluvial soil on channel benches, channel bars, and in the bed of the Carmichael River, in situations where groundwater is likely to be closest to the surface, and clustered along a ‘gaining’ section of the river. In ‘losing’ sections of the river, the palms were recorded in much lower densities.

The majority of waxy cabbage palms (including most of the adults) are located within the western half of the Mine Area and, in this section, the population is considered likely to persist despite the predicted changes, together with other species in the riparian zone.

While the dominant riparian vegetation in the Carmichael River is tolerant of extended zero/low flow events, a predicted reduction in base flow volume, and a predicted increase in zero flow periods is likely to stress palms in locations where groundwater is predicted to be drawn down by up to around 4 m in the near vicinity of the river. In the 800 m stretch where drawdown of between 1 and 4 m is predicted, these changes are likely to result in the loss of some or all of the canopy trees (probably after a period of some years of slow decline). In particular, the waxy cabbage palm is unlikely to be able to tolerate such a combined reduction in access to base flow and groundwater, although the population survey counted only two juvenile palms in this section of the river.

The relatively low percentage of adults in this section of the river is likely to be indicative of the existing difficulties seedlings and sub-adults experience to become established where groundwater is deep, base flow volume is low, and zero baseline flow events are more common than upstream. It is not clear how many of the large number of juveniles in this section of the river will survive under existing conditions; based on the low relative number of adults present, high mortality rates are expected. However, all waxy cabbage palms (juveniles, sub-adults and adults) are expected to be challenged by the likely groundwater changes predicted by the modelling.

Proposed management measures, to control current impacts associated with cattle grazing and feral pig activity, do have the potential to result in improved habitat conditions upstream of the mine, which could lead to increased survival rates from juvenile to adult individuals. Even with the implementation of such management and mitigation measures, impacts to the waxy cabbage palm are likely to result from reduced base flow as the result of drawdown of the groundwater table, reductions in base flow from upstream, and increases in the frequency of zero base flow events. These impacts will result in a reduction in health, stress and probable mortality of waxy cabbage palm individuals located in the eastern half of the Mine Area, including 9 adults and 160 juveniles.

In summary, significant impacts to waxy cabbage palm in the eastern section of the Carmichael River are predicted to occur as a result of groundwater drawdown within the river channel, as it is likely that the Project will:

- Lead to a long-term decrease in the size of an important population of a species
- Reduce the area of occupancy of an important population
- Adversely affect habitat critical to the survival of a species

4.2.11 Offsets

Offset obligations under the EPBC Act are likely to be required for the waxy cabbage palm for the Project (Mine) area only, as follows:

- 4 ha for mine impact area

This is therefore the total offset requirement for the Project.

The availability of suitable habitat for offsets for the species is 2,744 ha; the Project requirement therefore represents approximately 0.15 percent of this available offset resource.

Residual project impacts on waxy cabbage palm can therefore be sufficiently offset through the delivery of land-based direct offsets.

In addition to the delivery of direct offsets and the proposed mitigation measures, indirect offsets may also be delivered through the following methods:

- Seed collection and planting programs within upstream reaches of the Carmichael River
- Relocation of individual plants if deemed a viable and successful method (to be determined through monitoring)
- Contributing to further research objectives for the species to broaden the understanding of distributional range, water dependency requirements and threatening process triggers.

4.2.12 Conclusion

Mine plan design has been optimised as far as possible to limit direct impact to individuals and habitat for the waxy cabbage palm.

As part of the proposed management measures detailed monitoring and research is proposed which will significantly increase the current level of information for the waxy cabbage palm particularly as the species has not previously been recorded within the locality.

A combination of mitigation and management measures to reduce impacts and offsets to address inevitable residual impacts to individuals of the species will be implemented to avoid significant impacts to the waxy cabbage palm.

4.3 Squatter pigeon (southern)

4.3.1 Ecology and legislation

The squatter pigeon (southern) is a ground-dwelling pigeon, listed as vulnerable under the EPBC Act. This species' distribution extends from central Queensland as far north as the Burdekin-Lynd divide to the southeast of the state (DSEWPaC, 2011b). At present, the total population size of the squatter pigeon (southern) is estimated to be around 40,000 breeding birds, with both the extent and the population size considered to be stable (DSEWPaC, 2011b). The squatter pigeon (southern) is locally abundant at some locations in the northern part of its current distribution and is considered to be common in cattle grazed country north of the Tropic of Capricorn (DSEWPaC, 2011b).

Habitat for this subspecies occurs mainly in grassy woodlands and open forests dominated by eucalypts, particularly those near water (DSEWPaC, 2011b). This subspecies has also been recorded less frequently in disturbed habitats such as stockyards, railways, and settlement. A variety of food items are taken by this ground-dwelling forager, including seeds (grass, legumes, herbs, forbs), insects and ticks (DSEWPaC, 2011b). The breeding season for the squatter pigeon (southern) typically extends from late winter months through to summer, although, if conditions are suitable, birds are said to be able to breed throughout most of the year (DSEWPaC, 2011b).

4.3.2 Desktop results

The desktop assessment indicated that a number of EPBC Act listed threatened fauna species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas, including the squatter pigeon (southern) (*Geophaps scripta scripta*) as summarised in Table 9.

Table 9 Squatter pigeon (southern) previously recorded or predicted to occur

Predicted to occur#		Previously recorded*		Recorded at Study Area	
Rail	Mine	Rail	Mine	Rail	Mine
✓	✓	✓	✓	✓	✓

4.3.3 Field survey methodology

Fauna surveys of the Study Area relevant to squatter pigeon (southern) are summarised in Table 10.

Table 10 Field surveys relevant to the squatter pigeon (southern)

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Mine Study Area	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Offsite Infrastructure Area	Black-throated finch targeted surveys	9 water watch sites, 31 watch sites, 6 remote camera sites	Autumn: May 2012
Post EIS			
Rail Study Area	Quarries MNES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Mine Study Area	Black-throated finch surveys	8 water body counts, 20 remote camera sites, 52 habitat and finch survey sites, 8 incidental observation sites	Autumn: May 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013

Fauna surveys included regular standardised bird surveys undertaken at each assessment site using the methods recommended by Birds Australia. This involved a timed 20 minute (minimum) survey of a two hectare search area (2 ha) by one ecologist, recording the number of birds seen or heard calling, and the presence and composition of any mixed flocks. These focused on listed threatened species such as the squatter pigeon (southern) where their presence was known or suspected.

Survey techniques for detecting squatter pigeon (southern) recommended within Survey Guidelines for Australia’s Threatened Birds (DEWHA, 2010) comprise area searches or transect surveys in suitable habitat and/or flushing surveys where birds are disturbed from the ground. The techniques employed are consistent with area searches.

The recommended level of survey effort within the guidelines is 15 hours for every 50 ha of suitable habitat. As each habitat assessment site was surveyed for birds on more than one occasion, this level of effort was broadly met by the surveys carried out.

4.3.4 Field survey results

Within the Project Mine and Rail Study Areas, squatter pigeons (southern) were recorded on the following occasions:

- One occasion during the September 2011 survey of the Rail Area
- Five occasions during the 2013 quarry surveys in the Rail Area (CDM Smith, 2013)
- Thirty-nine separate occasions across both spring 2010 and autumn 2011 surveys of the Mine Area
- Four occasions during April/May 2013 surveys of the Mine (Offsite) Area
- Two occasions during March/April 2013 at the Doongmabulla wetland and Mellaluka wetland to the west and south of the Mine Study Area

This subspecies was typically encountered on roads and tracks in open woodland and fringing riparian woodland habitats featuring a complex grassy understorey. Group size ranged from a single bird to 20 birds. Distribution of the squatter pigeon (southern) is likely to be limited across the Study Area by the availability of drinking water. Full details of squatter pigeon (southern) sightings are presented in EIS Volume 2 Section 5 Nature Conservation (Mine), EIS Volume 3 Section 5 Nature Conservation (Rail), SEIS Volume 4 Appendix J5 Offsite Infrastructure Ecological Assessment and SEIS Volume 4, Appendix J9 Quarry Impact Assessment Review.

Squatter pigeons (southern) observed at the Study Area are shown in Plate 3 while examples of habitat from which the subspecies was recorded are presented in Plate 4.

Plate 3 Squatter pigeons (southern) recorded from central part of Mine Study Area (May 2011)

Squatter pigeon observed onsite (April 2011)

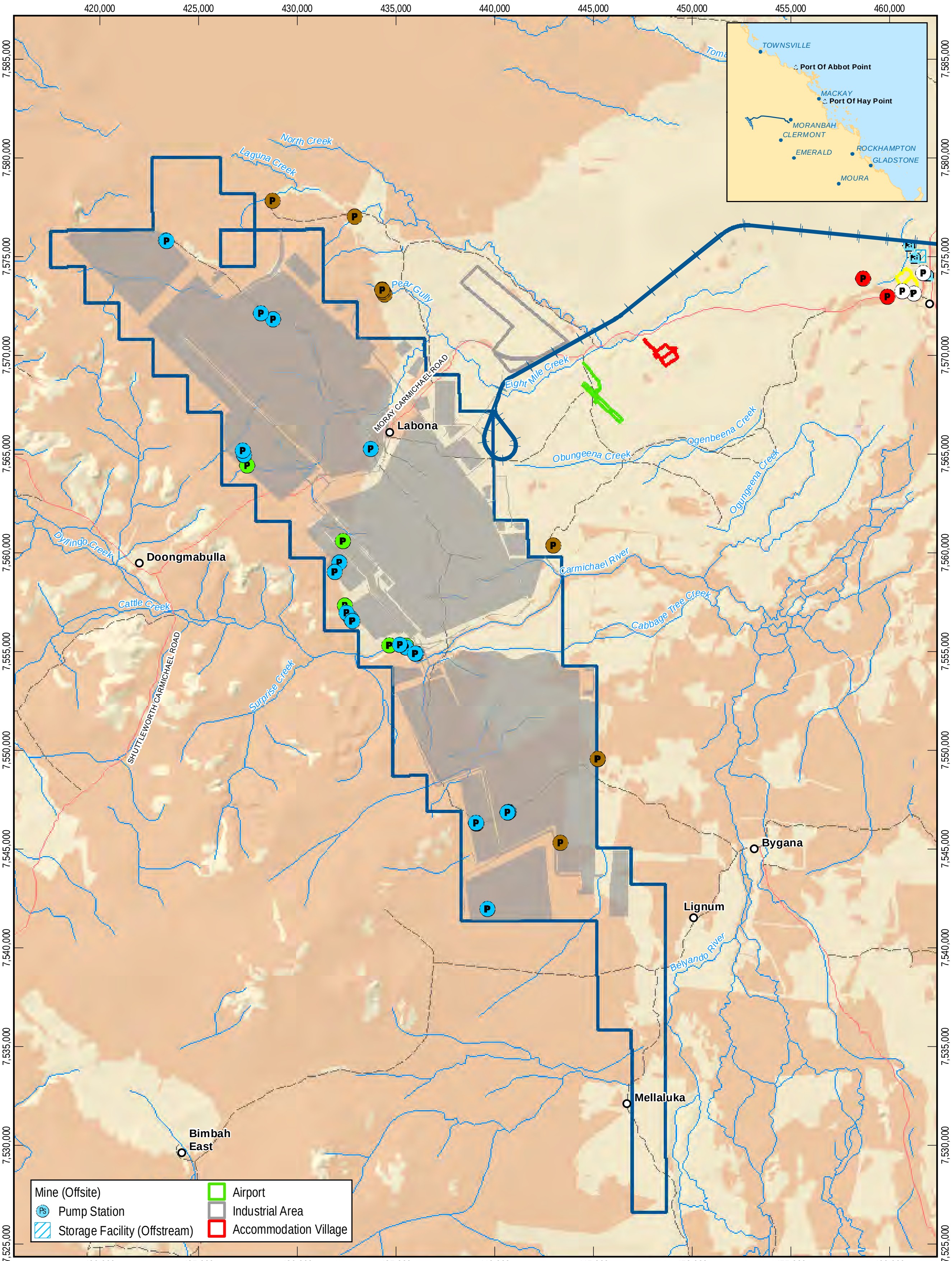
Squatter pigeons observed at cattle troughs onsite (April 2011)

Plate 4 Habitat from which squatter pigeon (southern) was recorded

Open eucalypt woodland along ephemeral creek (April 2011)

Open ironbark woodland with native grass understorey (April 2011)

Field and desktop analysis provides an indication of habitat that may be utilised by the squatter pigeon (southern) within the Rail and Mine Study Areas. To map potential habitat for the squatter pigeon (southern) beyond the Study Area, DERM Version 6.0b regional ecosystems (REs) characterised by open woodland and forest vegetation were identified and mapped. Potential squatter pigeon (southern) habitat proximal to the Mine and Rail Study Areas are presented in Figure 13 and Figure 14 respectively.



LEGEND

- squatter pigeon sightings - spring 2010
- squatter pigeon sightings - autumn 2011
- squatter pigeon sightings - spring 2011
- squatter pigeon sightings - autumn 2013
- squatter pigeon sightings (CDM Smith - 2013)
- Homestead
- Local Road
- Track
- Watercourse
- Potential squatter pigeon (southern) habitat - based on DNRM certified Regional Ecosystems version 6.0b and CDM Smith - Habitat Suitability
- Project (Rail)
- Project (Mine)
- Mine (Onsite)
- Quarry

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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

GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS
Locaton of squatter pigeon (southern) sightings and potential habitat within the Mine Study Area

Job Number	41-26422
Revision	C
Date	23-10-2013

Figure 13

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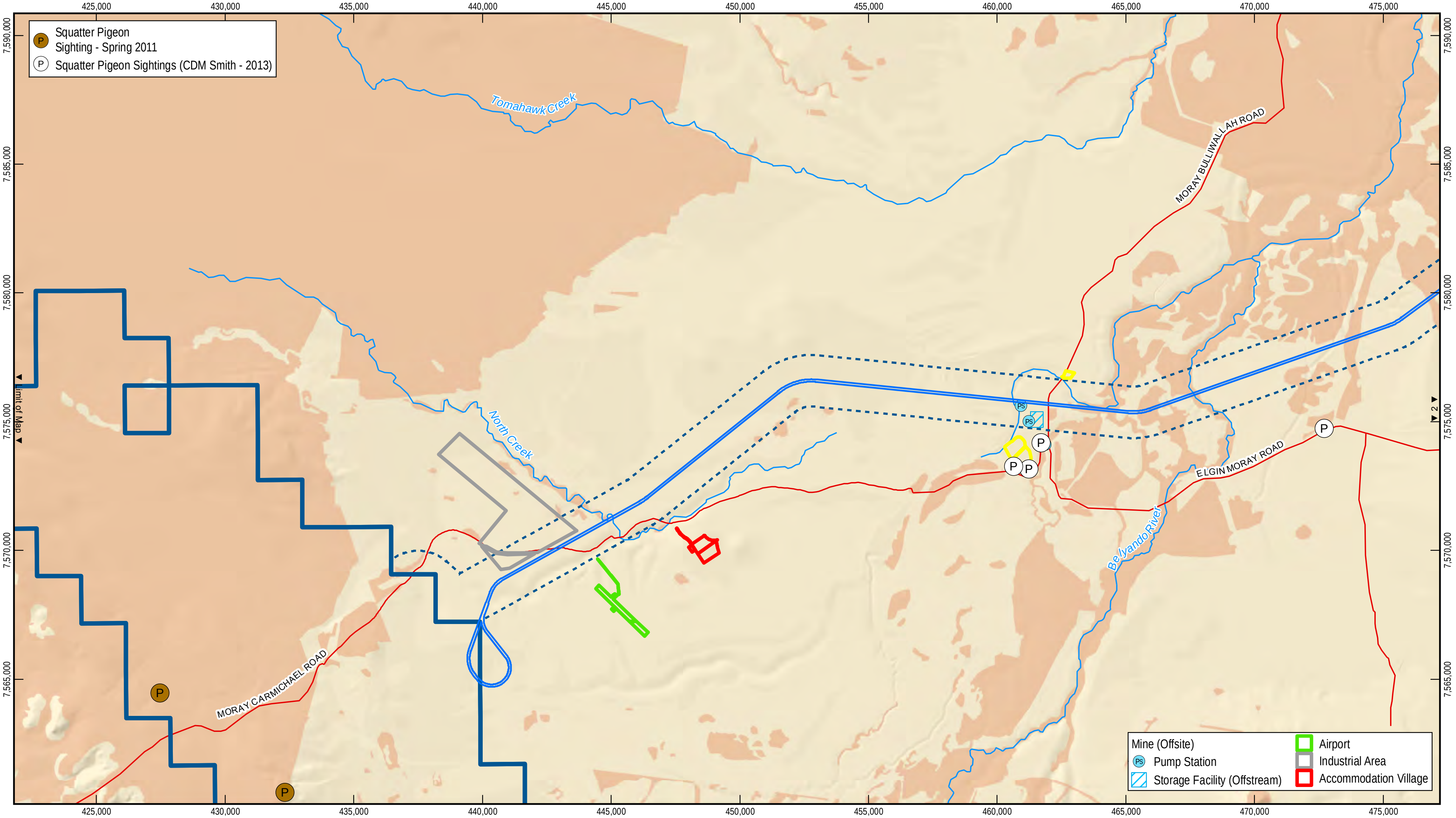
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DNRM: Regional Ecosystems v6.0 (2010); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities, Quarry, Mine (Onsite) (2013); CDM Smith: Sightings (2013); GHD: Squatter Pigeon Sightings, Potential Habitat (2011), Confirmed Sightings (2013). Created by: CA, MS



1:200,000 (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

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Potential Squatter Pigeon (Southern) Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b and CDM Smith Habitat Suitability
- Rail (West)
- Rail (East)
- Project (Mine)
- Quarry

GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	C
Date	23-10-2013

Location of squatter pigeon (southern) sightings and potential habitat at the Rail Study Area

Figure 14
Sheet 1 of 4

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Squatter Pigeon Habitat (2012); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Sightings (2012);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA

4.3.5 Status in project area

The presence of potentially suitable habitat extends beyond the Project and suggests that the squatter pigeon (southern) is likely to be present in much of the wider landscape, particularly to the west where remnant vegetation dominates the landscape. However, much of the landscape surrounding the Study Area is dominated by non-remnant vegetation with fragmented remnant vegetation often restricted to watercourses. Habitat utilisation and abundance is likely to be influenced by availability of water and prevalence of predators (especially cats and foxes). Predator prevalence may be related to the management regime of individual properties in the landscape surrounding the Study Area.

This subspecies appeared to be common in suitable habitat within the Study Areas, and is likely to be present wherever suitable habitat occurs in the landscape beyond the Study Areas. 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 (DSEWPaC, 2011b).

With respect to the Significant Impact Guidelines (DEWHA, 2009a), 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
- Populations that are near the limit of the species range (DEWHA, 2009a)

4.3.6 Threatening processes

Three main threats to the squatter pigeon (southern) are:

- Loss of habitat due to clearing for agricultural or industrial purposes
- Degradation of habitat by grazing herbivores
- Excessive predation, particularly by foxes and cats (DSEWPaC, 2011b)

4.3.7 Potential impacts

The impacts to mapped potential habitat for the squatter pigeon (southern) are summarised in Table 11.

Table 11 Habitat impacts to squatter pigeon (southern)

Project Area/Phase	Direct clearing (ha)	Indirect subsidence [1] (ha)	
Rail construction	337		-
Rail impact area	337		-
Mine construction	1,337		-
Mine operation	9,355		
		High impact	163
		Low impact	6,374
Sub total	*9,355*		*6,537*

Project Area/Phase	Direct clearing (ha)	Indirect subsidence [1] (ha)	
Off-site construction	5		-
Mine impact area	10,697		
Project impact area	**11,034**		**6,537**

Note:

Squatter pigeon (southern) potential habitat is mapped based on REs characterised by open woodland and forest vegetation.

[1] Subsidence areas have been split into high, low and no impact areas for individual species and communities

Habitat loss

An overall reduction in the local availability of habitat for the subspecies will occur primarily as a result of the operation phase of the Project. It is possible that the subspecies may disperse away from the developed parts of the Study Area (either temporarily and/or permanently), 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.

Weeds and pests

Increased human activity within the Project Area has the potential to lead to the introduction and increase of feral animal populations. This increase the risk of predation and mortality by feral animals.

Injury or mortality of species

It is anticipated that fauna mortality may occur during vegetation clearance, particularly for those cryptic and/or less mobile animals that may not be detected by the fauna spotter-catcher prior to or during vegetation clearing activities. This may therefore affect the squatter pigeon (southern), which often forages on the ground and tends to freeze or remain hidden as part of its defence.

4.3.8 Management and mitigation measures

The following management and mitigation measures are considered to be those of most relevance to squatter pigeon (southern) in response to the key threatening processes and predicted impacts identified above:

Habitat loss

Loss of habitat for the squatter pigeon (southern) is proposed to be staged, in accordance with the staged development of the operational components of the Mine (86 percent of potential habitat loss is associated with mine operation).

The provision and security of surface water throughout the Study Area may provide additional localised access to drinking water for the subspecies (or at least compensate for the loss of surface water resources in nearby parts of the Study Area). Those species with a noted affiliation to water (squatter pigeon (southern), 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, even where this resource is temporary, though the impacts on surface habitat might negate this effect.

Habitat fragmentation and degradation

Previously mined areas will be rehabilitated in parallel with development of previously unmined areas within the Study Area. No changes to current grazing regimes are predicted to occur.

Injury or mortality of species

Vegetation clearing will be undertaken in a sequential manner to allow more mobile fauna species such as squatter pigeon (southern) the opportunity to disperse away from clearing areas. All vegetation clearing will be undertaken in the presence of a qualified fauna spotter-catcher. Pre-demarcated habitat features should be thoroughly checked by a fauna spotter-catcher prior to clearing.

All vehicles and plant associated with vegetation clearing will adhere to site rules relating to speed limits. Speed limits will be developed, and clearly signposted so as to minimise the potential for road kills.

Site inductions are to include education regarding the key local fauna species of the site, including squatter pigeon (southern) and identification of protocols to be undertaken if fauna are encountered.

Weeds, pests and fire risk

Monitoring for and management of introduced animals in and adjacent to cleared areas to occur in accordance with a Project Weed and Pest Management Plan. This plan should include details relating to the monitoring, management and where necessary eradication of pest animals.

Given that cats pose a significant threat to squatter pigeon (southern), construction staff will not bring domestic animals to the Study Area.

4.3.9 Recovery plans, conservation advice and threat abatement plans

No recovery plan exists for the squatter pigeon (southern), but the Project's mitigation and management actions focusing on the rehabilitation of temporarily impacted areas and the removal and management of weed and pest species are consistent with addressing acknowledged threats to the species.

The approved Commonwealth conservation advice for squatter pigeon (southern) (TSSC 2008agp) includes priority actions to establish control measures for predators (especially cats and foxes) and to implement the appropriate recommendations outlined in the Threat Abatement Plan for Predation by Feral Cats and the Threat Abatement Plan for Predation by the European Red Fox in areas inhabited by the squatter pigeon (southern). The actions around pest management will contribute to the achievement of these priorities.

4.3.10 Residual impacts and impact significance

It is recognised that, in spite of the recommended management and mitigation measures, and the active rehabilitation of disturbed areas that will occur through the Mine's operational life, unavoidable loss of fauna habitat will occur. This will include loss of habitat for a number of listed threatened species confirmed present or likely to occur at the Study Area, including squatter pigeon (southern).

At a regional level, the contextual losses of potential habitat are summarised in Figure 15 and Table 12.

Table 12 Contextual losses of potential squatter Pigeon (southern) habitat

Area of clearing (ha)	Potential habitat –within bioregions (ha)		Percent loss of within bioregions
	Desert Uplands	Brigalow Belt	
11,034	4,466,635	11,719,539	0.07

As shown in Table 12, a total of 16,186,174 ha of potential squatter pigeon habitat is mapped within the Desert Uplands and Brigalow Belt bioregions within which the Project occurs. The area of proposed clearing represents 0.07 percent of the total potential habitat within these bioregions (0.25 percent of the Desert Uplands Bioregion and 0.09 percent of the Brigalow Bioregion).

The squatter pigeon (southern) present within the Study Area do not comprise an (or part of an) important population of the subspecies, nor does the habitat represent habitat critical to the survival of the subspecies.

As a result, no significant impacts to the squatter pigeon (southern) are predicted to occur, as the Project will not:

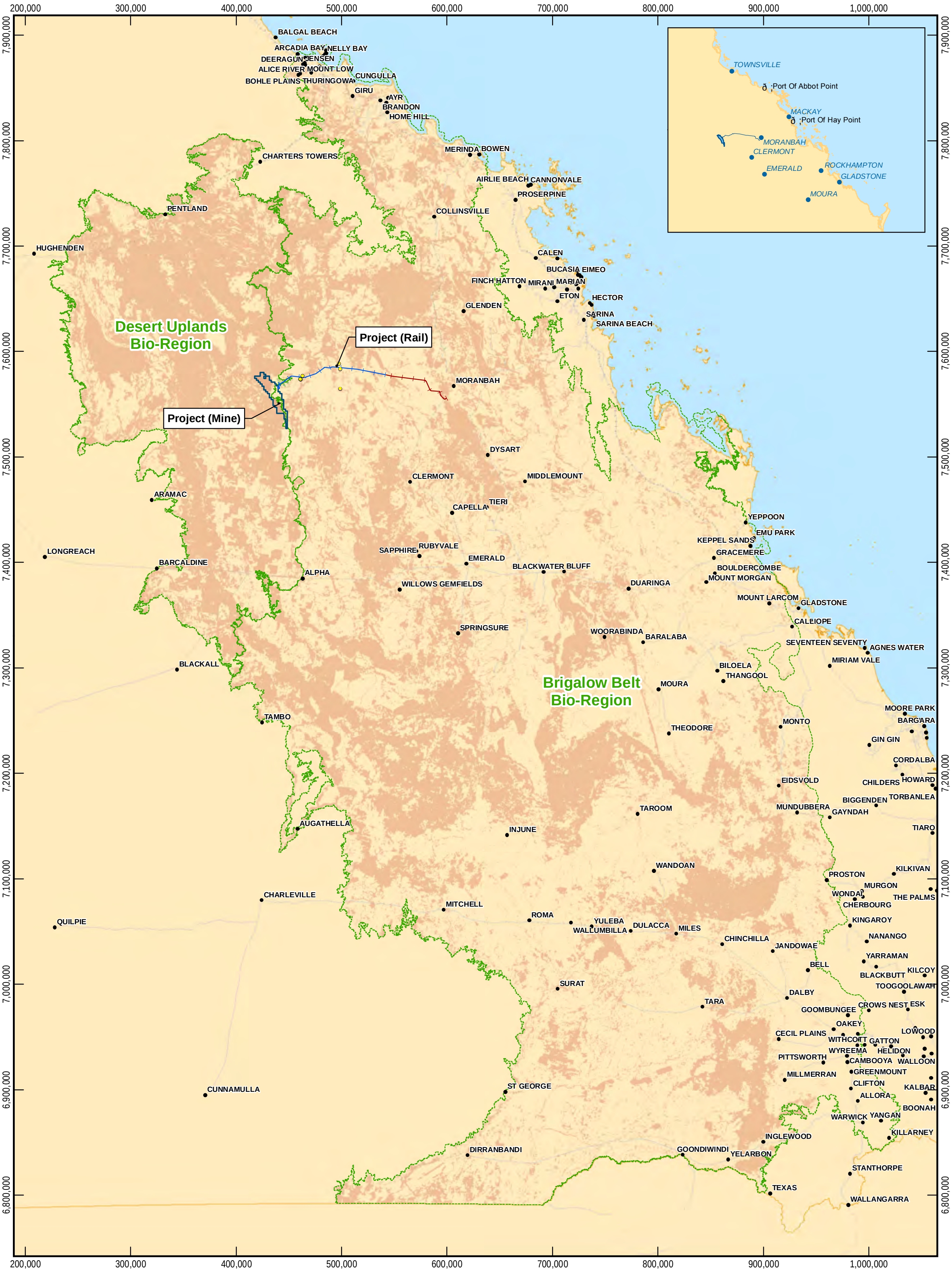
- Lead to a long-term decrease in the size of, reduce the area of occupancy of, fragment, or disrupt the breeding cycle of an important population
- Adversely affect, modify or destroy the availability or quality of habitat critical to the survival of the subspecies
- Result in the establishment of invasive species or disease to habitat critical to the survival of, or otherwise interfere with the recovery of, the subspecies.

4.3.11 Offsets

As no significant impacts to the squatter pigeon (southern) are predicted, offsets under the EPBC Act will not be required.

4.3.12 Conclusion

No significant impacts to the squatter pigeon (southern) are predicted. A combination of mitigation and management measures to reduce residual impacts to individuals of the species will be implemented to avoid a significant impact to the squatter pigeon (southern).. Offsets are not proposed for these residual impacts.



LEGEND

- Town
- Project (Mine)
- Bio Region
- Project (Rail)
- Mine (Offsite)
- Potential Squatter Pigeon Habitat - Based on DNRM Certified Regional Ecosystems Version 6.1
- Rail (West)
- Quarry
- Rail (East)

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:5,150,000 (at A4)

0 20 40 60 80

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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GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Squatter Pigeon Habitat
Bio-Region extent

Job Number	41-26422
Revision	2
Date	23-10-2013

Figure 15

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Data Source: © Commonwealth of Australia (Geoscience Australia): Town, (2007); DNRM: Bioregion, Regional Ecosystems (2011); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Offsite, Quarry (2013). Created by: MS

4.4 Black-throated finch (southern)

4.4.1 Ecology and legislation

The black-throated finch (southern) is listed as endangered under the EPBC Act. This small grass-finch has experienced a large decline in range in recent decades (DSEWPaC, 2011c). 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 (DSEWPaC, 2011c). The extent of occurrence of the species (i.e. *Poephila cincta*) has declined by approximately 80 percent since the 1980s, with the majority of this decline in the range of the endangered southern subspecies (DSEWPaC, 2011c).

The black-throated finch (southern) is a predominantly sedentary (Black-throated Finch Recovery Team, 2007; DEWHA, 2009b), gregarious bird that typically forages in groups of up to 30 individuals. During the breeding season (in the Townsville region breeding coincides with wet season (February to May)), only small daily movements between forage sites are made (DEWHA, 2009b). Movements of up to 3 km a day may occur during periods where forage resources are scarce. Larger movements are thought to be related to periods of drought and/or when water availability is reduced (DEWHA, 2009b). It often forms loose breeding colonies, where a number of nests are made in a single tree, or in neighbouring trees. The average clutch size is five, with chicks reaching sexual maturity at six months (DEWHA, 2009b).

The subspecies inhabits grassy open woodland and open forest habitats characterised by trees belonging to the genera Eucalyptus, Corymbia, Acacia and Melaleuca (DSEWPaC, 2011c). 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 (DSEWPaC, 2011c). Three critical habitat resources are required to support the subspecies:

- Water sources (both natural and artificial)
- Grass seeds (a mosaic of species that provide forage throughout the year (particularly during the wet season)
- Trees that provide suitable nesting habitat (DEWHA, 2009b; DSEWPaC, 2011c)

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, 2009b).

4.4.2 Desktop results

The desktop assessment indicated that a number of EPBC Act listed threatened fauna species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas, including the black-throated finch (southern), which is summarised in Table 13.

Table 13 Black-throated finch previously recorded or predicted to occur

Predicted to occur#		Previously recorded*		Recorded at Study Area	
Rail	Mine	Rail	Mine	Rail	Mine
✓	✓	✓	✓	✗	✓

Figure 16 indicates the location of the Project in the context of the regional distribution of potential black throated finch (southern) within the Brigalow Belt and Desert Uplands Bio-regions.

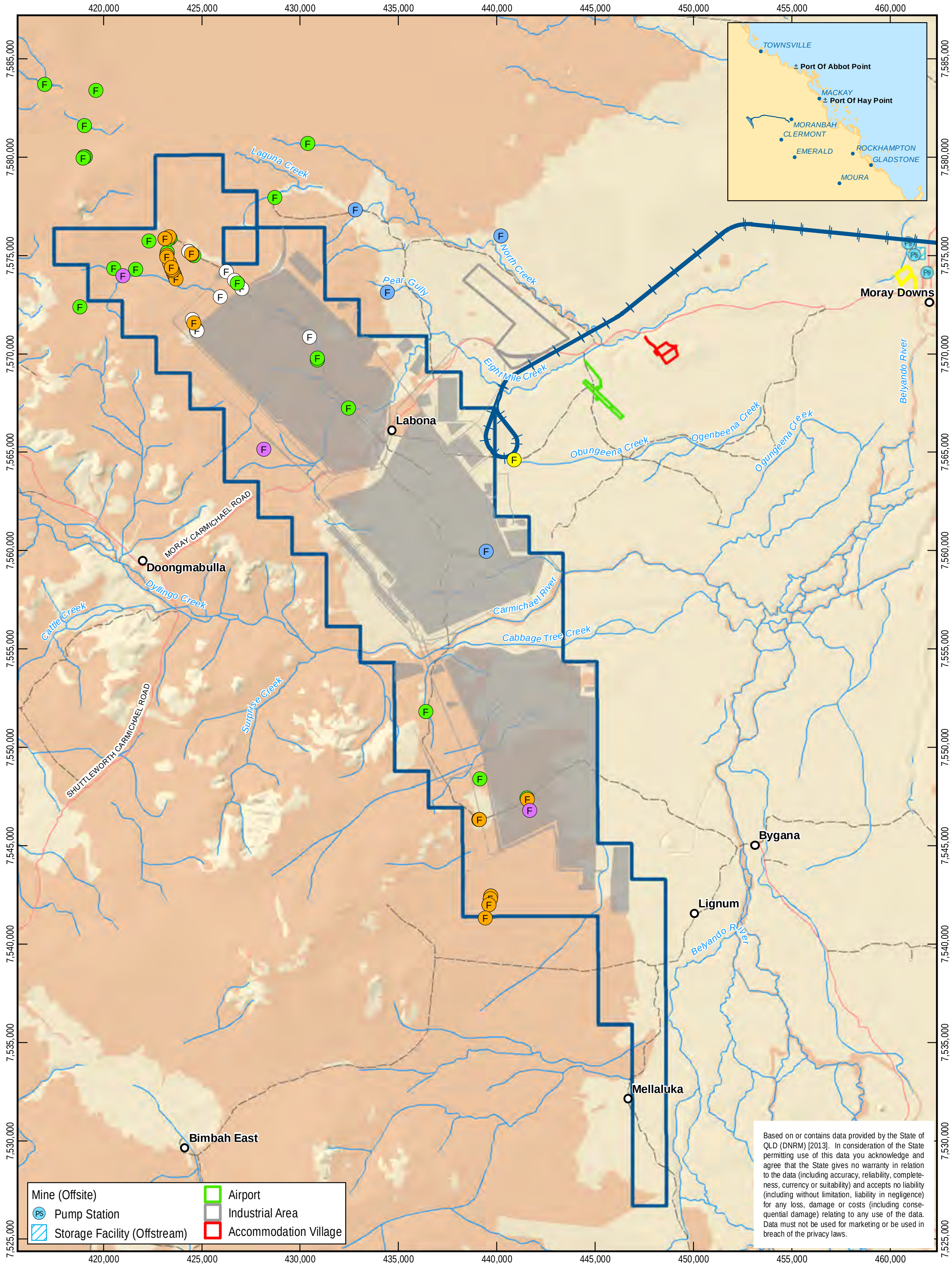
4.4.3 Field survey methodology

A combination of three survey methods was employed based on the recommended methods within the Significant Impact Guidelines for the Black-throated Finch (southern) (*Poephila cincta cincta*) (hereafter, the ‘Black-throated Finch (southern) Significant Impact Guidelines’) (DEWHA 2009). These methods comprised water source watches, two hectare counts and remote fauna cameras. Water source watches were undertaken within and adjacent to the Study Area following the recommended methods outlined in the ‘Background Paper’ to the Black-throated Finch (southern) Significant Impact Guidelines (DEWHA, 2009)[1]. Water source watches were conducted at nine different water sources for close to 28 person hours during the EIS surveys and at eight water sources during the SEIS surveys.

Standardised bird surveys were undertaken at each assessment site using the methods recommended for surveys by Birds Australia. This involved a timed 20 minute (minimum) survey of a two hectare search area (2 ha) by one ecologist, recording the number of birds seen or heard calling, and the presence and composition of any mixed flocks. A total of 31 searches (totalling 21 person hours) were dedicated to bird surveys within the Study Area during the EIS surveys and 52 searches (totalling 35 person hours) during the SEIS surveys.

In addition to water source watches and two hectare counts, remote fauna surveillance camera surveys were undertaken. This involved the use of un-manned motion-sensing cameras that were set up and left in situ to detect fauna over an extended period. Nine cameras were installed at six different water sources where water source watches were also performed during the EIS surveys. Twenty cameras were installed within the Project (Mine) area and 14 within the Offsite infrastructure area during the SEIS surveys.

This level of effort easily meets the requirements of the Survey Guidelines for Australia’s Threatened Birds (DEWHA, 2010) for the species.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Potential Black-Throated Finch (Southern) Habitat - Based on Field Verified Regional Ecosystems within the Mine Site and DNRM Certified Regional Ecosystems Version 6.0b outside the Mine Site
- Winter 2012 (Ecology and Heritage Partners)
- Autumn 2011 (EIS 1690 Surveys)
- Spring 2011 (EIS 1080 Surveys)
- Spring 2011 (EIS 1690 Surveys)
- Autumn 2012 (Targeted BTF Surveys)
- Autumn 2013 (Offsite Infrastructure Surveys)
- Autumn 2013 (Targeted BTF Surveys)
- Project (Rail)
- Project (Mine)
- Mine (Onsite)
- Quarry

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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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Potential Black-throated Finch (southern) Habitat

Job Number	41-26422
Revision	C
Date	23-10-2013

Figure 16

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Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DNRM: Regional Ecosystems v6.0 (2010); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani:Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities, Offsite, Quarries, Mine (Onsite) (2013); GHD: Sightings, Potential Habitat (2011), Condition Habitat, Confirmed Sightings (2013). Created by: BW, CA

4.4.4 Field survey results

Baseline survey results

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)) 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

Previous surveys for black-throated finch (southern) have been undertaken within the Mine and Rail Study Areas, these include:

- Within the Mine Study Area and Rail Study Area during surveys conducted in 2010/2011 for the EIS:
  - No black-throated finches (southern) were detected during any surveys of the Rail Study Area but are considered likely to occur within that environment given suitable habitat prevalence
  - No black-throated finches (southern) were detected during the spring 2010 survey of the Mine Study Area
  - Approximately 345 black-throated finches (southern) were recorded on 34 separate occasions during subsequent autumn and spring 2011 surveys of the Mine Study Area and also on the Moray Downs property
  - Within the broader Moray Downs property during May 2012 surveys – 95 black-throated finches (southern) were observed at 10 sites and in flocks of up to 30 individuals
- Within the Mine Study Area and broader Moray Downs property during June/July 2012 surveys (by Ecology and Heritage Partners Pty Ltd (unpublished data, 2012) – approximately 155 black-throated finches (southern) were observed at 12 sites
- Within the Mine (Offsite) Area during April/May 2013 surveys – one individual black-throated finch (southern) was recorded at one dam location
- Within the Mine Study Area and broader Moray Downs property during May 2013 – 208 black-throated finch (southern) observations were made from 26 locations, recognising that some of these might have been recounts of the same birds in certain areas.

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 within non-remnant vegetation and also drinking from farm dams surrounded by non-remnant vegetation have been made. Full details of black-throated finch (southern) sightings are presented in EIS Volume 4 Appendix N1 Mine Terrestrial Ecology Report and Appendix N3 Black-throated Finch Report and SEIS Volume 4, Appendix J2 Black-throated Finch Monitoring Survey Report. Plate 5 shows black-throated finches (southern) observed at the Study Area.

Plate 5 Black-throated finches (southern) during field surveys in Study Area

Stock troughs near Bygana West Nature Refuge (April 2011)

Farm infrastructure near southern boundary of Bygana West Nature Refuge (April 2011)

Farm dam at north of Study Area (May 2011)

North-west of Study Area (May 2011)

Locations within the Study Area where black-throated finches were observed are presented in Figure 17, Plate 7 and Plate 8. These include stock watering troughs, small scrapes and dams as well as natural habitats. Anthropogenic watering sources can be considered to represent a significant input to the suitability of habitat within this area where natural water sources are generally ephemeral and highly seasonal. Habitat within the Study Area is currently subject to impacts from cattle grazing, introduced grass species, weeds and pest species.

Records obtained from the Study Area are towards the south western extent of the subspecies' current known (i.e. post-1998) distribution. It is considered that the Mine Study Area contains habitat critical to the survival of the species as defined by the Significant Impact Guidelines (DEWHA, 2009a).

Plate 6 Water sources at southern part of Study Area (April 2011)

Plate 7 Open eucalypt woodland with native grass understorey at southern part of Study Area (April 2011)

Plate 8 Open eucalypt woodland with native grass understorey and farm dam at northern part of Study Area (May 2011)

Habitat mapping and suitability

Habitat mapping was undertaken after the completion of the field surveys for the EIS of the Mine Study Area to incorporate all records of black-throated finch (southern) from the initial EIS field surveys and to estimate the extent of important and potential habitat on Moray Downs in context of the Mine Area and the wider region. Habitat for the broader region was categorised into four different categories:

- **Important**: All RE polygons with a confirmed record of a black-throated finch (southern) that intersect with a 5 km buffer around the finch record, including non-remnant vegetation. A 5 km buffer is considered likely to cover habitat critical to the survival of the species necessary for activities such as foraging, breeding roosting or dispersal (DEWHA, 2009b).
- **Potential**: All RE polygons that do not contain black-throated finch (southern) records, but which are the same RE that correspond to all finch records in the above important category, and all REs that are considered potentially suitable habitat for the subspecies (i.e. records 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). These REs are 10.5.5, 10.3.6, 10.3.28, 10.7.7, (from this survey), and REs 10.3.9, 10.3.13, 10.4.8, 10.5.1, 10.7.11, 11.3.12, 11.3.25, 11.3.27, 11.3.30, 11.3.35 and 11.11.9 from the Black-throated Finch Recovery Plan (2007). All RE polygons containing these REs, even if they are part of a complex polygon, are included. For example, if a finch was recorded within RE 10.5.5, then all polygons of, or including, 10.5.5 are considered potential habitat. This includes all RE polygons sub-units (e.g. 10.5.5 a, b, c, etc.) alone or in a complex. Potential habitat includes REs within the Moray Downs/Carmichael Mine Study Area and REs beyond the Study Area in the presented map extent.
- **Other**: All remnant vegetation not included in the above categories.
- **Non-remnant**: all non-remnant vegetation excluding those within the 5 km buffer for the black-throated finch records in the important habitat category above.

Furthermore, an additional level of detail has been provided for the habitat of the Mine Study Area (and adjacent surrounds) whereby this has been classified as (currently) being high value (permanent water or otherwise) or low value habitat, as follows:

- **High value habitat (permanent water):** Is defined as REs that are listed in the Recovery Plan and Significant Impact Guidelines (Black-Throated Finch Recovery Team 2007; DEWHA 2009a; b) where black-throated finches have been recorded, and are REs where the primary surveys in the Study Area (GHD 2011; 2012) have consistently recorded the species, and noted them feeding and nesting. These REs are 10.3.6, 10.3.9, 10.3.28, 10.5.5 and 11.3.27. This potential habitat is further refined by distance to permanent water; being less than 3 km from artificial water sources (the 3 km zone as defined in the Significant Impact Guidelines for permanent water (i.e. wet and dry season use)). Any polygon that contains one of these RE types is included.
- **High value habitat:** Is defined as regional ecosystems that are listed in the Recovery Plan and Significant Impact Guidelines (Black-Throated Finch Recovery Team 2007; DEWHA 2009a; b) where black-throated finches have been recorded, and are REs where the primary surveys in the Project Area (GHD 2011; 2012) have consistently recorded the species, and noted them feeding and nesting. These REs are 10.3.6, 10.3.9, 10.3.28,

10.5.5 and 11.3.27. This potential habitat is further refined by distance to water; being more than 3 km from permanent water sources but within 1 km of drainage lines of the stream order 1, 2 and 3 (ephemeral water used during the wet season). Any polygon that contains one of these RE types is included.

- **Low value habitat value:** Is defined as REs where black-throated finches have been recorded, and are listed in the Recovery Plan and Significant Impact Guidelines (Black-Throated Finch Recovery Team 2007; DEWHA 2009a; b), but based on the primary surveys in the Project Area (GHD 2011) are not considered high value habitat (i.e. containing important feeding and nesting resources). These REs are 10.3.13, 10.4.8, 10.5.1, 10.7.11, 11.3.12, 11.3.25, 11.3.30, 11.3.35, 11.11.9. Only polygons where these are the dominant RE are included.

The division of the Mine Study Area into these high and low value habitat areas is based on the presence of known or potential habitat for the species with reference to RE mapping and location of water (i.e. artificial water points and drainage lines). These represent the key resources for the species; feeding and breeding (REs) and drinking (water sources). Similar classifications of habitat value have been made for other comparable projects within the region (Alpha Coal Project, Kevin's Corner Project), although, for this Project, the definitions have been based upon field-verified data and observations within and adjacent to the Mine Area.

With respect to natural water sources, their significance to finches has been defined based on observations at the Mine Study Area over a number of years, and understanding of the landscape configuration in the Desert Uplands known to be important for the species. In this case, small, ephemeral watercourses are significant for the black-throated finch (southern) in the wet season, as these small pools allow the species to access a wide range of feeding sites. Streams of the order 1, 2 and 3 are considered most significant, whereas larger watercourses such as the Carmichael River are less important, especially due to the large array of other artificial and spring water sources available. Large running water sources are not suitable drinking sources for finches.

Artificial water sources (troughs, dams and springs) are considered important in both the wet season and dry season, and there are many observations and remote camera records of flocks of black-throated finches (southern) using these. The presence of permanent water is considered a major predictor of the distribution of the species and therefore is a core facet in defining the two types of high value potential habitat. The distribution of REs considered suitable habitat for the species are extensive in the region and, though important, the landscape context, condition (i.e. historical management) and spatial arrangement is more important than simply the presence or absence of the RE type.

With regards to the Mine (Offsite) Area, potential habitat predominantly occurs within riparian fringing woodlands adjacent to North Creek. Field surveys during April/May 2013 indicate that these areas have been substantially degraded by the proliferation of buffel grass and are unlikely to represent important breeding or foraging habitat for the black-throated finch (southern). Within the Rail Study Area, suitable habitat for the black-throated finch (southern) occurs at the western extent of the Project (Rail), near the Mine Area. Potential habitat within the Rail Study Area is presented in Figure 18.

Figure 17 and Figure 18 indicate that much of the remnant vegetation to the north, west and south of the Mine Study Area (that is, outside of the Mine 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 Mine Study Area.

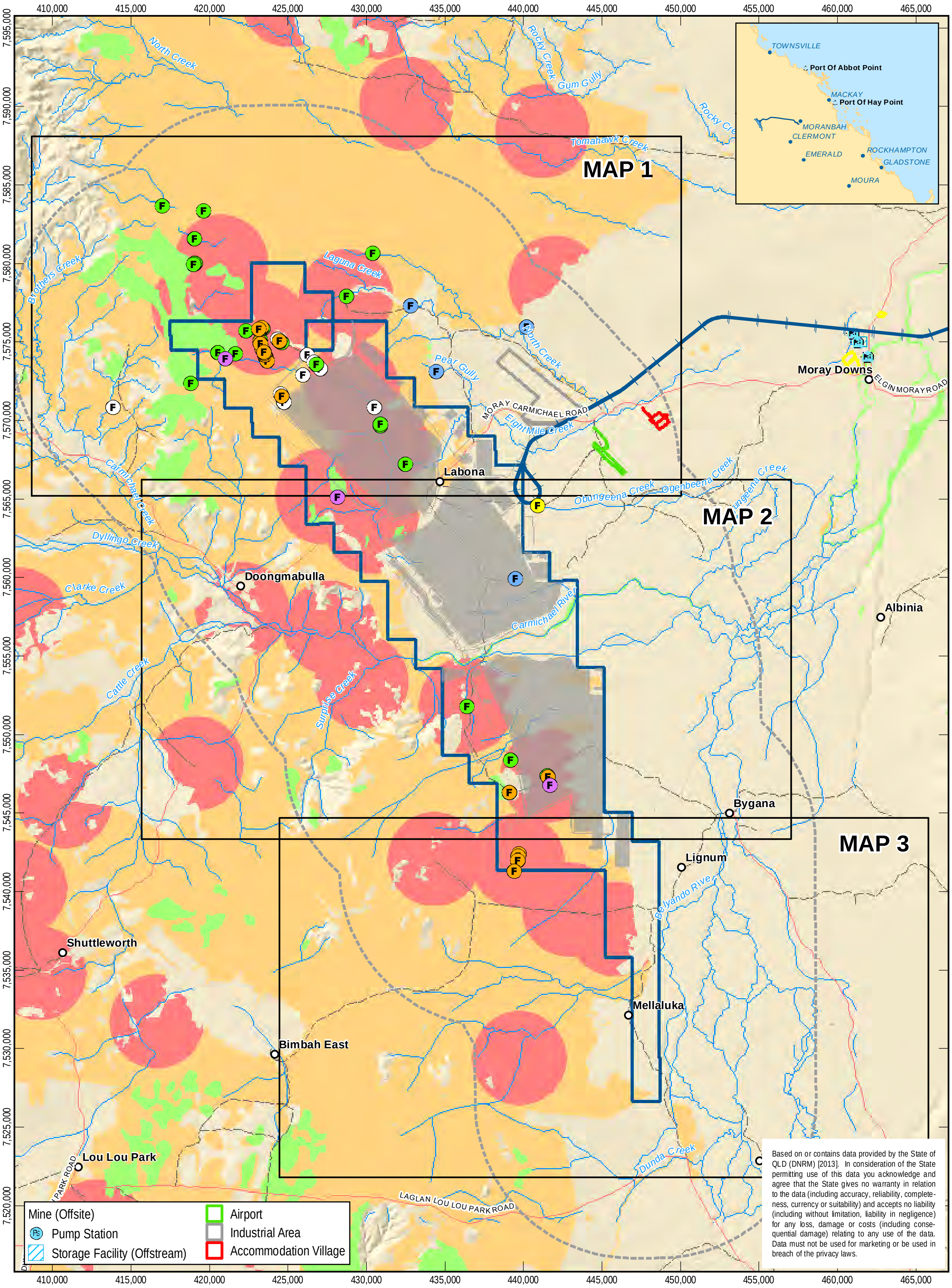
Monitoring survey results

In discussion with the DSEWPaC and the Black-throated Finch Recovery Team, Adani have committed to the development and implementation of a black-throated finch (southern) monitoring program, to gain a better understanding of the population size, seasonal movements and key habitats and potential nesting areas used by the black-throated finch (southern), both at the Mine site and adjacent Moray Downs and Bygana properties. Field surveys were first undertaken in May 2013 (and were also being undertaken in October 2013) to collect further baseline information on the habitat preferences, ecology, temporal and spatial variation in distribution, coarse population estimates and effects of land management. This survey is the first of a series of monitoring surveys that will take place over the next 12 months, continuing in following years. A review of the first survey results indicates the following in terms of information contributing to knowledge of the black-throated finch (southern) ecology in the Study Area, and more widely for north central and eastern Queensland (full results are presented within the SEIS Volume 4, Appendix J2 Black-throated Finch Monitoring Survey Report):

- The highest numbers of black-throated finch (southern) are consistently recorded in the intact remnant vegetation dominated by *Eucalyptus melanophloia* woodlands (RE 10.5.5) and the associated *E. similis* (RE 10.5.1) and *E. populnea/brownii* woodlands (RE 10.3.6/10.3.28). This vegetation on the site, especially in the north-west, west and south-west, is in particularly good condition due to the low level of artificial watering points, low degree of exotic pasture invasion, the presence of poison bush (*Gastrolobium grandiflora*) which is toxic to cattle, and seemingly a history of low or light grazing. Many grass species that are considered “decreasers”, that is vulnerable to disappear due to cattle grazing, are diverse and of a high cover abundance (Kutt and Kemp, 2012; O'Reagain and Bushell, 2011). This includes a large number of grass species (e.g. *Alloteropsis*, *Triodia*, *Digitaria*, *Enteropogon*, *Eriachne*, *Panicum*) considered preferred food sources for the black-throated finch (southern) (Black-throated Finch Recovery Team, 2007).
- Field survey data indicates that black-throated finches (southern) are more likely to utilise smaller and ephemeral water sources (troughs, scrapes, puddles in drainage lines) than large exposed water points.
- An additional five sites where black-throated finches (southern) were reported was provided through the use of camera trapping. Camera trapping is able to record continuously for a prolonged period of time (i.e. over 30 days) and present information on daily water use, and time of water use. Interestingly in water sources where finches were recorded, their use was not necessarily daily, suggesting that they might use a variety of different water sources daily. Furthermore, the types of water used were mainly troughs and scrapes rather than large dams.
- There was no clear difference in composition of woodland bird assemblages across the sites (i.e. between the sites with black-throated finch (southern) present or absent), but there were a number of woodland bird species more abundant where black-throated finch (southern) was present. This is likely a function of the fact that black-throated finches (southern) were found in intact rather than non-remnant vegetation, and the general bird abundance and species richness is higher in these sites.

- The vegetation patterning between black-throated finch (southern) presence and absence sites indicated that particular grass species and woody vegetation are more abundant in sites where black-throated finch (southern) is present – some of these reflect the regional ecosystems types they prefer (e.g. *Acacia elachantha*, *Grevillea parallela*), and some reflect an association with preferred diet (e.g. *Triodia pungens*, *Panicum effusum*). As mentioned previously, many of the species preferred as food sources by the black-throated finch (southern) are impacted and decrease in the presence of cattle grazing.
- Black-throated finches (southern) are often found in mixed species feeding flocks often with other granivorous species, and especially with black-faced woodswallows. Mixed feeding flocks are a typical component of the avifauna of the tropical savannahs of northern and central Queensland (Vanderduys et al., 2012).
- This survey identified nesting sites in the Study Area for the first time. One was evidence of an adult bird carrying nesting material (*Panicum* stalks), and two others were actual nests being used by black-throated finch (southern). There was no evidence of breeding, and black-throated finch (southern) use nests on an annual basis to roost at night, as well as breed (DEWHA, 2009b). The size, shape and location of the nests were typical of other recorded instances of black-throated finch nests in northern Queensland (Black-throated Finch Recovery Team, 2007).

Existing populations of the black-throated finch (southern) are thought to be highly fragmented (DSEWPaC, 2011c). 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'.



LEGEND

Homestead	Winter 2012 (Ecology and Heritage Partners)	Autumn 2012 (Targeted BTF Surveys)	Project (Rail)	High Value Habitat (Permanent water)
Local Road	Autumn 2011 (EIS 1690 Surveys)	Autumn 2013 (Offsite Infrastructure Surveys)	Project (Mine)	High Value Habitat
Track	Spring 2011 (EIS 1080 Surveys)	Autumn 2013 (Targeted BTF Surveys)	Mine (Onsite)	Low Value Habitat
Watercourse	Spring 2011 (EIS 1690 Surveys)	Project (Mine) 10km Buffer	Quarry	

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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

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Black-throated Finch (southern) value habitat (high/low condition)

Job Number 41-26422
Revision C
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Index Map
Figure 17

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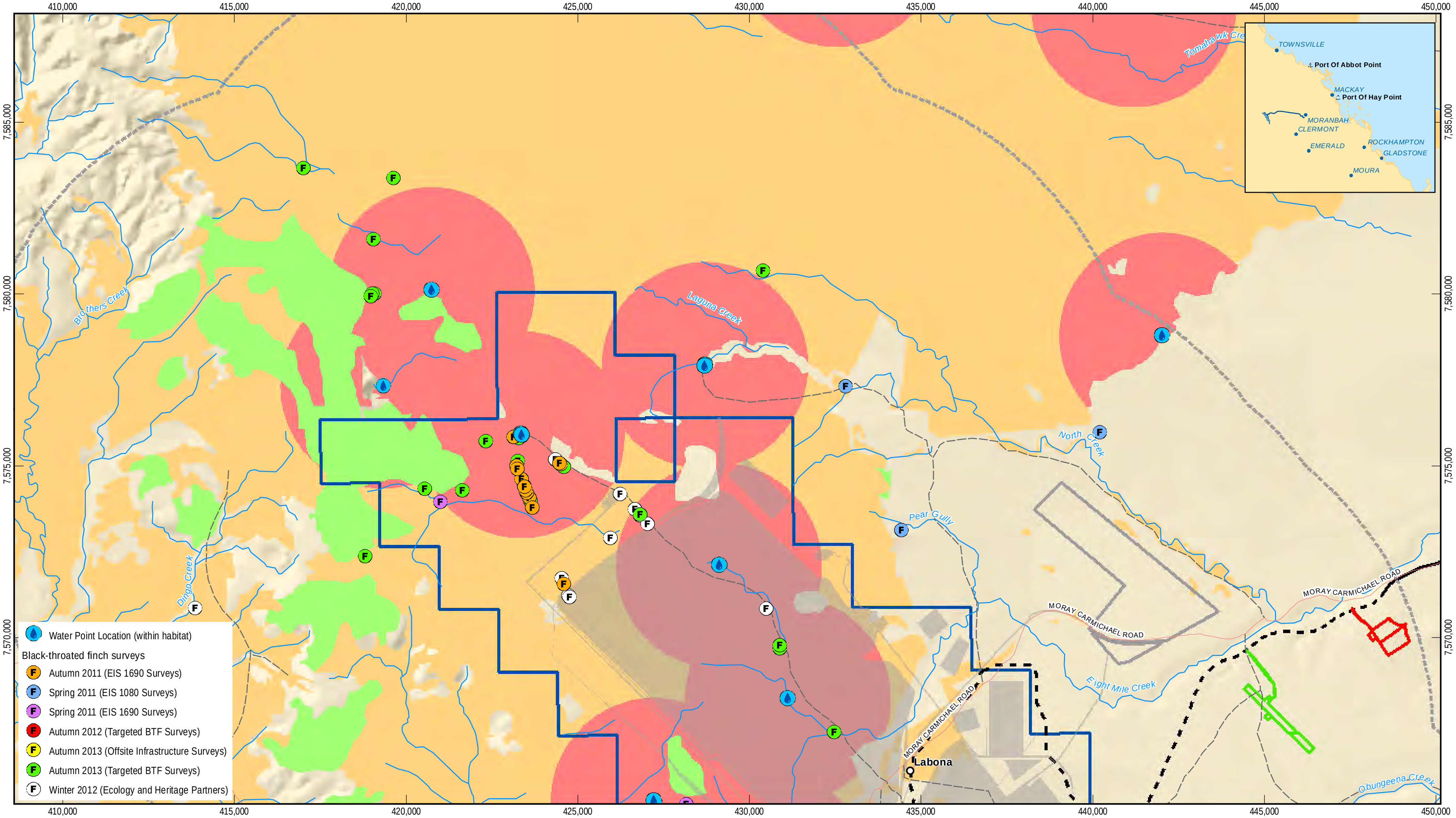
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DNRM: Regional Ecosystems v6.0 (2010); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani:Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities, Offsite, Quarries, Mine (Onsite) (2013); GHD:Sightings, Potential Habitat (2011), Value Habitat, Confirmed Sightings (2013). Created by: MS



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Kilometres

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

N

LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Rail Corridor
- Project Area
- Road Corridor
- Road Corridor (proposed)
- Project (Mine) 10km Buffer
- High Value Habitat (Permanent water)
- High Value Habitat
- Low Value Habitat
- Mine (Onsite)
- Mine (Offsite)
  - Airport
  - Industrial Area
  - Accommodation Village

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Carmichael Coal Mine and Rail Project SEIS

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Date | 05-11-2013

Black-throated finch (high/low) value habitat

Figure 17

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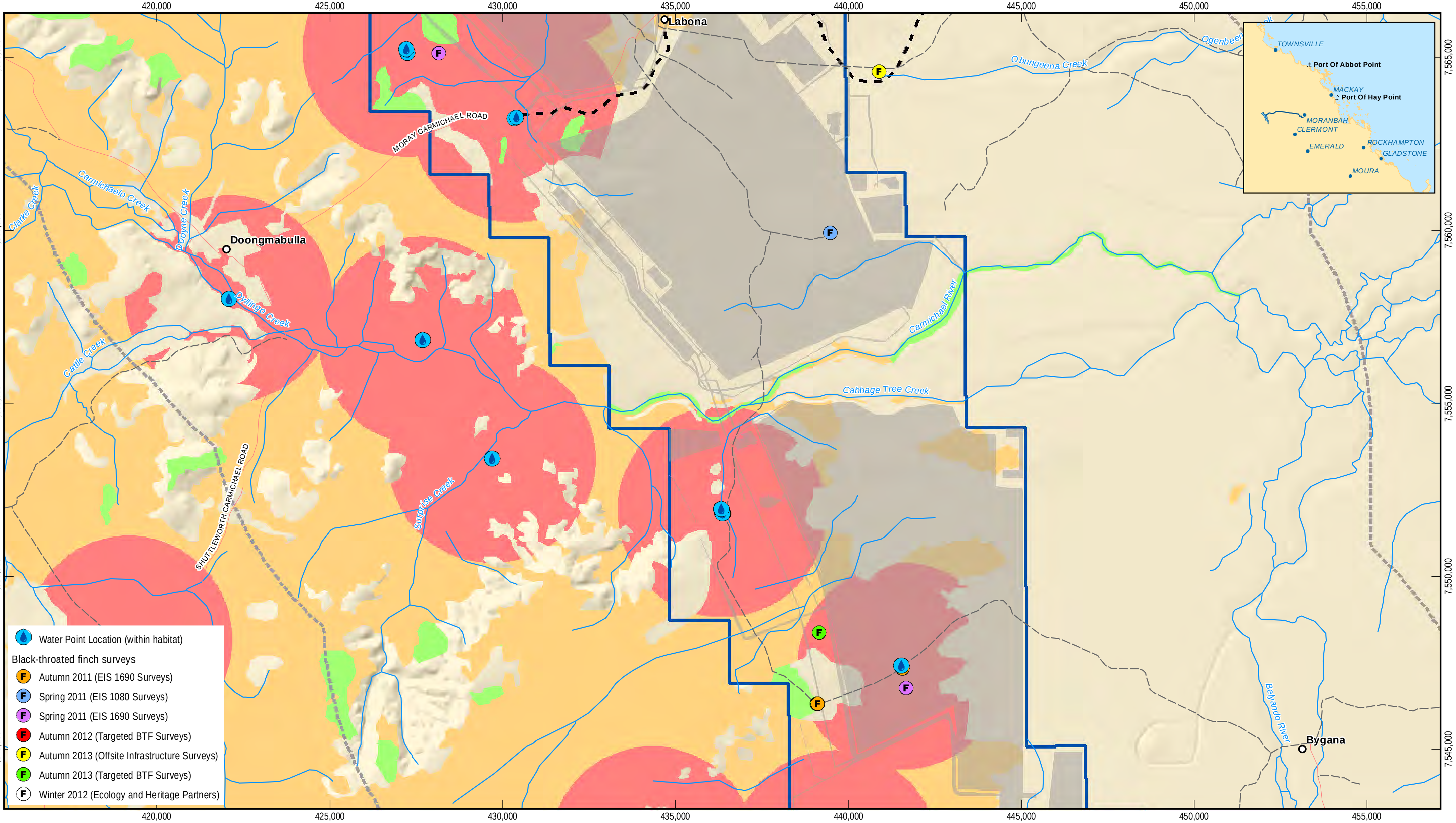
Data source: DME: EPC1690 (2010)/EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007); Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013); ESRI: Hillshade (2009); GHD: High/Low Value Habitat, Sightings (2013). Created by: MS



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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

LEGEND

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- Mine (Onsite)
- Mine (Offsite)
- Airport
- Industrial Area
- Accommodation Village

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Black-throated finch (high/low) value habitat

Figure 17

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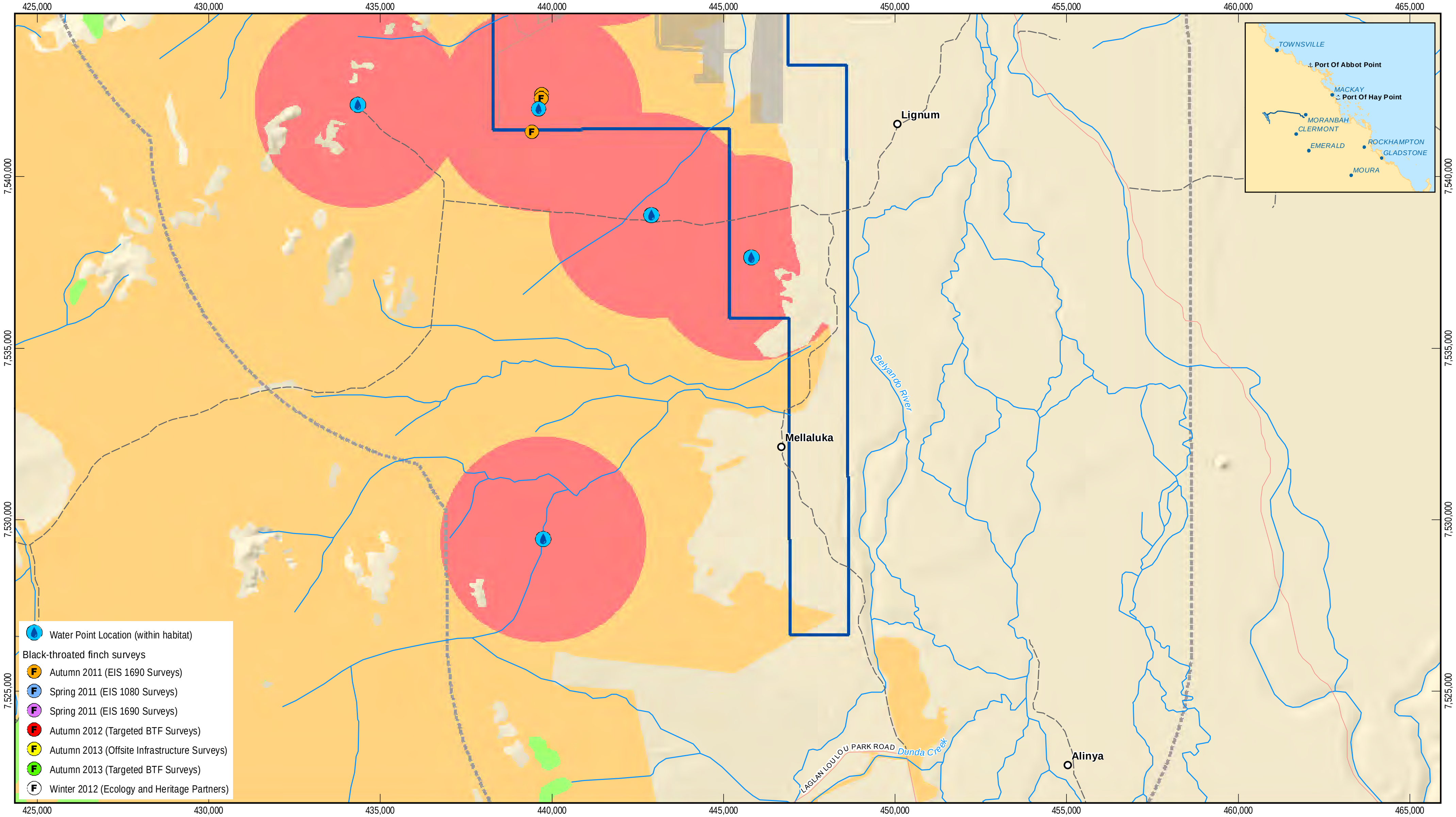
Data source: DME: EPC1690 (2010)/EPC1080 (2011); © Commonwealth of Australia (Geoscience Australia): Watercourse, Tracks (2007); Adani: Alignment Opt11 Rev 2 (SP1 and 2)(2013), Offsite Infrastructure (2013); ESRI: Hillshade (2009); GHD: High/Low Value Habitat, Sightings (2013). Created by: MS



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Kilometres

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Black-throated finch (high/low) value habitat — Figure 17

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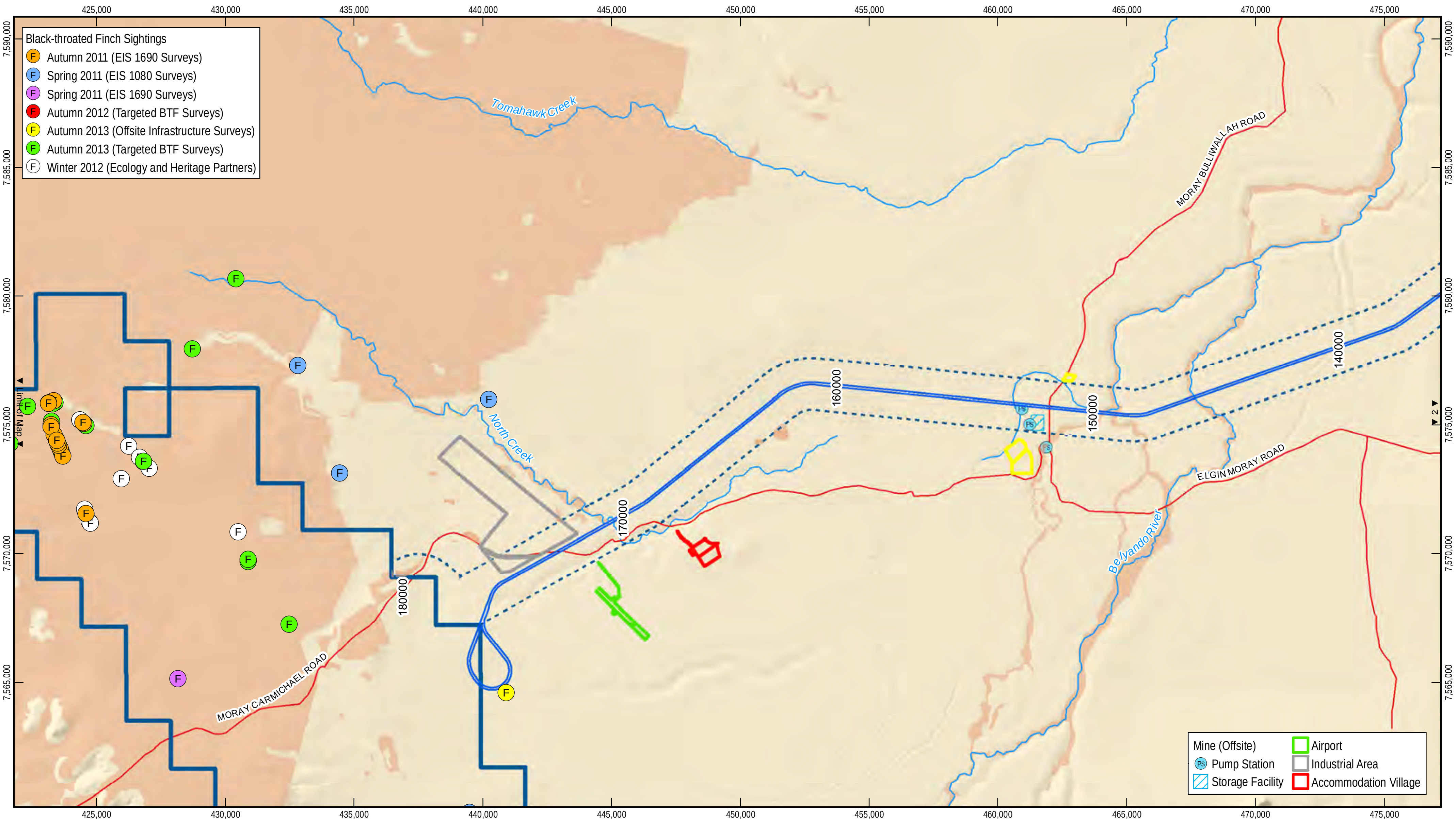

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Kilometres

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

N

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Potential Black-Throated Finch (Southern) Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b
- Project (Rail)
- Project (Mine)
- Quarry

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Potential Black-throated Finch (southern) Habitat at the Rail Study Area and the Surrounding Landscape

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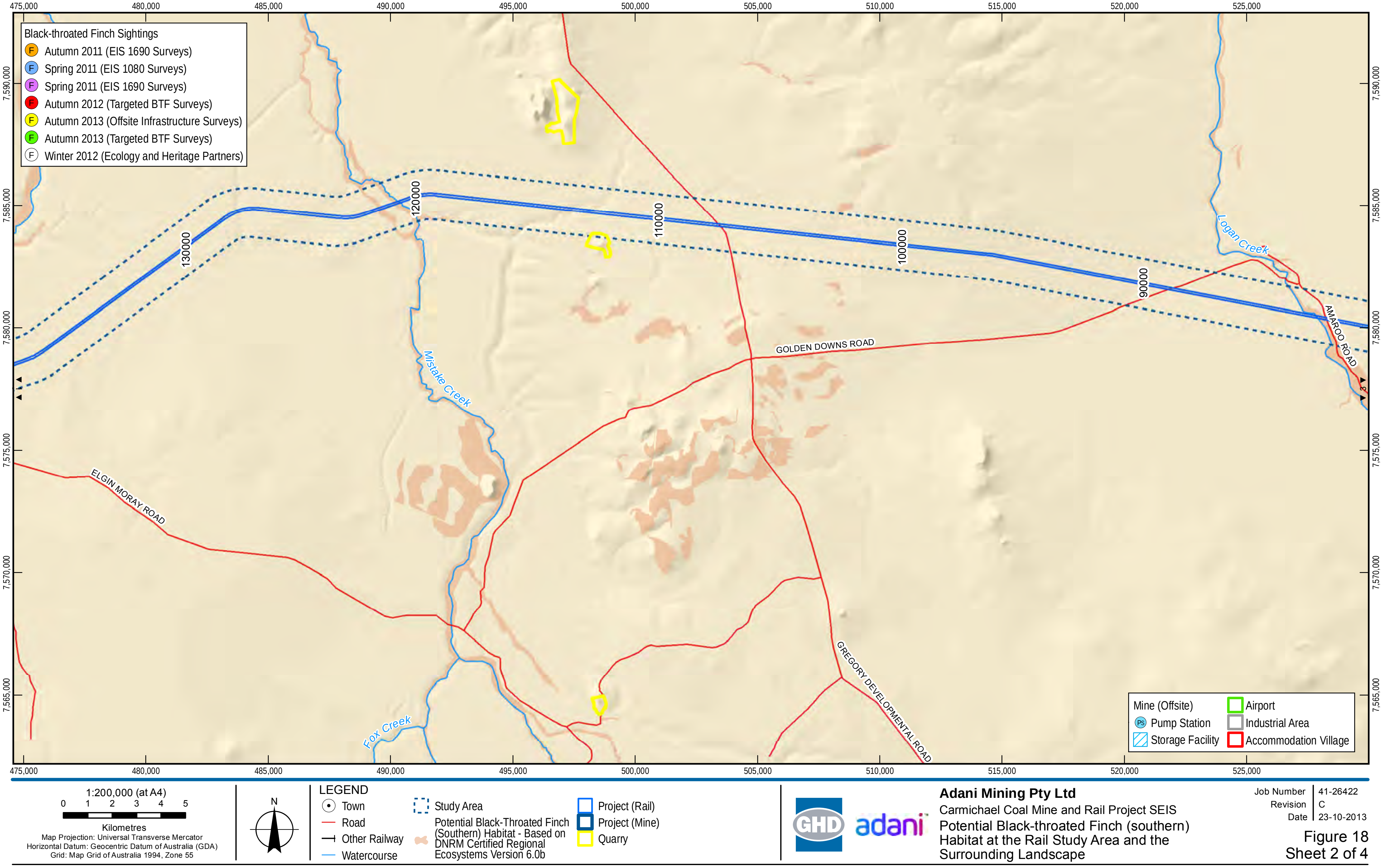
Data source: DNRM: DEM (2008), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Potential Black-throated Finch Habitat, Sightings (2011),(2012), (2013); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3, Quarry (2013); DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES



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Carmichael Coal Mine and Rail Project SEIS

Potential Black-throated Finch (southern) Habitat at the Rail Study Area and the Surrounding Landscape

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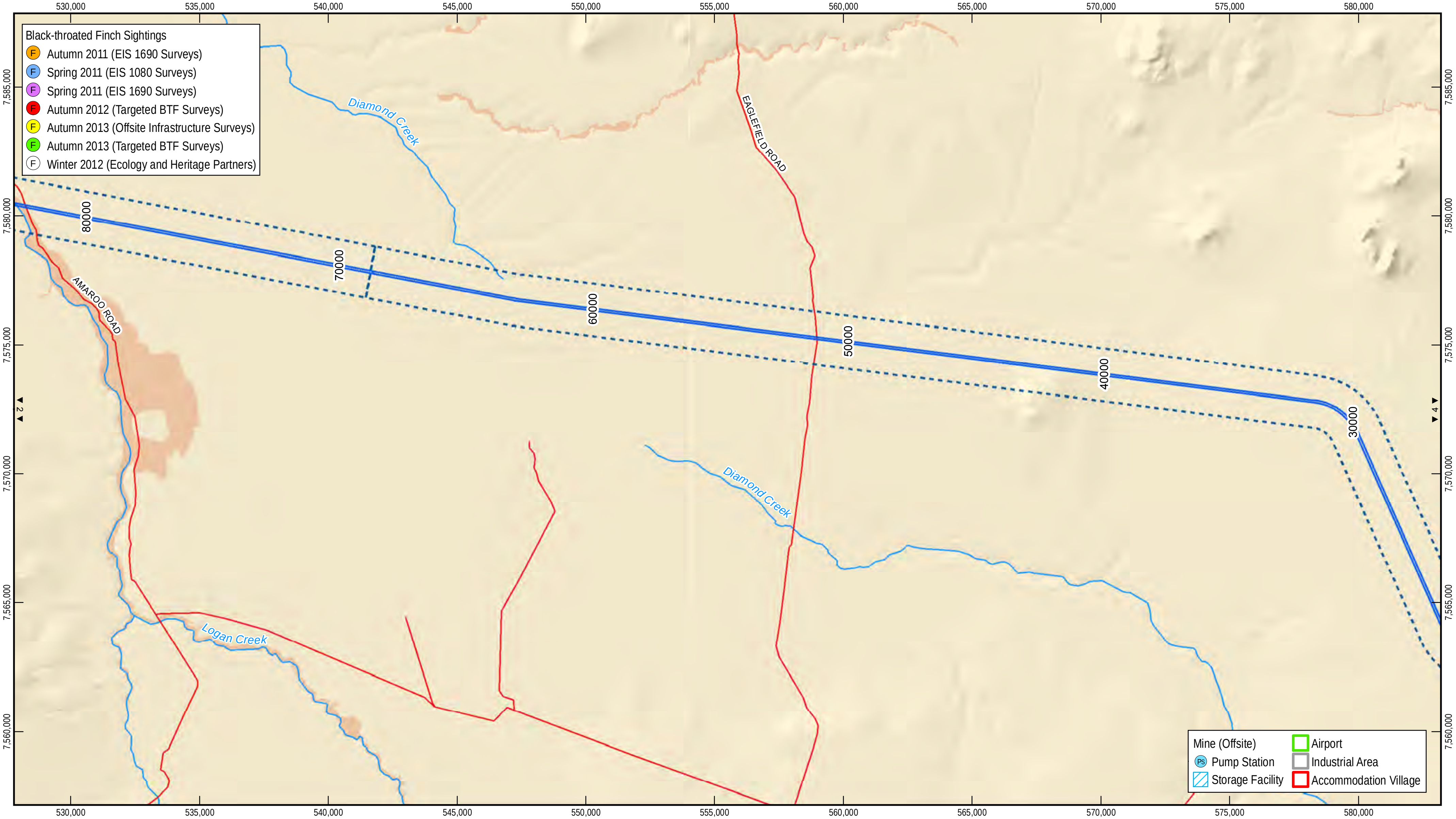

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Kilometres

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

N

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Potential Black-Throated Finch (Southern) Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b
- Project (Rail)
- Project (Mine)
- Quarry

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Carmichael Coal Mine and Rail Project SEIS
Potential Black-throated Finch (southern) Habitat at the Rail Study Area and the Surrounding Landscape

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Data source: DNRM: DEM (2008), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Potential Black-throated Finch Habitat, Sightings (2011),(2012), (2013); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3, Quarry (2013); DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES

4.4.5 Status in project area

Based on the currently available information acquired from desktop and field studies, and in consideration of the Significant Impact Guidelines (DEWHA, 2009a), it is considered that the Mine 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:

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

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 Significant impact guidelines for the endangered black-throated finch (southern) (DEWHA, 2009b). As such, it is possible that the population at the Study Area is part of a collection of local populations.

4.4.6 Threatening processes

The decline of the black-throated finch (southern) is largely attributable to extensive agriculture and pastoralism, and the associated widespread clearing of habitat and conversion of the ground cover to predominantly exotic pastures across New South Wales and Queensland (DEWHA 2009a). It is no coincidence then that locations where the black-throated finch (southern) remain in large numbers contains extensive areas of intact tropical savanna woodlands, lightly or not grazed, with ample available water and native grass species (NRA 2007a). The black-throated finch (southern) Significant Impact Guidelines (DEWHA, 2009b) and recovery plans and research have suggested that the array of possible threats to the species may include:

- clearing and fragmentation of habitat
- degradation of habitat by domestic stock and rabbits, including alterations to fuel load
- vegetation structure and wet season food availability
- alteration of habitat by changes in fire regime
- invasion of habitat by exotic weed species, including exotic grasses
- illegal trapping of birds
- predation by introduced predators
- hybridisation with escapees of the northern subspecies.

In the Mine Area, a range of threats and impacts have been identified over the course of more general terrestrial ecological surveys (GHD 2011) and targeted black-throated finch (southern) monitoring (GHD 2012; 2013b). However, the following specific threats in reference to the current knowledge of black-throated finch (southern) ecology, site-specific factors and understanding of the staged development of the Mine Area that is proposed to occur, can be identified:

- Clearing nesting trees via general infrastructure development or maintenance activities (e.g. fire breaks, new tracks)

- Fragmentation of key habitat areas via general infrastructure development or maintenance activities (e.g. fire breaks, new tracks)
- Increased exotic pasture and weed invasion of key habitat areas via poor grazing land management, machinery, soil disturbance, or other vectors
- Grazing or increased grazing in of key habitat areas that changes the ground cover composition or removes resources at periods of resource bottlenecks
- Wildfire or inappropriate fire management of key habitat areas that changes the ground cover composition or removes resources at periods of resource bottlenecks
- Feral animal predation on adult birds, nests or eggs
- Loss or degradation of water sources via cattle and pig access, or changes in the groundwater and surface flows

4.4.7 Potential impacts

Impacts to mapped potential habitat for the black-throated finch (southern) subspecies are described in Table 14.

Table 14 Impact to potential black-throated finch habitat

Project Area/Phase	Direct clearing (ha)		Indirect subsidence (ha)	
Rail construction		16		-
Rail impact area		16		-
Mine construction				-
	High value – Permanent water	788	High impact	-
	High value (excluding permanent water)	395	Low impact	-
	Low value	18		-
	Sub total	*1,201*		-
Mine operation				-
	High value – Permanent water	6,352	High impact	163
	High value (excluding permanent water)	1,775	Low impact	6,145
	Low condition	27		
	Sub total	*8,154*	*Sub total*	*6,308*
Off-site construction		3		-
Mine total impact area		9,358		6,308
Project impact area		**9,374**		**6,308**

Note:

black-throated finch (southern) potential habitat is mapped based on those REs within which records of species have been obtained

Habitat loss

This subspecies has been encountered in all targeted surveys undertaken within the proposed Mine Area. The number of black-throated finch (southern) observations suggests that the subspecies occurs in large numbers in the area and that much of the habitat is in good condition. The sub-population of black-throated finch (southern) in the landscape that encompasses the Mine Area and adjacent properties to the north and west, is seemingly large and potentially significant in context of the existing known populations (i.e. Townsville).

Of the potential habitat for the black-throated finch (southern) identified at the Study Area, Figure 17 presents the 'important areas' for the black-throated finch (southern) at the Study Area, as defined in the Black-throated Finch (Southern) Significant Impact Guidelines (DEWHA, 2009b). These areas are defined as areas of identified potential habitat within 5 km of any post-1995 (i.e. Project field survey) sightings of the subspecies. A total of 9730 ha of identified black-throated finch (southern) potential habitat are proposed to be impacted by vegetation clearing over the life of the Project. Approximately 84 percent of the habitat areas to be directly impacted are high condition habitat.

The area of direct impact has been minimised as far as possible throughout the design and development of the mine plan. The most significant area of changes was relocating out of pit stockpiles from the western portion of the mine site (over the underground mining area on EPC 1690) to the eastern edge (overlaying EPC 1080) resulting in the reduction of a direct impact of some 7,000 ha to the current indirect impact of 6,308 ha. This change to the mine plan resulted in an approximately 40 percent reduction in the potential area of direct impact. In addition, more recent changes to the mine plan between the EIS and SEIS included the removal of open cut pits in the northern extent of the mine and conversion of open cut pits to underground longwall panels; this has resulted in a further reduction of the potential area of direct impact.

Loss of habitat for the black-throated finch (southern) will be staged, in accordance with the staged development of the operational components of the Mine. Previously mined areas will be rehabilitated in parallel with development of previously unmined areas within the Study Area. Nonetheless, an overall reduction in the local availability of habitat for the subspecies will occur as a result of the operation phase of the Project. It is possible that the subspecies may disperse away from the developed parts of the Study Area, either to suitable, un-impacted 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.

Habitat alteration through subsidence

All of the habitat to be indirectly impacted by subsidence is considered to be high condition habitat for the black-throated finch (southern). However, only a very small part of this habitat (approximately 2.6 percent) is considered to be subject to high subsidence impacts, with the rest low or no subsidence impact.

Those species with a noted affiliation to water (squatter pigeon (southern), 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, even where this resource is temporary, though the destructive impact on surface habitat might negate this effect. 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 may 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. However, as the subsidence will occur gradually and in a complex and partly unpredictable manner, the data being collected by this long-term monitoring in the Mine Area will provide information regarding the best strategies over time to mitigate negative effects and manage key resources for black-throated finch (southern) on the Mine Area.

Changes to hydrology: surface water

Existing hydrology will be altered as a result of the mine operations through realignment of watercourses as well as removal of some existing farm dams and cattle troughs. Diversion drains around the perimeter of the mine site as well as areas of ponding and drainage management within the subsidence area provide water sources. The provision and security of surface water in those potential habitat areas may provide additional localised access to drinking water for the subspecies (or at least compensate for the loss of surface water resources in nearby parts of the Study Area).

Injury or mortality of species

Bird species, such as the black-throated finch (southern) are less likely to be directly impacted by operational works, suffering mortalities, but are more likely to be indirectly affected by works reducing habitat availability within the local landscape and would, therefore, suffer displacement.

4.4.8 Management and mitigation

Habitat loss

The 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 Area. Management actions will seek to maintain and where possible enhance habitats and populations (e.g. through pest control, provision of water sources, appropriate grazing and fire management) in unmined parts of the Mine Area, as well as in adjacent areas. Management actions to encourage dispersal away from areas that will be cleared for staged Mine operations will also be developed.

Adani is seeking to manage the Moray Downs Property to the north, west and southwest of the Mine Area to preserve and enhance environmental values that will support the neighbouring black-throated finch (southern) population observed in the Mine Area.

The property will be managed through the implementation of a Management Plan, which will specifically address the key threatening processes to the species. The Management Plan will be consistent with those plans developed for the Mine Area in regards to black-throated finch (southern) monitoring and management.

The benefit of this approach is that Adani are the current leaseholders of this property and therefore have a strong ability to effectively manage this property to achieve the stated and agreed objectives. Adani is confident in the value and success of this mitigation measure for the following reasons:

- Black-throated finch (southern) have been regularly observed in areas of existing grazing impacts, and hence Adani can control grazing on these mitigation areas of the property to maintain supporting habitat.
- The black-throated finch (southern) has been observed to utilise natural and artificial water sources and therefore a program of the placement of artificial water sources on this property will assist in black-throated finch (southern) population support and to increase the carrying capacity in areas with high value habitat that do not have permanent water.
- Adani has a superior understanding through repeated field surveys of black-throated finch (southern) habitat preferences and therefore selecting areas that can be either maintained or improved in regards to environmental values and supporting capacity for the black-throated finch (southern).
- An integrated mitigation measure in this part of the property will connect with the directly and indirectly impacted areas of the Mine. Therefore, during progressive clearing towards the west, over the life of the mine, habitat connectivity and corridors are maintained for the species and population movement and enhancement can be achieved through connectivity of supporting permanent water sources.
- The approach supports the ongoing monitoring program proposed and the establishment of localised reference sites that are outside the Mine disturbance footprint and can be maintained throughout the life of the project.
- The approach aligns with the broader ecological objectives at a State and Federal level such as maintaining corridors and connectivity and also aligns with the priorities outlined in the Queensland Governments Galilee Basin Offset Strategy.
- Any future proposals or impacts to this property would need to recognise these arrangements and hence relevant legal mechanisms could be developed to provide this certainty.

The phased construction schedule will allow important population, movement and habitat information to be collected, particularly with respect to seasonal use, key areas, nest sites, important feeding areas and management of threatening processes. As such, there will be opportunities to undertake construction and clearing in periods of least potential impact (i.e. non-nesting times) and potentially encourage dispersal away from the developed parts of the Mine Area, either to suitable habitat within other parts of the Mine Area, or to other suitable habitat in the landscape to the north, west and south of the Mine Area. This includes the Moray Downs Property and other areas procured and managed as offsets.

Other species management actions

The detail of the key management actions for black-throated finch (southern) in the Mine Area and offset sites will be developed as part of a Black-throated Finch Management Plan (SMP) prior to the commencement of construction, and in reference to data from the adaptive monitoring program. There are broad management and mitigation actions outlined in the EIS and SEIS reports (GHD 2011; 2012; 2013a); however, the key components in the SMP will be:

- **Water point management**: As a key resource for the black-throated finch (southern) are permanent water sources, of the appropriate size and water quality, management actions to maintain existing sources and troughs, or to create of new water sources, to encourage

dispersal and use of habitat currently more than 3 km from existing water, will be developed. This will include:

  – Maintaining and enhancing existing water sources by fencing from stock and feral animals, to prevent their degradation and reduction in water quality
  – Fencing key ephemeral water sources, such as springs and rocky pools, to prevent access by stock and feral animals in the wet season
  – Provision of new water sources (i.e. troughs) using a raised design to discourage access by macropods, cattle and feral animals, such as pigs and cats. Raised troughs have successfully been used for threatened bird species in conservation reserves, such as Newhaven Station and Gluepot Station managed by BirdLife Australia and the Australian Wildlife Conservancy. The use and manipulation of water sources is an important tool is maintaining black-throated finch (southern) in the landscape, or encouragement to use other suitable habitat, where the appropriate food resources exist, but where there are not regular water sources present.

- **Cattle grazing**: A key factor in the decline of black-throated finch (southern) across its range has been the increase and intensification of agriculture, including land clearing, and habitat modification associated with cattle grazing. Recent surveys at the Mine Area have clearly indicated that the best habitat and most abundant populations of the finch are located in areas that have not been cleared and have historically been very lightly grazed and, as a consequence, have a diverse ground cover and food resource. Cattle grazing reduces native grass diversity and promotes weed incursions. Therefore, key management actions will include:

  – Careful management and/or exclusion of cattle grazing from existing areas where black-throated finch (southern) is located
  – Carefully managed cattle grazing in potential habitat locations and offset sites, where cattle grazing occurs, that includes wet season spelling, and reduced stocking rates in key resource dependent (bottleneck) periods (i.e. late dry season) and during periods where El Nino weather patterns are dominant.

- **Fire management:** Inappropriate fire regimes can have a significant impact on both the food sources and nest trees of the black-throated finch (southern). Using appropriate fire regimes and management, especially during key resource dependent (bottleneck) periods, will be a critical management action. As part of a wider fire management plan for the Mine Site, the promotion of ecological burning regimes for black-throated finch (southern) will be required and this will include:

  – Late wet season/early dry season mosaic burns, to break up the country and prevent extensive late dry season wildlife
  – Some wet season storm burning, when appropriate
  – Maintenance of a range of fire ages in the black-throated finch (southern) habitat areas
  – Clear networks of fire breaks that help promote a range of fire ages across remaining finch habitat and offset areas.

- **Weeds**: The most significant weeds that will affect black-throated finch (southern) habitat and feeding habitat condition are introduced pasture grass species, such as Buffel Grass *Pennisetum ciliare*, Indian Couch *Bothriochloa pertusa*, Grader Grass *Themeda*

quadrivalvis and Seca *Stylosanthes* spp. These species are promoted by cattle grazing (directly and indirectly) and soil disturbance, and can become monocultures that exclude native grass species. Key actions to management weed impacts will include:

  – The production of a Vehicle Weed Hygiene Procedure and a Weed Management Plan that defines actions for weed control during and after clearing and construction activities
  – Habitat rehabilitation methods that exclude the use of exotic pasture species, and instead use local native grass species known to be black-throated finch (southern) food species.

- **Feral animals**: Though there is little evidence that black-throated finches (southern) are directly impacted by feral animals, it is probable that feral cats would prey on the species if given the opportunity. Species such as pigs will degrade water sources and feeding areas via wallowing and rooting. Controlling feral animals through trapping and shooting is largely an ineffective use of time and resources, unless it is intensive and on-going. The reduction of feral animals can only be achieved via the removal of 70-80% of the population annually, to prevent recruitment and breeding counteracting the decrease in the number of feral animals. As such, there is increasing cachet in novel feral animal management techniques and these should be applied with respect to black-throated finch (southern) management, including:
  – The reduction or elimination of baiting of dingoes. These animals are the top order predators in Australia and are known to exclude feral cats from their territories (i.e. the species most likely to prey on black-throated finch (southern)) and reduce feral pigs and kangaroos, both species that can degrade resources for the finch
  – The use of raised or fenced water sources (as described above) that prevent establishment and use by feral animals, such as cats and pigs, and native species, such as kangaroos.
- **Vehicle traffic**: Though probably a lesser impact, increased traffic, human and machine activity may cause direct mortality of black-throated finches (southern), especially as this species does feed in roadside vegetation. Vehicles are also a vector for the transport and introduction of exotic grass species, which will invade and degrade habitat. As such, specific black-throated finch (southern) management actions should be included in any Traffic and Road Safety Management Plans, as well as the species management plan. The production and application of a Weed Hygiene Procedure and provision of on-site wash down facilities to prevent the spread of new exotic species and particular fire prone high biomass grasses are also required. Other actions will include:
  – Minimisation of the extent of proposed new road network, particular in areas adjacent to feeding and nesting sites
  – Reduction in speed limits and install speed reduction infrastructure such as whoa-boys and speed humps
  – Installation of information and warning signs at key black-throated finch (southern) feeding and nesting areas.

Management plan

Adani will provide a Draft Black-throated Finch Management Plan for approval prior to the commencement of construction. The Plan will include the following:

- A management framework that aligns with the other project management plans
- Clear statements regarding the intent, approval requirements, objectives and actions
- Details of how the management plan will be applied across the project phases – pre construction / construction / operation / post operations, offset areas
- Details of the current and proposed adaptive monitoring program to support the plan objectives
- Details of how experts will be used in a review capacity to inform ongoing monitoring and management
- Incorporates all proposed management and mitigation measures, including reference to how these will align with the Significant Impact Guidelines and the National Recovery Plan.
- Specific performance targets and how these will be measured and reported

A draft Black-throated Finch Adaptive Monitoring Plan has been prepared comprising a four part monitoring program including:

- Regional distribution (species distribution modelling)
- Regional distribution (surveys)
- Local monitoring (observational) on the Mine Area
- Local monitoring (detailed) on the Mine Area

This plan will be incorporated into the Black Throated Finch Management Plan. The third monitoring component has commenced, and the first survey was conducted in May 2013 (SEIS Volume 4, Appendix J2, Black-throated Finch Monitoring Survey Report) and this established 80 long-term monitoring sites. Comprehensive vegetation and habitat data is being collected at each site, and the survey methods follow those in EPBC Significant Impact Guidelines. The aim of this monitoring is to collect detailed information on habitat use, distribution across the Mine Area, nest sites, variation in sites where black-throated finch were present and absent, types of water sources preferred for use, habitat condition, weed, fire and grazing effects and landscape use. The surveys will continue over time to provide data on temporal and spatial variation of habitat use in the Mine Area and will contribute significant local data for incorporation into the Black-throated Finch Species Management Plan for the Mine Area, which will assist in refinement of species recovery actions and mitigation of impacts on the Mine Area. In the case of subsidence, which will occur gradually and in a complex and partly unpredictable manner, the data being collected by this monitoring will provide information regarding the best strategies over time to mitigate negative effects and manage key resources for black-throated finch on the Mine Area.

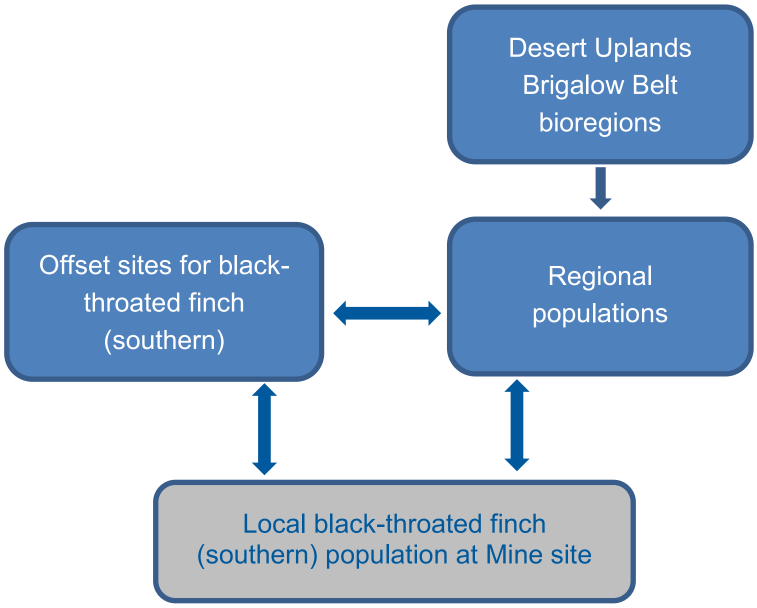
The highest numbers of black-throated finch are consistently recorded in mosaics of the intact remnant vegetation dominated by ironbark *Eucalyptus melanophloia* woodlands (10.5.5) and the associated yellowjack *E. similis* (10.5.1) and box *E. populnea*/*brownii* woodlands (10.3.6/10.3.28). This vegetation in these areas, especially in the north-west, west and south-west, is in particularly good condition due to the low level of artificial watering points, low degree of exotic pasture invasion, the presence of poison bush (*Gastrolobium grandiflora*) which is toxic to cattle, and seemingly has a history of low or light grazing. Many grass species that are considered 'decreasers' (i.e. vulnerable to disappear due to cattle grazing) are diverse and of a high cover abundance in these areas (e.g. *Alloteropsis*, *Triodia*, *Digitaria*, *Enteropogon*, *Eriachne*, *Panicum* which are considered preferred food sources for the black-throated finch). In many sites, where black-throated finch were absent (despite the vegetation type being suitable) the influx of exotic pastures (buffel grass, Indian couch, *Stylosanthes*) was high and there was evidence of heavy grazing and low grass diversity. The reduction and removal of cattle grazing will be a significant management action, in addition to ecologically sensible fire regimes, and the protection of natural water sources and the provision of raised water troughs, which will also control feral animal abundance.

To inform the development of the black-throated finch (southern) species 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
- The management of areas for biodiversity onsite (in the Mine Area) and in the Mine (Offsite) area (in offset areas) contributes to the recovery actions for the black-throated finch (southern)

Key components of the species management plan will be the development and application of adaptive monitoring program to inform management. The concept of adaptive monitoring has four key elements: (i) the requirement to pose tractable (flexible and evolving) questions; (ii) the need to employ a statistical design at the outset; (iii) the use of a conceptual model of the ecosystem or entity being examined; and (iv) acknowledgment that land managers need to know about ecosystem change. Monitoring that addresses questions of spatial scale which will be important in designing effective management and mitigation actions, namely (i) are the finches sedentary in this area, (ii) are the finches locally migratory or (iii) are the finches regionally migratory in the wider area (Figure 19). As such, there are four components of the monitoring program that address these questions as well as providing contextual life history and ecology information that can be used to provide management and mitigation actions.

Figure 19 Model of the spatial relationships between the components of the monitoring program



Regional distribution (species distribution modelling): The intent of this component of the monitoring program is to review all records in the region (Einasleigh Uplands and Desert Uplands) and refine a habitat and distribution model using a combination of expert opinion and temporal and spatial species distribution models.

Regional distribution (surveys): The aim of this component of the monitoring program is to undertake systematic surveys in the adjacent Desert Uplands, Einasleigh Uplands and perhaps Northern Brigalow Belt regions in order to understand the regional distribution of the black-throated finch (southern).

Local monitoring (observational) on the Mine Area: The aim of this component of the monitoring is to undertake repeated and systematic surveys of black-throated finch (southern) distribution and habitat at the Mine Area to collect more detailed data regarding (i) habitat preferences, local habitat use (i.e. hotspots), preferred habitat structure and vegetation composition, diet, nesting sites and reliance on mixed species flocks, (ii) temporal variation in habitat use, (iii) coarse population estimates and any spatial and temporal variation in numbers, and (iv) response to existing land management effects (i.e. grazing, fire, weeds, water array).

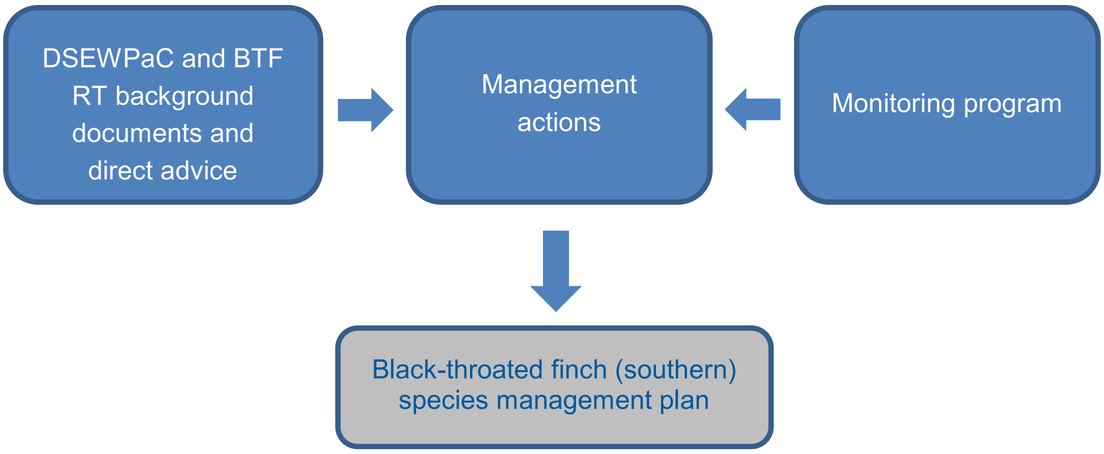
Local monitoring (detailed) on the Mine Area: The aim of this component of the monitoring is to undertake detailed surveys of black-throated finch (southern) habitat use, home range sizes, fine scale distribution changes over seasons, the genetic status of the local population and physiological health of the black-throated finch (southern) populations over time and especially in times of resource bottlenecks.

4.4.9 Recovery plans, conservation advice and threat abatement plans

Management and monitoring of impacts to the black-throated finch (southern) will 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 monitoring program, as described above, will be developed and implemented in consultation with relevant stakeholders (i.e. Black-throated Finch Recovery Team, Commonwealth and State governments) (Figure 20).

Figure 20 Relationship between expert knowledge, management and monitoring actions for the species management plan



Examples of recovery actions, as documented in the National Recovery Plan for the Black-throated Finch Southern Subspecies (Black-throated Finch Recovery Team, 2007), to be incorporated into the Project Species Specific Management Plan(s) (SEIS Volume 4, Appendix C3, Rail Applications) (Mine and Offsite (offset areas)) for the subspecies, may include:

- Investigating breeding requirements and threats to key breeding areas (Action 1.1)
- Investigating feeding and other habitat requirements (Action 1.2)
- Undertaking targeted surveys (to identify habitat) (Action 2.4)
- Securing selected sites for conservation (Action 3.1)
- Addressing threats on grazing lands (Action 3.2)
- Monitoring management effectiveness (Action 3.3)
- Determining suitability of birds in captivity for a reintroduction project (Action 4.1)

4.4.10 Residual impacts and impact significance

It is recognised that, in spite of the recommended management and mitigation measures, and the active rehabilitation of disturbed areas that will occur through the Mine's operational life, unavoidable loss of fauna habitat will occur. This will include loss of habitat for a number of listed threatened species confirmed present or likely to occur at the Study Area, including black-throated finch (southern).

At a regional level, the contextual losses of potential habitat are summarised in Figure 21 and Table 15.

Table 15 Contextual losses of potential habitat for black-throated finch (southern)

Area of clearing (ha)	Potential habitat –within bioregions (ha)		Percent loss of within bioregions
	Desert Uplands	Brigalow Belt	
9,567	3,598,955	12,684,606	0.16

As shown in Table 15, a total of 16,283,561 ha of potential black-throated finch (southern) habitat is mapped within the Desert Uplands and Brigalow Belt bioregions within which the Project occurs. The area of proposed clearing represents 0.16 percent of the total potential habitat within these bioregions (0.7 percent of the Desert Uplands Bioregion and 0.008 percent of the Brigalow Bioregion).

Based on the currently available information (acquired from desktop and field studies) and in consideration of the Significant Impact Guidelines (DEWHA, 2009a), it is considered that the Study Area, in particular the Mine Study Area, does support 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:

- A geographically distinct regional population, or collection of local populations, or
- A population, or collection of local populations, that occurs within a particular bioregion (DEWHA, 2009b).

Significant impacts to black-throated finch (southern) are predicted to occur as a result of the Project, as it is likely that the Project will:

- Lead to a long-term decrease in the size of an important population of a species
- Reduce the area of occupancy of an important population
- Adversely affect habitat critical to the survival of a species.

LEGEND

Town
Project (Rail)
Rail (West)
Rail (East)
Project (Mine)
Mine (Offsite)
Quarry
Bio Region
Potential Black-Throated Finch (Southern) Habitat - Based on DERM Certified Regional Ecosystems Version 6.1

1:5,150,000 (at A4)
0 20 40 60 80
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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Job Number 41-26422
Revision 2
Date 25-10-2013

Potential Black-Throated Finch Habitat
Bio-Region extent

Figure 21

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, (2007); DNRM: Bioregion, Regional Ecosystems (2011); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Offsite, Quarry (2013). Created by: MS

4.4.11 Offsets

Offset obligations under the EPBC Act are likely to be required for the black-throated finch (southern) for both the Project (Mine) and Project (Rail) areas as follows:

- 9,714 ha for mine impact area (9,551 ha direct and 163 ha high impact subsidence)
- 16 ha for rail impact area.

The total offset requirement for the Project is therefore 9,730 ha.

The availability of suitable habitat for offsets for the species is 95,649 ha; the Project requirement therefore represents approximately 10 percent of this available offset resource.

Residual project impacts on black-throated finch (southern) can therefore be sufficiently offset through the delivery of land-based direct offsets.

The following details will be considered in the provision of these offsets:

- The Revised Project Offset Strategy (SEIS Volume 4, Appendix F) integrates at a landscape scale and forms 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.
- The Revised Project Offset Strategy (SEIS Volume 4, Appendix F) is based on securing 'like for like' habitat. It includes 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 ongoing management.

The monitoring of proposed offset sites for black-throated finch (southern) has commenced with initial surveys of the adjacent Moray Downs and one of the proposed offset properties (October 2013). During those surveys, black-throated finches (southern) were found on one of the proposed offset properties.

4.4.12 Conclusion

The Study Area represents a population of black-throated finch (southern) at the edge of previously known regional extents for the species. Black-throated finch (southern) habitat within the Study Area is currently subject to impact from cattle grazing, introduced grass species, weeds and pest species. Observations during the field surveys also indicate that anthropogenic watering sources can be considered to represent a significant component in the suitability of habitat within the Study Area where natural water sources are generally ephemeral and highly seasonal.

Direct impacts to habitat from construction and operation of the Mine and Rail Project includes the clearing of 9,567 ha of potential habitat, representing 0.16 percent of the total potential habitat for the Desert Uplands and Brigalow Belt bioregions. The area of direct impact has been minimised as far as possible throughout the design and development of the mine plan, resulting in an initial potential impact reduction of some 40 percent.

The 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 Area. Management actions will seek to maintain and, where possible, enhance habitats and populations (e.g. through pest control, provision of water sources, appropriate grazing and fire management) in the indirectly affected parts of the Project Area and adjacent on Moray Downs..

A combination of mitigation and management measures to address residual impacts to individuals of the species will be implemented, to avoid significant impacts to the black-throated finch (southern) and to ensure the long-term viability of the population of black-throated finch (southern) located adjacent to the directly affected Project areas. This includes a range of management measures to address the key threatening processes identify within the black-throated finch (southern) Significant Impact Guidelines (DEWHA, 2009b) and recovery plans and research

As part of the proposed management measures, detailed monitoring and research are proposed, which will significantly increase the current level of information for the black-throated finch (southern) subspecies, particularly within the region.

Through the desktop and field studies undertaken for the Carmichael Coal Mine and Rail EIS and SEIS, Adani has gained a thorough knowledge and understanding of the residual impacts and hence offset obligations under both State and Commonwealth legislation.

Adani believes the residual impacts to the Black-throated finch can be offset within the Galilee Basin Bio-Region and that suitable offset properties exist and can be secured for this purpose. Of the five proposed offset properties listed in the Offsets Strategy (Section 8 of the MNES Report), the Black-throated finch has been confirmed present on one of these. And the other four properties have potentially suitable habitat to support the Black-throated finch. With a thorough understanding of the Black-throated finch’s habitat preferences gained through a series of detailed monitoring programs, Adani has an excellent understanding of the key requirements for this species and hence the ability to identify and confirm suitable offset properties.

4.5 Yakka skink

4.5.1 Ecology and legislation

The yakka skink (*Egernia rugosa*) is a large, strongly built skink that grows up to 40 cm long and is listed as vulnerable under the EPBC Act. The yakka skink is endemic to Queensland where its distribution is highly fragmented, at least partly as a result of land clearing. The majority of populations occur within the Brigalow Belt region. Habitat requirements of the species are poorly known. However, it has been recorded from rocky outcrops, sand plain areas and dense ground vegetation, in association with open dry sclerophyll forest (ironbark) or woodland, brigalow forest and open shrub land.

Within these broader habitat types, the yakka skink is often associated with partly-buried rocks, logs or tree stumps, root cavities and abandoned animal burrows. It is also known to excavate deep burrow systems. The yakka skink can persist in cleared habitats if shelter sites such as raked log piles, deep gullies, tunnel erosion/sinkholes and rabbit warrens are available.

4.5.2 Desktop results

The desktop assessment indicated that a number of EPBC Act listed threatened fauna species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas, including the yakka skink as outlined in Table 16.

Table 16 Yakka skink previously recorded or predicted to occur

Predicted to occur#		Previously recorded*		Recorded at Study Area	
Rail	Mine	Rail	Mine	Rail	Mine
✓	×	×	✓	×	×

The species is considered likely to occur within the Mine Study Area. This likelihood of occurrence ranking is based on distribution, presence of potentially suitable habitat and previous records from the region.

4.5.3 Field survey methodology

Fauna surveys of the Study Area relevant to yakka skink are summarised in Table 17.

Table 17 Field surveys relevant to yakka skink

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Mine Study Area	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Post EIS			
Rail Study Area	Quarries MNES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013

Fauna surveys included targeted active searches for reptiles (including yakka skink) within suitable habitats and according to the following methods, as recommended in the Draft Referral guidelines for the nationally-listed Brigalow Belt reptiles (DSEWPaC, 2011):

- diurnal searches (i.e. searching suitable microhabitats, turning woody debris and rocks, raking the soil surface and leaf litter beneath trees and peeling bark) in suitable habitats to look for reptiles or their sloughs
- spotlighting in suitable habitats across the Study Area between dusk and midnight, targeting water-inundated gilgais, wetlands, riparian habitats and adjacent suitable environments
- comprehensive trapping (including pitfalls, funnel trapping, Elliott trapping) in suitable habitats within the Study Area.

These methods are consistent with the recommendations of the Survey Guidelines for Australia's threatened reptiles (DSEWPaC, 2011).

4.5.4 Field survey results

Although this species is considered likely to occur within the Study Area, field survey efforts targeted for the yakka skink did not detect any individuals within the Study Area. The yakka skink is a cryptic species that generally occurs in low densities, therefore failure to detect its presence is not considered an indication of their absence. Rather, it is considered likely that this species occurs at the Study Area, based on its known distribution; the presence of suitable habitat and the fact that the species has been previously recorded within approximately 50 km of the Study Area (refer). The yakka skink could occur in a variety of habitat types across its range where suitable habitat complexity within ground layer microhabitats is maintained. A number of habitat and vegetation types across the Study Area may provide habitat for the yakka skink. These include, but are not limited to, the following:

- 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
- Eucalypt open woodland with native grass understorey
- Gidgee or mixed acacia woodland, on clay and clay loam plains with sparse shrub layer
- 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

Potential habitat for the yakka skink is presented in Figure 22 and Figure 23 for the Mine Study Area and Rail Study Area respectively.

4.5.5 Status in project area

Important yakka skink populations occur where colonies are identified or within 5 km of known records of the species. With respect to the Significant Impact Guidelines (DEWHA, 2009a), it is not considered that the Study Area supports an 'important population' of the EPBC Act-listed yakka skink, in so much as:

- The species was not detected at the Study Area during targeted surveys

- The Study Area is not considered to constitute habitat for key source populations (breeding/dispersal), especially given the availability of similarly suitable habitat in the surrounding landscape
- The Study Area does not occur at or near the limit of the yakka skink's distributional range

Therefore, 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, 2009a)

Any contiguous patch of vegetation that is suitable for the long-term persistence of a population, or for maintaining genetic diversity across the landscape, is important habitat for the yakka skink. Based on the fact that this species was not detected at the Study Area despite targeted surveys, and that similarly suitable habitat 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 (refer EIS Volume 4 Appendix N Mine Terrestrial Ecology Report, EIS Volume 4 Appendix AA Rail Ecology Report, SEIS Volume 4 Appendix J5 Offsite Infrastructure Ecological Assessment and SEIS Volume 4, Appendix J9, Quarries EPBC Environmental Impact Assessment Review (CDM Smith, 2013) for further discussion on the yakka skink at the Mine Study Area and Rail Study Area).

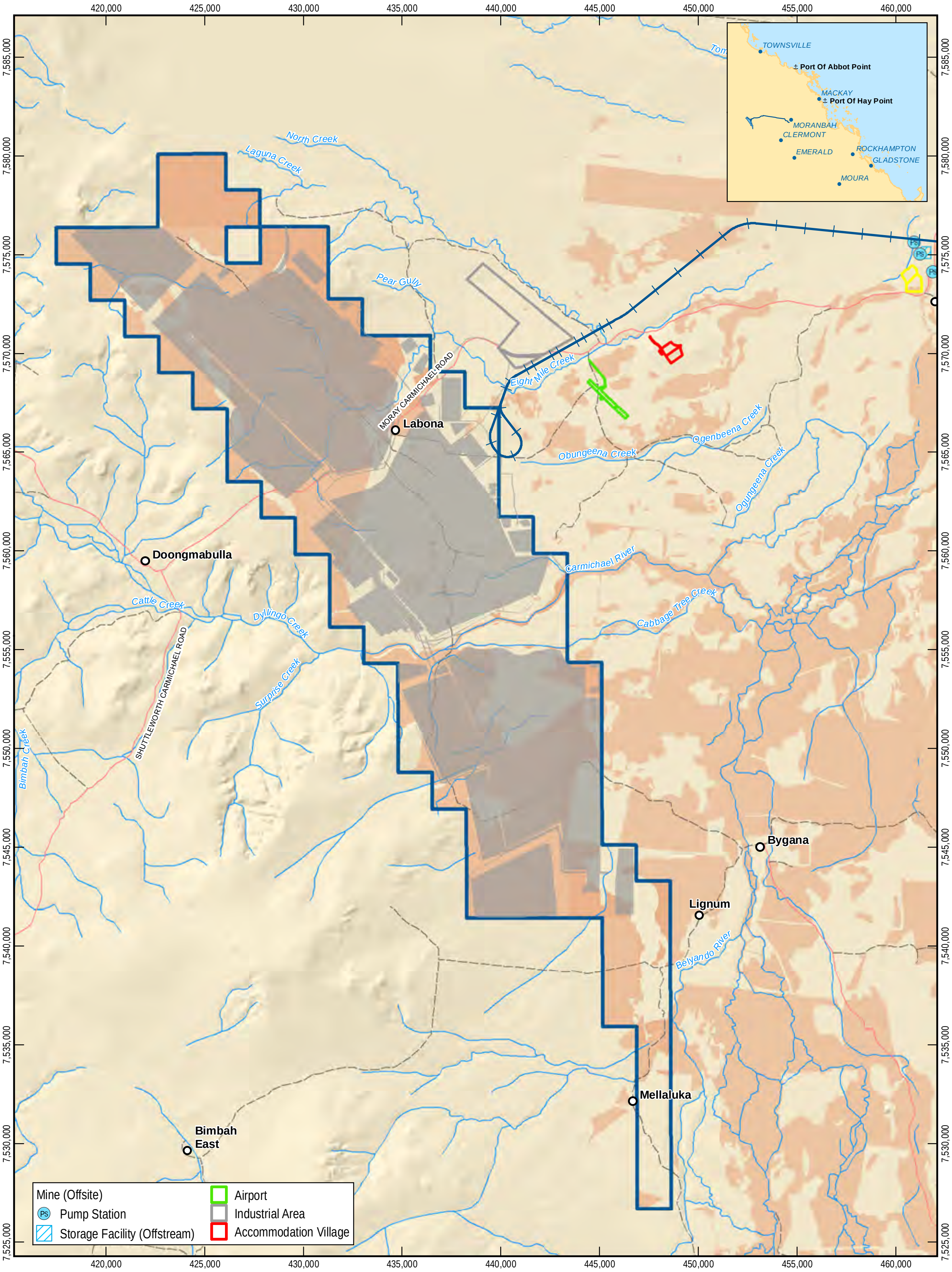
4.5.6 Threatening processes

The yakka skink is threatened by (Richardson 2006):

- habitat loss and degradation due to land clearing and thinning operations, mining, inappropriate roadside management, removal of woody debris and rocks that provide shelter sites, and inappropriate fire regimes
- destruction of burrow systems by the ripping of rabbit warrens or trampling by stock and feral pigs
- predation by cats and foxes

4.5.7 Potential impacts

Impacts to mapped potential habitat for yakka skink are summarised in Table 18. The EPBC Act listed vulnerable yakka skink was not recorded at the Study Area; however, it is considered likely to occur within the Project (Mine) area based on the suitability of habitat, previous records from the region, and the species' known distribution. It has been assessed as a species that may occur within the Project (Rail) area.



LEGEND

Homestead	Potential Yakka Skink Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b and CDM Smith Habitat Suitability	Project (Rail)	Mine (Onsite)
Local Road		Project (Mine)	Quarry
Track			
Watercourse			

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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GHD adani

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Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision C
Date 23-10-2013

Potential yakka skink habitat within the Mine Study Area

Figure 22

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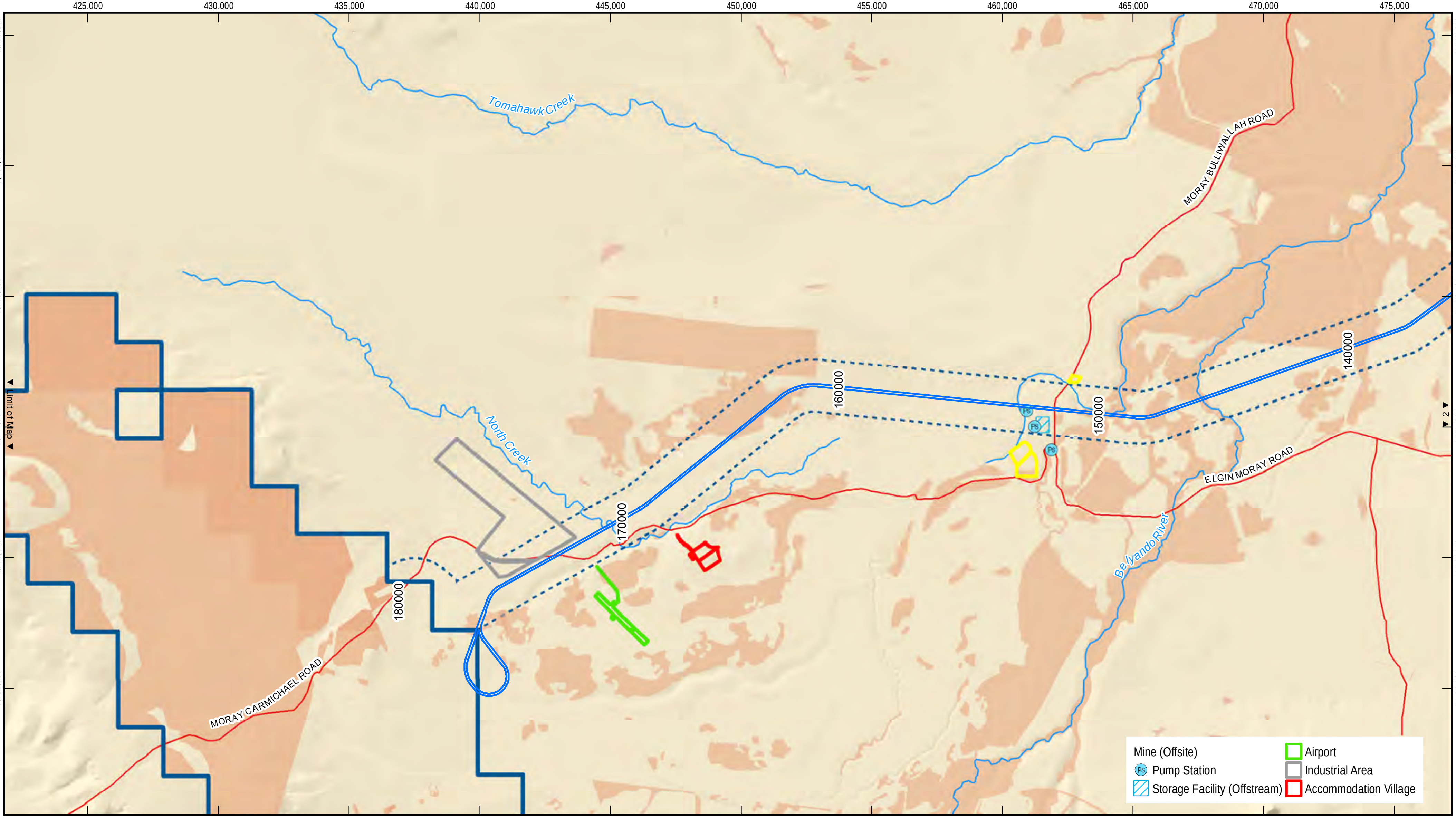
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DNRM: Regional Ecosystems v6.0 (2010); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Mine Offsite, Mine (Onsite), Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); GHD: Potential Habitat (2011). Created by: BW, CA



1:200,000 (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

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Potential Yakka Skink Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b
- Rail (West)
- Rail (East)
- Project (Mine)
- Quarry

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Job Number 41-26422
Revision C
Date 23-10-2013

Potential Yakka Skink Habitat Within Rail Study Area

Figure 23
Sheet 1 of 4

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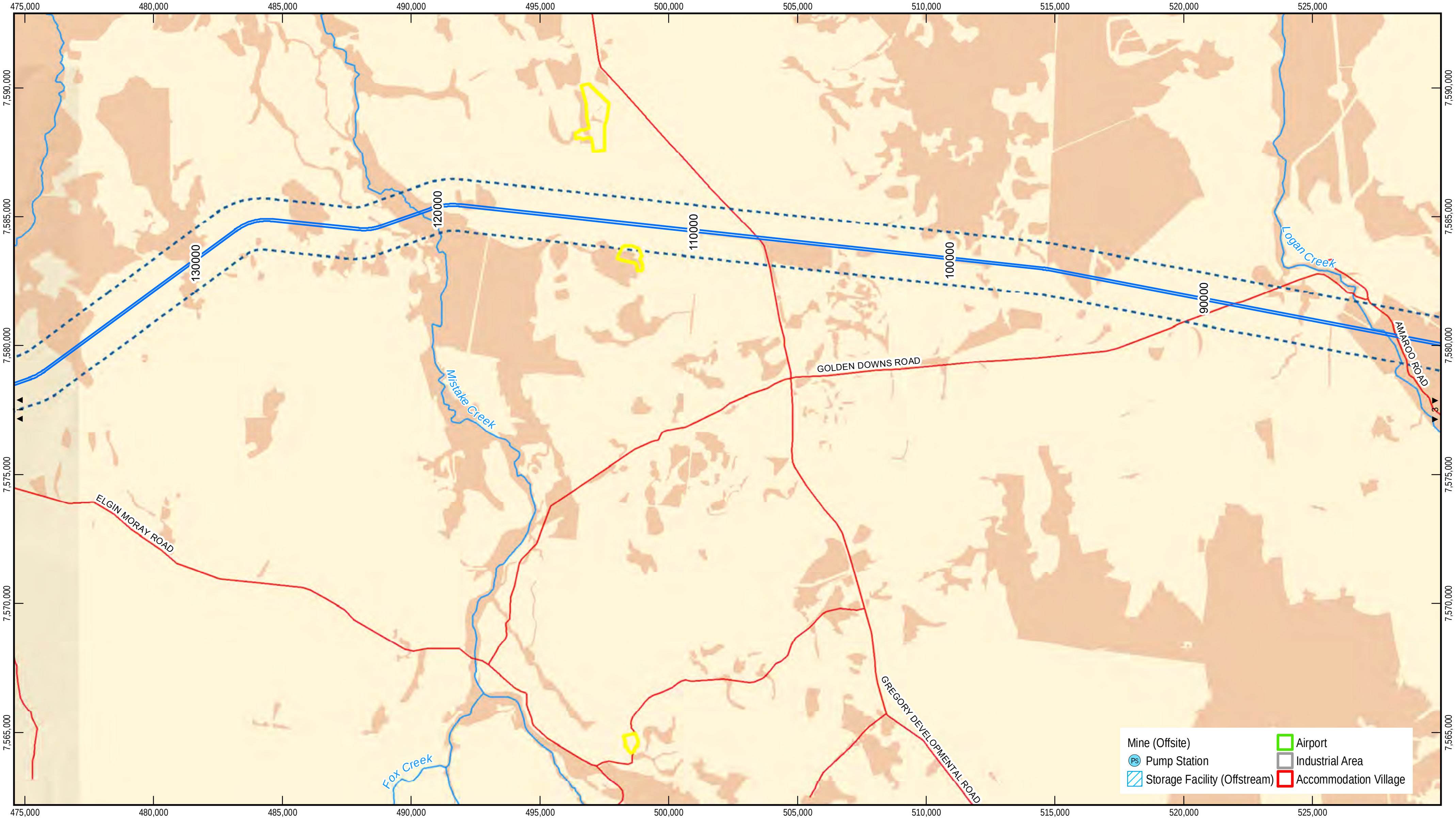
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Yakka Skink Habitat (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES



1:200,000 (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

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Potential Yakka Skink Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b
- Rail (West)
- Rail (East)
- Project (Mine)
- Quarry

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Job Number	41-26422
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Date	23-10-2013

Potential Yakka Skink Habitat Within Rail Study Area

Figure 23
Sheet 2 of 4

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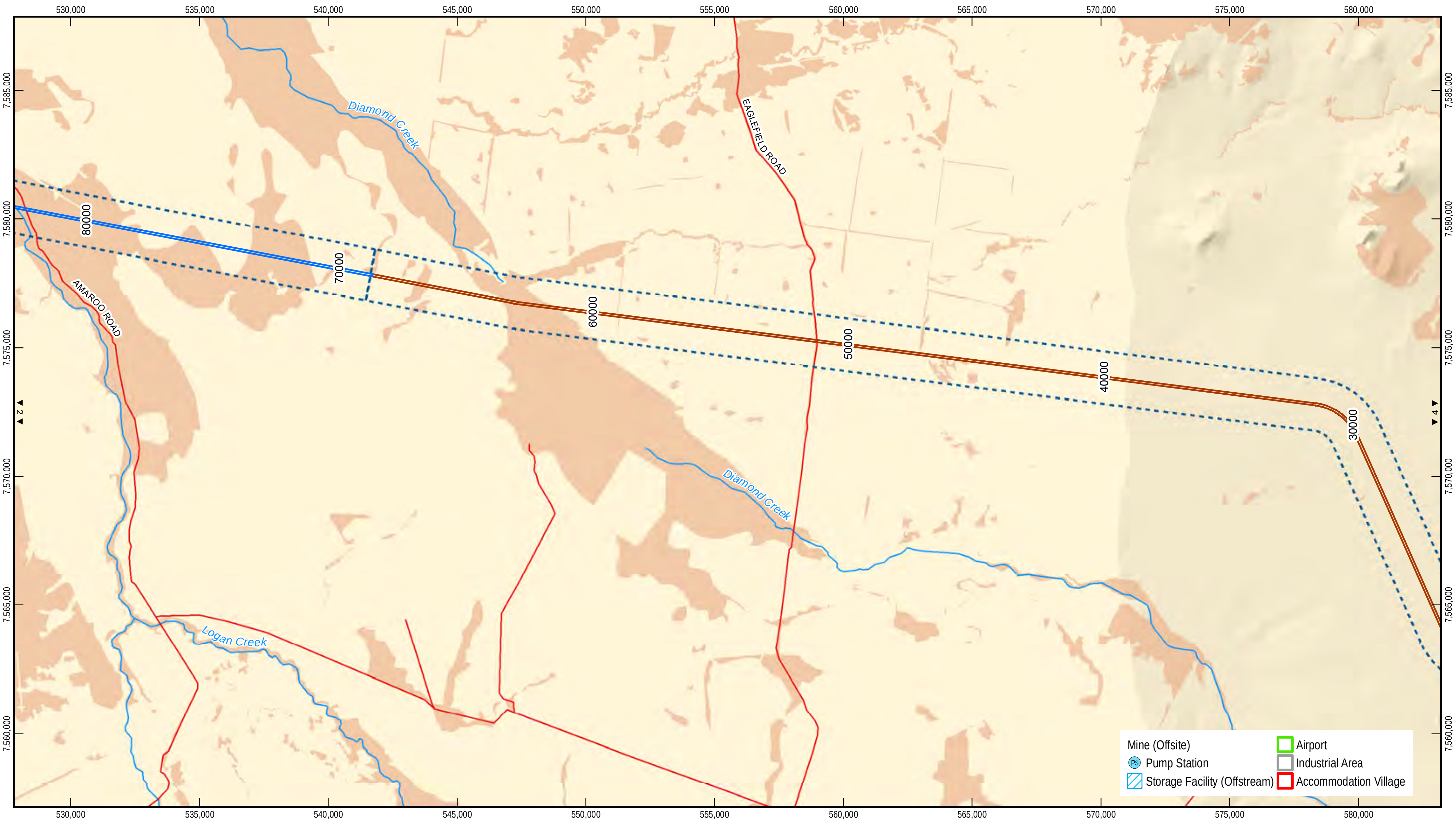
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Yakka Skink Habitat (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES



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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

LEGEND

- Town
- Road
- Other Railway
- Watercourse
- Study Area
- Potential Yakka Skink Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b
- Rail (West)
- Rail (East)
- Project (Mine)
- Quarry

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Potential Yakka Skink Habitat Within Rail Study Area

Job Number	41-26422
Revision	C
Date	23-10-2013

Figure 23
Sheet 3 of 4

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Yakka Skink Habitat (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007);
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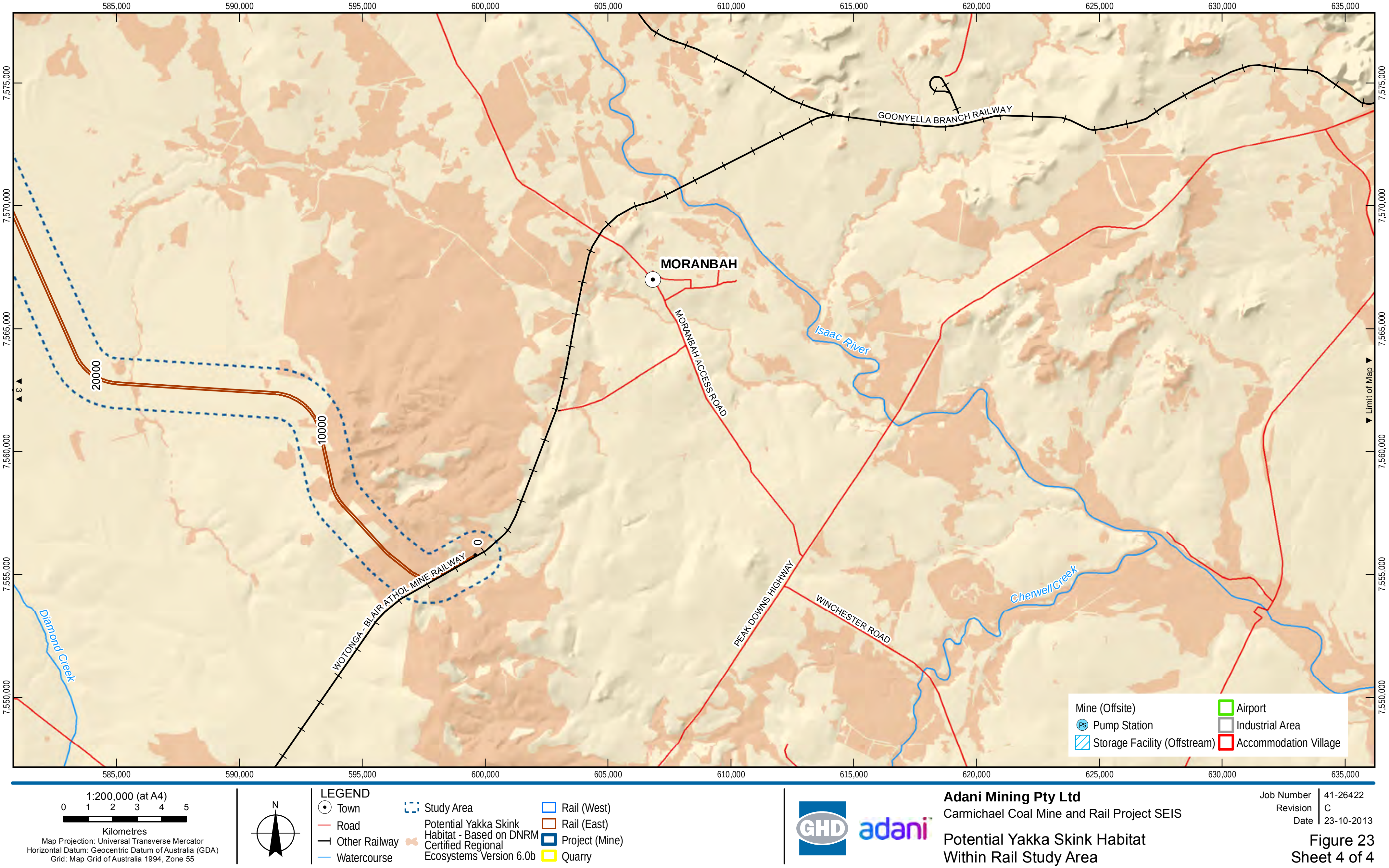

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision C
Date 23-10-2013

Potential Yakka Skink Habitat Within Rail Study Area

Figure 23
Sheet 4 of 4

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Yakka Skink Habitat (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES

Table 18 Impacts to potential habitat for yakka skink

Project Area/Phase	Direct clearing (ha)	Indirect subsidence (ha)	
Rail construction	-		-
Rail impact area	-		-
Mine construction	1,241		-
Mine operation		High impact	162
		Low impact	5,575
Sub total	9,062		*5,737*
Off-site construction	2		-
Mine impact area	10,305		
Project impact area	10,305		5,737
Note: Total clearing extent is based on the broad vegetation community/ fauna habitat types as they apply to each species.			

Habitat loss

An overall reduction in the localised extent of potential habitat for this species will occur as a result of the Project's operation phase. If present, it is possible that the species may disperse away from the developed parts of the Study Area (either temporarily and/or permanently), 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.

Injury or mortality

It is anticipated that fauna mortality will occur, particularly for those cryptic and/or less mobile animals that may not be detected by the fauna spotter-catcher prior to or during vegetation clearing activities. This may therefore affect the yakka skink, if present, which is cryptic, and may be more vulnerable if in torpor at the time of clearance or where located underground.

4.5.8 Management and mitigation measures

The following management and mitigation measures are considered to be those of most relevance to yakka skink, in response to the key threatening processes and predicted impacts identified above:

Habitat loss

The impacts associated with habitat loss have been minimised through the application of the following:

- Phasing: Loss of habitat for the yakka skink is proposed to be staged, in accordance with the staged development of the operational components of the Mine (89 percent of potential habitat loss is associated with mine operation).
- New water sources: The provision and security of surface water throughout the Study Area may provide additional localised access to drinking water for the species (or at least compensate for the loss of surface water resources in nearby parts of the Study Area). Those species with a noted affiliation to water (squatter pigeon (southern), 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, even where this resource is temporary, though the impacts on surface habitat might negate this effect.

- New micro-habitat: 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 ornamental snake and yakka skink.

Habitat fragmentation

Maintenance of fauna corridors will be particularly important to mitigate potential to impact upon not just the ground dwelling species (yakka skink and ornamental snake) but also threatened birds confirmed present or likely to occurring at the site.

Weeds and pests

Waste management, speed limits, fire controls, dust suppression, pest and weed controls, management of sewage and other potentially harmful wastes and pollutants will be utilised onsite to minimise direct or indirect impacts to fauna or pollution of the environment. All environmental controls will be documented within the EMP (construction). Efficacy of management measures will be audited regularly and records maintained to demonstrate compliance.

4.5.9 Recovery plans, conservation advice and threat abatement plans

A recovery plan for the Queensland Brigalow Belt Reptiles, including the yakka skink, was drafted by WWF-Australia in 2006 (Richardson 2006). The mitigation and management measures to be implemented by the Project are consistent with the recovery actions outlined in this plan, as follows:

- The implementation of a Fire Management Plan will contribute to the action ‘implement recommended fire management guidelines in property and reserve designs’.
- The implementation of a Weed and Pest Management Plan will contribute to the actions ‘restrict the use and spread of agricultural weeds, such as buffel grass’, and ‘facilitate on-ground projects to manage and protect habitats on a range of land tenures in line with recommended management guidelines e.g. in integrated weed and feral predator management programs’.

The management of pest species by the Project will be consistent with the threat abatement plans considered to be relevant to yakka skink, namely Threat Abatement Plan for predation by Feral Cats (DEWHA 2008zzp), Threat Abatement Plan for predation by the European Red Fox (DEWHA 2008zzq), and Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (AGDEH 2005p).

4.5.10 Residual impacts and impact significance

It is recognised that, in spite of the recommended management and mitigation measures, and the active rehabilitation of disturbed areas that will occur through the Mine’s operational life, unavoidable loss of fauna habitat will occur. This will include loss of habitat for a number of listed threatened species confirmed present or likely to occur at the Study Area, including yakka skink.

It is proposed that targeted additional field studies be undertaken, prior to clearance during the post EIS phase, to determine the presence of individuals, populations/colonies and/or important habitat areas for threatened species not detected during field surveys for the EIS, which are considered likely to occur at the Study Area (i.e. yakka skink). The findings of such studies will be a component of Project Species Specific Management Plan(s) (SEIS Volume 4, Appendix C3, Rail Applications) for these animals, and the outcomes will be directly linked to the Revised Offset Strategy Report (see SEIS Volume 4, Appendix F).

At a regional level, the contextual losses of potential habitat are summarised in Figure 24 and Table 19.

Table 19 Contextual losses of potential yakka skink habitat

Area of clearing (ha)	Potential habitat – within bioregions (ha)		Percent loss of within bioregions
	Desert Uplands	Brigalow Belt	
10,305	1,377,855	14,040,148	0.07

As shown in Table 19 a total of 15,418,003 ha of potential yakka skink habitat is mapped within the Desert Uplands and Brigalow Belt bioregions within which the Project occurs. The area of proposed clearing represents 0.07 percent of the total potential habitat within these bioregions (0.75 percent of the Desert Uplands Bioregion and 0.07 percent of the Brigalow Bioregion).

The yakka skink present within the Study Area do not comprise an (or part of an) important population of the species, nor does the habitat represent habitat critical to the survival of the species. As a result, no significant impacts to the yakka skink are predicted to occur, as the Project will not:

- Lead to a long-term decrease in the size of, reduce the area of occupancy of, fragment, or disrupt the breeding cycle of an important population
- Adversely affect, modify or destroy the availability or quality of habitat critical to the survival of the species
- Result in the establishment of invasive species or disease to habitat critical to the survival of, or otherwise interfere with the recovery of, the species.

4.5.11 Offsets

As no significant impacts to the yakka skink are predicted, offsets under the EPBC Act will not be required.

4.5.12 Conclusion

No significant impacts to the yakka skink are predicted. A combination of mitigation and management measures to address inevitable residual impacts to individuals of the species potentially present will be implemented.

LEGEND

- Town
- Project (Mine)
- Bio Region
- Project (Rail)
- Mine (Offsite)
- Yakka Skink Habitat - Based on DNRM Certified Regional Ecosystems Version 6.1
- Rail (West)
- Quarry
- Rail (East)

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1:5,150,000 (at A4)

0 20 40 60 80

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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Yakka Skink Habitat
Bio-Region extent

Job Number	41-26422
Revision	2
Date	23-10-2013

Figure 24

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, (2007); DNRM: Bioregion, Regional Ecosystems (2011); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Offsite, Quarry (2013). Created by: MS

4.6 Ornamental snake

4.6.1 Ecology and legislation

The ornamental snake is listed as vulnerable under the EPBC Act. The species occurs in the Brigalow Belt bioregion, where the majority of natural vegetation has been cleared for agriculture, mining and urban development, and has been degraded by overgrazing by stock. This has resulted in a decline in abundance in the past few decades (Cogger et al., 1993). The ornamental snake was predicted to occur within the Mine and Rail Study Areas. However, this cryptic species was not recorded in surveys for the EIS.

The ornamental snake is primarily associated with cracking clay soils. Ornamental snakes are nocturnally active, sheltering during the day under fallen timber, rocks, bark and in deep soil cracks. The species is probably active year round with the exception of the cooler months, with peak activity likely to be early summer through to the wet season. During dry times, the snake can remain inactive in suitable shelter sites for months (DSEWPaC, 2013e).

The ornamental snake prefers habitat within, or close to, habitat that is favoured by its prey (namely frogs). Preferred habitat includes woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions in Queensland RE land zone 4 (DSEWPaC, 2013e). The most common habitat of ornamental snake is brigalow, gidgee, blackwood or coolabah dominated vegetation communities, or pure grasslands associated with gilgais (DSEWPaC, 2013e).

4.6.2 Desktop results

The desktop assessment indicated that a number of EPBC Act listed threatened fauna species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas, including the ornamental snake as summarised in Table 20.

Table 20 Ornamental snake previously recorded or predicted to occur

Predicted to occur#		Previously recorded*		Recorded at Study Area	
Rail	Mine	Rail	Mine	Rail	Mine
✓	✓	✓	✓	✓	✓

4.6.3 Field survey methodology

The fauna surveys of the Study Area relevant to ornamental snake are summarised in Table 21:

Table 21 Field surveys relevant to ornamental snake

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Mine Study Area	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Post EIS			
Rail Study Area	Quarries MNES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013

Fauna surveys included targeted active searches for reptiles (including ornamental snake) within suitable habitats and according to the following methods, as recommended in the Draft Referral guidelines for the nationally-listed Brigalow Belt reptiles (DSEWPaC, 2011):

- diurnal searches (i.e. searching suitable microhabitats, turning woody debris and rocks, raking the soil surface and leaf litter beneath trees and peeling bark) in suitable habitats to look for reptiles or their sloughs
- spotlighting in suitable habitats across the Study Area between dusk and midnight, targeting water-inundated gilgais, wetlands, riparian habitats and adjacent suitable environments
- comprehensive trapping (including pitfalls, funnel trapping, Elliott trapping) in suitable habitats within the Study Area.

These methods are consistent with the recommendations of the Survey Guidelines for Australia's threatened reptiles (DSEWPaC, 2011).

4.6.4 Field survey results

REs from which this species is most commonly recorded in Queensland that are mapped within the Study Area include:

- RE 11.4.6 *Acacia cambagei* woodland on Cainozoic clay plains
- RE 11.4.8 *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
- RE 11.4.9 *Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains
- RE 11.3.3 *Eucalyptus coolabah* woodland on alluvial plains

During SEIS field works, two ornamental snakes were recorded from separate locations within the Mine (Offsite) Area during additional surveys undertaken for the SEIS (GHD, 2013). One individual was observed foraging within a patch of open woodland habitat that contained small amounts of brigalow. The other individual was found sheltering beneath fallen woody debris within a small, isolated patch of relatively high quality brigalow (Plate 9). Both individuals were found in active searches, one nocturnal and one diurnal.

In addition, two ornamental snakes were also observed at Borrow 7 and Moray Quarry during the 2013 quarry surveys (SEIS, Volume 4, Appendix J9 Quarry EPBC Impact Assessment Review).

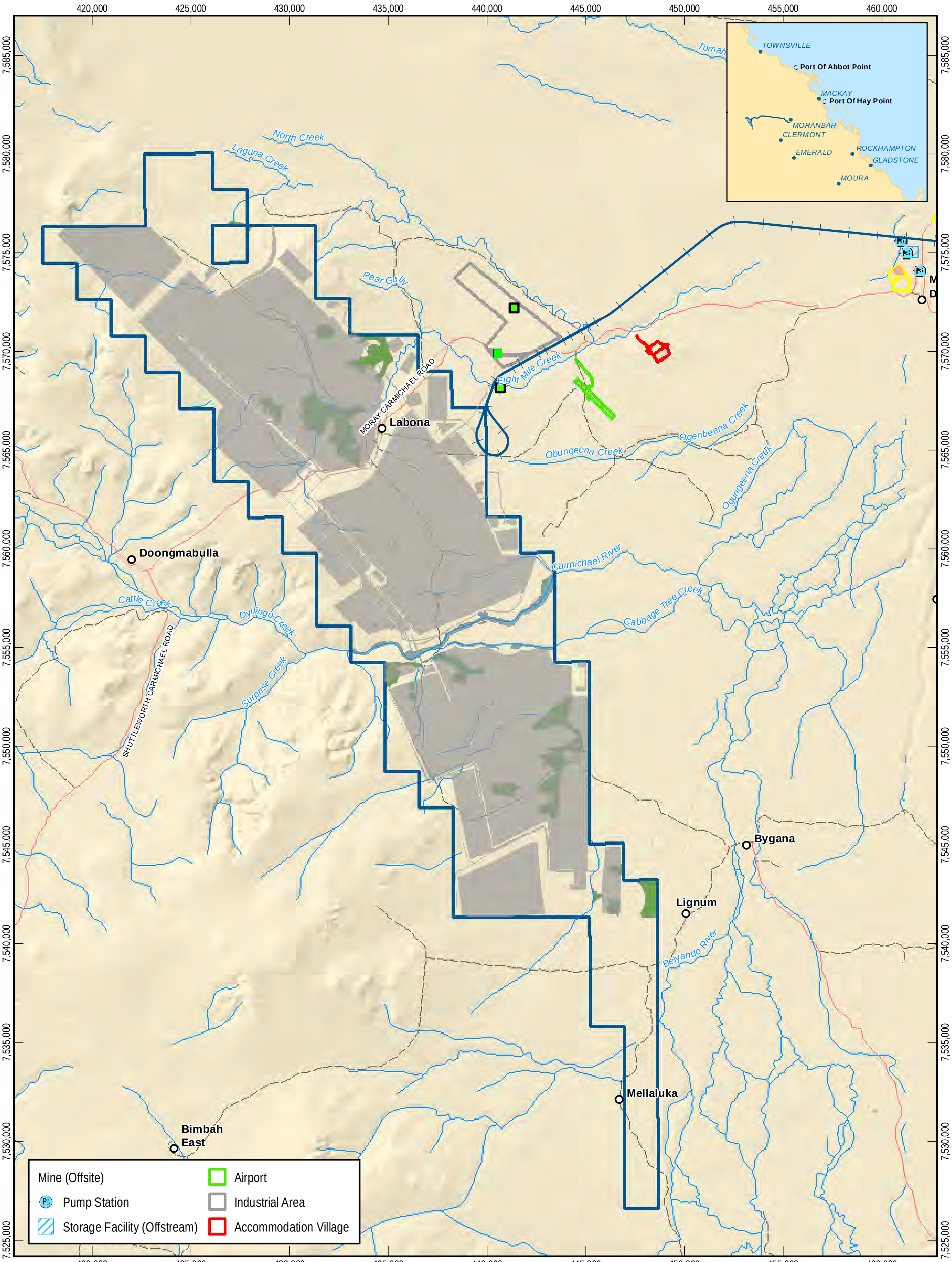
The ornamental snake was not recorded during field survey events for the Mine Study Area. However, this species is considered likely to occur within these environments, given the prevalence of suitable habitat.

Plate 9 Ornamental snake sightings within Mine (Offsite) Area

A conservative approach has been taken to mapping of potential habitat for this species (Figure 25 and Figure 26). Areas of potential habitat included areas of non-remnant and regrowth vegetation that contain suitable microhabitats (i.e. cracking clay soil with gilgais). The ornamental snake can occur in cleared areas, where suitable REs once occurred (DSEWPaC, 2011d). This is due the strong association between the ornamental snake and gilgais (which remain after vegetation has been cleared). These microhabitat features provide important refuges and foraging habitat for the ornamental snake.

Habitat and vegetation types across the Mine and Rail Study Areas may further provide habitat for the ornamental snake. These include, but are not limited to, the following:

- Eucalypt open woodland with native grass understorey
- Gidgee or mixed acacia woodland, on clay and clay loam plains with sparse shrub layer
- Brigalow shrubby woodland or open forest typically on clay and clay loam plains
- Eucalypt and acacia mixed woodland or forest often on clay soils
- Riparian woodland or forest fringing watercourses, and coolabah open woodland on grassy floodplain often with weedy understorey
- Open forest and woodland fringing watercourses and relict stream channels, and alluvial plains subject to flooding
- Natural and artificial water bodies



LEGEND

- Ornamental snake sightings - autumn 2013
- Ornamental snake sightings (CDM Smith) - 2013
- Homestead
- Local Road
- Track
- Watercourse

Potential Ornamental Snake Habitat Type

- Gidgee and brigalow woodland on clay plains
- Open forest and woodland fringing streams and on flood plains
- Habitat Suitability (CDM Smith)
- Project (Rail)
- Project (Mine)
- Mine (Onsite)
- Quarry

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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

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GHD adani

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Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	C
Date	05-11-2013

Ornamental snake sightings and potential habitat within the Mine Study Area

Figure 25

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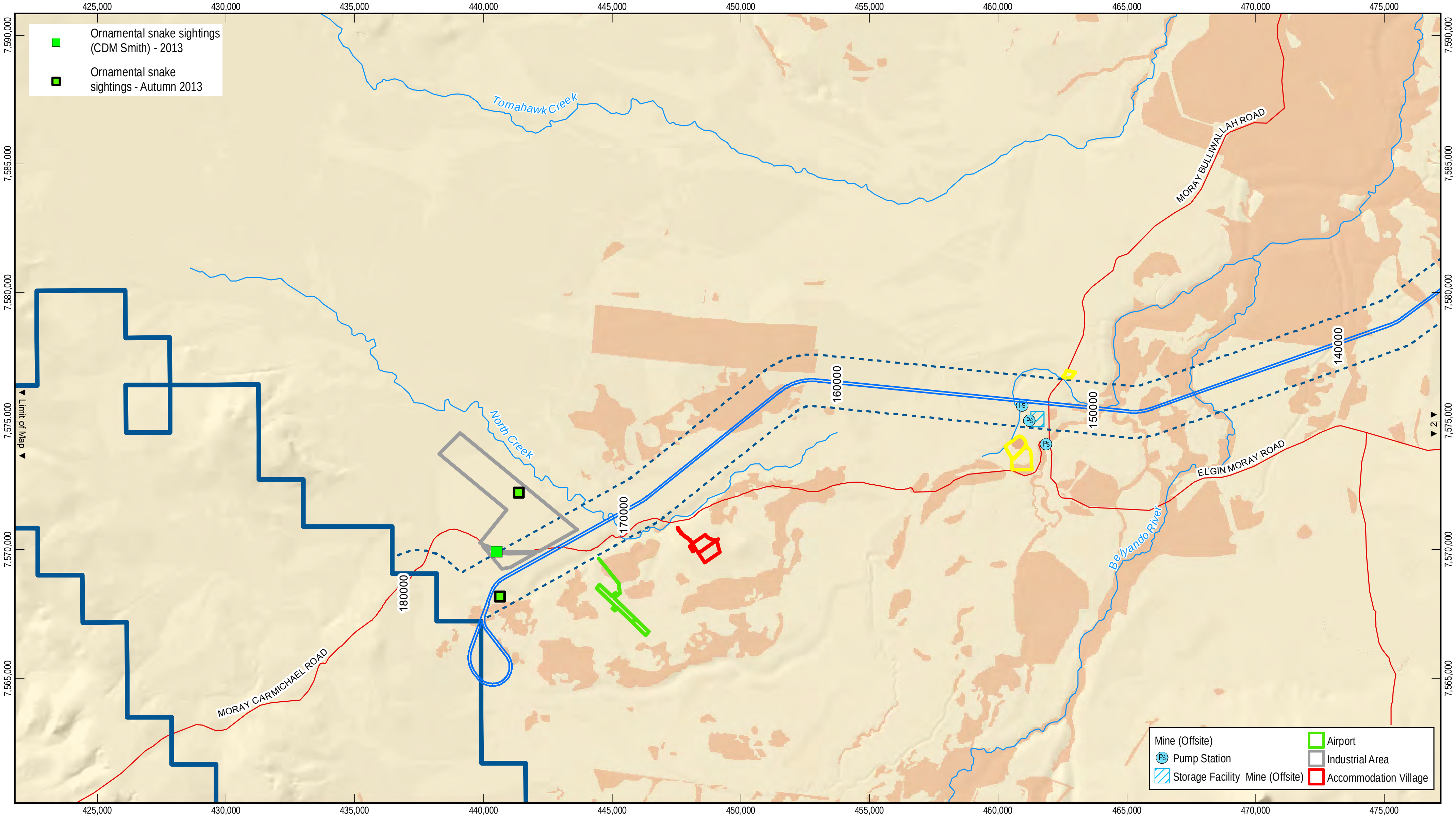
Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013), Facilities, Mine(Onsite) (2013); GHD: Potential Habitat (2011), Confirmed Sightings (2013). Created by: BW, CA



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

N

LEGEND
- Town
- Road
- Other Railway
- Watercourse
- Potential Ornamental Snake Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b
- Study Area
- Quarry
- Rail (West)
- Rail (East)
- Project (Mine)

GHD adani

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Revision	C
Date	05-11-2013

Potential Ornamental Snake Habitat Within the Rail Study Area

Figure 26
Sheet 1 of 4

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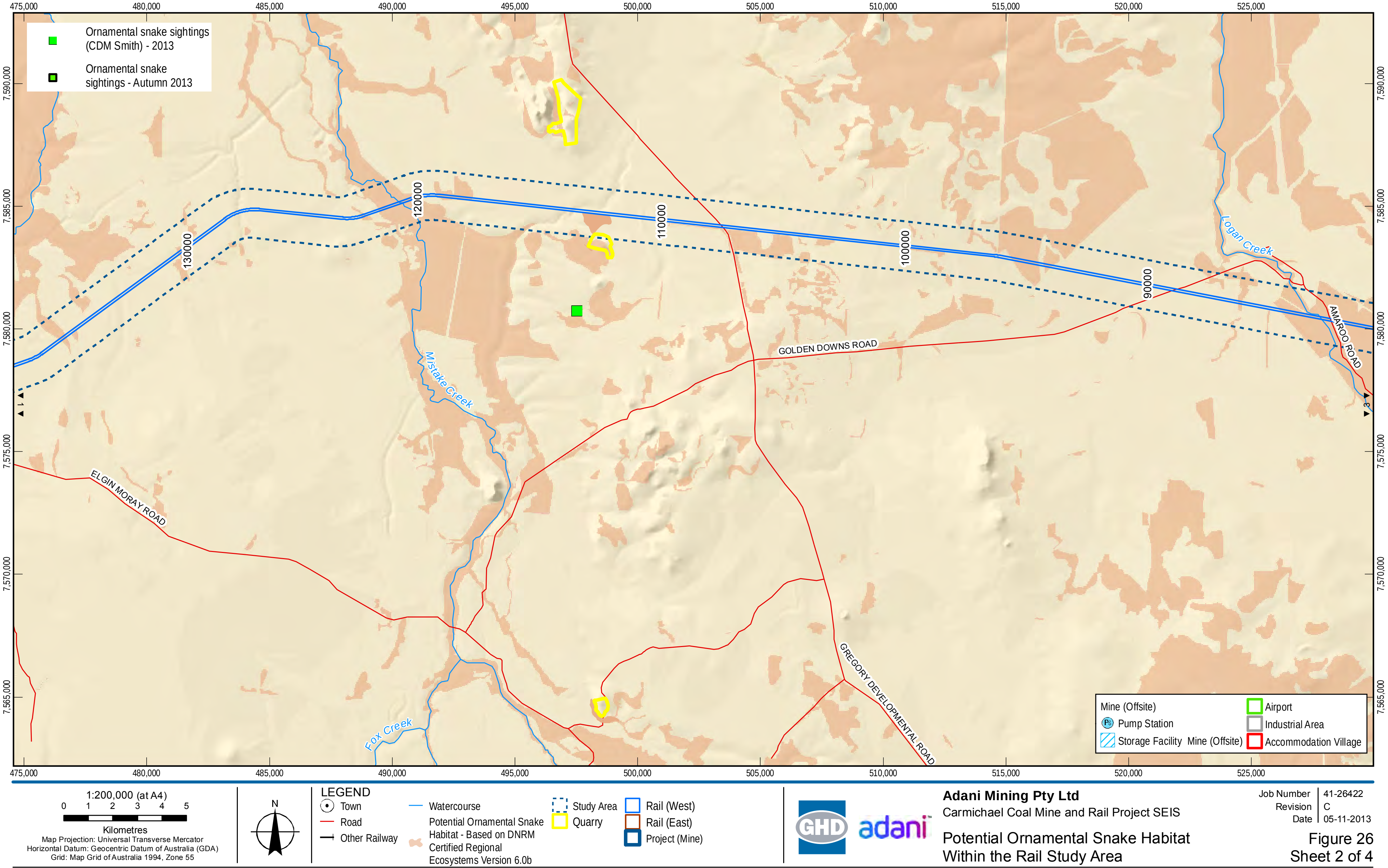
Data source: DNRM: DEM (2008), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Potential Ornamental Snake Habitat (2011); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA



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Job Number 41-26422
Revision C
Date 05-11-2013

Potential Ornamental Snake Habitat Within the Rail Study Area

Figure 26
Sheet 2 of 4

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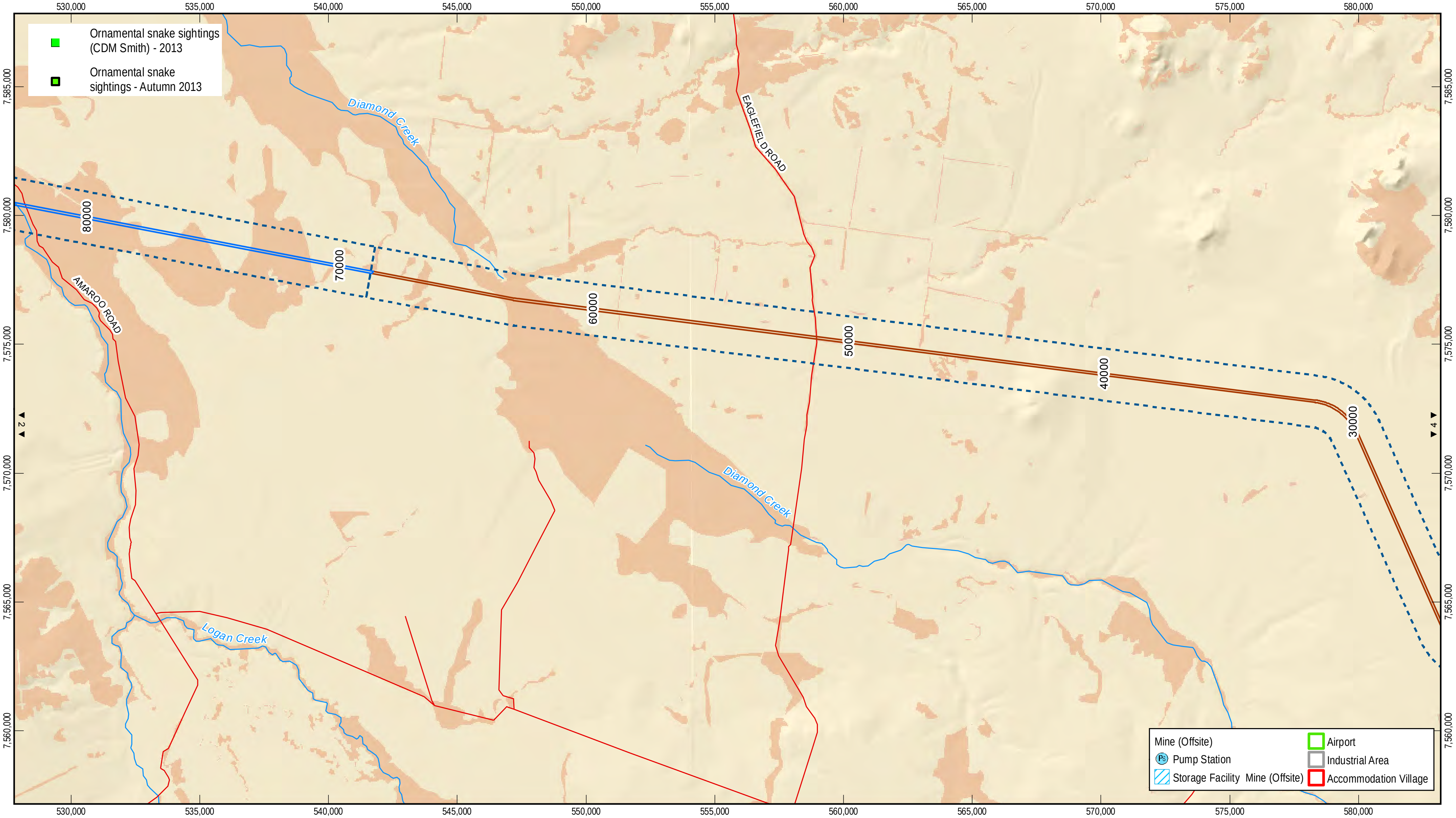
Data source: DNRM: DEM (2008), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); GHD: Potential Ornamental Snake Habitat (2011); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA



1:200,000 (at A4)

Kilometres

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

LEGEND
- Town
- Road
- Other Railway
- Watercourse
- Potential Ornamental Snake Habitat - Based on DNRM Certified Regional Ecosystems Version 6.0b
- Study Area
- Quarry
- Rail (West)
- Rail (East)
- Project (Mine)

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Job Number 41-26422
Revision C
Date 05-11-2013

Potential Ornamental Snake Habitat Within the Rail Study Area

Figure 26
Sheet 3 of 4

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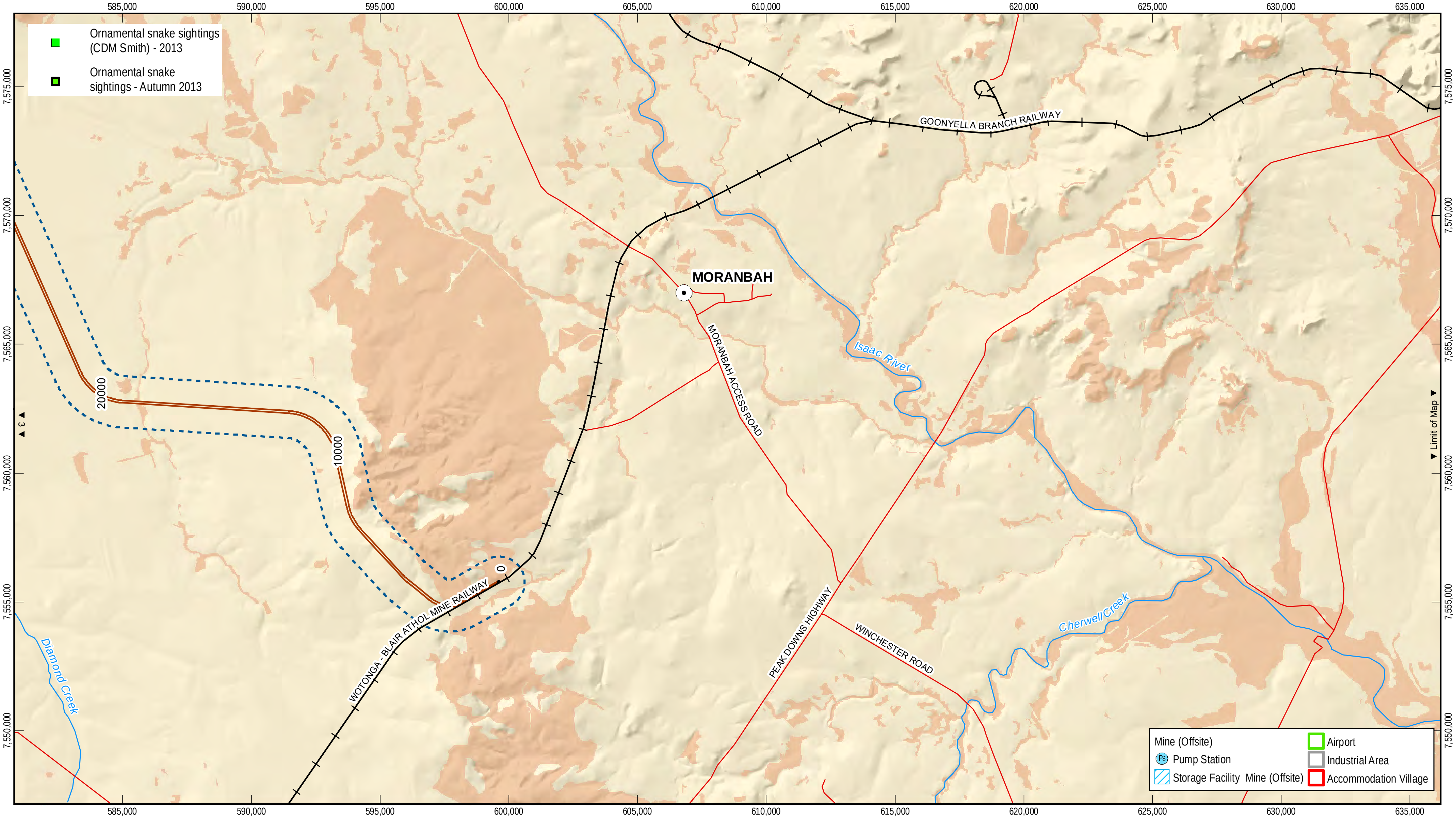

1:200,000 (at A4)

0 1 2 3 4 5

Kilometres

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

LEGEND

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- Study Area
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- Rail (West)
- Rail (East)
- Project (Mine)

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Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision C
Date 05-11-2013

Potential Ornamental Snake Habitat Within the Rail Study Area

Figure 26
Sheet 4 of 4

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Level 9, 145 Ann 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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4.6.5 Status in project area

On-ground assessments of habitat quality were undertaken within areas of mapped potential habitat within the Mine (Offsite) Area that suggest the quality of potential habitats is likely to vary substantially. In general, the quality of areas of non-remnant vegetation containing gilgais is expected to be very low, compared with areas of suitable RE. Factors that are likely to reduce the value of habitats for the ornamental snake include the degradation or alteration of gilgais by cattle and land clearing. These are important for providing foraging habitat. One of the main limiting factors determining the utilisation of potentially suitable habitat by the ornamental snake 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).

Important populations of the ornamental snake occur in remnant vegetation on, or surrounding, gilgai mounds and depressions. With respect to the Significant Impact Guidelines (DEWHA, 2009a), it is not considered that the Mine or Rail Study Areas supports an ‘important population’ of the ornamental snake as:

- The snake was recorded from two locations within the Mine (Offsite) Area and two of the quarries within the Rail Study Area, but not from the Mine Study Area despite targeted surveys
- The Study Area is not considered to constitute habitat for key source populations (breeding/dispersal), especially given the availability of similarly suitable habitat in the surrounding landscape
- The Study Area does not occur at or near the limit of the ornamental snake distributional range

Despite being recorded within the Study Area, the ornamental snake is 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, 2009a)

Based on the fact that suitable habitat for this 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’.

4.6.6 Threatening processes

The ornamental snake has undergone a decline in abundance in the past few decades. There are a variety of factors that are possibly contributing to this decline, including (Brigalow Belt Reptiles Workshop 2010; Cogger et al. 1993):

- Habitat loss through clearing (roads, ploughing, railways, mining-related activities, pipeline constructions)
- Habitat fragmentation
- Habitat degradation by overgrazing by stock, especially cattle, or grazing of gilgais during the wet season leads to soil compaction and compromising of soil structure

- Alteration of landscape hydrology in and around gilgai environments
- Alteration of water quality through chemical and sediment pollution of wet areas
- Contact with the cane toad
- Predation by feral species
- Invasive weeds

4.6.7 Potential impacts

Impacts to mapped potential habitat for ornamental snake are summarised in Table 22.

Table 22 Impacts to potential habitat for ornamental snake

Project Area/Phase	Direct clearing (ha)	Indirect subsidence (ha)	
Rail construction	350		-
Rail impact area	350		-
Mine construction	56		-
Mine operation			
		High impact	-
		Low impact	3
Sub total	*903*		*3*
Off-site construction	314		-
Mine impact area	960		
Project impact area	**1,624**		**3**
Note: Total clearing extent is based on the broad vegetation community/ fauna habitat types as they apply to each species.			

Habitat loss

An overall reduction in the localised extent of potential habitat for this species is proposed to occur primarily as a result of the Project’s operation phase. It is possible that the species may disperse away from the developed parts of the Study Area (either temporarily and/or permanently), 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.

Injury or mortality

It is anticipated that fauna mortality will occur, particularly for those cryptic and/or less mobile animals that may not be detected by the fauna spotter-catcher prior to or during vegetation clearing activities. This may therefore affect ornamental snake, which is cryptic and may be more vulnerable if in torpor at the time of clearance or where located underground.

4.6.8 Management and mitigation measures

The following management and mitigation measures are considered to be those of most relevance to ornamental snake, in response to the key threatening processes and predicted impacts identified above:

Habitat loss

The impacts associated with habitat loss have been minimised through the application of the following:

- Phasing: Loss of habitat for the ornamental snake is proposed to be staged, in accordance with the staged development of the operational components of the Mine (67 percent of potential habitat loss is associated with mine operation).
- New water sources: The provision and security of surface water throughout the Study Area may provide additional localised access to drinking water for the species (or at least compensate for the loss of surface water resources in nearby parts of the Study Area). Those species with a noted affiliation to water (squatter pigeon (southern), 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, even where this resource is temporary, though the impacts on surface habitat might negate this effect.
- New micro-habitat: 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 ornamental snake and yakka skink.

Habitat fragmentation

Maintenance of fauna corridors will be particularly important to mitigate potential to impact upon not just the ground dwelling species (yakka skink and ornamental snake) but also threatened birds confirmed present or likely to occurring at the site.

Changes to hydrology

Water recycling to supplement base flows in the Carmichael River during dry periods will be conducted in accordance with procedures outlined in the Water Balance Report (SEIS Volume 4 Appendix K2). This will see excess and treated water reintroduced to the river near the western Mine Area boundary, with due consideration to water quality. The intent is that this water will be introduced to the channel in a ‘gaining’ section of the river, where it will remain in the channel and thus contribute to base flows downstream.

Weeds, pests and fire risk

Waste management, speed limits, fire controls, dust suppression, pest and weed controls, management of sewage and other potentially harmful wastes and pollutants will be utilised onsite to minimise direct or indirect impacts to fauna or pollution of the environment. All environmental controls will be documented within the EMP (construction). Efficacy of management measures will be audited regularly and records maintained to demonstrate compliance.

4.6.9 Recovery plans, conservation advice and threat abatement plans

A recovery plan for the Queensland Brigalow Belt Reptiles, including the ornamental snake, was drafted by WWF-Australia in 2006 (Richardson 2006). The mitigation and management measures to be implemented by the Project are consistent with the recovery actions outlined in this plan, as follows:

- The implementation of a Fire Management Plan will contribute to the action ‘implement recommended fire management guidelines in property and reserve designs’.

- The implementation of a Weed and Pest Management Plan will contribute to the actions 'restrict the use and spread of agricultural weeds, such as buffel grass', and 'facilitate on-ground projects to manage and protect habitats on a range of land tenures in line with recommended management guidelines e.g. in integrated weed and feral predator management programs'.

The management of pest species by the Project will be consistent with the threat abatement plans considered to be relevant to ornamental snake, namely Threat Abatement Plan for predation by Feral Cats (DEWHA 2008zzp), Threat Abatement Plan for predation by the European Red Fox (DEWHA 2008zzq), and Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs (AGDEH 2005p).

4.6.10 Residual impacts and impact significance

It is recognised that, in spite of the recommended management and mitigation measures, and the active rehabilitation of disturbed areas that will occur through the Mine's operational life, unavoidable loss of fauna habitat will occur. This will include loss of habitat for a number of listed threatened species confirmed present or likely to occur at the Study Area, including ornamental snake.

At a regional level, the contextual losses of potential habitat are summarised in Figure 27 and Table 23.

Table 23 Contextual loss of potential habitat for ornamental snake

Area of clearing (ha)	Potential habitat –within bioregions		Percent loss of within bioregions
	Desert Uplands	Brigalow Belt	
1,624	63,019	4,113,439	0.03

As shown in Table 23 a total of 4,176,458 ha of potential ornamental snake habitat is mapped within the Desert Uplands and Brigalow Belt bioregions within which the Project occurs. The area of proposed clearing represents 0.03 percent of the total potential habitat within these bioregions (2.07 percent of the Desert Uplands Bioregion and 0.32 percent of the Brigalow Bioregion).

The ornamental snake present within the Study Area do not comprise an (or part of an) important population of the species, nor does the habitat represent habitat critical to the survival of the species. As a result, no significant impacts to the ornamental snake are predicted to occur, as the Project will not:

- Lead to a long-term decrease in the size of, reduce the area of occupancy of, fragment, or disrupt the breeding cycle of an important population
- Adversely affect, modify or destroy the availability or quality of habitat critical to the survival of the species
- Result in the establishment of invasive species or disease to habitat critical to the survival of, or otherwise interfere with the recovery of, the species.

LEGEND

- Town
- Project (Rail)
- Rail (West)
- Rail (East)
- Project (Mine)
- Mine (Offsite)
- Quarry
- Bio Region
- Ornamental Snake Habitat - Based on DNRM Certified Regional Ecosystems Version 6.1

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:5,150,000 (at A4)

0 20 40 60 80

Kilometres

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

N

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Ornamental Snake Habitat
Bio-Region extent

Job Number	41-26422
Revision	2
Date	05-11-2013

Figure 27

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, (2007); DNRM: Bioregion, Regional Ecosystems (2011); Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Offsite, Quarry (2013). Created by: MS

4.6.11 Offsets

As no significant impacts to the ornamental snake are predicted, offsets under the EPBC Act will not be required.

4.6.12 Conclusion

As no significant impacts to the ornamental snake are predicted. A combination of mitigation and management measures to address inevitable residual impacts to individuals of the species will be implemented. Brigalow

4.7 Brigalow TEC

4.7.1 Ecology and legislation

The Brigalow TEC is listed as endangered under the EPBC Act and comprises vegetation communities dominated or co-dominated by brigalow (*Acacia harpophylla*). Within Queensland, 16 REs are described as forming part of this TEC. All of these REs are located in the Brigalow Belt, the South-East Queensland or the Mulga Lands bioregions; none are located in the Desert Uplands.

The listed ecological community is characterised by the presence of brigalow as one of the three most abundant tree species (Butler 2007). Brigalow is usually either dominant in the tree layer or co-dominant with other species such as *Casuarina cristata* (belah), other species of *Acacia*, or species of *Eucalyptus*. Occasionally belah, or species or *Acacia* or *Eucalyptus* may be more common than brigalow within the broad matrix of brigalow vegetation. The structure of the vegetation ranges from open forest to open woodland. The height of the tree layer varies from about 9 m in low rainfall areas (averaging around 500 mm per annum) to around 25 m in higher rainfall areas (averaging around 750 mm per annum) (Butler 2007). A prominent shrub layer is usually present.

4.7.2 Desktop results

Four TECs listed under the EPBC Act were identified as having potential to occur in the Study Area from desktop results, including brigalow (*Acacia harpophylla* dominant and co-dominant).

4.7.3 Field survey methodology

Flora surveys of the Study Area relevant to Brigalow TEC are summarised in Table 24. Flora survey efforts employed standardised approaches recognised by regulatory agencies for describing the existing floristic environment and to inform the presence of any protected species. The assessments conducted identified whether EPBC Act protected taxa were present, and whether the constituent REs of TECs occurred.

Table 24 Flora surveys relevant to Brigalow TEC

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic flora	24 sites, 3 sites 24 sites, 1 site	Autumn: May 2011 Spring: September 2011

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
Rail Study Area	Assessments for Property Maps of Assessable Vegetation	Various sites along corridor	Winter: June/July 2012
Mine Study Area	Terrestrial and aquatic flora	60 sites, 19 sites 168 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Mine Study Area	Doongmabulla and Mellaluka Springs survey	Unstructured opportunistic survey effort	Autumn: May 2012
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Post EIS			
Rail Study Area	Quarries MNES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Mine Study Area	Doongmabulla and Mellaluka Springs survey	Unstructured opportunistic survey effort	Autumn: May 2012 Autumn: March/April 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013
Offsite Infrastructure Area	BioCondition	10 sites	Autumn: April/May 2013
Offsite Infrastructure Area	PVMP and PMAV	49 flora sites	Autumn: April/May 2013

4.7.4 Field survey results

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 636 ha of these REs are present within the Rail Study Area and approximately 270 ha of these REs are present within the Mine Study Area (including approximately 3 ha within the Mine (Offsite) Area). In the Rail Study Area, the majority of this brigalow is located west of Gregory Developmental Road, with several small patches occurring close to Diamond Creek, Mistake Creek and approaching the Belyando River. The distribution of Brigalow TEC within the Study Area and in the context of the wider landscape is presented in Figure 28.

In the Mine Study Area, the majority of this brigalow is located south of the Carmichael River along the eastern boundary of the Study Area at the junction of EPC 1080 and EPC 1690, 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. Within the Mine (Offsite) Area, this TEC occurred in small patches, often in heterogeneous polygons with mixed eucalypt woodland REs and grassland communities. The condition of the TEC within the Study Area was moderate, due to disturbance from cattle grazing, clearing and weed invasion. The distribution of brigalow TEC at the Mine Study Area is presented in Figure 29.

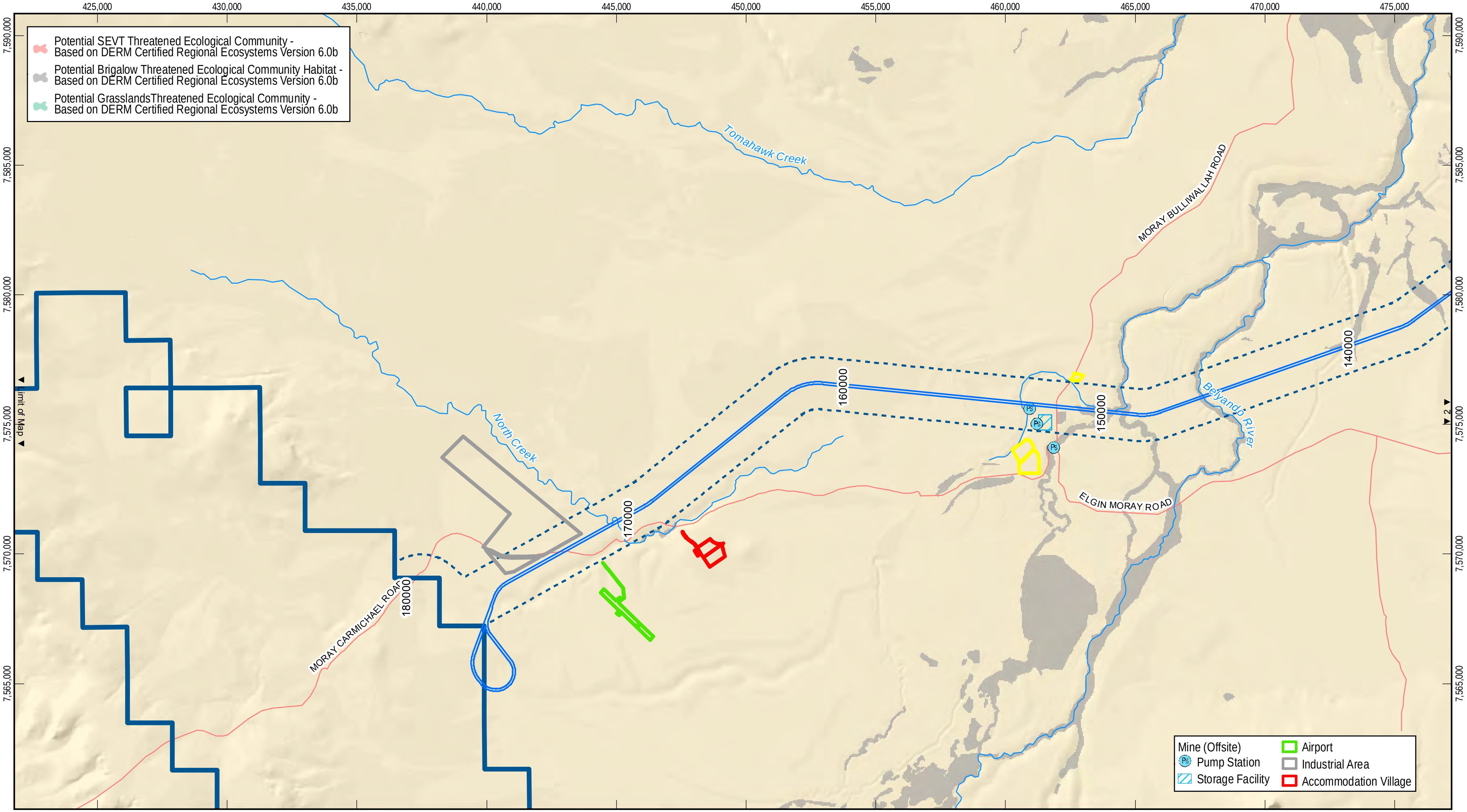
4.7.5 Status in project area

Parts of the Brigalow TEC present within the Project (Mine) Area may be considered to constitute ‘habitat critical to the survival of the community’, where these could represent ‘areas that are necessary for the long-term maintenance of the TEC’. In particular, this may apply to a single large patch of Brigalow TEC that occurs to the south of the Carmichael River, although it is likely that this is made up of a number of mixed RE polygons and is unlikely to comprise TEC vegetation throughout.

Other parts of the TEC present (north of the Carmichael River within the Project (Mine) area and areas present within the Project (Rail) area are unlikely to meet this (and other) criteria listed under the Significant Impact Guidelines for endangered TECs. These are generally much smaller in extent, more substantially fragmented and isolated, and in poorer condition, where subject to edge effects (as a result of their small size) including weed invasion and incursions by cattle where grazing surrounding cleared land.

4.7.6 Threatening processes

Brigalow communities have undergone a severe decline since the 1940s and now occupy 10 percent of their former range (DEH, 2001). The main threatening process is broad scale clearing, which historically has been done to create grasslands for grazing. Broad scale clearing of remnant and regrowth vegetation is now managed through legislation in Queensland. Therefore, the main threatening process for this TEC is legislatively controlled. However, it is unlikely that the Brigalow TEC will recover to its former state, given that the vast majority of the cleared areas where this community dominated are now productive grazing lands.



1:200,000 (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

LEGEND

Town
State Road
Local Road
Other Railway
Watercourse
Study Area
Rail (West)
Rail (East)
Project (Mine)
Quarry

GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Potential threatened ecological communities within the Rail Study Area and surrounding landscape

Job Number | 41-26422
Revision | C
Date | 05-11-2013

Figure 28
Sheet 1 of 4

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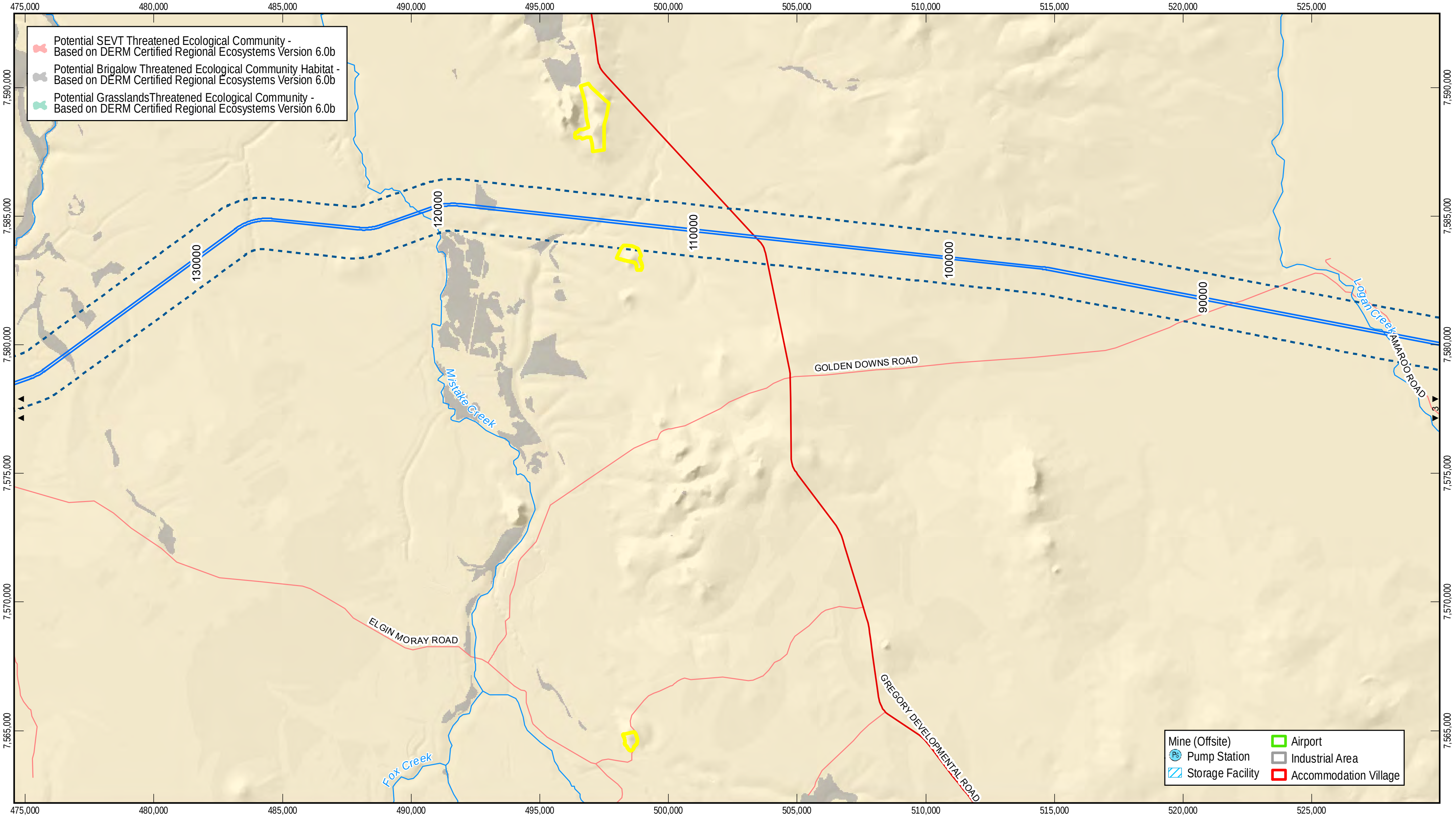
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Threatened Ecological Communities (2012), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013);DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES



1:200,000 (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

LEGEND

Town
State Road
Local Road
Other Railway
Watercourse
Study Area
Rail (West)
Rail (East)
Project (Mine)
Quarry

GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Potential threatened ecological communities within the Rail Study Area and surrounding landscape

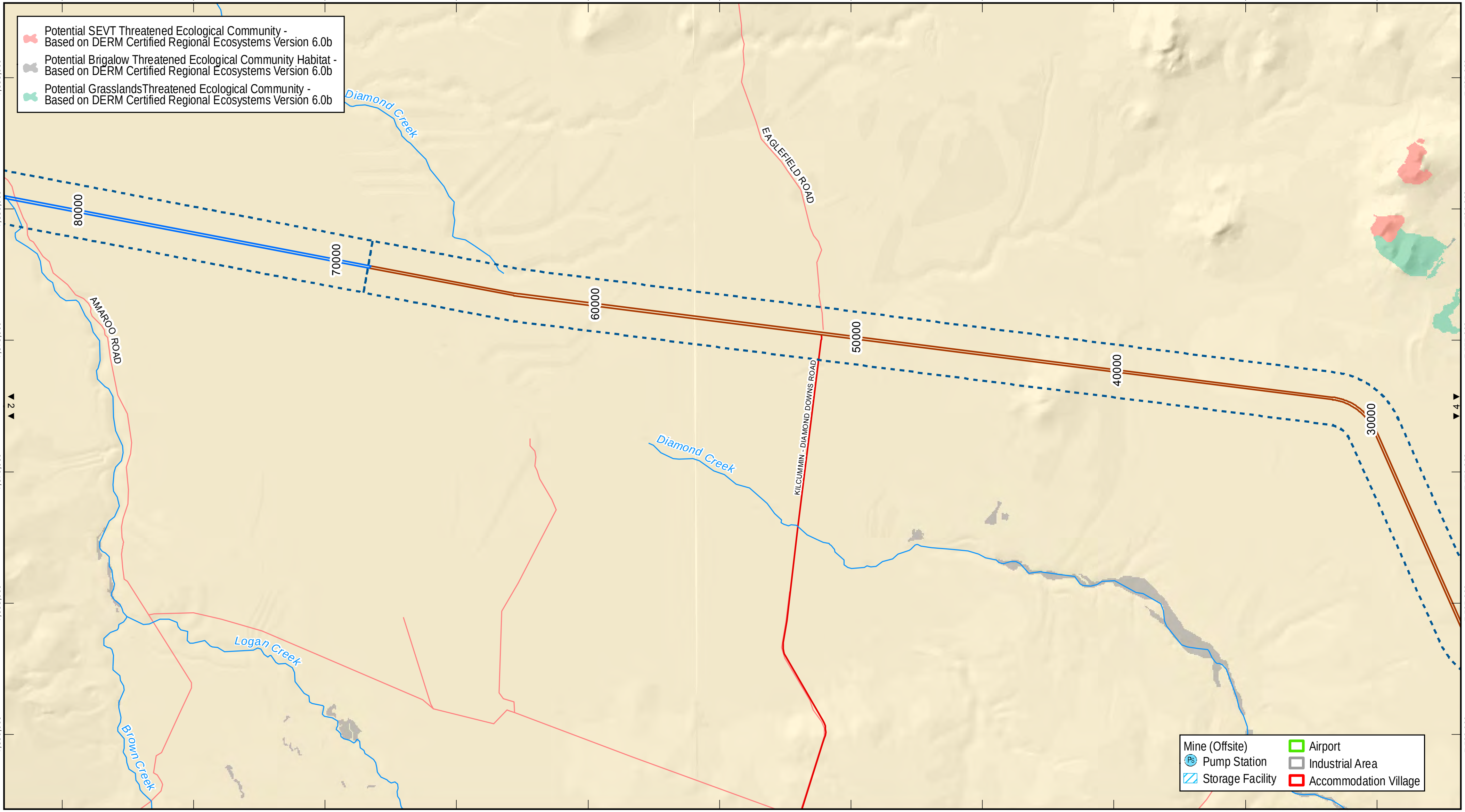
Job Number 41-26422
Revision C
Date 05-11-2013

Figure 28
Sheet 2 of 4

G:\41\26422\GIS\Maps\MXD\0600_Ecology\41_26422_0638_rev_c.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Threatened Ecological Communities (2012), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt9 Rev 3 (2013);DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES



1:200,000 (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

LEGEND

Town · State Road · Local Road · Other Railway · Watercourse · Study Area · Rail (West) · Rail (East) · Project (Mine) · Quarry

GHD adani

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Carmichael Coal Mine and Rail Project SEIS

Potential threatened ecological communities within the Rail Study Area and surrounding landscape

Job Number 41-26422
Revision C
Date 05-11-2013

Figure 28
Sheet 3 of 4

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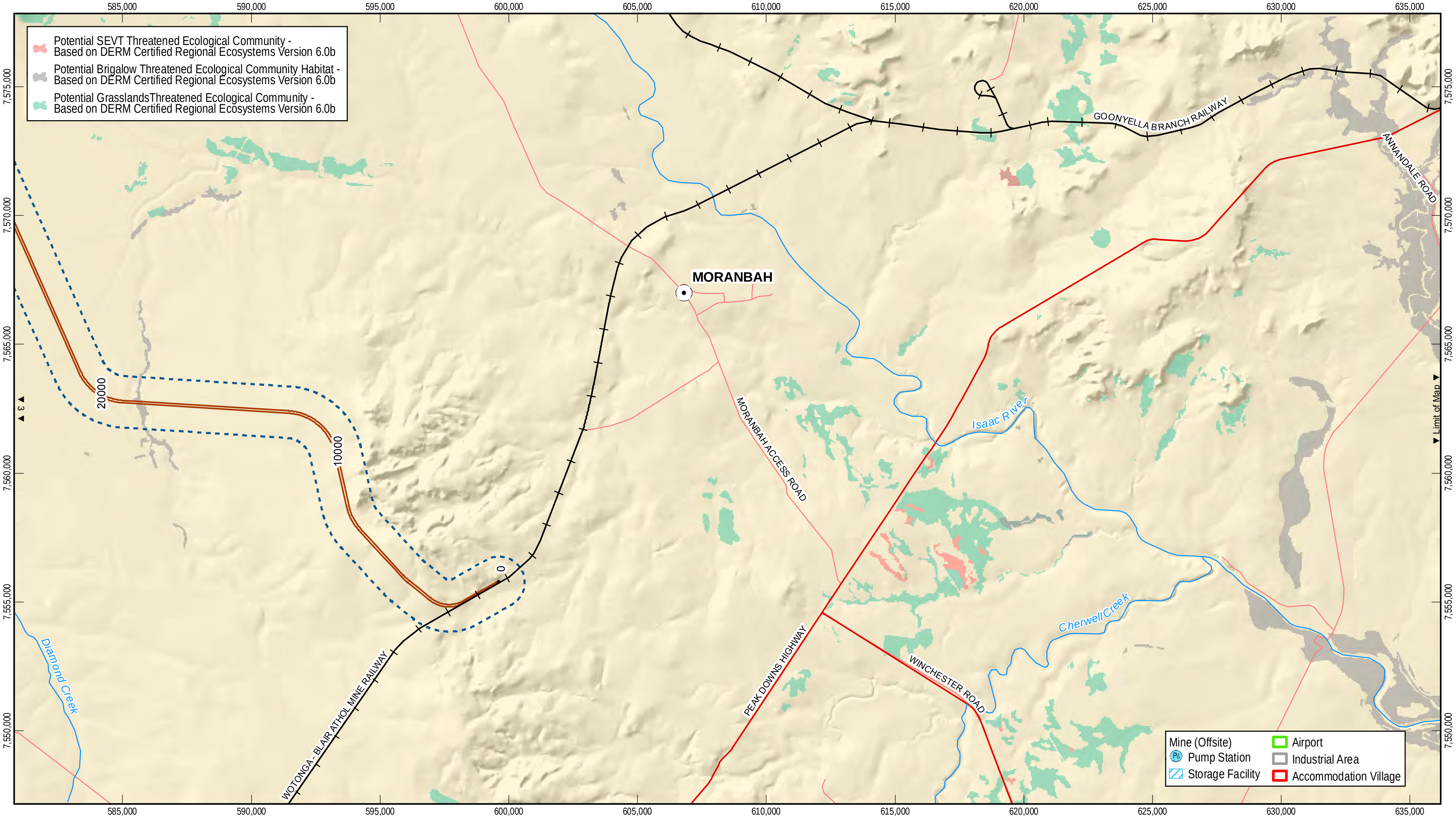
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Potential Threatened Ecological Communities (2012), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013);DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES



1:200,000 (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

LEGEND

- Town
- State Road
- Local Road
- Other Railway
- Watercourse
- Study Area
- Rail (West)
- Rail (East)
- Project (Mine)
- Quarry

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Carmichael Coal Mine and Rail Project SEIS

Potential threatened ecological communities within the Rail Study Area and surrounding landscape

Job Number	41-26422
Revision	C
Date	05-11-2013

Figure 28
Sheet 4 of 4

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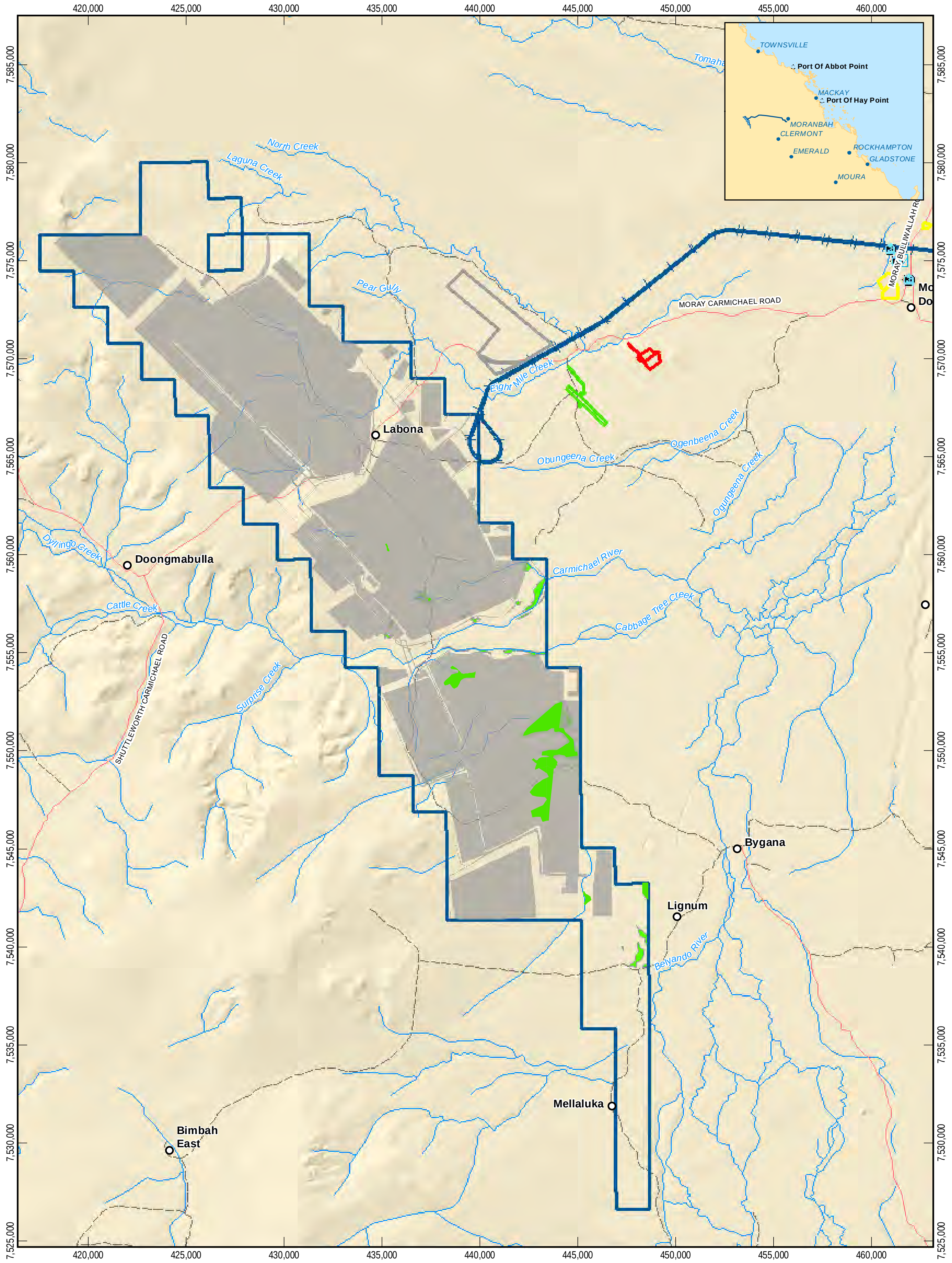
Data source: DNRM: DEM (2008), Potential Threatened Ecological Communities (2012), © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013);DME: EPC1690 (2010) / EPC1080 (2011). Created by: MR, CA, ES



LEGEND

- Homestead
- Local Road
- Track
- Watercourse
- Brigalow Threatened Ecological Community
- Project (Rail)
- Project (Mine)
- Mine (Onsite)
- Quarry
- Mine (Offsite)
- Pump Station
- Storage Facility (Offstream)
- Airport
- Industrial Area
- Accommodation Village

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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

GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision C
Date 05-11-2013

Brigalow Threatened Ecological Community at the Mine Study Area

Figure 29

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Level 9, 145 Ann 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); DNRM: Threatened Ecological Communities (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Mine Offsite, Mine (Onsite), Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013). Created by: BW, CA

4.7.7 Potential impacts

Total clearing extents of mapped Brigalow TEC are summarised in Table 25.

Table 25 Total clearing extent of Brigalow TEC

Project Area/Phase	Direct clearing (ha)	Indirect subsidence (ha)	
Rail construction	27		-
Rail impact area	27		-
Mine construction	554		-
Mine operation	27		
		High impact	-
		Low Impact	3
Sub total	*27*		*3*
Off-site construction	-		-
Mine impact area	581		3
Project impact area	**608**		**3**
Note: Total clearing extent is based on the extent of constituent REs of the TEC.			

The Brigalow TEC within the Rail Study Area occurs in contiguous patches associated primarily with creek lines. As for the grasslands TEC, the Brigalow TEC patches are fragmented by non-remnant and cleared habitat, but offer corridors along the waterways for fauna movements. It is expected that 27 ha of this TEC will be cleared to facilitate the rail corridor infrastructure development.

Within the Mine Study Area, an extant patch of Brigalow TEC occurs south of the Carmichael River. In total, across the Mine Study Area, 581 ha of this TEC will be affected by vegetation clearing to facilitate mining and stockpiling works. Clearing of the Brigalow TEC will occur late in the operational schedule sequence, several decades from first operational activity commencement.

4.7.8 Management and mitigation measures

The TEC to be affected will be as a direct result of vegetation clearing. Vegetation clearing is an unavoidable consequence of the Project. Where possible, the Project footprint has been located in existing cleared areas. However, where the clearing of remnant vegetation, including that protected under the EPBC Act, is unavoidable and cannot be satisfactorily avoided, managed and mitigated, offsets are likely to be provided in accordance with the relevant EPBC Act and State offset policy (refer SEIS Volume 4 Appendix F Revised Offsets Strategy). Likely offset requirements for the Project are discussed further in Section 8.

4.7.9 Recovery plans, conservation advice and threat abatement plans

The Commonwealth decision was such that a recovery plan for Brigalow TEC was required, to contribute to the protection, conservation and management of the community and to provide for the research and management actions necessary to stop the decline of, and support the recovery of, the community so that the chances of long-term survival in nature are maximised. The national recovery plan for the Brigalow TEC (Butler 2007) provides the main framework for the community's recovery.

Specific objectives proposed for the recovery plan (Butler 2007) are to:

- increase the area of the Brigalow ecological community and its representation in conservation reserves
- improve knowledge of the Brigalow ecological community and its condition as habitat for native species
- mitigate key threats to the Brigalow ecological community by controlling fire, weeds and animal pests.

The main recovery actions proposed in the national recovery plan include the following management actions:

- facilitating the restoration of degraded remnants
- establishing regional benchmarks for habitat condition for each of the component vegetation types and regional ecosystems
- establishing and implementing pest plans for key areas of the ecological community
- establishing and implementing fire reduction plans for key areas of the ecological community.

4.7.10 Residual impacts and impact significance

The protected REs recorded for the Project that make up the Brigalow TEC are known to occur within the landscape immediately surrounding the Study Area and across the broader region, as well as within the Study Area itself (refer Table 26). Residual impacts from clearing across the Study Area are less than 1 percent of the subregional extent of the TEC. Within Queensland, approximately 66 percent of extant Brigalow TEC occurs within protected area estates. Therefore, in general terms of the permanent removal of area, it is considered that this Project will have a minor impact on prevalence of this TEC across Queensland as a result of clearing from the Project footprint.

Table 26 Contextual losses of Brigalow TEC

Proposed clearing area (ha)	TEC extent in Queensland[1] (% impact)	Bioregion current extent[2] (% impact)	Subregions current extent[3] (% impact)	Protected area estate (% of Queensland current extent)[4]
608 ha	75,187,246 ha (0.00077%)	15,050,991 ha (0.0037%)	1,373,593 ha (0.04%)	49,428,835 ha (66%)

[1] Extent of TEC located within Queensland only, excludes areas located within other states. Figures calculated from DERM, 2010a, b, c, 2011a: regional ecosystem ‘current extent’ as of 2006 based on the regional ecosystems comprising each TEC.

[2] TEC current extent within the Brigalow Belt bioregion as impacted by the Project.

[3] Subregions include the Belyando Downs and Northern Bowen Basin of the Brigalow Belt bioregion, which are intersected by the project.

[4] Protected area estate = land tenured as national park, state forest and timber reserves within Queensland (DERM, 2010a, b, c, 2011a).

Furthermore, management measures will be implemented to minimise habitat losses within the Study Area and to ensure that no losses of this TEC will be realised outside the Study Area, through offsetting. No invasive species that could detriment the TEC will be introduced or spread as a consequence of the Project and chemicals that would detriment the TEC will not be spread into the regionally remaining patches of this TEC. Accordingly, while impacts from localised losses are expected for the Brigalow TEC, subregional or regional impacts are not expected to be significant following the implementation of mitigation, management and offsets.

Nevertheless, clearing of vegetation for the Project will result in reductions in the extent, diversity and abundance of these communities and the species that utilise them within the local environment. Therefore, significant impacts on the local presence of the Brigalow TEC are predicted to occur, given:

- Clearing of 27 ha of this TEC at the Rail and 249 ha of this TEC in the Mine Areas will reduce the extent of this ecological community within the local and regional landscape
- This clearing will remove the majority of identified areas of this TEC at the Mine Area (some of which may be considered to be habitat critical to the survival of the TEC) and has the potential to fragment this TEC within the Rail Area.

4.7.11 Offsets

Offset obligations under the EPBC Act are likely to be required for Brigalow TEC for both the Project (Mine) and Project (Rail) areas as follows:

- 581 ha for mine impact area (581 ha direct, no high impact subsidence)
- 27 ha for rail impact area

The total offset requirement for the Project is therefore 608 ha.

The availability of suitable habitat for offsets for the species is 5,519 ha; the Project requirement therefore represents approximately 11 percent of this available offset resource.

Residual project impacts on Brigalow TEC can therefore be sufficiently offset through the delivery of land-based direct offsets.

4.7.12 Conclusion

Significant impacts on the local presence of the brigalow TEC are predicted to occur. A combination of mitigation and management measures to reduce impacts and offsets to address inevitable residual impacts to individual community areas will be implemented to avoid significant impacts to brigalow TEC.

4.8 GAB springs

4.8.1 Ecology and legislation

The community of native species dependent on natural discharge of groundwater from the GAB (abbreviated to ‘GAB discharge spring wetlands’) TEC comprises a community of species of flora and fauna including fish, invertebrates and aquatic and terrestrial plants clustered around discharge springs emanating from the GAB (Fensham et al., 2010). For this reason, the TEC is geographically limited to the GAB and is listed as endangered under the EPBC Act.

4.8.2 Desktop results

Four TECs listed under the EPBC Act were identified as having potential to occur in the Study Area from desktop results, including the GAB discharge spring wetlands.

4.8.3 Field survey methodology

Flora surveys of the Study Area relevant to GAB discharge spring wetlands are summarised in Table 27. Flora survey efforts employed standardised approaches recognised by regulatory agencies for describing the existing floristic environment and to inform the presence of any protected species. The assessments conducted identified whether EPBC Act protected taxa were present, and whether the constituent REs of TECs occurred.

Table 27 Flora surveys relevant to the GAB discharge spring wetlands

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Mine Study Area	Terrestrial and aquatic flora	60 sites, 19 sites 168 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Mine Study Area	Doongmabulla and Mellaluka Springs survey	Unstructured opportunistic survey effort	Autumn: May 2012
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Post EIS			
Mine Study Area	Doongmabulla and Mellaluka Springs survey	Unstructured opportunistic survey effort	Autumn: May 2012 Autumn: March/April 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013
Offsite Infrastructure Area	BioCondition	10 sites	Autumn: April/May 2013
Offsite Infrastructure Area	PVMP and PMAV	49 flora sites	Autumn: April/May 2013

4.8.4 Field survey results

Surveys confirmed that this TEC is not present within the Study Area. However, impacts to regional aquifers as a result of groundwater draw down have the potential to impact this TEC.

The nearest GAB discharge spring is the Doongmabulla Springs complex, which comprises discrete pools and patches of grassland, sedgeland and woodland created by the outflow of artesian water from a cluster of three spring groups (Joshua, Moses and Little Moses), all of which contribute base flow to nearby riverine channels. Each spring group contains at least one spring; in the case of the Moses spring group, there are more than 65. Collectively, the spring groups are known as the Doongmabulla Springs complex.

The Doongmabulla Springs complex is approximately 4.5 km in diameter, and is located approximately 9.8 km directly west of the western boundary of the Project Area.

The Joshua Spring is a single spring now modified to a turkey's nest dam. This flow is directed to an adjacent shallow wetland of approximately 2 ha, and the remainder drains to the Carmichael River. The wetland contains the aquatic herb *Myriophyllum artesium* and the grass *Sporobolus partimpatens*. It has been postulated that this spring contributes a proportion of the Carmichael River's base flow downstream of this point. Joshua Spring is located towards the north-western edge of the Doongmabulla Springs complex.

Moses Spring is a spring group (protected as the Doongmabulla Nature Refuge) that comprises at least 65 individual springs spread over an irregular area 2.5 km long and 1.3 km wide (approximately 325 ha). These springs are mostly mound springs, with mounds developed up to 1.5 m tall. However, some are seepage springs only, that is, water seeps from beneath a rock or has not yet formed a mound (these often form a vegetated spring). All springs have a wetted area around them that generally encompasses at least the mound (or adjacent pools where there is no mound) and sometimes a much larger area. Five wetland areas larger than 0.5 ha have developed in association with the run-off from these springs. Seven threatened species are associated with Moses Spring (five of which are GAB endemics, and one of which is a partial endemic), and these are further described in the springs technical report (SEIS Volume 4 Appendix J3 Doongmabulla and Mellaluka Springs Report).

Little Moses Spring, located directly beside the Carmichael River, comprises a group of seepages from the side of a low slope with one large pool. No threatened species or GAB endemic species occur at this spring. Little Moses Spring is a tear-shaped inundated sedgeland/wetland approximately 200 m long and 50 m wide with an open pond in the centre. Along the same elevation as this main pond, groundwater was observed emanating from the ground during the 2012 survey, supporting the theory that this spring may be fed from local recharge (i.e. a recharge spring). Little Moses Spring is located approximately 8.8 km directly west of the western Mine Area boundary.

The Doongmabulla Springs complex as a whole contains a comparatively high number of flora and fauna species endemic to GAB spring wetlands, including the following EPBC Act listed species:

- Salt pipewort (*Eriocaulon carsonii*) – listed as endangered under the EPBC Act, observed at Moses Spring during the 2013 field survey
- Blue devil (*Eryngium fontanum*) – listed as endangered under the EPBC Act, observed at Moses Spring during the 2013 field survey
- Waxy cabbage palm (*Livistona lanuginose*) – listed as vulnerable under the EPBC Act, observed at Moses and Little Moses Springs during the 2013 field survey

The Doongmabulla Springs complex has been given a GAB discharge spring wetland conservation ranking of 1a (the highest), based on the presence of these endemic species (Fensham et al., 2010).

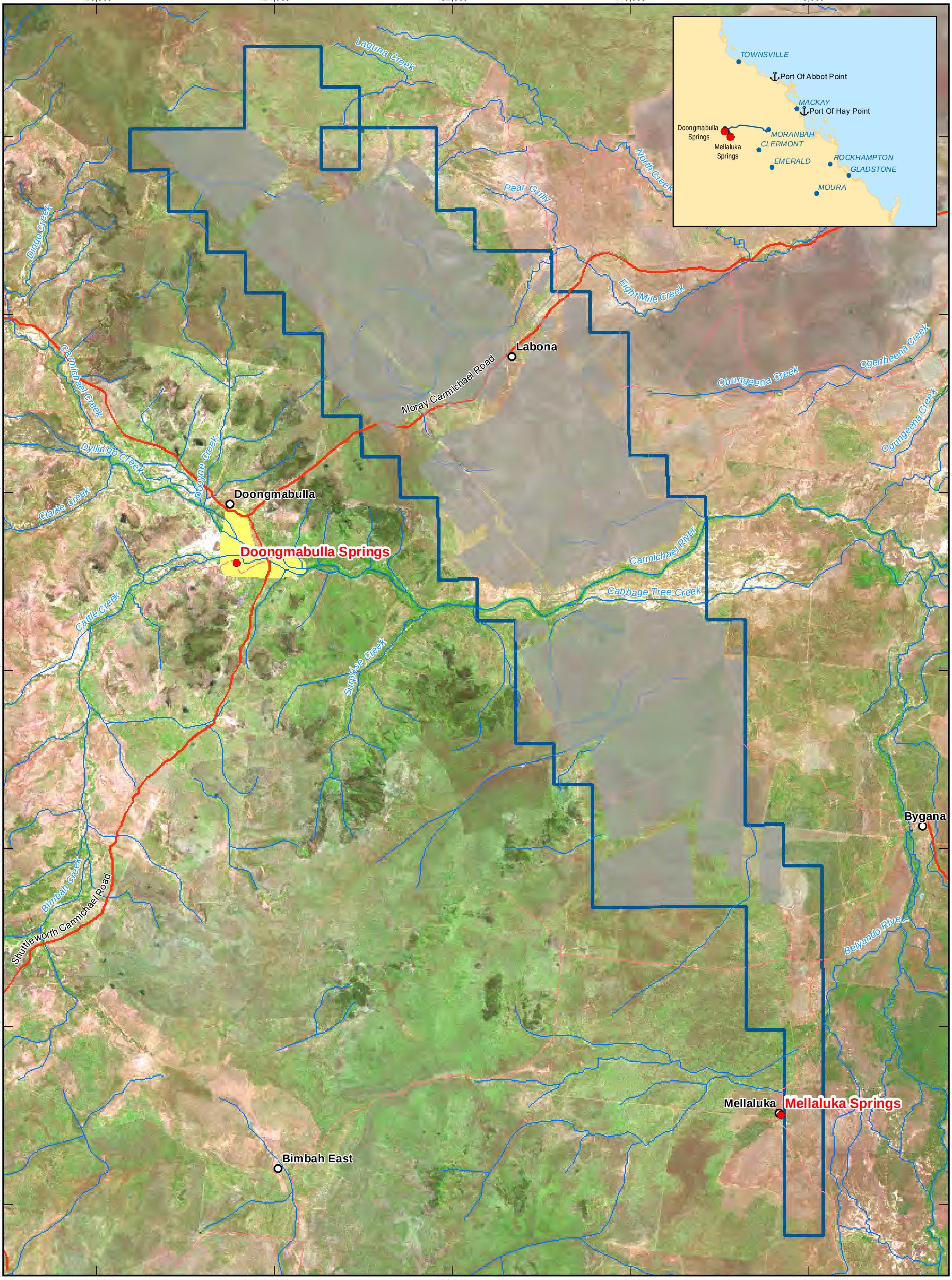
Of the three spring groups within the Doongmabulla complex, the Moses Spring group meets the criteria for definition as the 'community of native species dependant on natural discharge of groundwater from the Great Artesian Basin' TEC (DSEWPaC, 2013f), declared as endangered under the EPBC Act.

A fourth spring group, the Mellaluka Spring group, is located near the south-western corner of the eastern section of the Mine Area, on Mellaluka Station. It is not believed to be fed by a GAB aquifer, as the aquifer for this spring is believed to be located in Permian strata. As a result, this spring group cannot meet the criteria for designation as part of the GAB discharge springs TEC and is therefore not considered further within the assessment of impacts to TECs. Further details of the ecological values of the Mellaluka Springs are presented in SEIS Volume 4 Appendix J3 Doongmabulla and Mellaluka Springs Report.

4.8.5 Status in project area

Given its relative value, parts of the Moses Spring group may be considered to constitute 'habitat critical to the survival of the community', where these could represent 'areas that are necessary for the long-term maintenance of the TEC'.

Other parts of the Doongmabulla Springs complex are unlikely to meet this (and other) criteria listed under the Significant Impact Guidelines for endangered TECs.



LEGEND

- Homestead
- Spring Locations
- Minor Road
- Track
- Watercourse
- Directory of Important Wetlands
- Project (Mine)
- Mine (Onsite)

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:250,000 (at A4)

0 2 4 6 8

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 SEIS

Job Number 41-26422
Revision A
Date 05-11-2013

Location of Doongmabulla and Mellaluka Springs

Figure 30

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: Data Source: GA: Watercourses, Roads, Homesteads (2007); DME: Carmichael Mine Site; DNRM: Springs, DOI Wetlands (2009), Landsat (2005); Adani: Alignment (SP1 & 2), Mine (Onsite) (2013). Created by: AJ, MS

4.8.6 Threatening processes

The greatest threatening process for GAB springs is drawdown resulting from groundwater extraction for domestic and agricultural use and mining/coal seam gas extraction (Fensham et al., 2010). Extraction has led to the inactivity of the majority of artesian-fed springs, with an estimated 81 percent of springs currently listed as inactive since their discovery, due to reduced subterranean pressure (Fairfax and Fensham, 2002). This threatening process is relevant to the TEC and the Doongmabulla Springs complex as a whole.

Further impacts on the spring-associated ecological communities arise from artificial alterations of the seep points, with some springs being removed altogether, or modified to suit the needs of livestock (Fensham et al., 2011). The Doongmabulla Springs complex currently experiences disturbance, with the Joshua Spring modified to a ‘turkey-nest’ dam to service the domestic needs of Doongmabulla Station.

Introduced plants and animals have had significant impacts on the integrity and robustness of both GAB and non-GAB spring communities, with pugging (from both feral animals and livestock), pig rooting, wallowing and direct and indirect competition for resources all acting to degrade ecological values of springs (Fensham and Price, 2004). The Doongmabulla Springs complex currently experiences impacts in the form of pugging from cattle and pigs.

4.8.7 Potential impacts

Changes to hydrology

Changes to groundwater hydrology have the potential to occur as a result of the operational phase of the Project (Mine). Impacts to groundwater and base flow in the Carmichael River are discussed in SEIS Volume 4 Appendix K1 Revised Mine Hydrogeology Report Revised and Appendix K6 Groundwater Assessment Addendum, but are summarised here where relevant to the TEC. While the TEC is not present within the Study Area, it was considered to have the potential to be impacted indirectly as a result of pressure reduction.

A summary of modelling predictions for (maximum) pressure reductions in the aquifers at the Doongmabulla and Mellaluka spring groups from the Revised Mine Hydrogeology Report (SEIS Volume 4 Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum) is provided in Table 28. The reduction in pressure and the impacts on the different types of springs are also conceptually presented in Figure 31.

Table 28 Modelling predictions for pressure reductions in aquifers

Spring	Predicted reduction in pressure – Operation (metres)	Predicted reduction in pressure – Post-closure (metres)
Doongmabulla Spring group		
Joshua Spring	0.19	0.16
Moses Springs		
Moses1	0.06	0.06
Moses2	0.08	0.08
Moses3	<0.05	0.05
Moses4	<0.05	<0.05

Spring	Predicted reduction in pressure – Operation (metres)	Predicted reduction in pressure – Post-closure (metres)
75A	0.08	0.07
75B	0.12	0.11
75C	0.12	0.11
75D	0.07	0.07
75E	0.09	0.09
Little Moses Spring	<0.05	<0.05
Mellaluka Spring group		
Mellaluka Spring	<0.05* – 1.14**	1.6* -9.07**
Stories Spring	<0.05* – 2.34**	8.2* – 13.4**
Lignum Spring	0.06* – 8.22**	14.8* - 25.6**
Note: *Upper most aquifer; ** Permian-age strata		

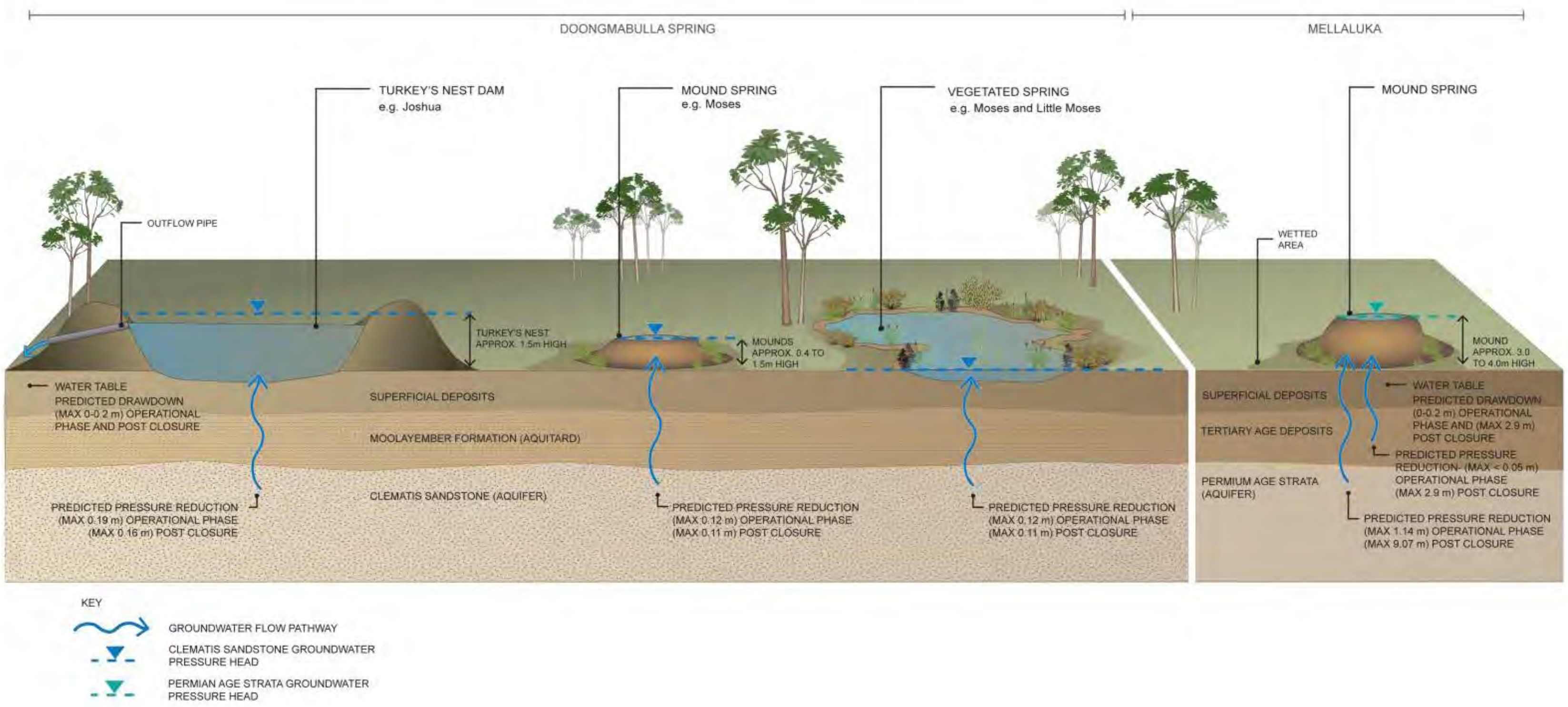


Figure 31 Groundwater pressure reductions in the aquifers at Doongmabulla and Mellaluka Springs

The high flow is evidence of a strong head of pressure, amounting to at least 1 m above the surrounding plain and likely at least 1 m more. Therefore, it is probable that a 19 cm reduction in pressure in the aquifer supplying the Joshua Spring is likely to result in a negligible reduction in flow. The threatened species found at the Joshua Spring wetland, *M. artesium* and *S. partimpatens*, are unlikely to be impacted, as the water supply to the wetland in which they occur is not likely to be reduced to an extent that will affect these species.

At Moses Spring, a total of 65 active springs were counted, of which 56 had a recognisable mound, five were ‘small artesian seeps’ and the other four springs were ‘non-mounding artesian springs’ (springs that had a pool but no mound). Spring morphologies observed during surveys are discussed in more detail in the springs technical report, Volume 4 Appendix J3 of the SEIS. Twelve of the mounds were less than 20 cm high, 24 were 20 – 50 cm high, and 20 were higher than 50 cm. The highest mounds were approximately 1 – 1.5 m tall (that is, 1.5 m above the level of the surrounding plain).

The threatened species associated with the Moses Springs are generally present on or immediately adjacent to the mounds, seeps or pools. Most mounds are separated from other mounds by bare sections of plain. The majority of the population of endemic and/or threatened species at Moses are located within wetland areas fed by seepage from the springs. These wetlands generally form sedgeland or grassland, rarely with trees (weeping paperbark clumps or individual waxy cabbage palms).

The size of these wetlands appears to vary greatly with the seasons. During the 2012 survey, the wetlands were extensive and were overflowing into pools in the Cattle Creek channel that were up to 1.5 m deep. However, during the 2013 survey, all of the deep pools observed in 2012 were dry. Seasonal fluctuations appear to be a normal part of the ecology of these wetland areas.

The worst case predicted reduction in pressure in the aquifer at the Moses Spring group varies (see Table 28), with springs closest to the Mine Area in the east predicted to experience a reduction in pressure of 0.12 m and those in the far west predicted to experience a reduction in pressure of less than 0.05 m.

The presence of mounds up to 1.5 m in height indicates that the spring has an existing pressure head up to 1.5 m above ground level. With the majority of springs in the Moses Spring group located in the western half, the predicted reduction in pressure is generally less than 0.08 m. These reductions in pressure are expected to have a minor impact on the springs and associated wetlands, falling within the range of seasonal fluctuations to which the springs are already adapted. Therefore, it is thought that the reduction in flow will be within a tolerable range.

Groundwater modelling predicts that reduction in pressure in the Little Moses Spring will be less than 0.05 m. This would result in the pond level dropping by 0.05 m, and it is expected this would represent a negligible impact on the ecology of the spring and the sedgeland that fills most of its surface area.

Mellaluka spring group is located near the south western corner of the eastern section of the Mine Area, on Mellaluka Station. It is not believed to be fed by a GAB aquifer and therefore, does not meet the criteria for TEC designation. Unlike the negligible changes for the other spring groups, during the operational phase, the maximum predicted reduction in pressure for these springs is in the Permian-age strata aquifer, with up to 1.14 m predicted for at the

Mellaluka spring, 8.22 m at Lignum Spring and 2.34 m at Stories Spring. The post-closure predicted reduction in pressure is likely to result in a loss of ecological function for all springs in the Mellaluka Springs group. This impact would occur around 2070, based on current planning for the Mine. It is predicted the main Mellaluka Spring will see drawdowns of up to 9.07 m in Permian-age strata, with the northern springs (Stories and Lignum Springs) predicted to experience drawdowns of up to 13.4 and 25.6 m in Permian-age strata respectively. This is well below ground level and only the most deep-rooted trees associated with the springs will still be able to access groundwater at this depth. It is concluded that impacts to this spring group will be serious during operations for at least the Lignum and Stories Springs, and of significant magnitude post-closure for the entire spring group.

4.8.8 Management and mitigation measures

The impacts identified on springs affected by the Project (Mine) are not expected to commence until approximately 2020, with reduction in pressure of the aquifers expected by approximately 2035 (see SEIS Volume 4 Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum).

Proposed mitigation and management measures for Doongmabulla (and Mellaluka) Springs include:

- Flow monitoring of the outlet at Joshua spring to monitor changes in output, and in the Carmichael River immediately adjacent to Joshua spring, to monitor contributions to surface water flow and seasonal changes.
- Mapping and measurement (using GPS equipment capable of sub-metre accuracy) of the ‘vegetated area’ perimeter of the main wetland areas at the Moses Spring group quarterly (there are five main wetland areas).
- Mapping and measurement (using GPS equipment capable of sub-metre accuracy) of selected isolated mound springs (those discrete mounds outside the wetland areas) at Moses Spring group should be conducted on a seasonal basis by a suitably qualified botanist prior to and during the predicted drawdown impact. At least 10 should be selected over the entire spring group (these same 10 to then be resurveyed at each repeat survey), focussing on differing sized mounds and gaining a good geographic spread over the entire group. This should include a complete species list of the mound vegetation, a photographic record (taken from at least two locations consistently), diameter, height and perimeter measurements (diameter taken from the same places each time), and flow measurements. If a mound should disappear during the Mine life, a nearest neighbour replacement should be selected.
- Ecological studies of the two threatened species listed under the EPBC Act that occur at Moses Spring – blue devil and salt pipewort – should be conducted annually. This should be done in consultation with the Queensland Herbarium using an appropriate survey method for small herbs (the latter of which is a clumping species). Consideration should be given to changing the frequency of surveys if population changes are noted.
- A baseline survey of aquatic invertebrates at Moses Spring conducted by a suitably qualified ecologist/entomologist prior to mining operations commencing, to determine the presence of endemic species.

- A baseline water level should be established at a reference location for the springs, and water levels should be measured against this baseline on a quarterly basis during mining operations.
- These monitoring events should commence at least one year before mining operations (in order to continue a baseline understanding of existing conditions), and continue for at least two years after mining operations are completed.
- At the conclusion of baseline surveys (after at least one year of surveys prior to commencement of mining operations), a Baseline Ecological Condition report should be prepared for the springs.
- An annual report on the spring condition, including statistical comparison to baseline condition, should be provided including reporting on any change from baseline conditions and planned actions.
- These surveys should utilise data gained from studies into groundwater levels conducted by the Mine in the vicinity.
- Ongoing monitoring of Mellaluka Springs will be focused on groundwater studies and is outlined in the Mine Hydrogeology Report (GHD, 2013r).

Pumping groundwater to the surface may act to offset the loss of some sections of the Mellaluka Spring wetland, and it is recommended that the proponent consider installing electric submersible pumps when drawdown commences for this purpose. A wetland remediation and management plan should be prepared at this time in consultation with the Mellaluka owner. A pump may also be required to ensure the continuation of water to the Mellaluka homestead.

All surveys and other works will be conducted in consultation with the Doongmabulla and Mellaluka property owners.

Management plan

Adani will provide a Draft Groundwater Dependant Ecosystem (GDE) Management Plan for approval prior to the commencement of construction.

This plan will address impacts to the following GDE's:

- Doongmabulla Springs Complex
- Mellaluka Springs Complex
- Carmichael River , particularly the Waxy Cabbage Palm

The Plan will include the following:

- A management framework that aligns with the other project management plans
- Clear statements regarding the intent, approval requirements, objectives and actions
- Details of how the management plan will be applied across the project phases – pre construction / construction / operation / post operations, offset areas
- Details of any proposed adaptive monitoring program to support the plan objectives.
- Details of how experts will be used in a review capacity to inform ongoing monitoring and management

- Incorporates all proposed management and mitigation measures, including reference to relevant State and Federal Guidelines of relevance to these GDE's
- Specific performance targets and how these will be measured and reported

4.8.9 Recovery plans, conservation advice and threat abatement plans

The overall objective of the national recovery plan for the GAB discharge spring wetlands TEC (Fensham, Ponder and Fairfax, 2010) is to maintain or enhance groundwater supplies to GAB discharge spring wetlands, maintain or increase habitat area and health, and increase all populations of endemic organisms.

The priority actions to which the Project will contribute (as part of mitigation and management measures to be implemented) are:

- monitoring current spring flows
- controlling feral animals and preventing the further spread of other exotic fauna
- completing an inventory of endemic species in GAB springs and monitoring populations of endemic species
- encouraging landholders to responsibly manage springs.

4.8.10 Residual impacts and impact significance

Surveys confirmed that this TEC is not present within the Study Area. There is no information available on the wider regional extents of this community at a broader, landscape scale beyond the study area. However, impacts to regional aquifers as a result of groundwater draw down were considered to have the potential to impact this TEC.

The Doongmabulla Springs complex 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) and may comprise habitat critical to the survival of that community as a result (parts of Moses Springs only).

Conservative (i.e. worst case) modelling indicates that the influence of Mine dewatering reaches the location of the Doongmabulla Springs, with a maximum predicted reduction in pressure in the aquifer of between <0.05 and 0.12 m (operation phase) and <0.05 and 0.12 m (post-closure) at these springs. These levels of reductions (generally less than 5 percent at Moses Springs and within the range of natural seasonal fluctuations) are likely to have negligible adverse impacts at Moses Springs and, at most, negligible adverse impacts to Joshua and Little Moses Springs.

Significant impacts are predicted to occur to the Mellaluka Springs group at the time of Mine decommissioning, but this group does not form part of the TEC.

No significant impacts to the GAB discharge spring wetlands TEC will occur, as the Project will not:

- Reduce the extent of, fragment, or increase fragmentation of the ecological community
- Adversely affect habitat critical to the survival of the ecological community, or destroy or modify factors necessary for the survival of the community
- Cause substantial changes or reductions in species compositions, quality or integrity

4.8.11 Offsets

As no significant impacts to the GAB discharge springs wetlands TEC are predicted, offsets under the EPBC Act will not be required.

4.8.12 Conclusion

The Project will not result in significant impacts to any area of GAB discharge springs TEC.

5. Listed migratory species – environmental values and impacts

5.1 Overview

5.1.1 Species and communities confirmed or likely to occur

The desktop assessment, summarised in Table 2, indicated that a number of EPBC Act listed migratory species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas (including quarries). A likelihood of occurrence assessment for EPBC Act migratory species was undertaken and details are provided in EIS Volume 2, Section 5 Mine Nature Conservation, EIS Volume 3, Section 5 Rail Nature Conservation and SEIS Volume 4, Appendix J1 Revised Ecological Assessment Report. The likelihood of occurrence assessment found:

- Confirmed present:
  - Eastern great egret (*Ardea modesta*)
  - Satin flycatcher (*Myiagra cyanoleuca*)
  - Rainbow bee-eater (*Merops ornatus*)
- 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*)
  - As discussed in Section 4, where a difference in likelihood of occurrence outcome exists between the Mine and Rail Study Areas, the higher likelihood outcome has been assumed across the Study Area to provide a conservative understanding of the potential to impact a species as a result of the Project being implemented.

Details of the assessment are provided in Table 29.

Table 29 Commonwealth listed migratory species for Mine and Rail Study Areas – likelihood of occurrence

Species	EPBC Act status	Predicted to occur#		Previously recorded*		Recorded at Study Area		Likelihood of occurrence^	
		Rail	Mine	Rail	Mine	Rail	Mine	Rail	Mine
common sandpiper *Actitis hypoleucos*	migratory (Bonn; CAMBA; JAMBA; ROKAMBA); marine	x	x	x	✓	x	x	Unlikely to occur	Likely
fork-tailed swift *Apus pacificus*	migratory (CAMBA; JAMBA, ROKAMBA); marine	✓	✓	✓	x	x	x	May occur	Likely
cattle egret *Ardea ibis*	migratory (CAMBA; JAMBA); marine	✓	✓	x	x	x	x	Likely	May occur
eastern great egret *Ardea modesta*	migratory (CAMBA; JAMBA, ROKAMBA); marine	✓	✓	x	x	✓	✓	Confirmed present at both Mine and Rail Study Areas	
sharp-tailed sandpiper *Calidris acuminata*	migratory (Bonn; CAMBA; JAMBA; ROKAMBA); marine	x	x	✓	x	x	x	May occur	Unlikely to occur
curlew sandpiper *Calidris ferruginea*	migratory (Bonn; CAMBA; JAMBA; ROKAMBA); marine	x	x	x	✓	x	x	Unlikely to occur	Likely
Latham's snipe *Gallinago hardwickii*	migratory (Bonn; CAMBA; JAMBA; ROKAMBA); marine	✓	✓	✓	x	x	x	May occur	Likely
white-bellied sea eagle *Haliaeetus leucogaster*	migratory (CAMBA); marine	✓	✓	✓	x	✓	x	Confirmed present during quarry surveys	Likely
white-throated needletail *Hirundapus caudacutus*	migratory (CAMBA; JAMBA, ROKAMBA); marine	✓	✓	✓	x	x	x	Likely	Likely
Caspian tern *Hydroprogne caspia*	migratory (CAMBA; JAMBA); marine	x	x	x	✓	x	x	Unlikely to occur	Likely
black-tailed godwit *Limosa limosa*	migratory (Bonn; CAMBA; JAMBA; ROKAMBA); marine	x	x	x	✓	x	x	Unlikely to occur	Likely
rainbow bee-eater *Merops ornatus*	migratory (JAMBA); marine	✓	✓	✓	✓	✓	✓	Confirmed present at both Mine and Rail Study Areas	
black-faced monarch	migratory (Bonn); marine	x	✓	x	x	x	x	May occur	May occur

Species	EPBC Act status	Predicted to occur#		Previously recorded*		Recorded at Study Area		Likelihood of occurrence^	
		Rail	Mine	Rail	Mine	Rail	Mine	Rail	Mine
Monarcha melanopsis									
spectacled monarch *Monarcha trivirgatus*	migratory (Bonn); marine	x	x	x	x	x	x	May occur	May occur
satin flycatcher *Myiagra cyanoleuca*	migratory (Bonn); marine	✓	✓	x	x	x	✓	Likely	Confirmed present
glossy ibis *Plegadis falcinellus*	migratory (Bonn; CAMBA); marine	x	x	✓	x	x	x	Likely	Likely
Australian painted snipe *Rostratula australis*	migratory (CAMBA); marine	✓	✓	x	✓	x	x	May occur	May occur
common greenshank *Tringa nebularia*	migratory (Bonn; CAMBA; JAMBA; ROKAMBA); marine	x	x	x	✓	x	x	Unlikely to occur	Likely
marsh sandpiper *Tringa stagnatilis*	migratory (Bonn; CAMBA; JAMBA; ROKAMBA); marine	x	x	x	✓	x	x	Unlikely to occur	Likely

✓ = species detected in search or survey, x = species not detected in search or survey

Predicted to occur within approximately 50 km of Study Area: DSEWPaC Protected Matters Search Tool

* Previously recorded within approximately 50 km of Study Area: desktop sources including Wildlife Online/Birds Australia

Bonn: Convention on the Conservation of Migratory Species of Wild Animals

CAMBA: Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment

JAMBA: Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment
ROKAMBA: Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds

5.1.2 Direct impacts associated with the Project

During development of the Project and preparation of the EIS and SEIS, substantial consideration was given to minimising the potential impacts on migratory species, including minimising the Project footprint, setback options and construction staging. These measures have been adopted such that the impacts identified in this chapter are those which could not reasonably be avoided or minimised through design changes and refinements.

To assess the potential impacts of the Project on matters of NES, the Rail and Mine components of the Project are addressed separately. The potential impacts from the Rail and Mine components will be realised across different time frames and will impact matters of NES in different ways. Therefore, to accurately assess the impacts on matters of NES, the construction and operational phases for the Rail and Mine component have been assessed independently. However, collective or cumulative impacts as a result of both aspects of the Project progressing simultaneously are noted where appropriate. Table 7 provides a summary of the key Project components and potential associated environmental impacts.

Table 30 Key Project components and potential environmental impacts on migratory species

Project component	Potential environmental impacts
Mine lease area	
Open cut pits	Habitat loss Habitat fragmentation and degradation Changes to hydrology (surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk
Underground mining area	Habitat alteration through subsidence Changes to hydrology (surface water)
Overburden disposal (out of pit waste dumping), water management dams and flood levee	Habitat loss Habitat fragmentation and degradation Changes to hydrology (surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk
Off-lease infrastructure area	
Workers accommodation village and associated facilities, permanent airport site, industrial area and water supply infrastructure	Habitat loss Habitat fragmentation and degradation Changes to hydrology (surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk
Rail	
Rail corridor (95 m wide) including rail line, maintenance road, passing loops and bad order sidings	Habitat loss Habitat fragmentation and degradation Changes to hydrology (surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk

Project component	Potential environmental impacts
Rolling stock maintenance yard, ballast and material stockpiles, Borrow 7	Habitat loss Habitat fragmentation and degradation Changes to hydrology (groundwater or surface water) Injury or mortality of species Disturbance and displacement of species (dust, light, noise) Weeds, pests and fire risk

5.1.2.1 Rail construction

Description of activities

Construction of the Project (Rail) will involve the following activities:

- Site preparation including site clearance, construction camp establishment, installation of temporary and permanent fencing, installation of drainage and water management controls and construction of site access
- Civil works including bulk earthworks, black soil treatment, construction of cuts and embankments, installation of permanent drainage controls, construction of temporary haul roads, establishment of concrete batching plants, bridge and water course crossing construction and development of quarries and borrow areas
- Track works including installation of the rail, signalling infrastructure and maintenance infrastructure

Collectively, the temporary and permanent infrastructure comprises the Project footprint for the construction phase of the Project. The extent of the Project footprint is presented in Figure 2.

Potential impacts

Potential impacts arising from the construction of the Project (Rail) may include:

- Vegetation clearing
  - Loss of 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
- Degradation of water quality and aquatic habitat
- 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)
- Wildlife disturbance
  - Disturbance to breeding, roosting and foraging behaviours

These generic impacts are discussed in more detail below; species specific impacts are discussed in Sections 5.2 to 5.5.

Habitat loss

Construction of the rail infrastructure will require clearing a permanent 95 m wide rail corridor to allow rail infrastructure to be established. Clearing will also be necessary for temporary construction infrastructure outside the 95 m corridor, including track and bridge laydown areas, turning circles and concrete batching plants, as well the permanent maintenance facility. Clearing will also be required for construction of the five quarries that will provide materials during construction.

The construction of the Project (Rail) will result in the direct clearing of potential habitat for migratory birds within the Project (Rail) footprint. This loss of habitat may reduce the availability of suitable areas for roosting, foraging and breeding of migratory bird populations. Additionally, it is predicted that 12 major watercourse crossings and approximately 76 minor watercourse crossings (including unmapped ephemeral drainage lines) may be affected. The majority of the watercourses intersected by the Project (Rail) footprint are ephemeral streams that provide limited aquatic habitat and therefore disturbance impacts will be limited at these locations. However, cattle water troughs also provide a source of water to avian fauna and are common throughout the construction footprint. Consequentially, construction activities will reduce local availability of habitats associated with natural and artificial water bodies.

Habitat fragmentation and degradation

Clearing of vegetation and construction activities within the Project (Rail) footprint will cause fragmentation of adjacent habitat used for foraging, roosting and breeding by migratory birds. In addition to fragmentation, clearing and construction activities will result in temporary localised increases in noise, vibration and light disturbance. Habitat degradation may also occur due to increased exposure to dust, wind, weeds and introduced animals. Exposure to any of these effects may alter habitat composition and quality 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 altered and the diversity of native species reduced.

Vegetation clearing also has the potential to facilitate erosion (water and wind) particularly on soil types with a high erosion potential and on high gradient slopes. Where vegetation clearing occurs on floodplains and near drainage lines, erosion may cause sedimentation of waterways, potentially degrading downstream aquatic and riparian habitats.

Injury or mortality of migratory birds

Injury or mortality to individuals may occur during construction as a result of interaction with construction vehicles or equipment. It is anticipated that fauna mortality will occur, particularly for those cryptic and/or less mobile species.

Disturbance and displacement of migratory birds

Individuals and/or populations of some migratory bird species recorded in the Study Area will be lost from the local environment due to clearing and watercourse disturbance associated with construction of the Project (Rail). Increased anthropogenic disturbance in the Study Area also has potential to alter migratory bird behaviour, primarily as a result of increased exposure to light, noise, dust, vehicles and people.

Weeds, pests and fire risk

Increased movement of people, vehicles, machinery, vegetation waste and soil may facilitate the spread of weeds within the construction area. Pest and feral species may disrupt ecosystems by outcompeting and replacing native species and increasing predation pressures, thus altering ecosystem diversity and potentially disrupting ecosystem / habitat function. Additionally, feral animals such as the cane toad are known to prey on the eggs and nestlings of migratory birds (DSEWPaC, 2011f).

Eleven introduced plants were detected within the Rail Study Area, of which, three are 'declared plants' under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act). Increasing the prevalence of weeds within the construction footprint and the potential for weed spread beyond to the surrounding landscape may reduce the quality of habitats used for foraging, roosting and breeding by some migratory bird species.

Mitigation and management measures

Mitigation and management measures associated with construction of the Project (Rail) are detailed in the EIS Volume 3, Section 5 and identified within the Rail EMP (SEIS Volume 4, Appendix W) and the Rail and Offsite Infrastructure Threatened Species Management Plans (SEIS Volume 4, Appendix C3). Key management and mitigation measures that will be implemented to minimise impacts to migratory bird populations are summarised here.

Habitat loss

The total extent of vegetation clearing, required for the rail construction phase has been minimised in the design phase of the Project (Rail) through avoidance. The Project (Rail) alignment has as far as is practicable (and in consideration of other environmental, social and technical constraints) been located in areas that have been previously cleared or degraded by both past and current land use practices (refer EIS Volume 1 Section 1 Introduction for discussion on Project alternatives).

Detailed design and layout for construction will further consider opportunities to avoid sensitive habitat areas, and make use of non-remnant/cleared land. Clearance extents will be restricted to only that necessary for the Project (Rail).

Habitat fragmentation and degradation

Habitat fragmentation and degradation will be avoided through minimising human and vehicle access to river and creek bed and banks. Construction of dedicated river/watercourse crossings (as far as practical) will reduce the need for personnel, equipment, machinery and plant to traverse the river/watercourse and limit disturbance to bed and banks. A Project Erosion and Sediment Management Control Plan will be implemented to limit degradation of downstream habitat areas used for foraging, roosting and breeding of migratory bird populations.

Design will incorporate stormwater management infrastructure and mechanisms to minimise the change in flow regime of watercourses where appropriate and mitigate potential scour. This may include holding tanks and/or gross pollutant traps.

Disturbance and displacement of species

Vegetation clearing will be undertaken in a sequential manner to allow any migratory bird populations present to disperse away from clearing areas. Prior to clearing, all demarcated habitat features will be checked for migratory bird species by a fauna spotter and at risk species will be relocated as required. A Fauna Species Relocation and Salvage Plan (part of the Rail and Offsite Infrastructure Threatened Species Management Plans (SEIS Volume 4, Appendix C3)) will be developed to facilitate relocation of migratory bird individuals and/or nests according to species requirements (particularly if foraging, breeding or roosting populations are encountered during clearing activities). A fauna mortality register will be maintained to document the location and frequency of mortality and the fauna species most susceptible to injury and death, to enable on-going modifications to fauna conservation management strategies where necessary.

Rehabilitation of cleared areas will occur as soon as practicable after cleared areas are no longer required. Areas to be cleared will be demarcated onsite and clearance operations will be supervised by a suitably experienced ecologist to monitor compliance with clearance extents and for avoidance of impacts to fauna.

Weeds, pests and fire risk

Fauna fencing, speed limits, fire controls, light spill controls, dust suppression, pest and weed controls will be utilised onsite to minimise direct or indirect impacts to migratory birds.

5.1.2.2 Rail operation

Description of activities

The operational footprint of the rail infrastructure includes the 95 m wide rail corridor and permanent infrastructure, including:

- Rail corridor (95 m wide) (fenced and inclusive of maintenance/service road, passing loops and bad order sidings)
- Rolling stock maintenance yard (western end of the Project)
- Ballast and material stockpiles
- Borrow 7

Operation of the Project (Rail) will enable transportation of up to 100 Mtpa to port. Rail operation will occur 24 hours, 7 days a week, for a period of up to 90 years. No clearing of vegetation is expected to occur within the operation phase of the Project (Rail) other than that required for maintenance of infrastructure and access tracks.

Potential impacts

Potential impacts arising from the operation of the Project (Rail) may include:

- Wildlife disturbance
  - Fauna mortality
- Introduction of pest and weed species:
  - Competition with native species, predation of native species
  - Habitat degradation (presence and prevalence of pest and weed species) and reduction in resource availability

- Alteration to air quality and noise environs from altered exposure to disturbance:
  - Disturbance to roosting and foraging areas
  - Habitat degradation from dust settling

Injury or mortality of species

Operation of the Project (Rail) represents an increased risk to migratory birds from train and maintenance vehicle strikes. The risk to migratory birds posed by vehicular traffic is significantly less than the risk posed throughout the construction phase of the Project (Rail) as vehicular traffic will be lower than that during the construction phase. Vehicles movements will be controlled by enforced speed limits particularly in areas of known foraging, roosting or breeding habitat; it is not considered likely that adverse impacts on migratory birds will result as a consequence of train or vehicle strikes during operation.

Disturbance and displacement of species

The higher intensity of activity at and near disturbed areas associated with the Project (Rail) operations may disrupt the behaviour of migratory bird populations, 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 migratory bird populations).

Weeds, pests and fire risk

Increased movement of people, vehicles, machinery, vegetation waste and soil may facilitate the spread of weeds within the operational area. Pest and feral species may disrupt ecosystems by outcompeting and replacing native species and increasing predation pressures, thus altering ecosystem diversity and potentially disrupting ecosystem function of foraging, roosting or breeding habitat. Additionally, feral animals such as the cane toad have been known to prey on the eggs and nestlings of migratory birds (DSEWPaC, 2011f).

Eleven introduced plants were detected within the Study Area, of which, three are ‘declared plants’ under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act). Increasing the prevalence of weeds within the operation footprint and the potential for weed spread beyond to the surrounding landscape may reduce the quality of habitats for some migratory bird populations.

The introduction of weeds and pests as well as indirect impacts to vegetation (e.g. dust settlement) can influence foraging and other migratory bird population behaviours. These anthropogenic influences can therefore result in increased mortality potential, including potential consequence of a change in the fire regime of the site.

Mitigation and management measures

Injury or mortality of species

Incidents of fauna strike and mortality will be monitored during operation. Carcases will be disposed of away from the rail corridor to reduce the occurrence of predators, such as raptors and pest fauna, also being struck by moving trains. Operational areas will be appropriately fenced to restrict the ability of fauna to move across the rail line.

Disturbance or displacement of species

The railway infrastructure will not be lit, with the exception of the balloon loop and maintenance facility. This will mitigate any potential lighting impacts on fauna behaviour for the majority of the length of the corridor.

Habitat fragmentation and degradation

Operation of the rail infrastructure will result in landscape fragmentation on a local scale. Design of the Project (Rail) aimed to minimise impacts as far as practical by avoiding fragmenting habitat. Other measures that will be implemented during operation of the Project (Rail) to mitigate and ameliorate potential fragmentation and degradation of roosting, foraging and breeding habitat include establishment of sediment traps at strategic locations to protect water bodies from sediment and pollutants.

Weeds, pests and fire risk

Fencing, fire controls, pest and weed controls will be incorporated into the EMP (operation) to minimise direct or indirect impacts to migratory bird populations including roosting, foraging and breeding habitat areas

5.1.2.3 Mine construction

Description of activities

Construction of the Project (Mine) will include development of the Mine and Mine (offsite) infrastructure, including a workers accommodation village, an industrial area, a permanent airport and water supply infrastructure.

Construction of the Project (Mine) will be progressive with a timeframe that achieves peak production within 10 years. There is an initial intense construction phase (first three years) to realise first Mine activity. Rehabilitation and progressive development will occur throughout the life of the Project (Mine).

Potential impacts

Potential impacts arising from construction of the Mine (onsite and offsite infrastructure) may include:

- Loss of fauna habitat (including roosting, foraging and breeding areas) - clearing of land during the construction phase of the Project is proposed to result in a loss of approximately 24 ha of remnant vegetation and approximately 2,599 ha of non-remnant vegetation. One permanent dam (Brigalow Dam) will also be lost as a result of Project construction
- Landscape fragmentation, reduction in connectivity and reduced capacity for fauna dispersal
- Degradation of terrestrial and aquatic habitat adjacent to and downstream of cleared areas, including erosion of surface soils
- Fauna mortality

Habitat loss

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. The main value of these dams is drinking water for fauna however, the dams may also be utilised by some threatened bird species as well as commonly occurring listed migratory species. While the dam is likely to represent a localised water source for fauna, potentially including migratory species, water is readily available from other farm dams throughout the surrounding agricultural landscape

The existing cleared land that dominates the Project (Mine) construction area has relatively low terrestrial ecological value, and supports a lower diversity of flora and fauna species than more complex habitats featuring remnant vegetation. During various field surveys, these cleared areas were generally not found to provide a suite of habitat resources for migratory species.

Changes to hydrology

There are no mapped water bodies within the workers accommodation village or industrial precinct and permanent airport. However, construction of the offsite water supply infrastructure will result in temporary disturbance of aquatic habitats while pipelines are buried under streams and drainage lines, including barriers to flow, temporary diversions, disconnection of the floodplain and changes to surface flows.

The disturbance of the riparian zone may trigger erosion and sedimentation impacts and resulting degradation of adjacent and downstream habitats. Management measures will be implemented during construction to mitigate potential impacts to downstream water bodies that could influence matters of NES. These would include changes in water quality as a result of erosion, introduction of contaminants, wastes or other pollutants.

Alteration of the topography of the landscape to achieve development of the Mine infrastructure will result in changes to surface flows and geomorphology. The existing open grazing land will be compacted and developed and, as such, the resultant land will have a higher potential for runoff. Appropriate stormwater management, including use of water storage dams, will be required to manage potential for erosion and scouring from runoff to manage risk of contaminants entering watercourses.

Injury or mortality of species

Injury and mortality may occur where animals are struck by vehicles or plant.

Disturbance and displacement of species

Behavioural disruption may also arise as a result of increased vehicular activity and a change in disturbance types at the Study Area, such as increased dust mobilisation and increased exposure to noise, light and vibration.

Weeds, pests and fire risk

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. Introduction and/or spread of weeds and pest species may occur from construction works. In particular, rubbish and wastes associated with the workers accommodation village may attract feral animals such as pigs and dogs, which would adversely affect native biodiversity. Measures will be required to manage pests, weeds and wastes to minimise potential impacts from weeds and pests on the ecological integrity and functioning of non-disturbed lands and waterways.

Mitigation and management measures

Habitat loss

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 EIS 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.

Detailed design will aim minimise the extent of land to be cleared for the construction of the Mine and Mine (offsite) infrastructure. Where land clearing is required, the following management and mitigation measures will be implemented to minimise impacts:

- The extent of vegetation clearing will be identified on construction plans and in the field. Areas that are not to be cleared or damaged will be identified on construction plans and in the field. Clearing extents will communicated to all necessary construction personnel and clearing activities will be supervised by an ecologist to monitor compliance of vegetation clearing with the defined clearing extents.
- Each water supply storage facility (offsite infrastructure) will include an associated storage area, which will be located, where possible, within existing cleared, non-remnant or disturbed areas.
- Management of land disturbed as a result of construction works will occur in accordance with the Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2). 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). The objective of land rehabilitation will be to provide habitat resources for those localised flora and fauna assemblages identified in EIS Volume 2, Section 5 Mine Nature Conservation.
- Vegetation clearing will be undertaken in a sequential manner to allow mobile fauna to disperse away from clearing areas. Prior to clearing, all demarcated habitat features will be checked for fauna by a fauna spotter-catcher and at-risk species will be relocated. A Fauna Relocation Plan (a component of the Land Management (Flora and Fauna) Plan) will be developed to facilitate relocation of fauna individuals according to species requirements (particularly if conservation significant fauna species are encountered during clearing activities). A fauna mortality register will be maintained to document the location and frequency of mortality and the fauna species most susceptible to injury and death, to enable on-going modifications to fauna conservation management strategies where necessary.

Habitat fragmentation and degradation

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. Vegetation clearing will be minimised through the implementation of the habitat loss mitigation measures outlined above.

Changes to hydrology

Detailed design will incorporate stormwater management infrastructure and mechanisms to minimise the change in flow regime of watercourses where appropriate and mitigate potential pollution. This may include holding tanks and/or gross pollutant traps. Existing access tracks will be used where possible and new tracks will align to traverse previously disturbed areas. Where watercourse crossings are required, crossing locations will be selected to avoid or minimise disturbance to aquatic flora, waterholes, watercourse junctions and watercourses with steep banks.

A Project Erosion and Sediment Control Plan will be implemented to limit degradation of downstream aquatic habitat. If temporary stream or channel diversions are required to facilitate activities in wet periods, stream flow will be maintained to provide connectivity between aquatic habitats and facilitate aquatic fauna passage.

Weeds, pests and fire risk

Waste management, fire controls, pest and weed controls will be utilised onsite to minimise direct or indirect impacts to fauna or flora due to weeds, pests and fire. All environmental controls will be documented within the EMP (construction).

5.1.2.4 Mine operation

Description of activities

The operation phase of the Project (Mine) will involve the following activities:

- Underground mining staged through development with subsidence of mined areas
- Open cut mining staged through development and rehabilitation of pits over the duration of the Mine life
- Management of overburden through disposal (out of pit waste dumping) and development and rehabilitation of waste areas over the duration of the Mine life
- Development and maintenance of clean water diversion drains to be established along the boundary of the Study Area, and separating clean inflows from dirty water areas
- Operation of offsite water supply infrastructure
- Operation of a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure
- Establishment of sediment ponds to receive water from mining operations
- Development and maintenance of a 500 m buffer from the centre of the Carmichael River, with establishment of a flood levee bordering the 500 m buffer zone adjacent to the Carmichael River

The staged, non-sequential operation of the Mine is proposed to occur over 60 years and will include:

- Underground mining in the west of the Project (Mine) Area
- Open cut mining in the centre of the Project (Mine) Area
- Overburden disposal (out of pit waste dumping) and water management dams in the east of the Project (Mine) Area

Potential impacts

Potential impacts to migratory species due to operation of the Project (Mine) will include:

- Habitat loss resulting from vegetation clearing and changes to topography and the resultant potential for fauna mortality
- Habitat fragmentation and degradation (i.e. erosion of surface soils, degradation of water quality)
- Changes to hydrology resulting from disturbance of surface watercourses and removal of watercourses/water bodies leading to:
  - Fauna mortality
  - Loss of habitat for species
  - Alteration/degradation of water quality
- Introduction of pest and weed species:
  - Competition with native species, predation of native species
  - Habitat degradation (presence and prevalence of pest and weed species) and reduction in resource availability
- Altered exposure to noise, light and dust disturbances, causing:
  - Disturbance to roosting and foraging areas
  - Habitat degradation from dust settling

Habitat loss

Land clearing for the Project's operation phase will reduce the local availability of habitat resources for listed migratory birds present within the Project Area. Vegetation clearing will be sequential and will not occur across the entire mining footprint in a single event. The staged loss of habitats, over the life of the Mine, will reduce the local availability of foraging, breeding and shelter resources for migratory species.

If migratory birds are present during clearing, it is possible they will disperse away from the developed parts of the Study Area (either temporarily and/or permanently), 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

As such, while large tracts of habitat suitable for these matters of NES will be affected, alternative habitat suitable for these species exists adjacent to the Study Area and within the broader region.

The loss of habitat, is a considerable impact of the Project. The EPBC Act and State offset policy will be addressed in terms of the offsetting requirements.

Additional information regarding offset requirements for the Project is provided in Section 8.

Habitat fragmentation and degradation

Mine operations may reduce the ability for fauna to disperse across the landscape by fragmenting the landscape, thereby reducing fauna corridors and increasing foraging dispersal distance for local migratory species.

Land clearing will also result in an increase in exposed earth surfaces and a reduction in vegetated buffer between habitat locations, potential increasing the potential for habitat degradation through edge effects.

Changes to hydrology: surface water

Staged clearing of the land within creek catchments and creation of dams associated with offsite water supply infrastructure has the potential to disturb bed and bank substrates and lead to localised erosion and sediment transport to downstream habitats.

The primary impact to aquatic habitats will relate to mobilisation of sediments and other contaminants into the aquatic environment. However, the potential impacts to these habitats are not expected to have an impact on migratory species on a regional scale as:

- The Study Area does not support an important population of any of migratory species
- The species are well represented in landscapes that surround the Study Area, where suitable alternative habitat is prevalent and will persist
- The species are not considered to be dependent upon any habitat within the Study Area for any particular lifecycle stages

Underground mining will result in subsidence potentially altering the local topography above underground mining areas and, in the long-term, altering surface hydrology patterns and vegetation assemblages. The area of land potentially subject to the impacts of subsidence is 6,827 ha. Whilst flow from upstream within the catchment is proposed to be diverted away from this area, it is expected that some flow will occur in this area as a result of localised rainfall. There is potential for this water to accumulate in subsidence depressions, creating new surface water resources. These water resources may not be drained, but rather kept to support the ecological values of the system. Design of the underground Mine plan should seek to minimise the potential for alteration to surface topography (and overland flows), such that impacts to vegetation communities and fauna habitats in these areas are minimised.

Injury or mortality of species

Vegetation clearing for Mine operation may also result in injury or mortality where animals are struck by vehicles or plant. Animals that are unable to disperse away from areas under active clearing are particularly susceptible to injury or death. Management and mitigation measures to reduce the potential for fauna mortality as a result of land clearing activities during Mine operations are largely analogous to those described for the construction phase of the Project.

Disturbance and displacement of species

Habitat degradation and behavioural disruption may arise as a result of increased activity around the Mine site. Habitat degradation and associated behavioural disruption may result from increased dust mobilisation and increased exposure to noise, light and vibration. Increased human activity may also alter the fire regime of the landscape, which could affect vegetation and fauna. These processes will potentially disturb or displace migratory species.

Weeds, pests and fire risk

Pest and weed management is important to mitigate potential indirect impacts to migratory species and habitat, such as the effects of dog and cat population densities on mortality of migratory birds. To manage risk and potential for pest and feral species spread, and the potential for introduction of new feral species, during operation of the Project (Mine) an integrated suite of actions will be implemented.

Mitigation and management measures

Habitat loss

The management of impacts to migratory 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 Project Area
- Weed and pest animal monitoring and management within the Project Area
- Monitoring of species populations during breeding months to gain an understanding of the species' use of the area on a local scale.

Where native vegetation clearing is required, the following management and mitigation measures will be implemented:

- The extent of vegetation clearing will be restricted to the minimal amount necessary for mining operations. During initial mining operations, only mining areas subject to the first stage of sequential clearing will be impacted. Vegetation clearing or the disturbance of areas that are not subject to mining will be minimised prior to their operational dates.
- The extent of vegetation clearing for each stage of mining operation will be identified on construction plans and in the field. Areas that must not be cleared or damaged will also be identified on construction plans and in the field. Clearing extents will be communicated to all necessary construction personnel involved.
- Vegetation clearing operations are to be supervised by an ecologist to monitor compliance of vegetation clearing within the defined clearing extents.
- Prior to clearing of any remnant vegetation, the non-remnant areas that will remain unmined should be revegetated and managed to reach remnant status (to match pre-clearing extent). This will be detailed in the Project Land Management (Flora and Fauna) Plan.
- Where land clearing occurs near or within ephemeral waterways, this will be undertaken during dry conditions to minimise the likelihood of erosion and sediment mobilisation during and after rainfall events.

- Prior to construction and mining operation, baseline field surveys to identify initial weed populations and ongoing monitoring of these populations and for any new occurrences are to be undertaken. Any weed populations identified are to be actively managed with the goal to reduce the spread of and eradicate weed species from the Study Area. This will be detailed in the Project Weed and Pest 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 to strive to achieve a 'no net loss of vegetation and watercourse' approach. This is to include, but not be limited to, measures including the reinstatement of drainage channels, riparian vegetation, and soil profiles to the pre-mining extent, using flora species of local provenance and undertaking revegetation activities. Management of previously disturbed land will occur in accordance with the Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2). This plan will detail how disturbed land (including watercourses) will be managed and rehabilitated, including (but not limited to) details about seed collection, flora regeneration and landscape architecture (i.e. topography). The objective of land rehabilitation should be to provide habitat resources for localised flora and fauna assemblages.

Habitat fragmentation and degradation

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

- Staged Mine development will seek to maintain east-west connectivity where possible throughout the Mine's operational life. The strip of land to be protected on either side of the Carmichael River will be managed so as to maintain and provide biodiversity values.
- Vegetation clearing will be undertaken in a sequential manner to allow more mobile fauna species the opportunity to disperse away from clearing areas. Employees will be made aware of environmental management requirements for vegetation clearing and fauna management and all employees will adhere to requirements at all times.
- Management of land that is yet to be mined, or is to remain unmined, will be undertaken in accordance with a Project Land Management (Flora and Fauna) Plan. This plan will detail how land not subject to direct impacts (i.e. vegetation clearing) should be managed (including details relating to land use (cattle grazing) and fire management), such that the terrestrial ecological values, including connectivity, of such areas are maintained, and where possible, enhanced. This plan will be implemented in conjunction with its component sub-plans relating to the maintenance/enhancement of terrestrial ecological values of undeveloped parts of the Study Area (i.e. Project Species Specific Management Plan(s) (SEIS Volume 4, Appendix C3 Rail Applications).

Changes to hydrology: surface water

Management actions to mitigate risks to aquatic habitats are identified as follows:

- Design and sequencing of site use to incorporate stormwater management infrastructure and mechanisms to manage runoff. Stormwater management mechanisms and monitoring requirements will be developed prior to any operational activities for each operational area of the Study Area (as it is progressively developed) and incorporated in the Water Quality Management Plan.

- Activities that affect watercourse path, including stormwater flow paths or creation of dams, are not to commence until suitable diversion and management of flows is achieved to avoid unnecessary interruption of flows, erosion and water quality degradation.
- Vegetation clearing activities will, where possible, seek to avoid alteration to waterways such that the impacts to water quality and downstream flows are minimised to the greatest extent possible.
- Dust suppression activities to be undertaken where appropriate.
- Management of erosion and sedimentation will be undertaken in accordance with a Project Erosion and Sediment Management Plan.
- Management of potential contaminant or waste release, or emergency response to such, to be documented within the EMP (operation). Regular water quality monitoring to be completed to confirm adequacy of management and mitigation measures. Monitoring requirements, water quality targets, corrective actions and reporting requirements to be clearly articulated in an Operational Water Quality Management Plan, embedded within the EMP (operation).
- Natural attributes of any aquatic habitats created throughout the mining operation will be enhanced. This will be achieved using measures including establishment of riparian zones with suitable native species and 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. Rehabilitation of, or enhancement of, previously disturbed habitat at surface water courses and the creation of fringing habitat for terrestrial species adjacent to constructed water storages and dams will include a requirement for woody debris or other suitable structures that will promote establishment of aquatic flora and fauna. In addition, works will seek to identify and implement enhancement opportunities in newly created aquatic habitats that may arise as a result of subsidence. These measures will be identified within the Draft Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Draft Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2).
- No water will be sourced from the Carmichael River
- Sewage will be treated to Class A standard such that value and quality of aquatic habitats is not adversely impacted.

Injury or mortality of species

Management measures to reduce the potential impact of injury or mortality to individual animals, includes:

- Vegetation clearing will be undertaken in a sequential manner to allow fauna species the opportunity to disperse away from clearing areas. All vegetation clearing will be undertaken in the presence of a qualified fauna spotter-catcher. Pre-demarcated habitat features should be thoroughly checked by a fauna spotter-catcher prior to clearing. Provisions for the relocation of fauna should be made prior to the commencement of clearing.

- All vehicles and plant associated with vegetation clearing will adhere to site rules relating to speed limits. Speed limits will be developed, and clearly signposted so as to minimise the potential for road kill.
- Site inductions are to include education regarding the local fauna of the site and identification of protocols to be undertaken if fauna are encountered.

Weeds, pests and fire risk

To minimise the risk and potential for pest and feral species spread, and the potential for introduction of new feral species during operation, mitigation and management measures will include:

- A Project Waste and Resources Management Plan and Hazardous Substances Management Plan will be implemented, and include waste management and disposal protocols and procedures. This plan will incorporate protocols relating to the:
  - disposal of vegetation waste (in a manner that minimises potential for spread of weeds)
  - disposal of food scraps and the like (to minimise potential for pest animals to access food wastes).
- Monitoring for and management of introduced animals in and adjacent to cleared areas to occur in accordance with a Project Weed and Pest Management Plan. This plan will include details relating to the monitoring, management and where necessary eradication of pest animals.
- Management of weeds in and adjacent to cleared areas to occur in accordance with a Project Weed and Pest Management Plan. This plan will include details relating to the monitoring, management and where necessary eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols.
- Weed audits of areas to be developed (during staged mining operations) will be conducted at a suitable time of the year when growing conditions and identification of weed species are optimal. These audits should cover the applicable development area with a particular focus on high risk locations, such as areas of black soil so that appropriate scale weed mapping can be undertaken to identify weed hotspots, for incorporation into the Project Weed and Pest Management Plan.

Disturbance and displacement of species

Management and mitigation measures relevant to the disturbance and displacement of migratory species include:

- Directional lighting will be used where lighting is required.
- Dust suppression actions will be undertaken in all cleared areas, at stockpiles and on all unsealed roads at suitably regular intervals.
- Frequent maintenance of machinery and plant will be undertaken to minimise unnecessary noise and risk of sparks or other creating a fire hazard.
- Implement a Project Bushfire Management Plan (SEIS Volume 4, Appendix S2 Bushfire Management Plan) to document protocols and actions for preventing accidental fires, including how fuel loads are to be stored and maintained across the Study Area.

- Speed restrictions, adherence to roads and use of trained fauna spotters are required to minimise mortality risk to fauna from increased vehicular activity at site.

5.2 Eastern great egret

5.2.1 Ecology and legislation

The eastern great egret is a moderately large wading bird, listed as migratory (CAMBA, JAMBA, ROKAMBA) and marine under the EPBC Act. This species is widespread throughout southern and eastern Asia and Australasia (DSEWPaC, 2011e). Within Australia, the species occurs in all states and territories with major breeding colonies present along the coast of the Northern Territory, the Channel Country of south-western Queensland, north-eastern South Australia, the Darling Riverine Plains region of New South Wales and the Riverina region of New South Wales and Victoria (DSEWPaC, 2011e). The eastern great egret undertakes regular multi-directional movements, mostly to and from breeding colonies and toward the coast during the dry season (DSEWPaC, 2011e). Long-distance migrations within Australia and to New Zealand and Papua New Guinea are suspected (DSEWPaC, 2011e). The population of eastern great egrets has been estimated at between 25,000 to 100,000 individuals (DSEWPaC, 2011e).

The eastern great egret inhabits a wide range of wetland habitats including shallows of rivers, estuaries, tidal mudflats, freshwater wetlands, sewage ponds, irrigation areas and larger dams (Pizzey and Knight, 2007). Foraging occurs by wading through shallow to moderately deep water where fish, insects, crustaceans, molluscs, frogs, lizards, small birds and mammals are taken from the water and vegetation (DSEWPaC, 2011e). Breeding in this species is influenced by rainfall but generally occurs between November and April. In Australia, breeding colonies generally occur in wooded and shrubby swamps including mangrove forests, Melaleuca swamps, and mixed eucalypt/acacia/lignum swamps (DSEWPaC, 2011e).

5.2.2 Desktop results

The desktop assessment indicated that a number of EPBC Act migratory species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas, including the eastern great egret (*Ardea modesta*).

Table 31 Eastern great egret previously recorded or predicted to occur

Predicted to occur#		Previously recorded*		Recorded at Study Area	
Rail	Mine	Rail	Mine	Rail	Mine
✓	✓	x	x	✓	✓

5.2.3 Field survey methodology

Fauna surveys undertaken relevant to eastern great egret of the Study Area are outlined in Table 32.

Table 32 Eastern great egret field survey methodology

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Mine Study Area	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Post EIS			
Rail Study Area	Quarries MNES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013

Fauna surveys included regular standardised bird surveys undertaken at each assessment site using the methods recommended by Birds Australia. This involved a timed 20 minute (minimum) survey of a two hectare search area (2 ha) by one ecologist, recording the number of birds seen or heard calling, and the presence and composition of any mixed flocks.

5.2.4 Field survey results

The eastern great egret was recorded on one occasion during the September 2011 survey of the Rail Study Area and on four occasions across the three survey events of the Mine Study Area. The species was typically observed at farm dams. Group size ranged from a single bird to more than 10 birds. Field and desktop analysis provides an indication of habitat that may be utilised by the eastern great egret within the Rail and Mine Study Areas. These habitats have been mapped as fringing open forest/woodland habitat and natural and artificial water bodies. The distribution of these habitat types within the Study Areas and broader region is presented in Figure 32 and Figure 33.

5.2.5 Status in project area

Habitat at the Study Area is likely to be used on a temporary to permanent basis by this species. As the eastern great egret is common and widespread, and suitable habitat is likely to occur over much of the surrounding landscape, habitat at the Study Area is not considered to constitute ‘important habitat’ as defined in the Significant Impact Guidelines (DEWHA, 2009a), that is:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion (as defined in DEWHA, 2009a) of the population of a species, and/or
- Habitat that is of critical importance to the species at particular life-cycle stages, and/or
- Habitat utilised by a migratory species which is at the limit of the species’ range, and/or
- Habitat within an area where the species is declining (DEWHA, 2009a)

5.2.6 Threatening processes

Threating process include the loss and degradation of habitat as a result of alternation of water flows, draining and clearing of wetlands, burning of wetland vegetation, salinisation and invasion of weeds (DSEWPaC, 2011e).

5.2.7 Potential impacts

Potential impacts to migratory species have been discussed in detail in EIS Volume 2, Section 5 Mine Nature Conservation and SEIS Volume 4, Appendix J1 Revised Ecological Assessment Report, but are summarised for construction and operation of the Mine (including offsite infrastructure areas) below.

Habitat loss

An overall reduction in the localised extent of potential habitat for this species will occur as a result of clearing of 20 ha of habitat and the loss of 12 permanent dams associated with the Mine and 300 ha associated with the rail project.

If present, it is possible that the species may disperse away from the developed parts of the Study Area (either temporarily and/or permanently), 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.

5.2.8 Management and mitigation measures

In spite the Project’s recommended management and mitigation measures and the active rehabilitation of disturbed areas that will occur through the Project’s operational life, unavoidable loss of habitat for the Eastern great egret will occur. Management measures to be implemented to minimise the effects of habitat loss for the Eater great egret include:

- Active, targeted management of riparian habitat adjacent to the clearing footprint
- Rehabilitation to incorporate and sustain riparian structure and composition within the landscape
- Adherence to water quality management procedures to ensure any foraging habitat areas are not degraded

- Implementation of appropriate fire management procedures to reduce the risk of habitat loss
- Adherence to the Project Weed and Pest Management Plan will reduce the occurrence of predation on eggs, nestlings and individuals; additionally, management of weeds will reduce the likelihood of infestation and degradation of foraging and breeding areas.

The details for such management approaches and actions will consider the staged nature of operations, and will be detailed within Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail Applications) (under the overarching Project Land Management (Flora and Fauna) Plan).

5.2.9 Recovery plans, conservation advice and threat abatement plans

No recovery, conservation or threat abatement plans exist for the Eastern great egret in Australia.

5.2.10 Residual impacts and impact significance

The potential to realise a significant impact upon eastern great egret within the Study Area has been considered against criteria identified by DSEWPaC. In summary:

- The Study Area does not support an important population for this species
- The Study Area does not support an ecologically significant proportion of the population of this species
- Measures identified in Section 5.2.8 are expected to manage the potential to directly or indirectly impact this species
- This species is well represented in landscapes that surround the Study Area, where suitable alternative habitat is prevalent and will persist
- This species is not considered to be dependent upon any habitat within the Study Area for any particular lifecycle stages

As such, while large tracts of habitat suitable for this species will be affected, the Project is not predicted to result in significant adverse impacts to eastern great egret by:

- Substantially modifying (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroying or isolating an area of important habitat for the species
- Resulting in an invasive species that is harmful to the species becoming established in an area of important habitat for the species
- Seriously disrupting the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species

5.2.11 Offsets

As no significant impacts to the eastern great egret are predicted, offsets under the EPBC Act will not be required.

5.2.12 Conclusion

No significant impacts to the eastern great egret are predicted. A combination of mitigation and management measures to reduce potential impacts to eastern great egret will be implemented to avoid residual impacts to the species.

5.3 Rainbow bee eater

5.3.1 Ecology and legislation

The rainbow bee-eater is a medium-sized insectivore, listed as migratory (JAMBA) and marine under the EPBC Act. This species is widespread throughout Australia, eastern Indonesia, eastern Papa New Guinea and the Bismarck Archipelago (DSEWPaC, 2011f). Within Australia, the rainbow bee-eater occurs throughout the country, but population numbers are reduced in the severely arid regions of central and Western Australia and the species has not been recorded in Tasmania. Migratory patterns in this species are complex and vary between locations. Populations that breed in southern Australia migrate northward to northern Australia, Indonesia and Papua New Guinea in February to April. Populations that breed in northern Australia are considered to be resident with migration restricted to small-scale movements between habitats (DSEWPaC, 2011f).

The rainbow bee-eater inhabits open forests and woodlands, shrublands and various cleared habitats including farmland. The species is often recorded near permanent water, particularly in arid or semi-arid areas where riparian, floodplain or wetland vegetation assemblages are utilised. The rainbow bee-eater is commonly observed in disturbed habitats and areas of human habitation including roadside vegetation, quarries and mines (DSEWPaC, 2011f). The rainbow bee-eater primarily feeds on bees and wasps but other insects are also consumed. Foraging usually occurs in flight, but prey is also captured from the ground and from foliage (DSEWPaC, 2011f). In Australia, breeding occurs from August to January and nesting occurs in an enlarged chamber at the end of a long burrow or tunnel.

5.3.2 Desktop results

The desktop assessment indicated that a number of EPBC Act migratory species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas, including the rainbow bee eater (*Merops ornatus*).

Table 33 Rainbow bee eater previously recorded or predicted to occur

Predicted to occur#		Previously recorded*		Recorded at Study Area	
Rail	Mine	Rail	Mine	Rail	Mine
✓	✓	✓	✓	✓	✓

5.3.3 Field survey methodology

Fauna surveys undertaken relevant to rainbow bee eater of the Study Area are outlined in Table 34. Fauna surveys included regular standardised bird surveys undertaken at each assessment site using the methods recommended by Birds Australia. This involved a timed 20 minute (minimum) survey of a two hectare search area (2 ha) by one ecologist, recording the number of birds seen or heard calling, and the presence and composition of any mixed flocks.

Table 34 Rainbow bee eater field survey methodology

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Mine Study Area	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Post EIS			
Rail Study Area	Quarries MNES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013

5.3.4 Field survey results

The rainbow bee-eater was recorded on one occasion during the September 2011 survey of the Rail Study Area and on seven occasions across the three survey events of the Mine Study Area. Rainbow bee-eaters were also observed at the North Creek Quarry (potential burrows)), Back Creek and Disney Quarry (CDM Smith, 2013). The species was typically observed within open woodland and riparian habitats. Group size ranged from a single bird to around 60 birds. All habitats at the Study Area were considered to provide potentially suitable habitat for this species. Habitat at the Study Area is likely to be used on a temporary to permanent basis by this species. As the rainbow bee-eater is common and widespread, and suitable habitat is likely to occur over much of the surrounding landscape, habitat at the Study Area is not considered to constitute 'important habitat' as defined in the Significant Impact Guidelines (DEWHA, 2009a), that is:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion (as defined in DEWHA, 2009a) of the population of a species, and/or
- Habitat that is of critical importance to the species at particular life-cycle stages, and/or
- Habitat utilised by a migratory species which is at the limit of the species' range, and/or
- Habitat within an area where the species is declining (DEWHA, 2009a)

5.3.5 Threatening processes

The introduced cane toad, which feeds on eggs and nestlings, is the only identified threat to this species (DSEWPaC, 2011f).

5.3.6 Potential impacts

Potential impacts to migratory species have been discussed in detail in EIS Volume 2, Section 5 Mine Nature Conservation and SEIS Volume 4, Appendix J1 Revised Ecological Assessment Report, but are summarised for construction and operation of the Mine (including offsite infrastructure areas) below.

Habitat loss

An overall reduction in the localised extent of potential habitat for this species will occur as a result of clearing of 10,756 ha of habitat associated with the Mine Project and 2,703 ha and two dams associated with the Rail Project.

If present, it is possible that the species may disperse away from the developed parts of the Study Area (either temporarily and/or permanently), 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.

Weeds and pests

Increased human activity within the Project Area has the potential to lead to the introduction and increase of feral animal populations. This increase the risk of predation and mortality by feral animals.

5.3.7 Management and mitigation measures

Active management of potential habitats particularly those containing active riparian zones, to maintain ecologic processes including plant pollinator mutualism, preserve water quality, and prevent weed and pest infestation. Potential habitat bordering disturbed areas containing permanent water sources will be retained to provide a transitional refuse and suitable connectivity to adjoining potential habitat areas. These strategies can improve the quality for rainbow bee-eater habitats adjacent to the clearing footprint.

Monitoring and eradication of pest species will be undertaken as required.

In spite of the recommended management and mitigation measures, and the active rehabilitation of disturbed areas that will occur through the Project's operational life, unavoidable loss of habitat for rainbow bee eater will occur.

Further details of the active management approaches and actions are detailed within Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail Applications) (under the overarching Project Land Management (Flora and Fauna) Plan).

5.3.8 Recovery plans, conservation advice and threat abatement plans

No recovery, conservation or threat abatement plans exist for the rainbow bee-eater in Australia.

5.3.9 Residual impacts and impact significance

The potential to realise a significant impact upon rainbow bee-eater within the Study Area has been considered against criteria identified by DSEWPaC. In summary:

- The Study Area does not support an important population of this species

- The Study Area does not support an ecologically significant proportion of the population of this species
- Measures identified in Section 5.3.7 are expected to manage the potential to directly or indirectly impact this species
- This species is well represented in landscapes that surround the Study Area, where suitable alternative habitat is prevalent and will persist
- This species is not considered to be dependent upon any habitat within the Study Area for any particular lifecycle stages

As such, while large tracts of habitat suitable for the rainbow bee-eater will be affected, the Project is not predicted to result in significant adverse impacts to rainbow bee-eater species by:

- Substantially modifying (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroying or isolating an area of important habitat for the species
- Resulting in an invasive species that is harmful to the species becoming established in an area of important habitat for the species
- Seriously disrupting the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species

5.3.10 Offsets

As no significant impacts to the rainbow bee eater are predicted, offsets under the EPBC Act will not be required.

5.3.11 Conclusion

No significant impacts to the rainbow bee-eater are predicted. A range of mitigation and management measures to reduce potential impacts to rainbow bee-eater will be implemented to avoid residual impacts to the species.

5.4 Satin flycatcher

5.4.1 Ecology and legislation

The satin flycatcher is an insectivorous woodland bird, listed as migratory (Bonn) and marine under the EPBC Act. This species is widespread in eastern Australia and vagrant to New Zealand (DSEWPaC, 2011g). In central Queensland, the satin flycatcher is most common in coastal areas but is also scattered on the Great Divide and occasionally further west. The satin flycatcher overwinters in northern Australia and Papua New Guinea, returning to south-eastern Australia in the summer (DSEWPaC, 2011g).

Habitat for this species includes heavily vegetated gullies in forests, taller woodlands, trees in open country and coastal forests along eastern Australia (Pizzey and Knight, 2007). The majority of individuals are recorded in wet sclerophyll eucalypt forests near wetlands or watercourses (DSEWPaC, 2011g). Satin flycatchers forage in the canopy and sub-canopy of trees where they feed primarily on insects. Breeding in this species occurs during the summer period with nests usually located in a fork on an outer tree branch. Satin flycatchers return to the same locality each year, often nesting in the same tree (DSEWPaC, 2011g).

5.4.2 Desktop results

The desktop assessment indicated that a number of EPBC Act migratory species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas, including the satin flycatcher (*Myiagra cyanoleuca*).

Table 35 Satin flycatcher previously recorded or predicted to occur

Predicted to occur#		Previously recorded*		Recorded at Study Area	
Rail	Mine	Rail	Mine	Rail	Mine
✓	✓	x	x	x	✓

5.4.3 Field survey methodology

Fauna surveys undertaken relevant to satin flycatcher of the Study Area are outlined in Table 36. Fauna surveys included regular standardised bird surveys undertaken at each assessment site using the methods recommended by Birds Australia. This involved a timed 20 minute (minimum) survey of a two hectare search area (2 ha) by one ecologist, recording the number of birds seen or heard calling, and the presence and composition of any mixed flocks.

Table 36 Satin flycatcher field survey methodology

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Mine Study Area	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Post EIS			
Rail Study Area	Quarries MNES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013

5.4.4 Field survey results

Satin flycatchers were opportunistically recorded on two occasions during the spring surveys (2010 and 2011) of the Mine Study Area. The species was observed within the open woodland and farm dam habitats and two individuals were observed on each occasion. Habitat at the Study Area is likely to be used on a temporary to permanent basis by this species. As the satin flycatcher is common and widespread, and suitable habitat is likely to occur over much of the surrounding landscape, habitat at the Study Area is not considered to constitute ‘important habitat’ as defined in the Significant Impact Guidelines (DEWHA, 2009a), that is:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion (as defined in DEWHA, 2009a) of the population of a species, and/or
- Habitat that is of critical importance to the species at particular life-cycle stages, and/or
- Habitat utilised by a migratory species which is at the limit of the species’ range, and/or
- Habitat within an area where the species is declining (DEWHA, 2009a)

5.4.5 Threatening processes

The main threat to the satin flycatcher is the loss of mature forests in south-eastern Australia as a result forest clearing and logging.

5.4.6 Potential impacts

Potential impacts to migratory species have been discussed in detail in EIS Volume 2, Section 5 Mine Nature Conservation and SEIS Volume 4, Appendix J1 Revised Ecological Assessment Report, but are summarised for construction and operation of the Mine (including offsite infrastructure areas) below.

Habitat loss

An overall reduction in the localised extent of potential habitat for this species will occur as a result of clearing of 5 ha of habitat associated with the Mine Project and 361 ha of habitat associated with the Rail project.

If present, it is possible that the species may disperse away from the developed parts of the Study Area (either temporarily and/or permanently), 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.

5.4.7 Management and mitigation measures

In spite of the management and mitigation measures being implemented to minimise habitat loss due to vegetation clearing and the active rehabilitation of disturbed areas that will occur through the Project’s operational life, unavoidable loss of habitat for satin flycatcher will occur.

To minimise the impacts of habitat loss for the Satin Flycatcher active, targeted management of suitable habitat adjacent to the clearing footprint will occur prior to clearing of satin flycatcher habitats to encourage individuals to disperse from proposed clearing areas (or attract them to adjacent areas). This may include but not be limited to, improving foraging and nesting resources, increasing access to watering locations, and management of pest and weed species, to enhance the value of adjacent areas. This action will seek to minimise habitat loss (through replacement) and will also act to minimise potential for mortality by providing migratory species with habitat refugia within the operational landscape. The details for such management approaches and actions will consider the staged nature of operations, and will be detailed within Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail Applications) (under the overarching Project Land Management (Flora and Fauna) Plan).

5.4.8 Recovery plans, conservation advice and threat abatement plans

No recovery, conservation or threat abatement plans exist for the satin flycatcher in Australia.

5.4.9 Residual impacts and impact significance

The potential to realise a significant impact upon satin flycatcher within the Study Area has been considered against criteria identified by DSEWPaC. . In summary:

- The Study Area does not support an important population of satin flycatcher
- The Study Area does not support an ecologically significant proportion of the population of satin flycatcher
- Measures identified in Sections 5.4.7 are expected to manage the potential to directly or indirectly impact satin flycatcher
- Satin flycatcher are well represented in landscapes that surround the Study Area, where suitable alternative habitat is prevalent and will persist
- Satin flycatcher is not considered to be dependent upon any habitat within the Study Area for any particular lifecycle stages

As such, while large tracts of habitat suitable for satin flycatcher will be affected, , the Project is not predicted to result in significant adverse impacts to satin flycatcher by:

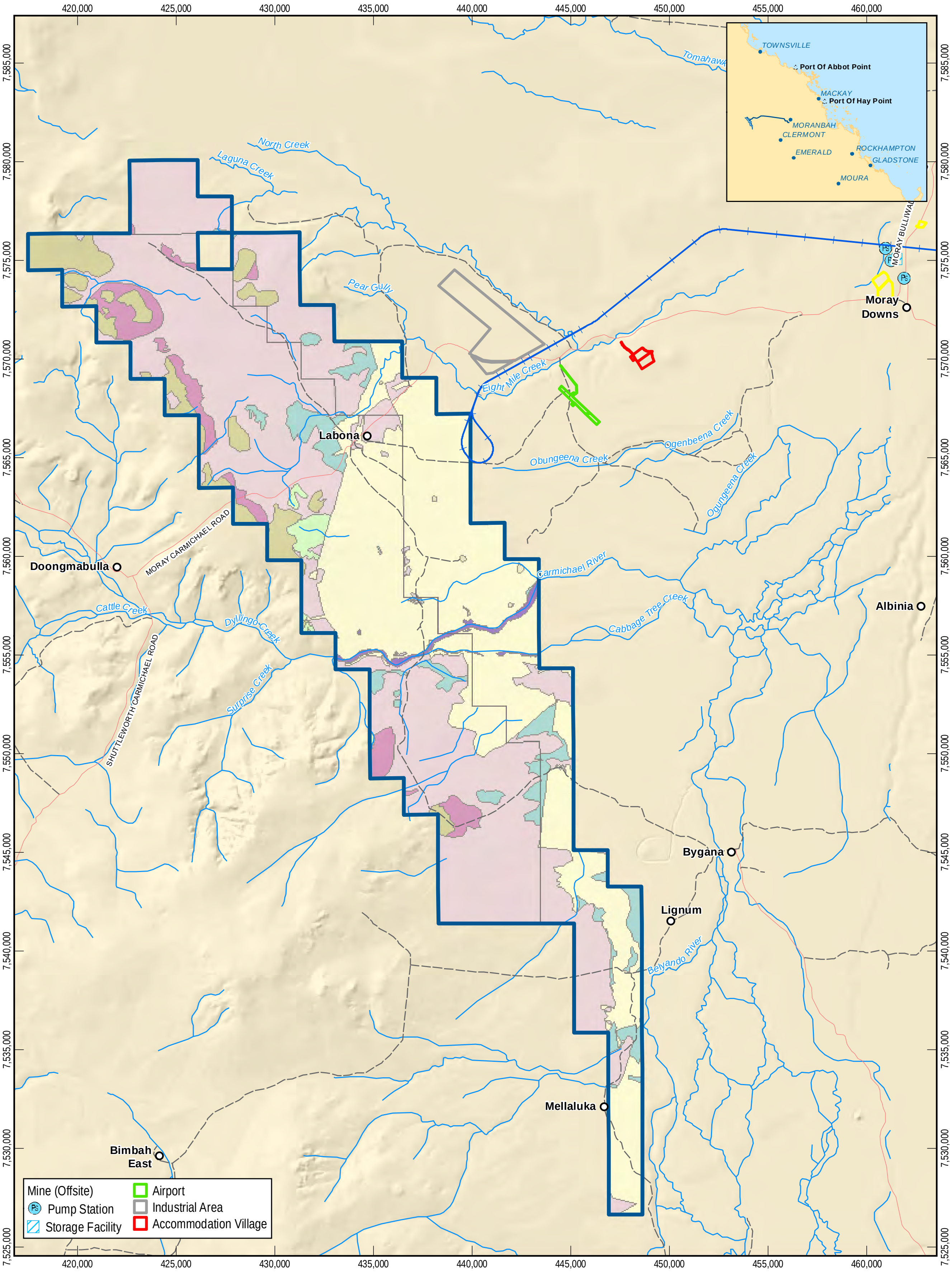
- Substantially modifying (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroying or isolating an area of important habitat for the species
- Resulting in an invasive species that is harmful to the species becoming established in an area of important habitat for the species
- Seriously disrupting the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species

5.4.10 Offsets

As no significant impacts to the satin flycatcher are predicted, offsets under the EPBC Act will not be required.

5.4.11 Conclusion

No significant impacts to the satin flycatcher are predicted. A combination of mitigation and management measures to reduce potential impacts to satin flycatcher will be implemented to avoid significant impacts to the satin flycatcher.



LEGEND

- Homestead
- Local Road
- Track
- Watercourse

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

- Project (Rail)
- Project (Mine)
- Quarry

Based on or contains data provided by the State of QLD (DNRM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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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

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GHD adani

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Vegetation communities of relevance to migratory fauna: Project Mine

Job Number	41-26422
Revision	C
Date	05-11-2013

Figure 32

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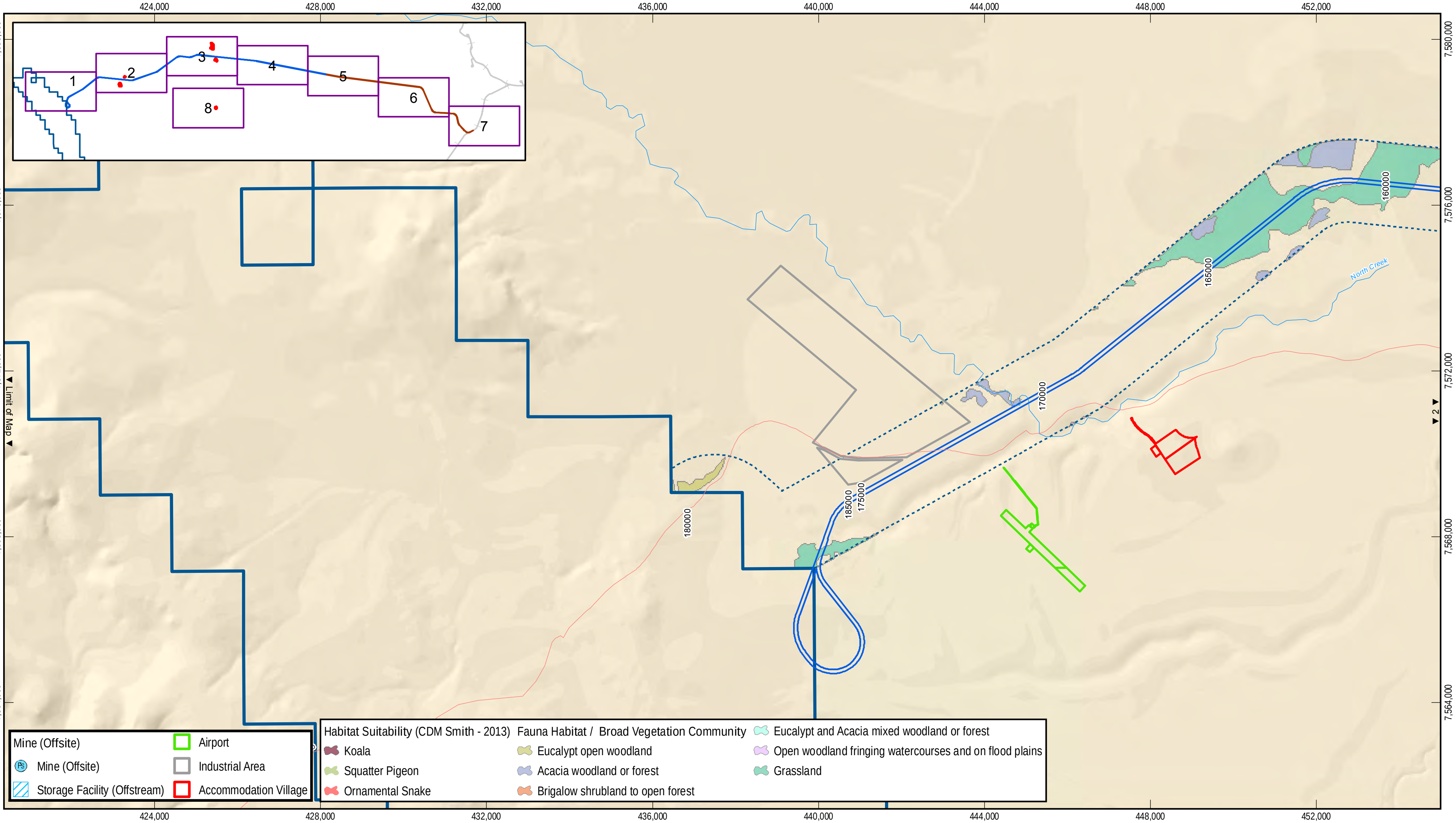
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DME: EPC 1690 (2010), EPC 1080 (2011); DNRM: Broad Vegetation Communities, Fauna Habitat Types (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road, Watercourse (2007); Adani: Quarry, Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013). Created by: BW, CA



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Kilometres

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

N

LEGEND

- State Road
- Local Road
- Other Railway
- Watercourse
- Study Area
- Mine (Onsite)
- Rail (West)
- Rail (East)
- Quarry

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Vegetation communities of relevance to migratory fauna: Project Rail

Job Number	41-26422
Revision	E
Date	05-11-2013

Figure 33
Sheet 1 of 8

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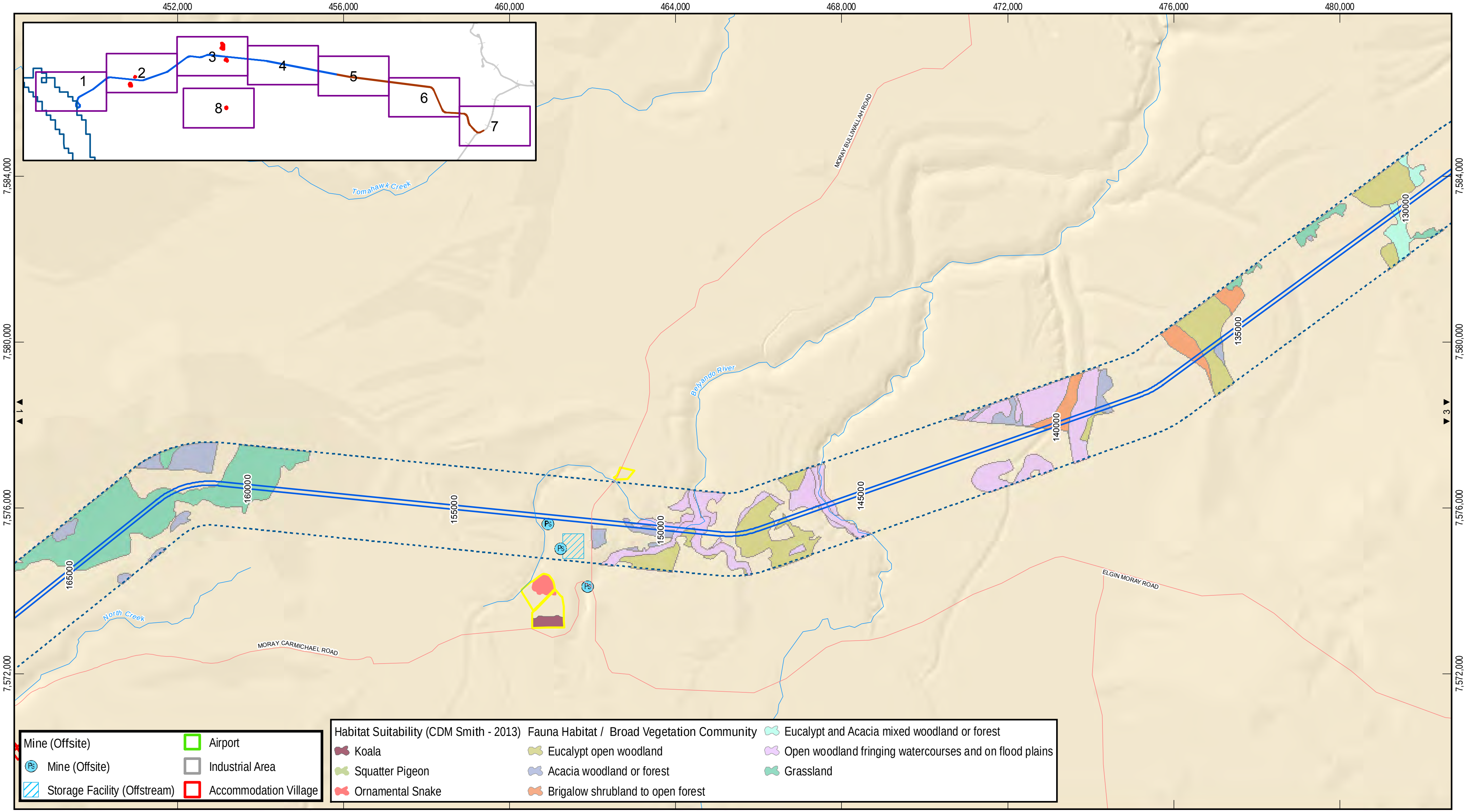
Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: DNRM: DEM (2008), Aquatic Habitat Type, Fauna Habitat / Broad Vegetation Type (2011); © Commonwealth of Australia (Geoscience Australia): Localities, Railways, Roads, Watercourse (2007);
Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013); DME: EPC1690 (2010)/EPC 1080(2011). Created by: BW, MS, CA



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0 1 2 3 4

Kilometres

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

N

LEGEND

- State Road
- Local Road
- Other Railway
- Watercourse
- Study Area
- Mine (Onsite)
- Rail (West)
- Rail (East)
- Quarry

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Carmichael Coal Mine and Rail Project

Job Number 41-26422
Revision E
Date 05-11-2013

Vegetation communities of relevance to migratory fauna: Project Rail

Figure 33
Sheet 2 of 8

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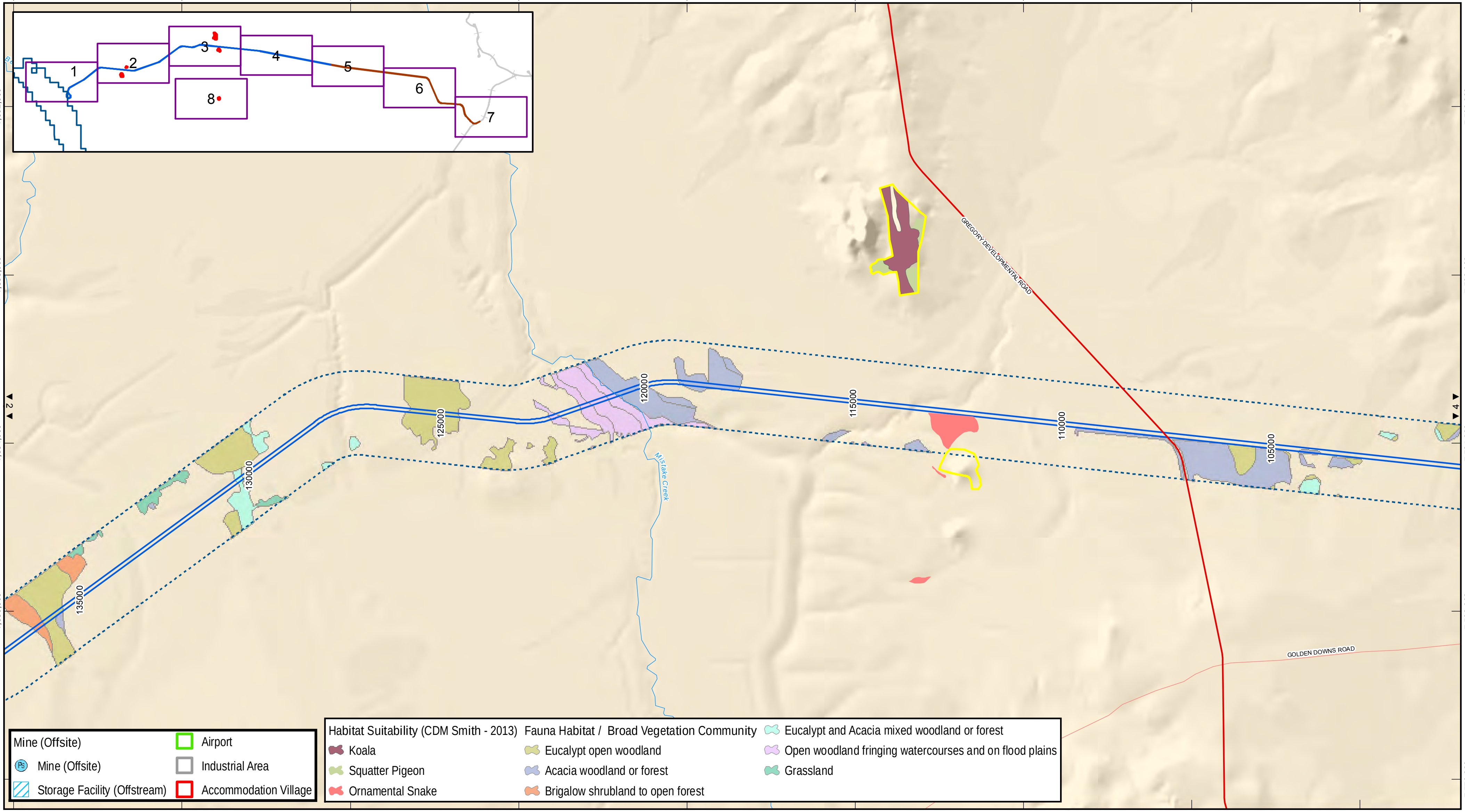

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Kilometres

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

N

LEGEND

State Road
Local Road
Other Railway
Watercourse
Study Area
Mine (Onsite)
Rail (West)
Rail (East)
Quarry

GHD adani

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Carmichael Coal Mine and Rail Project

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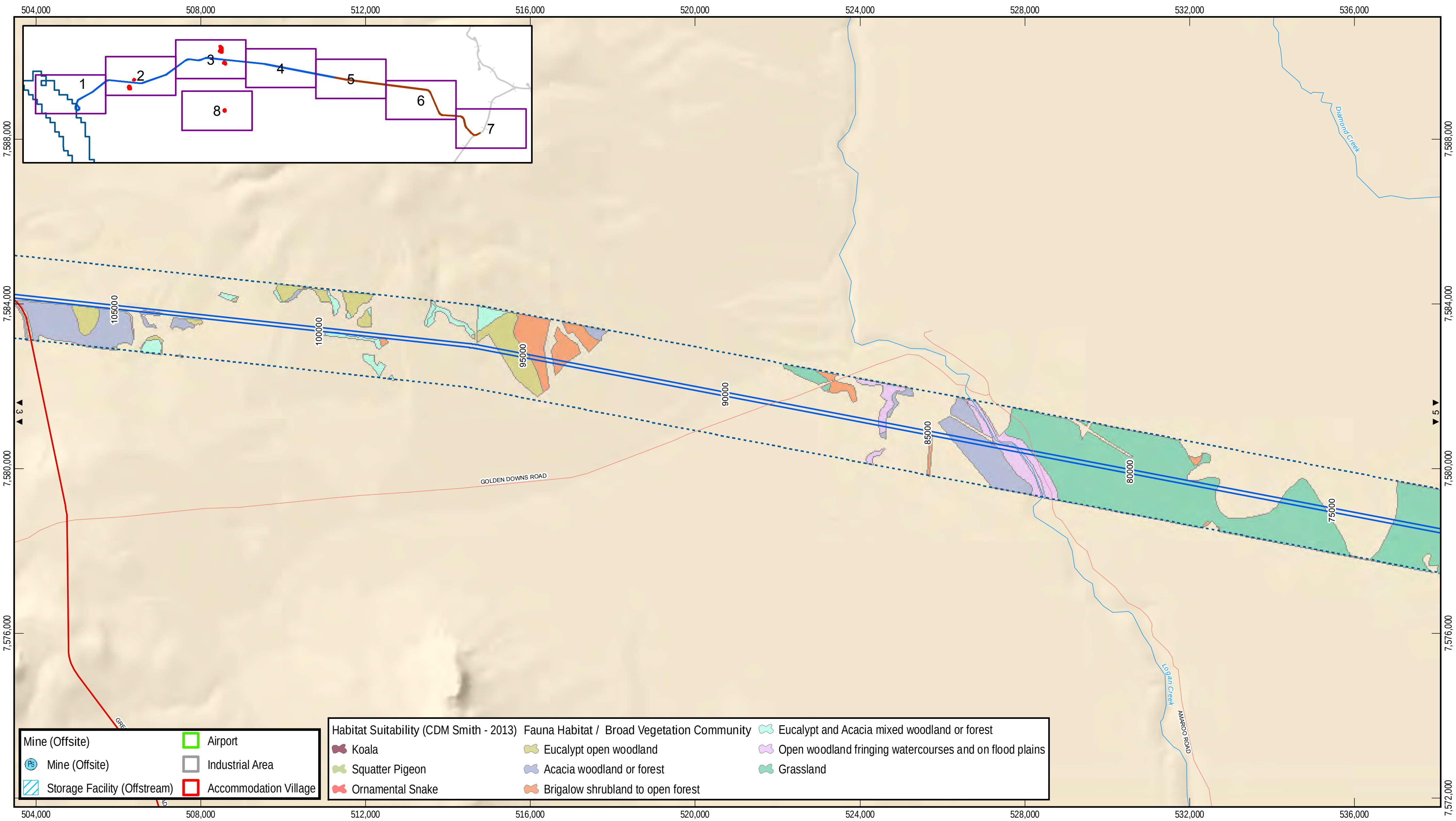

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Kilometres

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

N

LEGEND

State Road
Local Road
Other Railway
Watercourse
Study Area
Mine (Onsite)
Rail (West)
Rail (East)
Quarry

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Vegetation communities of relevance to migratory fauna: Project Rail

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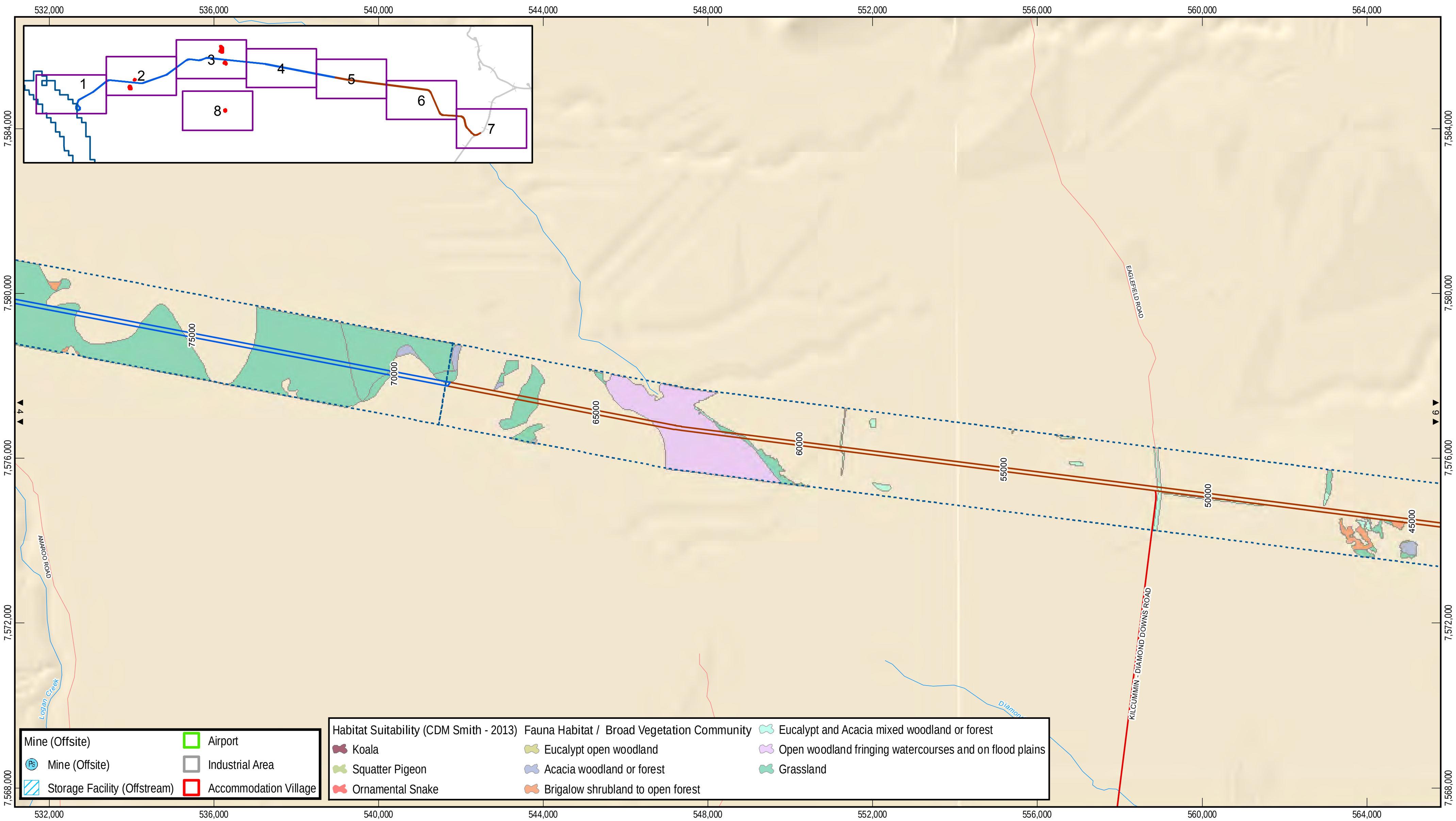

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Kilometres

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

N

LEGEND

State Road
Local Road
Other Railway
Watercourse
Study Area
Mine (Onsite)
Rail (West)
Rail (East)
Quarry

GHD adani

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Carmichael Coal Mine and Rail Project

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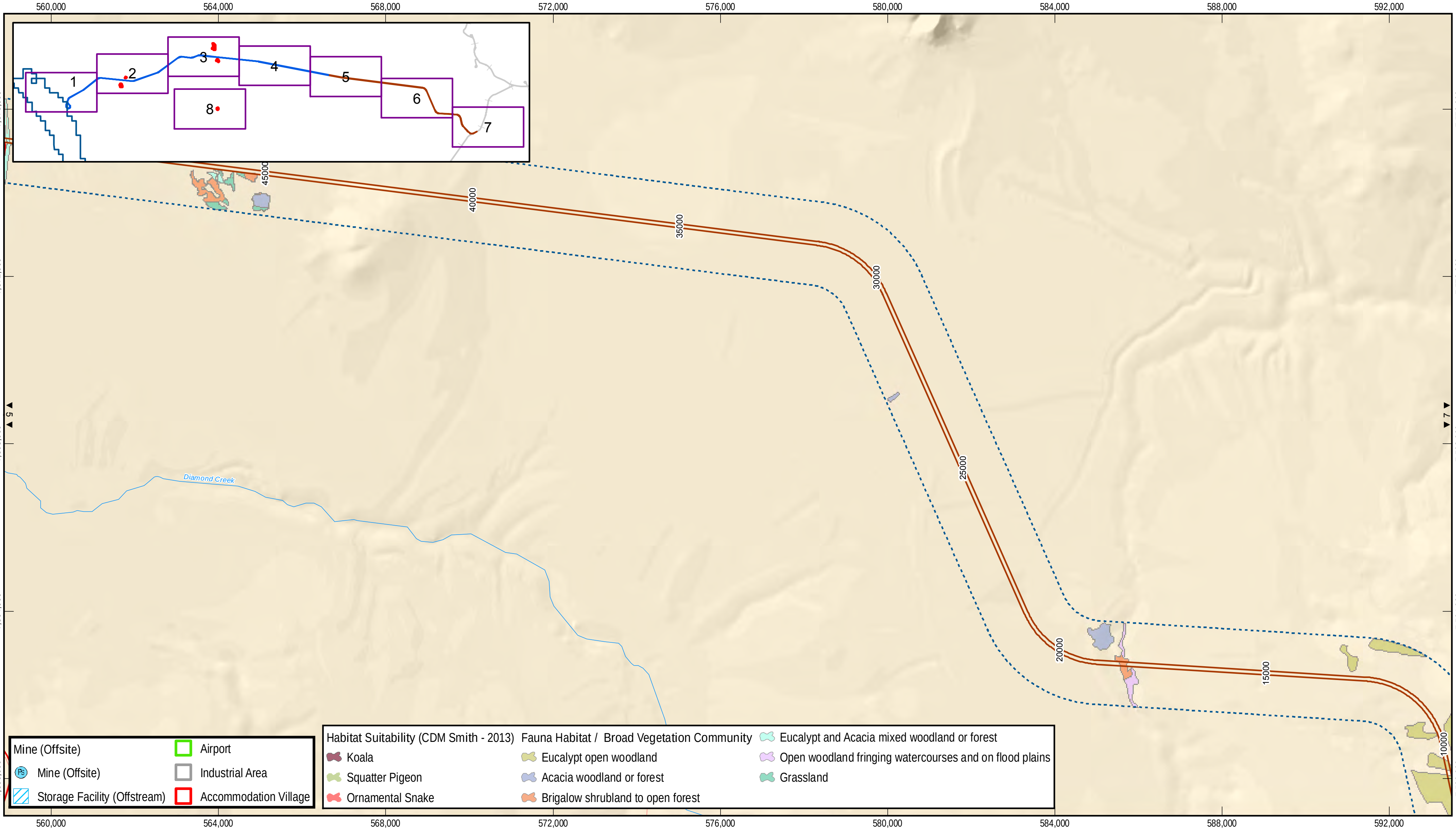

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Kilometres

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

N

LEGEND

State Road
Local Road
Other Railway
Watercourse
Study Area
Mine (Onsite)
Rail (West)
Rail (East)
Quarry

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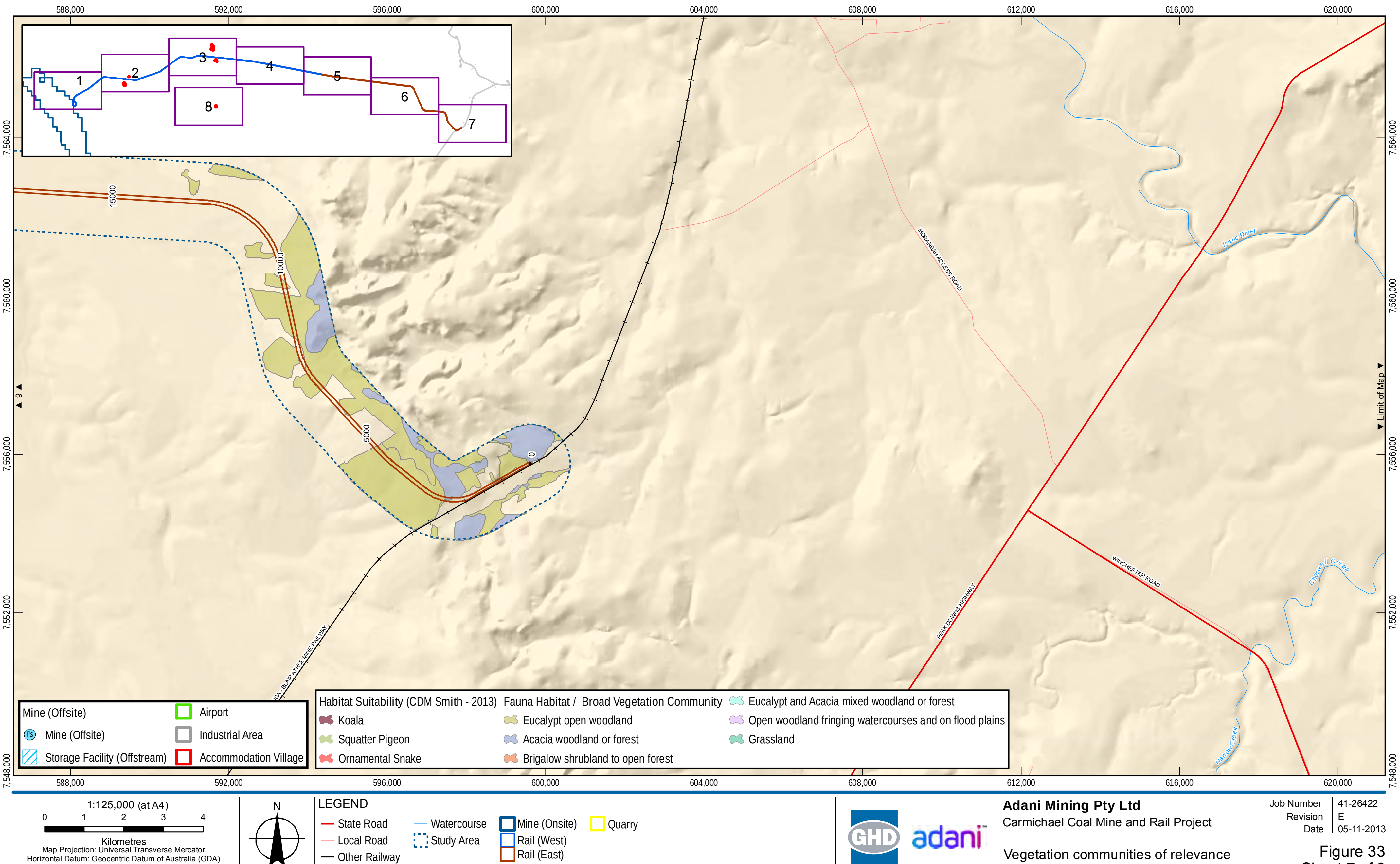

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Horizontal Datum: Geocentric Datum of Australia (GDA)
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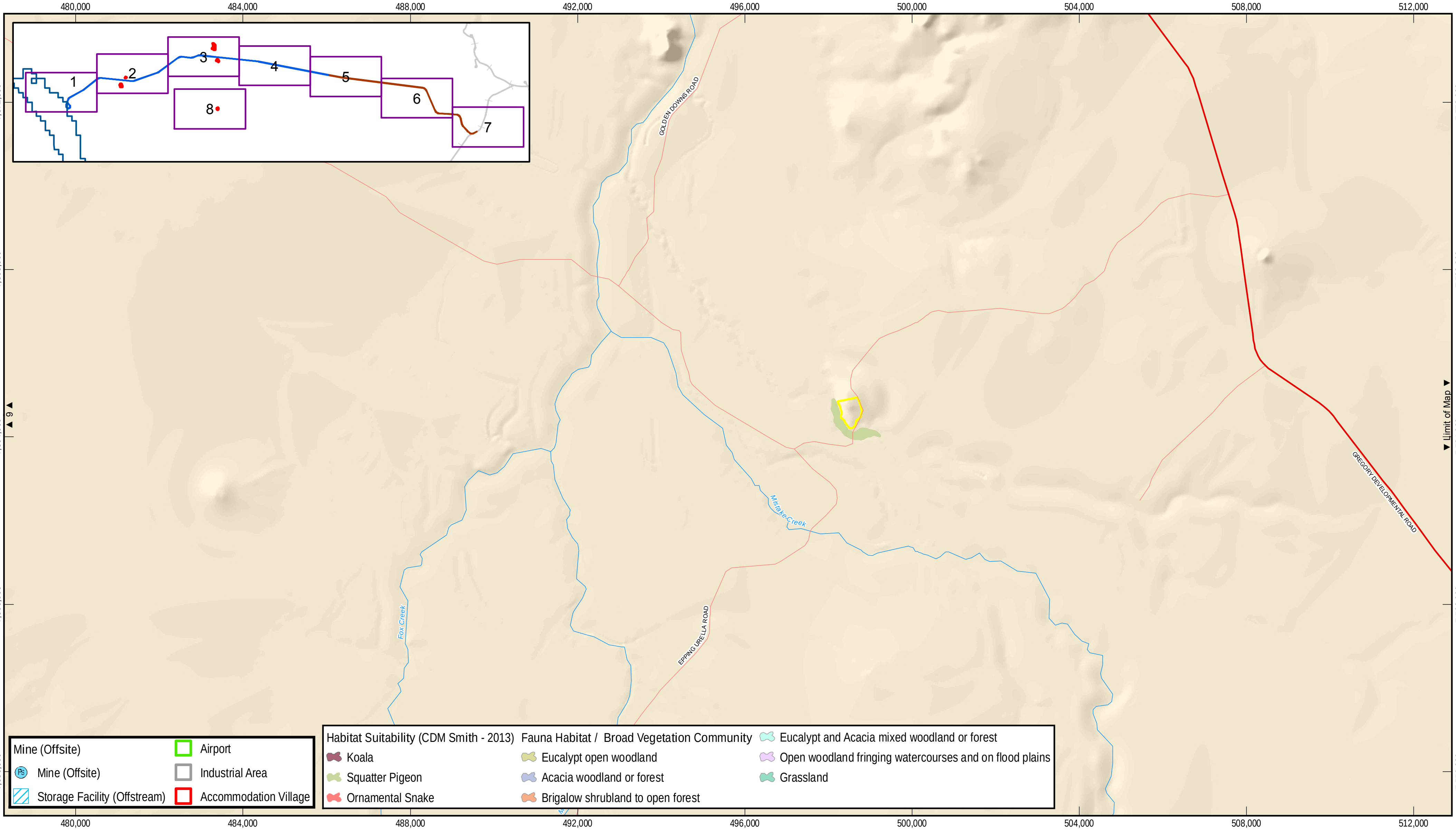

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Kilometres

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

N

LEGEND

- State Road
- Local Road
- Other Railway
- Watercourse
- Study Area
- Mine (Onsite)
- Rail (West)
- Rail (East)
- Quarry

GHD adani

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Carmichael Coal Mine and Rail Project

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5.5 Migratory species – likely to occur

5.5.1 Ecology and legislation

The following EPBC Act listed migratory species are likely to occur at the Study Area, based on distribution, presence of potentially suitable habitat and previous records from the region:

- Common sandpiper (*Actitis hypoleucos*) – migratory (Bonn; CAMBA; JAMBA; ROKAMBA) and marine EPBC Act – inhabits shallow, pebbly, muddy or sandy edges of rivers or streams from coastal to far inland areas including dams and lakes.
- Fork-tailed swift (*Apus pacificus*) – migratory (CAMBA; JAMBA; ROKAMBA) and marine EPBC Act – habitat preferences include open country from semi-deserts to coasts
- Curlew sandpiper (*Calidris ferruginea*) – migratory (Bonn; CAMBA; JAMBA; ROKAMBA) and marine EPBC Act – inhabits tidal mudflats, saltmarsh and saline and freshwater wetlands
- Latham's snipe (*Gallinago hardwickii*) – migratory (Bonn; CAMBA; JAMBA; ROKAMBA) and marine EPBC Act – habitat preferences include soft wet ground or shallow water with tussocks and other green or dead growth, wet parts of paddocks or near dams, scrub or open woodland.
- White-bellied sea eagle (*Haliaeetus leucogaster*) – migratory (CAMBA) and marine EPBC Act – inhabits coasts, estuaries, large rivers and inland lakes.
- White-throated needletail (*Hirundapus caudacutus*) – migratory (CAMBA; JAMBA; ROKAMBA) and marine EPBC Act – occupies airspace over forests, woodlands, farmlands, plains, lakes and favoured timbered ranges.
- Caspian tern (*Hydroprogne caspia*) – migratory (CAMBA; JAMBA) and marine EPBC Act – inhabits coastal and offshore waters, beaches, estuaries, larger rivers and lakes some inland
- Black-tailed godwit (*Limosa limosa*) – migratory (Bonn; CAMBA; JAMBA; ROKAMBA) and marine EPBC Act – widespread summer migrant to eastern Australia (Sept-April), mostly on the coasts but makes use of some inland lakes.
- Glossy ibis (*Plegadis falcinellus*) – migratory (Bonn, CAMBA) and marine EPBC Act – found in a broad variety of wetland habitats, including swamps, lagoons, rivers, irrigated paddocks and coastal regions. In Australia, it is most commonly observed on floodplains and inundated swamps and grasslands.
- Common greenshank (*Tringa nebularia*) – migratory (Bonn; CAMBA; JAMBA; ROKAMBA) and marine EPBC Act – inhabits mudflats, estuaries, saltmarshes, lake margins, wetlands and claypans.
- Marsh sandpiper (*Tringa stagnatilis*) – migratory (Bonn; CAMBA; JAMBA; ROKAMBA) and marine EPBC Act – inhabits wetlands, bore drains mangroves, tidal mudflats and estuaries

A number of habitat and vegetation types across the Study Area may provide habitat for these listed migratory species. Habitats likely to support the highest diversity of migratory species include:

- Fringing open forest/woodland
- Natural and artificial water bodies
- Eucalypt open woodland

As with the 3 bird species detected at the Study Area, these 11 species, assessed as being likely to occur, are common and widespread, and thus the Study Area is not considered to support 'important habitat', as defined in the Significant Impact Guidelines (DEWHA, 2009a), for any of these birds.

5.5.2 Desktop results

The desktop assessment indicated that a number of EPBC Act migratory species have been previously recorded or are predicted to occur within the desktop search extent encompassing the Mine and Rail Study Areas.

Table 37 Migratory species likely to occur in Study Area

Species	Predicted to occur#		Previously recorded*		Recorded at Study Area	
	Rail	Mine	Rail	Mine	Rail	Mine
common sandpiper *Actitis hypoleucos*	x	x	x	✓	x	x
fork-tailed swift *Apus pacificus*	✓	✓	✓	x	x	x
cattle egret *Ardea ibis*	✓	✓	x	x	x	x
curlew sandpiper *Calidris ferruginea*	x	x	x	✓	x	x
Latham's snipe *Gallinago hardwickii*	✓	✓	✓	x	x	x
white-bellied sea eagle *Haliaeetus leucogaster*	✓	✓	✓	x	✓	x
white-throated needletail *Hirundapus caudacutus*	✓	✓	✓	x	x	x
Caspian tern *Hydroprogne caspia*	x	x	x	✓	x	x
black-tailed godwit *Limosa limosa*	x	x	x	✓	x	x
glossy ibis *Plegadis falcinellus*	x	x	✓	x	x	x
common greenshank *Tringa nebularia*	x	x	x	✓	x	x
marsh sandpiper *Tringa stagnatilis*	x	x	x	✓	x	x

5.5.3 Field survey methodology

Fauna surveys undertaken relevant to migratory species in the Study Area are outlined in Table 38.

Table 38 Migratory species field survey methodology

Geography	Type of Survey	Survey Effort* (terrestrial, aquatic)	Time Completed
EIS			
Rail Study Area	Terrestrial and aquatic fauna	2 sites, 3 sites 22 sites, 1 site	Autumn: May 2011 Spring: September 2011
Mine Study Area	Terrestrial and aquatic fauna	69 sites, 19 sites 40 sites, 17 sites	Spring: November 2010 and November 2011 Autumn: April/May 2011
Offsite Infrastructure Area	Rapid assessment only Terrestrial and aquatic habitat	Unstructured opportunistic survey effort	Winter: June 2012
Post EIS			
Rail Study Area	Quarries MNES survey	5 sites	Summer: January/February 2013 Autumn: March 2013 Winter: July 2013
Offsite Infrastructure Area	Mine Offsite Infrastructure ecological assessment	49 flora sites, 38 fauna sites, 2 trapping sites, 14 remote camera sites, 12 aquatic sites	Autumn: April/May 2013

Fauna surveys included regular standardised bird surveys undertaken at each assessment site using the methods recommended by Birds Australia. This involved a timed 20 minute (minimum) survey of a two hectare search area (2 ha) by one ecologist, recording the number of birds seen or heard calling, and the presence and composition of any mixed flocks.

5.5.4 Field survey results

No species were identified present during the field surveys.

5.5.5 Threatening processes

Threating processes include the loss, degradation and fragmentation of habitat, alteration to hydrology (surface flows), draining and clearing wetlands and invasion of weeds. Other key threatening processes also include the introduction of habitat pathogens and predation by feral animals.

5.5.6 Potential impacts

Potential impacts to migratory species have been discussed in detail in EIS Volume 2, Section 5 Mine Nature Conservation and SEIS Volume 4, Appendix J1 Revised Ecological Assessment Report, but are summarised for construction and operation of the Mine (including offsite infrastructure areas) below. Mitigation measures for the construction and operation of the Project (Mine) are presented in Sections 5.2 to 5.4. The species confirmed present and likely to occur at the Mine Study Area are presented in Table 39, along with the total extent of clearing of potential habitat for those species (not including area subject to subsidence).

Table 39 Extent of habitat clearing for migratory species confirmed present and likely to occur

EPBC Act listed migratory species	Total clearing extent Mine	Total clearing extent Rail
Common sandpiper (*Actitis hypoleucos*)	20 ha and permanent dams (at least twelve)	-
Fork-tailed swift (*Apus pacificus*)	10,756 ha	-
Curlew sandpiper (*Calidris ferruginea*)	21 ha and permanent dams (at least twelve)	-
Latham's snipe (*Gallinago hardwickii*)	27 ha and permanent dams (at least twelve)	143 ha
White-bellied sea eagle (*Haliaeetus leucogaster*)	20 ha and permanent dams (at least twelve)	61 ha and two dams
White-throated needletail (*Hirundapus caudacutus*)	10,756 ha	2,703 ha and two dams
Caspian tern (*Hydroprogne caspia*)	20 ha and permanent dams (at least twelve)	-
Black-tailed godwit (*Limosa limosa*)	20 ha and permanent dams (at least twelve)	-
Glossy ibis (*Plegadis falcinellus*)	20 ha and permanent dams (at least twelve)	-
Common greenshank (*Tringa nebularia*)	20 ha and permanent dams (at least twelve)	-
Marsh sandpiper (*Tringa stagnatilis*)	20 ha and permanent dams (at least twelve)	-

5.5.6.1 Construction

Potential impacts associated with construction include:

- Loss of fauna habitat (including roosting, foraging and breeding areas)
- Degradation of terrestrial and aquatic habitat adjacent to and downstream of cleared areas
- Fauna mortality

5.5.6.2 Operation

Potential impacts associated with operation include:

- Clearing of land (vegetation clearing) and changes to topography:
  - Loss of fauna habitat
  - Fauna mortality
  - Habitat degradation (i.e. erosion of surface soils, degradation of water quality)
- Disturbance of surface watercourses and removal of watercourses and water bodies:

- Loss of habitat for species
  - Alteration/degradation of water quality
- Alteration in groundwater regime:
  - Changes to terrestrial habitat due to groundwater drawdown
  - Changes to surface water flows and aquatic habitat availability as a result of groundwater drawdown
- Introduction of pest and weed species:
  - Competition with native species, predation of native species
  - Habitat degradation (presence and prevalence of pest and weed species) and reduction in resource availability
- Alteration to air quality and noise environs from altered exposure to disturbance:
  - Disturbance to roosting and foraging areas
  - Habitat degradation from dust settling

5.5.7 Recovery plans, conservation advice and threat abatement plans

Common sandpiper *(Actitis hypoleucos)*

The *Wildlife Conservation Plan for Migratory Shorebirds*, the *Background Paper to the Wildlife Conservation Plan for Migratory Shorebirds* and *The Action Plan for Australian Birds* (Garnett & Crowley 2000) contain actions aimed at the conservation of migratory birds within Australia.

The *Significant impact guidelines for 36 migratory shorebirds Draft EPBC Act Policy Statement 3.21* provides guidelines for determining the impacts of proposed actions on migratory shorebirds. The policy statement also provides mitigation strategies to reduce the level and extent of those impacts.

Fork-tailed swift *(Apus pacificus)*

No recovery, conservation or threat abatement plans have been developed for the Fork-tailed swift.

Curlew sandpiper *(Calidris ferruginea)*

No specific recovery, conservation or threat abatement plans have been developed for the Curlew sandpiper in the region however, measures for conservation and management of the species has been identified in the North-West Marine Bioregional Plan (DSEWPaC 2012d). The Curlew Sandpiper has been identified as a conservation value in the North-west Marine Region.

Marine Bioregional Plans describe the marine environment and conservation values of each marine region, set out broad biodiversity objectives, identify regional priorities and outline strategies and actions to address these priorities.

Latham's snipe *(Gallinago hardwickii)*

No recovery, conservation or threat abatement plans have been developed for the Latham's snipe.

White-bellied sea eagle *(Haliaeetus leucogaster)*

No specific recovery, conservation or threat abatement plans have been developed for the White-bellied sea eagle in the region. Based on the major threats to the species, the long-term survival of the White-bellied Sea-Eagle in Australia depends primarily upon the retention of existing habitat (especially nesting habitat) and the protection of nesting sites from interaction with humans or human activity (Clunie 1994; Dennis and Lashmar 1996). The Brisbane City Council has prepared a *Coastal Raptors Conservation Action Statement* to assist with the management of these species in that area (DSEWPaC 2013i).

White-throated needletail *(Hirundapus caudacutus)*

No recovery, conservation or threat abatement plans have been developed for the white-throated needletail.

Caspian tern *(Hydroprogne caspia)*

No specific recovery, conservation or threat abatement plans have been developed for the Caspian tern in the region however, measures for conservation and management of the species has been identified in the South-West Marine Bioregional Plan (DSEWPaC 2012e).

Marine Bioregional Plans describe the marine environment and conservation values of each marine region, set out broad biodiversity objectives, identify regional priorities and outline strategies and actions to address these priorities.

Black-tailed godwit *(Limosa limosa)*

The *Wildlife Conservation Plan for Migratory Shorebirds*, the Background Paper to the Wildlife Conservation Plan for Migratory Shorebirds and The Action Plan for Australian Birds (Garnett & Crowley 2000) contain actions aimed at the conservation of migratory birds within Australia.

The *Significant impact guidelines for 36 migratory shorebirds Draft EPBC Act Policy Statement 3.21* provides guidelines for determining the impacts of proposed actions on migratory shorebirds. The policy statement also provides mitigation strategies to reduce the level and extent of those impacts.

Glossy ibis *(Plegadis falcinellus)*

No recovery, conservation or threat abatement plans have been developed for the glossy ibis.

Common greenshank *(Tringa nebularia)*

The *Wildlife Conservation Plan for Migratory Shorebirds* (AGDEH 2006) outlines national activities to support flyway shorebird conservation.

Marsh sandpiper *(Tringa stagnatilis)*

The *Wildlife Conservation Plan for Migratory Shorebirds*, the *Background Paper to the Wildlife Conservation Plan for Migratory Shorebirds* and *The Action Plan for Australian Birds* (Garnett & Crowley 2000) contain actions aimed at the conservation of migratory birds within Australia.

The *Significant impact guidelines for 36 migratory shorebirds Draft EPBC Act Policy Statement 3.21* provides guidelines for determining the impacts of proposed actions on migratory shorebirds. The policy statement also provides mitigation strategies to reduce the level and extent of those impacts.

5.5.8 Residual impacts and impact significance

The potential to realise a significant impact upon migratory species within the Study Area has been considered against criteria identified by DSEWPaC. As identified under Section 1.8.4, filtering of species has been undertaken for this assessment to consider only those species, which are known or likely to occur at the Study Area. Criteria, which define these likelihood of occurrence categories, are identified in Section 1.8.4. This approach is considered to be a conservative one, which captures all migratory species that could potentially be affected by the Project. The potential to realise a significant impact upon migratory species within the Study Area has been considered against criteria identified by DSEWPaC. Based on current knowledge, the assessment identifies that the Project is not expected to have a significant impact upon any migratory species.

5.5.9 Offsets

As no significant impacts to migratory species are predicted, offsets under the EPBC Act will not be required.

5.5.10 Conclusion

No significant impacts to migratory species are predicted to occur. A combination of mitigation and management measures to reduce potential impacts to migratory species will be implemented to avoid significant impacts.

6. Potential impacts on water resources

6.1 Overview

A number of water resources including in rivers, streams, wetlands, lakes and aquifers occur in the Study Area. Information on observed surface water flows, groundwater levels and a comparison of groundwater and surface water quality data for the Carmichael River suggests that flows and/or water levels are at least partly supported by direct groundwater flow from the underlying units and/or by discharge from the Doongmabulla Springs. The mining activities, in particular the development of the pits and underground workings are expected to have an impact on surface water at and around the Project (Mine) area. Groundwater modelling results indicate a reduction of around 1,000 m^3/d of river base flow within the Mine areas during the operation stages and 950 m^3/d at post closure.

The water balance study identifies all inflows and outflows on site and includes the proposed Mine water management principles. As part of the study the required major water management infrastructure, i.e. the water storages, have been identified, located and preliminary sized. The designed water management strategy focusses strongly on reusing water on site as much as possible and on minimising volumes of Mine affected water (MAW) on site. MAW is collected in two (2) central MAW dams, one (1) on each site of the Carmichael River. These dams are identified as the two (2) potential discharge points for MAW. Besides these dams, only the sediment dams for the overburden areas are expected to overflow.

The water balance model predicts total discharges to the Carmichael River of MAW to be in the order of magnitude of 3,000 to 4,000 ML per year for the first 40 years of the Mine life, and approximately 5,500 ML per year for the last 20 years of the Mine life.

As part of the Preliminary Flood Mitigation and Creek Diversion Design study (SEIS Volume 4, Appendix K4) a range of flood protection and mitigation infrastructure is proposed with the most significant being:

- 1 in 1,000 year ARI-immune flood protection levees for the Carmichael River corridor
- 1 in 100 year ARI-capacity local waterway diversion drains with the ability to provide 1 in 1,000 year ARI flood immunity to the pits through the Mine site, through the use of supplementary adjacent levees; maintaining natural flow paths and hydrology to the maximum extent practicable
- 1 in 50 year ARI-immune haul road and conveyor crossing of the Carmichael River

Subsequent modelling of the Carmichael River corridor with this proposed infrastructure in place and modelling of all the diversion drains indicated the ability of this infrastructure to protect the Mine site from large flood events. Afflux was found to be significant within the Mine area due to the combined effect of minor increased inflows from some of the diverted waterways, reduced runoff coming from the developed Mine internal areas and hydraulic constriction by the flood protection levees, haul road and conveyor crossing. Upstream of the haul road crossing afflux was modelled to peak at 0.98 m for the 1 in 1,000 year ARI event, but at the downstream eastern boundary this had already reduced to peak at 0.09 m adjacent to the Carmichael River and 0.27 m downstream of Cabbage Tree Creek. These values are reduced in smaller events, with afflux at the Mine area boundaries generally being relatively insignificant (0 – 0.09 m, with the higher values being confined to the eastern boundary downstream of Cabbage Tree Creek).

It is believed that the significant reduction in afflux values is predicted over this short distance indicates that neighbouring properties are likely to experience minimal increase in flood extents both downstream and, especially, upstream of the Mine area. The most significant afflux is confined within the Mine area.

The potential key components of the Project (Mine) that could impact on the geomorphology of waterways include construction of infrastructure within the waterways or floodplains and the subsidence effects of underground mining. This geomorphology assessment has determined that the on-site and downstream significance of these potential impacts will be negligible to low if appropriate mitigation measures are taken.

Construction will progressively occur over a period of several years and provide for the following Project (Mine) and Project (Offsite) infrastructure components (includes on lease and off lease elements):

- Mine Infrastructure Areas (MIA's)
- Coal Handling and Preparation Plant (CHPP)
- Water and waste management facilities
- Mine airport
- Flood protection levees
- Roads
- Haul road and conveyor bridge crossing of the Carmichael River
- Offsite water supply infrastructure
- Offsite Industrial Area
- Mine Workers Accommodation Village
- Upgrade of Elgin Moray and Moray Carmichael Road

Key construction activities associated with this work include the use of construction vehicles and machinery, storage of materials, bulk earthworks and works within or next to existing watercourses.

6.2 Potential impacts

6.2.1 Change in flows and flooding

The potential effects of construction activities on surface water hydrology and hydraulics include:

- Temporary increased surface runoff as a result of vegetation clearance, topsoil removal and soil compaction on land adjacent to watercourses
- Changed flow velocities, increased erosion and subsequent changes in bed and bank stability as a result of works within or adjacent to watercourses
- Change in local flows (higher in some regions, lower in others) as a result of watercourse diversions or temporarily restricted flows during construction. This would be a localised effect and not expected to impact outside of the construction area.

Carmichael River

Major infrastructure construction works are proposed to be undertaken within the Carmichael River flood plain consisting of:

- The bridge over the Carmichael River to convey the haul road and conveyors
- The Mine protection flood levees on the northern and southern banks of the River.

Works within the river floodplain can potentially cause scour and erosion leading to water quality problems and obstruction of flow leading to velocity and flood level problems.

Local creeks and streams

The creeks and streams located adjacent to the proposed construction works are ephemeral and relatively small in size. Effects of any change to surface water flows within these creeks are therefore likely to be confined to the local vicinity. Furthermore, given the relatively small area of catchments to be disturbed during construction, it is unlikely that any loss of catchment area will substantially change runoff flow volumes.

6.2.2 Change to available water supply

Construction water requirements are described in the SEIS Volume 4, Appendix K2 Water Balance Report. The predicted maximum water demand during the construction staging is expected to be in 2016 – 2017 where the water demand will reach 5.48 ML/day. For the initial development and construction phases, the required water for 2014 – 2022 will be provided by a combination of Mine dewatering and river flood extraction.

6.2.3 Changes to water quality

The assessment of the existing surface water quality environment identified that the surface water resources onsite display both spatial and temporal variability. Sampling covering a dry season (2011) and a wet season (2013) provided sufficient information to determine sub-regional WQOs for environmental protection at 95 percent species protection level for the Carmichael River. Provided the WQOs are met at a specified location on the Carmichael River (edge of the discharge mixing zone) during construction and operation of the Mine, no adverse impacts will be detected further downstream in the Carmichael River or receiving waters.

Construction activities have the potential to impact on water quality via mobilisation of sediments and pollutants. Without controls, significant impacts on downstream water users may arise from major diesel spills, prolonged release of smaller quantities of hydrocarbons and release of untreated sewage. Suitable mitigation measures are available to avoid or mitigate potential impacts and risks to surface water quality and with these measures in place, significant impact or risk is not expected.

Operational activities have the potential to impact on water quality via discharge of contaminants to the environment. The potential for this to occur will be managed by a range of site water management strategies and environmental authority permit conditions. This is expected to negate any impacts to water quality of the site. There is however residual risk in the potential for events larger than design capacity to occur in extreme circumstances and cause uncontrolled releases of MAW or SAW into the environment.

Appropriate design of the water management infrastructure, in conjunction with regular inspection, servicing and monitoring of the receiving environment will mitigate the potential for

impacts associated with uncontrolled MAW releases due to infrastructure overtopping or failure. The mitigation options are expected to leave minimal residual probability of uncontrolled releases.

Minimal impacts to the water quality of surface water resources onsite are expected to be realised from operational water usage if the reuse quality characteristics are achieved. The most likely parameter to be impacted is salinity, should MAW be used for operational water requirements.

6.3 Management and mitigation measures

The key mitigation measure in relation to construction impacts on hydrology and hydraulics is to design all diversions and structures to minimise impacts on the natural hydrology of the catchment.

Construction activities should be undertaken in a way that minimises the disturbance in and immediately adjacent to waterways. Temporary fencing off of areas around waterways to avoid unnecessary disturbance should be implemented to help achieve this. Stormwater, erosion and sediment control infrastructure and management techniques such as:

- Erosion control mats
- Soil binding
- Geofabric lining
- Rock lining
- Sediment fencing
- Diversion and catch drains
- Berms
- Chute
- Energy dissipaters
- Sedimentation basins, should be implemented before any works upstream or within waterways commence.

Temporary creek crossings such as causeways or culvert crossings should be implemented immediately for any creek crossing where water is expected to flow during the time the crossing will be used. Allowing stream flows to pass over or under the crossing will minimise impacts on natural flows and allow water to reach downstream ecosystems.

Where practicable, preference should be given to completing works within watercourses or floodplains in dry periods. In areas where works cannot be completed before the wet season, work should be planned ahead so that all disturbed areas within or adjacent to watercourses can be stabilised and robust controls can be installed to minimise the potential effects of erosion.

The design of sedimentation ponds will be in accordance with IECA's (2008) *Best Practice Erosion and Sediment Control.* Water monitoring will be undertaken as described in SEIS Appendix K3 Water Quality Report and the Mine Environmental Management Plan (SEIS Volume 4, Appendix Q1 Environmental Management Plan - Mine).

In addition, an erosion and sediment control plan should be prepared in accordance with IECA's (2008) *Best Practice Erosion and Sediment Control* (as described in SEIS Volume 4, Appendix K3 Water Quality Report) to minimise the risk of erosion and loss of bed and bank stability. Assuming the above mitigation measures are included as part of the Project proposal, no significant impacts are expected to occur on surface water quantity and quality during construction.

The following measures should be included in the environmental management plan in relation to construction of the diversion drains and levees:

- Construction works should be undertaken in low flow periods and preferably in dry periods
- Weather conditions should be monitored and if significant rain events are forecast, any in-stream works should cease and disturbed streams should be stabilised
- Requirements of the guideline *activities in a watercourse, lake or spring associated with a resource activity or mining operations* (WAM/2008/3435) should be adhered to, or if these cannot be met, conditions of a riverine protection permit should be complied with
- An operational erosion and sediment control plan should be prepared to minimise the risk of erosion and bed and bank stability. The plan should follow the IECA's (2008*)* erosion and sediment control guideline.

The following measures should be included in the environmental management plan in relation to construction of the haul road crossing across the Carmichael River:

- Construction will be preferentially undertaken in dry conditions to prevent a flow event from damaging the construction work and spreading of contaminants during a flow event
- Even during dry periods, weather conditions will be monitored and if a significant rain event is forecasted any in-stream work should cease, works should be stabilised and any equipment removed from the floodplain
- Disturbance areas on either side of the haul road crossing should be kept minimal
- All disturbed areas will be stabilised as soon as reasonably possible
- An operational erosion and sediment control plan should be prepared to minimise the risk of erosion and bed and bank stability. The plan should follow the IECA's (2008*)* erosion and sediment control guideline.

The following measures should be included in the environmental management plan in relation to construction of the levees:

- Construction of the pit protection levees should be undertaken in low flow periods and preferably in dry periods
- Construction of the Carmichael River levees to be preferentially undertaken in dry conditions to prevent a flow event from damaging the construction work and spreading of contaminants during a flow event
- For the construction of the pit protection levees it is important that the lowest section, the final drainage point is build last to:
  - prevent runoff being captured during construction within these areas

- prevent damage to the levees during construction

- Weather conditions should be monitored and if significant rain events are forecast, any work within floodplain areas should cease, works should be stabilised and any equipment removed from the floodplain
- Disturbance areas on either side of the levees should be kept minimal
- All disturbed areas will be stabilised as soon as reasonably possible
- An operational erosion and sediment control plan should be prepared to minimise the risk of erosion and bed and bank stability. The plan should follow the IECA's (2008*)* erosion and sediment control guideline.

Measures to mitigate and/or manage potential impacts have been identified, including those that will be implemented through engineering design, management plans and monitoring programs. Implementation of identified measures is considered to substantially reduce the risk of impact to water quality, such that the majority of actions are considered to have no residual risk. Those actions with residual risk to water quality include:

- The mobilisation of pollutants to water resources as a result of a spill outside bunded areas
- The loss of 25 percent of the local catchment and alteration of flows associated with this loss
- Potential flow on effects to water quality as a result of changes to the interaction between groundwater and surface water
- The potential for on-site storages (MAW and sediment dams) to overflow during a storm event greater than the design criteria accommodates resulting in contaminated water being released to the environment.

7. Cumulative and consequential impacts

7.1 Introduction

An evaluation of the potential cumulative impacts resulting from the Project including an estimation of the overall size, significance and likelihood of these impacts has been undertaken. That assessment is reported in detail in EIS Volume 1, Section 9 Cumulative Impacts. The assessment has also been updated here based on submissions made on the EIS and new publicly available information. The assessment, as it relates to matters of NES, is summarised here.

7.2 Relevant projects

The Project is located within the Galilee Basin and, as such, is closely related to other projects currently under investigation or expected to commence investigations. A number of projects have been identified as having particular relevance to this assessment in terms of potential to realise cumulative impacts associated with project development. At the same time, some projects potentially offer the opportunity for co-location of infrastructure, which could reduce cumulative impacts. Some projects have been identified as related to this Project as, that is, providing necessary supporting infrastructure for the export of coal. Figure 34 defines the spatial boundary (Study Area) for the cumulative impact assessment and shows the footprint of each project included in the cumulative impact assessment.

The following projects are currently under assessment or have been approved. The publicly available EIS and SEIS reports for these projects have been included in this Project's impact assessment as they are relevant in terms of cumulative impacts associated with the Project:

- Alpha Coal Project (EPBC 2008/4648, 2008/4647)
- Kevin's Corner Project (EPBC 2009/5033)
- China First Coal Project (also known as Galilee Coal Project (Northern Export Facility)) (EPBC 2009/4737)
- South Galilee Coal Project (EPBC 2010/5496)

Adani is also aware of the following proposals within the region, three of which had been identified prior to the EIS submission; however, insufficient information is available at the time of writing (July 2013) to enable inclusion in the cumulative assessment:

- China Stone Coal Project (MacMines): development of two open cut and two underground mines with ultimate production for export of 30 Mtpa via a rail spur line linking into the proposed Project (Rail) corridor to export coal through the Port of Abbot Point. The EIS for this project is currently under preparation; however, no publicly available information is currently available to support understanding of potential cumulative impacts.
- Alpha West Coal Project (GVK Hancock Coal Pty Ltd): a proposed 24 Mtpa capacity underground mine located immediately to the west of the Alpha Coal Project. A concept study has been completed for this Project; however, no publicly available information is currently available to support understanding of potential cumulative impacts.

- Alpha North Coal Project (Waratah Coal): proposed coal mines located north of the proposed Alpha West Coal Project. Feasibility studies have commenced for the project; however; no publicly available information is currently available to support understanding of potential cumulative impacts.
- Carmichael East Coal Project (Waratah Coal): located to the north of the Alpha North Coal Project within the western portion of EPC 1080, which is immediately adjacent to the western boundary of the Mine Project Area. No publicly available information is currently available for this project to support understanding of potential cumulative impacts.

The following projects are relevant as they offer the opportunity for co-location of infrastructure and, therefore, potential reduction of cumulative impacts:

- China First Coal Project (also known as Galilee Coal Project (Northern Export Facility)) (EPBC 2009/4737): Rail element
- Alpha Coal Project (EPBC 2008/4648, 2008/4647): Rail element
- Goonyella to Abbot Point Rail Project (EPBC 2011/6082)
- Aurizon Central Queensland Integrated Rail Project (EPBC 2012/6321)
- North Galilee Basin Rail (Adani Mining Pty Ltd): Located from Mistake Creek west of Moranbah to the Port of Abbot Point (near Bowen). The draft Terms of Reference for the project is currently undergoing public consultation and as such, have not been finalised.

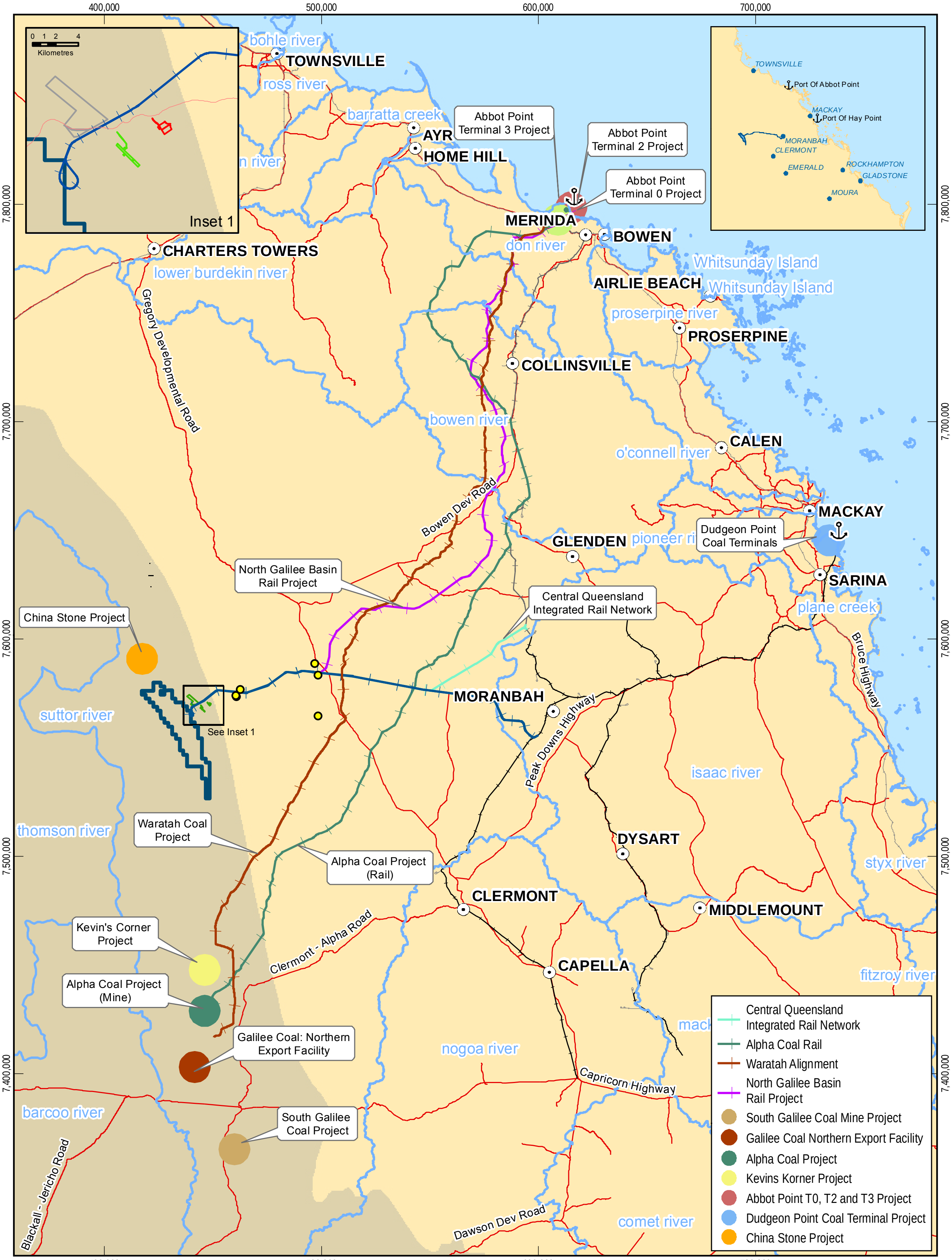
The above projects will be required to consider the impact of cumulative development having regard for the Project.

The following projects are relevant as they provide necessary supporting infrastructure for the export of coal:

- Abbot Point Terminal 0 Project (EPBC 2011/6194)
- Port of Hay Point (Dudgeon Point Coal Terminals) (EPBC 2012/6240)

A number of similar projects are proposed, but will not provide any supporting infrastructure to the Project. Therefore, these projects have been excluded from the cumulative impact assessment:

- Abbot Point Terminal 2 Project (EPBC 2011/6194): this project is a dedicated coal terminal being developed by BHP Billiton for the purpose of servicing its own coal export requirements. It is unlikely that third party access to the coal terminal would be available. BHP Billiton has publicly stated in 2012 that this project is on hold.
- Abbot Point Terminal 3 Project (EPBC 2008/4468): this project is a dedicated coal terminal being developed by Hancock Infrastructure Pty Ltd for the purpose of servicing its own coal export requirements. It is unlikely that third party access to the coal terminal would be available.



LEGEND

Major Port
Population Centre
River Basin
State Road
Other Rail Network
Goonyella System
Newlands System
Project (Rail)
Project (Mine)
Mine (Offsite)
Galilee Basin
Quarry
Mine (Offsite)
Pump Station
Storage Facility (Offstream)
Airport
Industrial Area
Accommodation Village

1:2,500,000 (at A4)
0 25 50 75 100
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 SEIS

Job Number	41-26422
Revision	D
Date	05-11-2013

Cumulative Impact Assessment Projects Figure 34

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Data Source: DNRM: LGA (2011); DMR: State Roads (2008); DME: EPC1690 (2010), EPC1080 (2011); Adani: Alignment (SP1 & 2) (2013), Facilities (2013); Other Projects (2012/13). Created by: NR, MS, ES

1.1 Cumulative impact assessment

7.2.1 Listed threatened ecological communities

Review of the relevant projects for threatened ecological communities listed under the EPBC Act that are predicted to occur in the Galilee Basin has been completed to understand whether there is potential to have cumulative loss of these communities. Findings from that review are provided in Table 40. It is important to note that a combined total cumulative impact data is not presented due to different methodologies and hence resultant quantitative findings presented by each Project.

Table 40 Potential impact on threatened ecological communities

Species and likelihood of occurrence	Project impact	Other project impacts	TEC area within bioregion [1]	Cumulative impact [2]
Brigalow (*Acacia harpophylla* dominant and co-dominant) Confirmed present	Clearing of 608 ha	Alpha Coal Project (Rail) - clearing of 100.5 ha South Galilee Coal Project – clearing of 14 ha Not present within Kevin's Corner Project or Galilee Coal Project areas.	15,050,991 ha	Total clearing 708.5 ha 0.0046 percent loss within bioregion
The community of native species dependant on natural discharge of groundwater from the Great Artesian Basin (GAB) Known to occur west of Mine Study Area	Minor indirect impacts	Not directly impacted by any project areas. May be subject to indirect impacts	Not applicable	No direct impact Minor direct impact

Notes:
[1] Regional ecosystems mapped within the Brigalow Belt Bioregions

[2] Total area of clearing does not take account of differing methods for determining impacts applied across different projects.

7.2.1.1 Brigalow TEC

Within Queensland, approximately 65 percent of extant Brigalow TEC occurs within protected area estates. Therefore, these areas are protected; however, there is the potential for the projects in the Galilee Basin to have a cumulative impact on the TECs, and therefore, on the presence of TECs within Queensland generally. Clearing will result in reductions in extent, diversity and abundance of these communities and the species that utilise them. In relation to the Brigalow TEC there is potential for significant cumulative impact given:

- Clearing from multiple projects (Alpha Coal Project, South Galilee Coal Project and this Project) of this TEC will reduce the extent of this ecological community within the local and regional landscape
- Clearing has the potential to fragment this TEC
- The alteration of landscape due to mining activities will affect the persistence of this TEC
- Drawdown of groundwater levels may modify factors necessary for this TECs persistence in the landscape surrounding the proposed developments

7.2.1.2 Great Artesian Basin TEC

The community of native species dependant on natural discharge of groundwater from the Great Artesian Basin TEC is found at the Doongmabulla Springs complex. The Doongmabulla Springs complex is approximately 4.5 km in diameter, and is located approximately 9.8 km directly west of the western Project Area boundary. This wetland contains six flora species of conservation significance, including two species known to be endemic to the Doongmabulla Springs (the herb *Erygynium fontanum* and the grass *Sporobolus pamelae*). The main threatening processes for this TEC are aquifer drawdown (due primarily to uncapped bores, but also to mining activities), excavation of springs, exotic flora and fauna invasion and stock damage, access by tourism, and impoundments (Fensham et al., 2010). The predicted reduction in aquifer pressure at Doongmabulla Springs is 0.02 m during both the operational and post-closure phases of the Project (Mine) (refer section 4.8.7). The overall predicted level of impact is deemed to be minor.

The cumulative impact to groundwater from the other mines within the Study Area is unlikely to impact upon the GAB aquifer and GAB springs, which may be associated with areas of the GAB discharge spring wetlands TEC (Waratah Coal Pty Ltd, 2013).

7.2.2 Listed threatened flora

Although a number of protected flora species were predicted to occur within the Study Area based on EPBC searches, none were detected during field investigations. However, field investigations did detect the waxy cabbage palm which desktop assessment did not predict to occur in the Study Area. The waxy cabbage palm was not recorded from field surveys of the other projects, and therefore, it is not expected that any cumulative impacts to this species will occur. Therefore, impacts to this species are considered to be those as described under Section 4.8.7 and only related to this Project.

7.2.3 Listed threatened fauna

Four listed terrestrial fauna species are confirmed present or likely to occur within the Study Area:

- Black-throated finch
- Squatter pigeon
- Yakka skink
- Ornamental snake

These species were also either confirmed present or are considered likely to occur by the other projects in the Galilee Basin. There is a potential for these species to be cumulatively impacted within the region through habitat loss from clearing and/or subsidence from each project. The yakka skink, which is considered likely to occur in the study area, has also been confirmed likely to occur by the other projects in the Galilee Basin. Although each project has provided an estimate of potential direct and indirect impacts associated with the various project activities, these cannot be simply combined to provide an overall understanding of the potential cumulative impact on each species within the Galilee Basin due to the following differences:

- The assessment approaches for identifying potential habitat, impacts and the portrayal of this information for each species differ for each project and therefore cannot be combined cumulatively.
- The Project is located at the boundary of the Brigalow Belt and Desert Uplands bioregions, a number of projects in the Galilee Basin are located within both bioregions yet others are only within one bioregion.
- The differences in potential habitat size, values, functionality and importance across these bioregions for each species.

The use of the area calculated during the offset process for each project is considered the most appropriate and consistent way in which to determine the cumulative quantitative impacts on these species. To support the cumulative impact analysis, information from all projects in the Galilee Basin has been reviewed to identify potential impact to these listed species as a result of habitat loss. Table 41 lists the potential impact to each species from the direct (clearing for Mine and Rail Projects) and indirect (subsidence, where available) loss of habitat for the individual projects within the Galilee Basin.

Table 41 Potential impact on threatened species from cumulative habitat loss

Project	Species confirmed present or likelihood of occurrence	Direct impact	Indirect impact
Black-throated finch			
Carmichael Coal Mine and Rail Project	confirmed present	9,567 ha of potential habitat	6,884 ha of potential habitat
Alpha Coal Project	likely to occur	7,932 ha of high potential habitat 3,746 ha of low potential habitat	not identified
Kevin's Corner Project	limited potential to occur	730 ha of high value habitat	270 ha of high value habitat
Galilee Coal Project	confirmed present	2,789 ha primary habitat 2,053 ha secondary habitat	8,758 ha primary habitat 667 ha secondary habitat
South Galilee Coal Project	likely to occur	230 ha potential habitat	0 ha potential habitat
Cumulative impact		*27,047* *0.17 % of bioregion*	*16,579* *0.10 % of bioregion*

Project	Species confirmed present or likelihood of occurrence	Direct impact	Indirect impact
Squatter pigeon			
Carmichael Coal Mine and Rail Project	confirmed present	11,033 ha of potential habitat	6,913 ha of potential habitat
Alpha Coal Project	confirmed present	habitat modelling not feasible 13,180 ha of remnant vegetation (Mine and rail)	not identified
Kevin's Corner Project	confirmed present	882 ha of high value habitat	276 ha of high value habitat
Galilee Coal Project	confirmed present	2,789 ha primary habitat 2,053 ha secondary habitat	8,758 ha primary habitat 667 ha secondary habitat
South Galilee Coal Project	likely to occur	4,990 ha potential habitat	0 ha potential habitat
Cumulative impact		*34,927* *0.22 % of bioregion*	*16,614* *0.10 % of bioregion*
Ornamental snake			
Carmichael Coal Mine and Rail Project	confirmed present	1,623 ha of potential habitat	3 ha of potential habitat
Alpha Coal Project	confirmed present	1,794 ha of high potential habitat 739 ha of low potential habitat	not identified
Kevin's Corner Project	likely to occur	602 ha of high value habitat	242 ha of high value habitat
Galilee Coal Project	potential to occur	33.7 ha primary habitat 878 ha secondary habitat	12 ha primary habitat 1,100 ha secondary habitat
South Galilee Coal Project	likely to occur	4,990 ha of mostly suboptimal habitat (non-remnant vegetation or non-clay substrates)	0 ha potential habitat
Cumulative impact		*10,660* *0.25 % of bioregion*	*1357* *0.01 % of bioregion*
Yakka skink			
Carmichael Coal Mine and Rail Project	likely to occur	10,306 ha of potential habitat	6,163 ha of potential habitat (includes 162 ha high impact)
Alpha Coal Project	likely to occur	1,690 ha high value potential habitat	2,897 ha high value potential habitat 844 ha low value potential habitat
Kevin's Corner Project	likely to occur	2,801 ha high value potential habitat 588 ha low value	12,380 ha high value potential habitat 2,577 ha low value

Project	Species confirmed present or likelihood of occurrence	Direct impact	Indirect impact
		potential habitat	potential habitat
Galilee Coal Project	likely to occur	1,422 ha primary habitat 590 ha secondary habitat	3,482 ha primary habitat 969 ha secondary habitat
South Galilee Coal Project	likely to occur	585 ha high value potential habitat	0 ha potential habitat
Cumulative impact		*17,982* *0.12 % of bioregion*	*29,312* *0.19 % of bioregion*

A significant impact to the black-throated finch (southern) is predicted to occur as a consequence of both this Project and as a result of cumulative loss of habitat across other projects within the Galilee Basin. The cumulative loss of habitat across projects will increase pressure on black-throated finch habitat in the Galilee Basin, and is likely to exacerbate the potential significant impact resulting directly from the Project.

Squatter pigeon is likely to be present in much of the wider landscape than that occupied by the Project. This is based on the presence of potentially suitable habitat, which extends beyond the Galilee Basin, particularly to the west where remnant vegetation dominates the landscape. However, much of the landscape surrounding the Galilee Basin is dominated by non-remnant vegetation with fragmented remnant vegetation often restricted to watercourses. The squatter pigeon has been confirmed present at all project locations within the Galilee Basin with the exception of the South Galilee Coal Project. As this species is considered to be widely distributed and have relatively broad habitat preferences, large areas of potential habitat have been identified as being either directly or indirectly impacted by each project. Although unlikely to utilise all impacted potential habitat identified within each Project area, an overall reduction in the regional availability of habitat for the subspecies will occur as a result of the projects.

It is possible that the squatter pigeon may disperse away from the developed parts of the Galilee Basin, to suitable habitat within other parts of the Galilee Basin. Preservation and enhancement of the corridor along the Carmichael River by the Project may ameliorate the impact of some of the habitat loss by providing an ongoing corridor to facilitate dispersal of these species in the local landscape.

The ornamental snake was confirmed present on both this Project and Alpha Coal project site. The presence of the ornamental snake is highly dependent on areas that contain suitable microhabitats (i.e. cracking clay soil with gilgais) within potential habitat areas. A cumulative impact assessment only highlights the loss of overall potential habitat, thereby appearing more significant than is likely to be the reality. Impacts to the species will be felt at a higher magnitude from each individual Project whereby localised populations may be directly impacted through the destruction of important microhabitat features instead of impacted from a cumulative sense.

The yakka skink was confirmed likely to occur on this Project and within all the other projects in the Galilee Basin. In part due to its cryptic nature, it has not been confirmed present during any surveys carried out for these projects. The yakka skink can occur across a variety of habitat types, but is highly dependent upon the existence of a number of structural features at the microhabitat level (log piles, rocks, sandy gullies, burrows and warrens). Cumulative impact assessment only represents the loss of potential habitat at the broad vegetation community scale and will therefore be an over-estimation of the actual presence of the species across those areas. Broad-scale predicted impacts are therefore more likely to be restricted to localised effects upon individuals and groups living communally within an individual Project area, through the loss and/or degradation of those microhabitat features, where present.

Each proponent will be required to provide offsets in accordance with Commonwealth and State policies for unavoidable impacts on potential habitat for each of the abovementioned species. These offsets should take account of the potential cumulative impacts that each project will realise, addressing indirect impacts, fragmentation and loss of habitat regionally instead of considering only localised direct impacts or habitat loss. This has been accounted for by this Project in designing and considering offset requirements.

The barrier that will be created by operation activities associated with the mine has the potential to limit the ability of terrestrial flora and fauna to disperse across the landscape. This is particularly applicable to habitats at the north and south of the Project (Mine) 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.

Habitat fragmentation, and any reduction in connectivity or corridor function will be of focus in offsetting measures, particularly in the north and south of the Project (Mine) Area. Figure 35 shows the potential corridors and the location of threatened species to the north, south and centre of the Project (Mine) Area and the adjacent China Stone EPC. East-west connectivity 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 Project (Mine) 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. The corridor to the north and south will provide Black throated finch east-west connectivity.

East-west connectivity will also be provided through the centre of the Project (Mine) Area with a 1 km corridor along the Carmichael River. The Carmichael River corridor will provide east-west connectivity for squatter pigeon and hydrological connectivity for aquatic fauna.

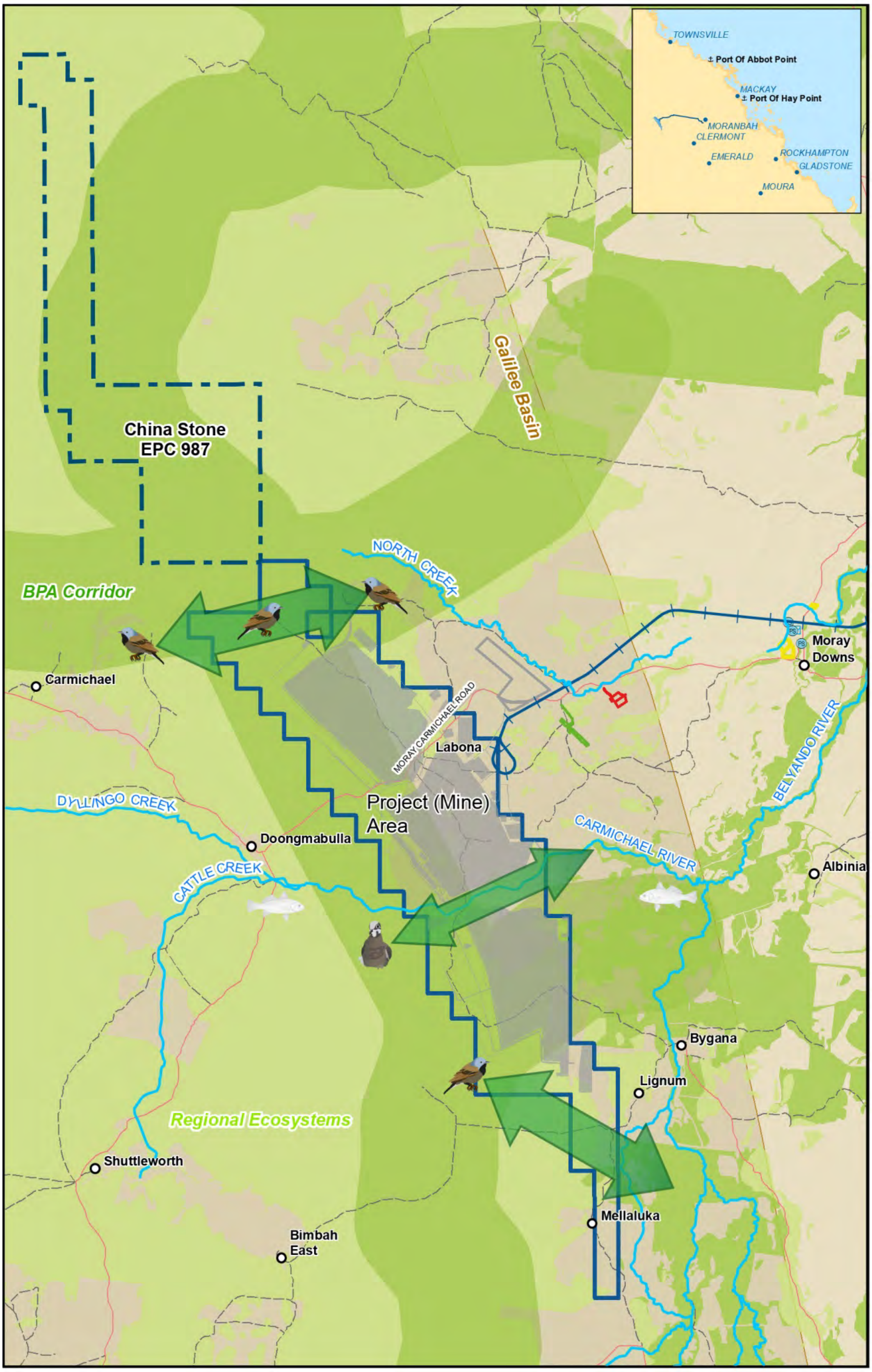

Figure 35 Local habitat connectivity across Project area

7.2.4 Listed migratory fauna

It is recognised that a cumulative unavoidable loss of habitat for migratory species will occur across the project sites. Alternative habitat suitable for these species exists adjacent to the Study Area and within the Galilee Basin. However, whilst the Project is not predicted to have a significant impact on migratory species, a potential significant cumulative impact on migratory species cannot be ruled out without further information on the impacts of each proposed project to determine whether or not there is likely to be a cumulative impact.

Potential habitat for migratory species is wide spread through the Desert Uplands and Brigalow Belt bioregions.

7.2.5 Aquatic ecology

Aquatic environment impacts have been considered given matters of NES, including the black-throated finch (southern) and waxy cabbage palm dependency upon these systems. The Mine Study Area is located within the Carmichael River catchment, which flows into the Belyando River within the Burdekin River Basin. The southern Galilee projects are also located within the Burdekin Basin.

The Project (Mine) will use a combination of flood water harvesting, reuse and groundwater to meet operational water needs. Modelling indicates groundwater drawdown at the Carmichael River will be between 1 and 4 m. A combination of design and engineering controls will be used at the Project (Mine) and no release of poor quality water will occur. Extractions from the Belyando River, associated with the offsite water supply infrastructure, have the potential to result in a cumulative impact. Modelling undertaken as part of the surface hydrology assessment showed that all required Water Resource Plan Environmental Flow Objectives were met under operational conditions, including extractions for the Project (Mine), and were therefore within the acceptable threshold for impact.

The Supplementary EIS for the Alpha Coal Project indicates a reduction of 0.4 percent in baseline median flows in the Belyando River at the Gregory Developmental Road (Hancock Prospecting Pty Ltd, 2011). The Supplementary EIS for the Alpha Coal Project states that no adverse water quality impacts are expected as a result of the project based on best practice management being implemented for the control of discharges (Hancock Prospecting Pty Ltd, 2011). These changes are within environmental flow objectives and well within the natural fluctuations in flow of this river.

The EIS for the South Galilee Coal Project will source water from groundwater bores and surface water harvesting for construction and also include dewatering and sourcing water from an external water supply to meet operational water needs. Wastewater will be treated on site and will be pumped to the onsite sediment dam system for the project.

The Supplementary EIS for the Galilee Coal Project (Waratah Coal Pty Ltd, 2013) states that the water management system to be implemented will prevent uncontrolled discharge of contaminated water for the Mine into the Burdekin River Basin and that no controlled release of poor quality Mine affected water is proposed.

The Project (Rail) has the potential to interact with the Alpha Coal Project (Rail) and the Galilee Coal Northern Export Facility (Rail) should more than one project proceed. The potential cumulative impacts on aquatic environmental values include:

- Loss of aquatic habitat
- Fauna mortality
- Alteration to in-stream and floodplain hydrology
- Increased sedimentation, run-off and dust
- Light, noise and vibration disturbance
- Increase in abundance and diversity of introduced species

Each proponent is expected to implement standard control measures to minimise the above potential impacts and thus no significant cumulative impact on aquatic systems, and therefore dependent species, the GBRMP and National Heritage Places are predicted.

No areas of Ramsar wetland are predicted to be impacted by this Project. The closest Ramsar wetland is 380 km from the site and not hydrologically connected to the Study Area by substantial barriers. Therefore, the Project will not contribute to any cumulative impacts on Ramsar wetlands that may be of relevance to other projects in the Study Area.

7.2.6 Water resources

A review of the relevant projects for impacts to surface and groundwater resources in the Galilee Basin has been completed to understand whether there is potential to have a cumulative impact. Findings from that review are provided in Table 42.

Table 42 Potential impact on water resources

Project	Catchments Affected	Surface water flow impacts	Groundwater aquifer and extraction/drawdown
Carmichael Coal Mine and Rail Project (Mine Area – 503 km^2)	Carmichael River Belyando River catchment Burdekin River Basin – Mine Area is 0.44% of the catchment	33 % reduced base flow in the Carmichael River No direct extraction from the Carmichael River Flood harvesting from Belyando River in line with the WRP	No direct drawdown from the GAB. Indirect impact on Doongmabulla Springs (0.2 m reduction in aquifer pressure) Groundwater drawdown 1 - 4 m in the Carmichael River. No regional groundwater aquifer connectivity
Alpha Coal Project (Mine Area – 337 km^2)	Lagoon and Sandy Creeks Belyando River catchment Burdekin River Basin - Mine Area is 0.26 % of the catchment	6.4 % reduction in mean annual flow in Lagoon and Sandy Creeks	Water table in GAB aquifer appears relatively unaffected by the Mine. Groundwater bore extraction of 631 to 1,577 ML/year

Project	Catchments Affected	Surface water flow impacts	Groundwater aquifer and extraction/drawdown
Kevin's Corner Project (Mine Area – 350 km^2)	Sandy Creek Belyando River catchment Burdekin River Basin - Mine Area is 0.27 % of the catchment	1.3 % reduction in mean annual flow in Sandy Creek	Water table in GAB aquifer appears relatively unaffected by the Mine.
Galilee Coal Project (Mine Area – 1,059 km^2)	Lagoon Creek Belyando River catchment Burdekin River Basin - Mine Area is 0.8 % of the catchment	33 % decrease in stream flows in Lagoon Creek	Negligible drawdown (less than 1 m) in the Clematis Sandstone. Predicted that depressurisation will not propagate to the GAB aquifer.
South Galilee Coal Project (Mine Area – 310 km^2)	Sandy Creek Belyando River catchment Burdekin River Basin – Mine Area is 0.2 % of the catchment	9 % reduction in mean annual flow in Tallarenha Creek 0.4 % reduction in mean annual flow in Native Companion Creek	Drawdown effects (5 m) on the Clematis Sandstone due to the South Galilee Coal mining.

Considerable water will be required for site operation. This demand for water demand will be met from a combination of water from dewatering, stored surface water and water imported from offsite. The influence of groundwater extraction for dewatering purposes on the groundwater resources across the Study Area is described in detail in the SEIS Volume 4, Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum. Impacts on groundwater levels, groundwater flow directions and volumes of groundwater within the Study Area will occur. Review of that information has informed how groundwater drawdown may influence water flows on/off site and, therefore, influence downstream aquatic environments connected to the GBR.

Groundwater model predictions suggest that mining induced drawdown will increase the rate of base flow loss across the Mine Area. The model predictions suggest water table drawdowns of less than 1 m along most of the Carmichael River corridor, although impacts of up to around 4 m in the river closest to the proposed open cut pits are predicted (see SEIS Volume 4, Appendix K1 Revised Mine Hydrogeology Report and Appendix K6 Groundwater Assessment Addendum).

Total impacts through a combination of reduced base flow upstream and increased base flow losses in the Carmichael River across the Mine Area are predicted to be around 1000 m^3/d (33 percent of the pre-development base flow) at the end of the Mine life and 950 m^3/d (31 percent of the pre-development base flow) post closure. No significant impacts on flows and/or levels are expected in any other local watercourses, including the Cabbage Tree Creek, since these creeks are ephemeral in nature and not thought to currently receive any substantial discharges from groundwater.

The Carmichael Coal Mine and a number of other projects are part of the larger Burdekin Catchment, and its sub catchment for the Belyando River. No other projects with available public information on impacts are within the Carmichael River Catchment. Potential cumulative

impacts arise predominantly from surface water flow impacts within the common catchment areas of the Belyando River.

In regards to water extraction from the Belyando Catchment, the Carmichael Coal project will seek approval through the Regional Water Plan to provide a flood harvesting allocation under that State approved and assessed management framework.

In regards to loss of catchment and flows from the Belyando Catchment, impacts are noted in regards to drawdown in base flow to the Carmichael River, albeit this river shows a natural loss of flows from west to east. The total reduction of catchment area is in the order of 0.44 percent. The contribution of surface water flows pre and post development is however considered to be less than this prediction, to be confirmed by ongoing flow gauging, when local rainfall and river flow of the Carmichael River is considered against the Belyando River and its sub catchments to the south.

7.3 Consequential impacts

The development of the Project and other coal mine and rail projects in the Study Area leads to consequential development that provides necessary supporting infrastructure for the export of coal. The relevant projects included are:

- Abbot Point Terminal 0 Project (EPBC 2011/6194)
- Port of Hay Point (Dudgeon Point Expansion) (EPBC 2012/6240)

Due to existing capacity restrictions on coal exports and the over-subscription to new export capacity currently in the project pipeline, the development of a new coal export terminal is likely to be required for the export of the Project coal. Development approval requirements at Commonwealth, State and Local levels will apply to any such proposals and they will require examination of potential impacts in the application stage and imposition of approval conditions by relevant administering authorities. On this basis, adequate controls are considered to be in place to identify and manage impacts from development that may by consequential to or facilitated by the Project.

7.4 Summary

The cumulative assessment provided in the EIS Volume 1, Section 9 Cumulative Impacts has been updated based on EIS submissions and new publically available information. The assessment has reviewed stated impacts from other projects and (utilising relevant information) to identify potential significant cumulative impacts. Assessment identified that the cumulative impacts having a low risk relate to:

- Aquatic ecology
- Surface water
- Groundwater

The cumulative impact, which has a high risk, relates to:

- Terrestrial ecology

The potential to affect matters of NES as a result of cumulative loss of habitat, as well as a result of direct and indirect impacts associated with the Project, has been considered in defining offsets of relevance to the Project. Those offsets are described further under Section 8 following. Under implementation of the proposed Project offsets it is considered that the overall impact of the Project (direct, indirect and cumulatively) can be managed.

8. Offsets

8.1 Introduction

The *EPBC Act Environmental Offsets Policy, 2012* has a list of seven suitable offset requirements that must be considered when determining suitable offsets for National environmental values. Suitable offsets must:

1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed development
2. Be built around direct offsets but may include indirect offsets or other compensatory measures
3. Be in proportion to the level of statutory protection that applies to the affected species or community
4. Be of a size and scale proportionate to the residual impacts being offset
5. Effectively manage the risks of the offset not succeeding
6. Be additional to what is already required or agreed to
7. Be efficient, effective, transparent, proportionate, scientifically robust and reasonable
8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced

8.2 Offset assessment methodology

It is important that an offset package under this policy seeks to deliver an overall conservation outcome that improves or maintains the protected environmental values being impacted (when compared to the value prior to the action occurring) and will contribute to the ongoing viability of that matter of NES. With this in mind, the following values are likely to be assessed by DSEWPaC when reviewing an offset package:

- The maturity and health of the communities or species impacted either directly or indirectly by the project
- The context of the impacted community or species at a local and landscape scale
- The value that the impacted community or communities may have in providing habitat to assist species in adapting to climate change
- The extent to which the proposed offset targets the specific environmental values being impacted by the project, with an expectation that an offset will offer at least an equivalent ecological benefit to the area being cleared/impacted.
- The level of certainty that the offset being offered will achieve the conservation gain being touted – where that certainty level is low, a higher quantity or variety of offsets may be required

The use of offsets to meet the watercourse and connectivity performance requirements in particular is complex and there is a substantial overlap in State and EPBC Act policy requirements. Calculation of the offset will be dependent on a number of factors including the quality of the habitat being cleared and of the habitat being offered as the offset (referred to as ecological equivalence). It is a general requirement that areas offered as offsets must be ecologically equivalent to the area being cleared, and that the total offset area required will be proportionate (or greater) to the ecological value of the offset habitat.

The Ecological Equivalence Methodology Guideline (DERM, 2011e) has been developed to assist in determining ecological equivalence between areas proposed for clearing and potential offset areas, under the *Policy for Vegetation Management Offsets* (DERM, 2011g) and the Queensland Biodiversity Offsets Policy (DERM, 2011d). This methodology is directly relevant and applicable to identification and determination of offsets that meet the EPBC Act offsets policy. To determine ecological equivalence BioCondition assessments of areas to be impacted and potential offset areas is used (Eyre et al., 2011). Site condition is assessed using a BioCondition score, which is based on a comparison between measurements of specific site-based attributes and a benchmark value for each of these attributes. Benchmark values can be obtained by undertaking assessment of 'best-on-offer' vegetation using the methodology for establishing reference sites for BioCondition (Eyre et al., 2006). By comparing attribute measurements to the benchmark values, it is possible to obtain a BioCondition score for a particular site. These scores can then be used to compare the overall condition of offset sites with areas impacted by a project, which is important for assessing ecological equivalence and confirming that adequate offsets are provided against predicted impacts.

8.2.1 Offset requirements

The legislative offset requirements of the project were identified by reviewing the following policies with regard to their applicability to the project:

- EPBC Act 1999 Environmental Offsets Policy, 2012 (EOP)
- Queensland Government Environmental Offset Policy, 2008 (QGEOP)
- Policy for Vegetation Management Offsets Version 3, 2011 (PVMO)
- Queensland Biodiversity Offset Policy Version 1, 2011 (QBOP)

8.2.2 Residual impact identification

Residual impact has been determined through analysis of direct and indirect impact information overlain on potential habitat mapping.

8.2.3 Offset identification

Ecofund identified potential offset areas through a strategic desktop assessment and spatial analysis that incorporated the legislative requirements under the applicable offset policies relevant to the affected environmental values. The package utilised information from the sources listed in Table 43.

Table 43 Data sources for environmental values requiring offsets

Environmental value to be offset	Data source
Threatened flora and fauna	Essential Habitat Factors V 3.1. VM Act Species Profile and Threats Database and species recovery plans Wildlife Online (DEHP) Protected matters search tool. EPBC Act 1999 Relevant scientific literature RE mapping (Version 6.0) RE description database (Version 6.0)
Threated ecological communities	SPRAT Profile including Recovery Plans and Policy Statements RE mapping (Version 6.0) RE description database (Version 6.0)
Threatened regional ecosystems and high value regrowth	RE/remnant vegetation mapping (Version 6.0) RE description database (Version 6.0) Regrowth vegetation (RV) mapping (Version 2.0) Property maps of assessable vegetation (PMAVs) (DEHP, 2013) Regrowth vegetation code (DEHP, 2011) Broad vegetation groups (DEHP, 2012) RE description database (Version 6.0)
Wetlands and wetland protected areas	RE mapping (Version 6.0) RE description database (Version 6.0); specifically REs associated with a wetland State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments
Watercourse vegetation	RE mapping (Version 6.0) RE description database (Version 6.0); specifically land zone 3 (quaternary alluvial systems)
Connectivity	Biodiversity Planning Assessment State and Regional corridor mapping RE mapping (Version 6.0) RE description database (Version 6.0) Regrowth vegetation mapping (Version 2.0)

Potential direct offsets were considered within areas that:

- Are land lease, leasehold or freehold lots as per the Queensland Digital Cadastral Database (Queensland Government), which are greater than or equal to 2 ha
- Are priority-designated areas within the Galilee Basin Offset Strategy
- Contain suitable environmental values as per the relevant policy criteria
- Are mapped as non-remnant, compliant HVR vegetation or category X on a property map of assessable vegetation (QBOP, 2011)
- Do not include non-compliant high value regrowth (HVR) that is:
  - An endangered RE on freehold or indigenous land
  - An endangered or of concern RE on leasehold land (agriculture and grazing)
  - Essential regrowth habitat
  - Within a WPA (QBOP, 2011)

- Contain remnant, HVR vegetation and/or non-remnant vegetation (EOP, 2012)
- Contain foliage projective cover (FPC) ≥6 percent (note this data will not be applied to grassland res).
- Do not include lots mapped as Queensland Estate, state-protected areas (including nature refuges) (DEHP 2012) or strategic cropping trigger areas (DEHP 2011)
- Do not include parts of lots that contain mining leases (Department of Employment, Economic Development and Innovation, August 2012)

Neither the Queensland nor the Australian Governments use offset-to-impact ratios when setting offset conditions. Instead, each has developed its own methods to calculate suitable offset requirements.

The Australian Government offset-to-impact ratios were superseded by the EPBC Act Offsets Assessment Guide (the Offset Assessment Guide) in October 2012. The Offset Assessment Guide applies where the impacted environmental value is a matter of NES species or ecological community. It utilises a balance sheet approach to measure and compare values essential to each matters of NES (i.e. habitat quality) between the impact area and offset area. The completed guide is used as a tool by Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) assessment officers to determine the suitability of the proposed offset. The Queensland Government calculates suitable offset requirements using the application of its ecological equivalence methodology. Ecological equivalence involves site-based ecological surveys combined with spatial analysis to score both impact and offset areas. For an offset to be accepted it must score the same or higher than the associated impact site.

To manage the risks of uncertainty these two methods introduce when conducting a desktop analysis, properties were prioritised that contain large areas of potential offsets. In addition, the results of the desktop and spatial analysis were added to the assessment of several additional properties identified by Adani as potentially suitable offset areas.

8.3 Offsets required

Throughout the planning and design stages of the Project, steps were taken to minimise the residual impact of the Project by avoiding native vegetation where reasonable and minimising the Project footprint. The Project (Rail) footprint in particular has as far as is practicable (and in consideration of other environmental, social and technical constraints) been located in areas that have been previously cleared or degraded by both past and current land use practices (refer EIS Volume 1 Section 3 Introduction for discussion on Project alternatives).

Notwithstanding, the removal of native vegetation will still occur within the Project (Mine) and Project (Rail) footprints. The impacts that will be realised from construction and operation of the Project are described below as they relate to the various matters of NES of relevance to the Project and with consideration to cumulative impacts across the landscape.

The proposed clearing impacts and offset implications for this Project are discussed in terms of the following EPBC Act environmental offset criteria:

- Clearing of threatened ecological communities
- Clearing of habitat for threatened species

State environmental offset criteria have also been taken into account and are detailed in the SEIS Volume 4, Appendix F Revised Offset Strategy Report. It is important to note that the Project (Mine) impacts detailed in this report pertain to those proposed in entirety for the 60 year operational life of the Mine and the 90 year operational life of the rail. Vegetation clearing is not proposed to occur across the entire mining footprint in a single event, but rather is proposed to be staged to correspond with the sequential development of coal extraction. Full details about the staged operations of the proposed Mine are provided in the Description of the Project (refer to SEIS Volume 4 Appendix B Updated Mine Project Description).

While recognising that vegetation clearing is proposed to be staged, for the purposes of this offset strategy, the assessment below considers the clearing of all vegetation proposed to occur within the indicative mining (operation) footprint over the life of the Mine. All calculations presented are approximate and based upon digitization of the Mine plan (as at August 2013). For the implementation of offsets, ground-truthing will be required with the areas proposed for offsetting confirmed following detailed design plans for the Mine.

Tthe Project will require the clearance of REs that are listed as components of TECs and are habitat for threatened species listed under the EPBC. As such, this action carries offset obligations to deliver an overall conservation outcome that improves or maintains the health, diversity and productivity of the environment as it relates to these matters of NES protected by the EPBC Act (DSEWPaC, 2012a). The potential impacts to matters of NES identified for the Project (Mine) and Project (Rail) and cumulatively across various projects have been assessed against the EPBC Act offset policy to identify the Project's offset requirements and are outlined below.

A number of migratory species are also confirmed present and likely to occur in the Study Area. Active, targeted management of habitats adjacent to the clearing footprint can improve their quality for migratory species. Establishing alternative habitats adjacent to the Project through active management prior to clearing migratory species habitats will encourage individuals to disperse from proposed clearing areas (or attract them to adjacent areas). This may include but not be limited to improving forage and nesting resources, increasing access to watering locations, and management of pest and weed species, to enhance the value of adjacent areas. This action will seek to minimise habitat loss (through replacement) and will also act to minimise potential for mortality by providing threatened species with habitat refugia within the operational Mine landscape. The details for such management approaches and actions will consider the staged nature of operations, and will be detailed within Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail Applications) (under the overarching Project Land Management (Flora and Fauna) Plan).

Matters of NES recorded from the Project (Mine) footprint that are predicted to carry offset obligations under the EPBC Act include:

- One threatened ecological community:
  - Brigalow (*Acacia harpophylla* dominant and co-dominant) – EPBC Act endangered
- One threatened flora species confirmed present:
  - Waxy cabbage palm (*Livistona lanuginosa*) – threatened EPBC Act, not predicted to occur in Study Area, detected in field assessments
- One threatened fauna species confirmed present:
  - Black-throated finch (southern) (*Poephila cincta cincta*) – endangered EPBC Act

Matters of NES recorded from the Project (Rail) footprint (including quarries) that are predicted to carry offset obligations under the EPBC Act include:

- One threatened fauna species considered likely to occur:
  - Black-throated finch (southern) (*Poephila cincta cincta*) – endangered EPBC Act
  - Glossy ibis (*Plegadis falcinellus*)

Direct impacts to these listed matters of NES include loss and alteration of habitat. The extent of potentially suitable habitat for each matter of NES mapped within the Project (Mine) and Project (Rail) footprints has been calculated and used to determine the likely required offset obligation for each matter of NES as a result of vegetation clearing. It should be noted that there is a large area of overlap in the proposed clearing extents for each species due to shared similar habitat requirements between species. In addition, the areas of potential suitable habitat for threatened species is based on mapping of suitable habitat for each species that was based on habitat types considered to be potentially suitable to support the species. This approach was a conservative approach and therefore a larger area has been estimated than is likely present on the ground.

Approximately 9 adults and 160 juvenile waxy cabbage palms are predicted to be impacted by the Project. The proposed clearing extents (not including area subject to subsidence) for matters of NES for the Project (Mine) and Project (Rail) are provided in Table 44.

Table 44 Estimate of impact areas relevant to EPBC Act offset requirements for Project

Environmental offset	Mine impact area (ha)	Rail impact area (ha)
Brigalow (*Acacia harpophylla* dominant and co-dominant)	581	27
Waxy cabbage palm	4	0
Black-throated finch (southern)	9714	16

8.3.1 Residual mine impacts

8.3.1.1 Threatened ecological communities

On-site vegetation clearing within the mine footprint is predicted to affect 581 ha of endangered brigalow (*Acacia harpophylla* dominant and co-dominant) threatened ecological community (EPBC Act).

8.3.1.2 Threatened fauna

Field surveys confirmed the presence of 10 listed species (including matters of NES and SSBV) within the mine footprint and documented an additional 15 listed species that are 'likely to occur' (EIS Volume 4, Appendix N1, Mine Terrestrial Ecology Report and SEIS Volume 4, Appendix J1, Revised Ecological Assessment Report). Of the 15 species 'likely to occur', 10 are migratory birds, which are designated and 'migratory' under the EPBC Act.

The threatened fauna species known to occur and likely to occur within the mine area are presented in Table 45. Of these, only the black-throated finch (southern) is predicted to carry offset obligations under the EPBC Act.

8.3.1.3 *Essential habitat*

No essential habitat is mapped within the mine footprint (SEIS Volume 4, Appendix J1, Revised Ecological Assessment Report).

8.3.1.4 *Threatened flora*

Ecological studies undertaken for the SEIS confirmed the presence of, and identified likely impacts to an EPBC listed threatened flora species, the waxy cabbage palm (*Livistona lanuginosa*). Whilst activities will be undertaken to avoid direct disturbance or clearing which would impact the population of waxy cabbage palm within the Carmichael River channel, there are potential impacts to individual plants as a result of ground and surface water changes. Waxy cabbage palm (*Livistona lanuginosa*) was detected during field surveys within the Carmichael River channel and has the potential impacted (SEIS Volume 4, Appendix J4, Population Survey of Waxy Cabbage Palm Report).

Table 45 Fauna affected by residual mine impacts

Common name	Scientific name	Status [1]		Likelihood of occurrence [2]
		EPBC act	NC act	
Reptiles				
Yakka skink	*Egernia rugosa*	V	V	Likely
Brigalow scaly-foot	*Paradelma orientalis*	-	V	Likely
Ornamental snake	*Denisonia maculata*	V	V	Likely
Birds				
Cotton pygmy-goose	*Nettapus coromandelianus*	-	Nt	Confirmed
Black-necked stork	*Ephippiorhynchus asiaticus*	-	Nt	Confirmed
Square-tailed kite	*Lophoictinia isura*	-	Nt	Likely
Squatter pigeon (southern)	*Geophaps scripta scripta*	V	V	Confirmed
Black-chinned honeyeater	*Melithreptus gularis*	-	Nt	Likely
Black throated finch (southern)	*Poephila cincta cincta*	E	E	Confirmed
Mammals				
Little pied bat	*Chalinolobus picatus*	-	Nt	Confirmed
Migratory birds				
Eastern great egret	*Ardea modesta*	M	Slc	Confirmed
Glossy ibis	*Plegadis falcinellus*	M	Slc	Likely
White-bellied sea eagle	*Haliaeetus leucogaster*	M	Slc	Confirmed
Latham's snipe	*Gallinago hardwickii*	M	Slc	Likely
Black-tailed godwit	*Limosa limosa*	M	Slc	Likely
Common greenshank	*Tringa nebularia*	M	Slc	Likely
Marsh sandpiper	*Tringa stagnatilis*	M	Slc	Likely
Common sandpiper	*Actitis hypoleucos*	M	Slc	Likely
Curlew sandpiper	*Calidris ferruginea*	M	Slc	Likely
Caspian tern	*Hydroprogne caspia*	M	Slc	Likely
Fork-tailed swift	*Apus pacificus*	M	Slc	Likely
White-throated needletail	*Hirundapus caudacutus*	M	Slc	Likely

Common name	Scientific name	Status [1]		Likelihood of occurrence [2]
		EPBC act	NC act	
Satin flycatcher	*Myiagra cyanoleuca*	M	Slc	Confirmed
Rainbow bee-eater	*Merops ornatus*	M	Slc	Confirmed
Note: [1] (-)- not listed; E-endangered; M-migratory; NT- near threatened; SLC- special least concern; V-vulnerable [2] Based on EIS Volume 4, Appendix N1, Mine Terrestrial Ecology Report and SEIS Volume 4, Appendix J1, Revised Ecological Assessment Report				

8.3.2 Residual rail impacts

8.3.2.1 Threatened ecological communities

Vegetation clearing within the rail footprint is predicted to affect 26.63 ha of endangered brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (EPBC Act).

8.3.2.2 Threatened fauna

Residual rail impacts may affect 18 listed (matters of NES and SSBV) fauna species including seven migratory avifauna. Field surveys confirmed the presence of five listed species (squatter pigeon, little pied bat, eastern great egret, white-bellied sea eagle and rainbow bee eater) within the rail footprint and documented an additional 10 listed species that are 'likely to occur' and three species which may occur (refer Table 46). Of these, only the black-throated finch (southern) is predicted to carry offset obligations under the EPBC Act.

Table 46 Fauna affected by residual rail impacts

Common name	Scientific name	Status [1]		Likelihood of occurrence
		EPBC Act	NC Act	
Reptiles				
Yakka skink	*Egernia rugosa*	V	V	May occur
Brigalow scaly foot	*Paradelma orientalis*	-	V	Likely
Ornamental snake	*Denisonia maculata*	V	V	Likely
Birds				
Cotton pygmy-goose	*Nettapus coromandelianus*	-	NT	Likely
Black-necked stork	*Ephippiorhynchus asiaticus*	-	NT	Likely
Square-tailed kite	*Lophoictinia isura*	-	NT	Likely
Squatter pigeon (southern)	*Geophaps scripta scripta*	V	V	Confirmed
Black-chinned honeyeater	*Melithreptus gularis*	-	NT	Likely
Black-throated finch (southern)	*Poephila cincta*	E	E	Likely
Mammals				
Little pied bat	*Chalinolobus picatus*	-	NT	Confirmed
Migratory birds				
Eastern great egret	*Ardea modesta*	M	SLC	Confirmed

Common name	Scientific name	Status [1]		Likelihood of occurrence
		EPBC Act	NC Act	
White-bellied sea eagle	*Haliaeetus leucogaster*	M	SLC	Confirmed
Latham's snipe	*Gallinago hardwickii*	M	SLC	Likely
Fork-tailed swift	*Apus pacificus*	M	SLC	May occur
White-throated needletail	*Hirundapus caudacutus*	M	SLC	May occur
Satin flycatcher	*Myiagra cyanoleuca*	M	SLC	Likely
Rainbow bee-eater	*Merops ornatus*	M	SLC	Confirmed
Note: [1] (-)- not listed; E-endangered; M-migratory; NT- near threatened; SLC- special least concern; V-vulnerable				

8.3.2.4 Essential habitat

No essential habitat is mapped within the mine footprint.

8.3.2.5 Threatened flora

No threatened flora was detected within the rail footprint.

8.4 Offset strategy

A number of potential direct and indirect impacts have been identified within the Project footprint. Impacts predicted to occur of relevance to matters of NES needing offsetting are primarily the direct loss of protected vegetation communities and habitat for threatened species. Offsets for these impacts must meet the offset requirements outlined in the relevant offset policies, including the EPBC Act Environmental Offsets Policy, Policy for Vegetation Management Offsets and Queensland Biodiversity Offset Policy.

The Revised Project Offset Strategy is described in detail in EIS Volume 1, Section 10 and SEIS Volume 4, Appendix F. The Offset Strategy provides a proposed approach to compiling an offset package that meets the Project's EPBC Act and State offset policy.

The Offset Strategy, including components of relevance to matters of NES, will be further developed and finalised following liaison and meetings between the key stakeholders including the client, relevant government agencies (i.e. DSEWPaC, DEHP and DNRM) and an environmental offset broker to discuss final offset requirements and proposed offset options for the Project. An assessment of the offset requirements and an options analysis has been undertaken and will be implemented into a final offsets package (or plan).

The potential for land based offsets on the Adani owned property, Moray Downs, and the Brigalow Belt and Desert Uplands bioregions was assessed and substantial offset potential was identified. The final suitability of offsets depends on an assessment of their ecological equivalence and the application of offset ratios by the Australian Government for those impacts (to vegetation) of relevance to offsetting matters of NES.

Ecofund identified potential direct offsets through a strategic desktop assessment and spatial analysis that incorporated the offset policy requirements relevant to the affected environmental values. The final suitability of these land-based offsets will be subject to future fieldwork (e.g. ecological equivalence, ground-truthing, target species surveys) and landholder consultation.

The offset options have been included as examples of how direct offsets for the project could be delivered. Should the preferred package option not prove viable, the landscape availability analysis demonstrates that additional alternative options are available. Should Adani deem it necessary (e.g. for commercial considerations, landholder willingness to participate), different properties that contain comparable environmental values may be substituted for the priority offset options.

The potential offset areas have yet to be ground-truthed to confirm the actual extent and suitability of environmental values on the ground and the figures represented in this package are based on a desktop assessment and spatial analysis.

8.5 Preferred package option

The preferred package option consists of five properties designated as Priority 1 and Priority 3 under the Queensland Galilee Basin Offset Strategy (GBOS) (Table 47). The identification of this preferred option was based on the number of properties necessary to meet the offset requirements (i.e. this option required fewer properties than alternative options to acquit the offset requirements).

Table 47 Preferred package option

Property name	Lot on plan	GBOS priority	Lot area (ha)
Property 1	Confidential	1	Confidential
Property 2	Confidential	1	Confidential
Property 3	Confidential	3	Confidential
Property 4	Confidential	3	Confidential
Property 5	Confidential	1	Confidential

On approval of the Revised Project Offset Strategy (SEIS Volume 4, Appendix F), an Environmental Offset Package will be developed to present the proposed solutions to fulfil the offset requirements of the project based on Queensland and Commonwealth legislation and offset policies in place at the time that the package is prepared. The package is likely to include a combination of direct and indirect offsets, offset payments and offset transfers.

8.5.1 Property 1

This property is located within a ‘priority 1’ area under the Galilee Basin Offset Strategy as the property largely consists of remnant vegetation designated as least concern, of concern and endangered. This property also contains stream order 1 – 4 watercourses.

One TEC, brigalow (*Acacia harpophylla*), may occur within this property in addition to habitat for matters of NES fauna such as;

- ornamental snake (*Denisonia maculata*)
- yakka skink (*Egernia rugosa*)
- red goshawk (*Erythrotriorchis radiatus*)
- squatter pigeon (southern) (*Geophaps scripta scripta*)
- Australian painted snipe (*Rostratula australis*)

Additional matters of NES are likely or known to occur within or surrounding the property, including migratory marine birds, migratory terrestrial birds and migratory wetland birds, which are not expected to be affected by residual project impacts. Habitat has been mapped for waxy cabbage palm within this property

8.5.2 Property 2

This property is located within a ‘priority 1’ area under the Galilee Basin Offset Strategy as the property largely consists of remnant vegetation designated as least concern and of concern. This property contains stream order 1 – 4 watercourses.

Three threatened ecological communities, brigalow (Acacia harpophylla), natural grasslands of the Queensland Central Highlands/northern Fitzroy Basin and weeping myall woodlands are likely to occur or may occur within this property. Additional matters of NES potentially occurring within the property and/or surrounding areas include habitat for threatened fauna, such as:

- ornamental snake (*Denisonia maculata*)
- yakka skink (*Egernia rugosa*)
- red goshawk (*Erythrotriorchis radiatus*)
- squatter pigeon (southern) (*Geophaps scripta scripta*)
- Australian painted snipe (*Rostratula australis*)

Additional matters of NES are likely or known to occur within or surrounding the property, including migratory marine birds, migratory terrestrial birds and migratory wetland birds, which are not expected to be affected by residual project impacts. Habitat has been mapped for waxy cabbage palm within this property

8.5.3 Property 3

The property is partially located within a ‘priority 3’ area under the Galilee Basin Offset Strategy. This property contains stream order 1 – 6 watercourses.

One TEC, brigalow (*Acacia harpophylla*), is known to occur within this property. Habitat for the following matters of NES listed fauna has the potential to occur on this property:

- ornamental snake (*Denisonia maculata*)
- yakka skink (*Egernia rugosa*)
- red goshawk (*Erythrotriorchis radiatus*)
- squatter pigeon (southern) (*Geophaps scripta scripta*)
- black-throated finch (southern) (Poephila cincta cincta)
- Australian painted snipe (*Rostratula australis*)

Additional MNES are likely or known to occur within or surrounding the property, including migratory marine birds, migratory terrestrial birds and migratory wetland birds, which are not expected to be affected by residual project impacts. Habitat has been mapped for waxy cabbage palm within this property

8.5.4 Property 4

This property is wholly located within a ‘priority 3’ area under the Galilee Basin Offset Strategy. This property contains stream order 1 – 7 watercourses.

Matters of NES listed fauna and/or fauna habitat potentially occurring within the property and/or surrounding areas include:

- red goshawk (*Erythrotriorchis radiatus*)
- squatter pigeon (southern) (*Geophaps scripta scripta*)
- black-throated finch (southern) (Poephila cincta cincta)
- Australian painted snipe (*Rostratula australis*)
- ornamental snake (Denisonia maculata)
- yakka skink (*Egernia rugosa*)

Additional matters of NES are likely or known to occur within or surrounding the property, including migratory marine birds, migratory terrestrial birds and migratory wetland birds, which are not expected to be affected by residual project impacts. Habitat has been mapped for waxy cabbage palm within this property.

8.5.5 Property 5

This property is wholly locations within a ‘priority 1’ area under the Galilee Basin Offset Strategy. This property contains stream order 1 – 5 watercourses.

Matters of NES listed fauna and/or fauna habitat potentially occuring within the property and/or surrounding areas include:

- squatter pigeon (southern) (*Geophaps scripta scripta*)
- black-throated finch (southern) (*Poephila cincta cincta*)
- eastern great egret (Ardea modesta)
- osprey (Pandion haliaetus)

Adani has undertaken preliminary field surveys of this property and has observed Black-throated finch in multiple locations. Reference monitoring sites and camera traps have been installed to establish further information in regards to the distribution and population of Black-throated finch on this property.

8.6 Indirect offsets

8.6.1 Purpose

To supplement direct offsets, indirect offsets in the form of research activities and/or the implementation of financial contributions towards research and education programs will be explored. Indirect offsets will be particularly pertinent where such initiatives complement other environmental management initiatives, such as species-specific management plans required for the project.

Where possible, on-ground initiatives should be implemented to compliment direct offsets and other environmental impact mitigation initiatives proposed for the project. Such initiatives are in line with direct offset options under the EOP, QBOP and PVMO; however, offset options that nominate a complementary approach need to be negotiated with DSEWPaC and DEHP to confirm that these options satisfy the requirements of all relevant policies.

8.6.2 Guiding principles

Adani will use the following principles to guide selection of suitable indirect offset methods:

- Deliver an overall conservation outcome that improves or maintains the viability project impacted environmental values
- Reflect the level of regulatory protection that applies to the environmental values
- Effectively account for and manage the risk of the indirect offset not being effective
- Be efficient, effective, timely, transparent, scientifically robust and reasonable
- Be readily measured, monitored, audited and enforced.

8.6.3 Examples of indirect offsets

8.6.3.1 Black-throated finch

Potential indirect offset options include the development or support of species-specific management plans. The black-throated finch in particular, is listed as 'endangered' under the EPBC Act and the NC Act and has a national recovery plan, which specifies threats and priority management objectives. Subject to regulatory support, the management of black-throated finch threats (e.g. feral predators) is expected to improve the quality of black-throated finch habitat and indirectly offset the project's residual impact while complementing a required species management plan (i.e. black-throated finch).

Examples of actions (and indicative funding options) that may be undertaken include:

- Investigate breeding requirements and threats to key breeding areas as there is currently no knowledge of factors affecting breeding success in wild black-throated finch
  - Conduct a study to investigate breeding in relation to landscape and management variables (e.g. landscape pattern, vegetation structure, fire, livestock grazing, rainfall and land condition)
  - Existing mapping and habitat modelling will be collated to determine all future mapping and modelling needs for the subspecies. New mapping and habitat modelling will be undertaken to remove gaps and identify further areas of potential habitat for the species.
- Undertake targeted surveys
  - Surveys should target areas of potential habitat and determine the status of the subspecies at each area.

8.6.3.2 Waxy cabbage palm

Residual project impacts on waxy cabbage palm can be sufficiently offset through the delivery of land-based direct offsets. In addition to the delivery of direct offsets and the proposed mitigation measures detailed in the SEIS (GHD, 2013c), indirect offsets may also be delivered through the following methods:

- Seed collection and planting programs within upstream reaches of the Carmichael River
- Relocation of individual plants if deemed a viable and successful method
- Contributing to further research objectives for the species to broaden the understanding of distributional range, water dependency requirements and threatening process triggers.

8.7 Offset implementation

The offset requirements of the project consider impacts from the construction and operation phases of the project's mine and rail components. Direct and indirect impacts consequently linked to project activities will occur in stages to reflect the proposed incremental nature of the development of the project.

8.7.1 Project development timeframe

Adani proposes to construct, operate and decommission the project as summarised in Table 48.

Table 48 Project development timeframe

Stage	Year	Project development
1 2014-2020	2014	Commence Rail construction Commence Quarry construction Undertake redevelopment of Moray Carmichael Road from Gregory Development Road to Mine site Commence construction of power, water supply and other external services Commence construction of workers accommodation village stage 1 & 2 Commence construction of permanent airport Commence construction of power, construction water supply and other external services Construction of flood harvesting infrastructure Commence construction of open cut facilities including Pits B/C and D/E MIA's, Site Fencing, Water Storage Dams and Temporary Roads.
	2015	Commence B ,D & E Pit box-cut Complete Pit B Diversion Drains Construct Carmichael River Northern Flood Protection Levies Commence construction of workers accommodation village stage 3 & 4 Complete construction of Permanent Airport Construct Additional Stages of Flood Harvesting Facilities
	2016	Commence C Pit box cut Produce first coal from open cut B, D & E Pits Complete open cut facilities for Pit B/C and D/E MIA, ROM and Overland Conveyors Complete B,D&E Pits HV Roads and HV Power Distribution Complete Coal Handling and Processing Plant Modules 1&2 and Tailings Cell Complete Product Handling and Train Load-out Facility Commence construction of workers accommodation village stage 5
	2017	First Coal Production from open cut C Pit Construct Underground Mine 1 MIA facilities Complete C Pit water diversion drain and HV Roads
	2018	Commence development and longwall operations of underground mine UG 1 Complete Coal Handling and Processing Plant Modules 3 & 4
	2019	Complete development operations in UG1 and commence longwall operations Construct coal processing plant (CPP) Bypass systems
2 2021-2031	2021	Construct Carmichael River southern flood protection levee Construct Carmichael River Crossing Commence development of underground mine UG 5 Dragline 1 commences in D Pit

Stage	Year	Project development
		Commence G Pit Commence minor rehabilitation of out of pit spoil emplacement (OOPSE)
	2022	Commence development of underground mines UG 4 and 5 Commence open cut facilities for Pit F/G and UG 4, MIA, ROM and Overland Conveyors
	2023	Complete open cut facilities for Pit F / G, Water Management
	2026	Commence F Pit Commence longwall operation of underground mine UG 5 Complete UG 5 MIA
	2027	Commence longwall operation of underground mine UG 4 Complete UG 4 overland conveyors and facilities
	2028	Commence development of underground mine UG 3 Complete expansion of Pit D/E MIA for UG 3
	2029	Rehabilitation works on Pits B, C, D, E OOPSE
	2030	Complete UG 5 Infrastructure Complete UG 1 longwall Operations
3 2032-2071	2035	Commence development of underground mine UG 2 Commence UG 2 MIA
	2036	Commence longwall operation of underground mine UG 3 Complete UG3 Infrastructure
	2040	Complete UG 4 longwall Operations
	2045	Complete UG 5 longwall Operations
	2051	Complete UG 3 longwall Operations Complete mining in C Pit commence final rehabilitation.
	2053	Complete mining in E Pit commence final rehabilitation
	2059	Complete UG 2 longwall Operations
	2061	Complete mining in D Pit commence final rehabilitation
	2068	Complete mining in G Pit commence final rehabilitation
	2069	Complete mining in F Pit commence final rehabilitation
	2070	Decommission Southern ROMs
	2071	Complete mining in B Pit commence final rehabilitation. Decommission Southern ROMs Commence mine site rehabilitation
	2072	Rehabilitate mine site

8.7.2 Implementation timeframe

It is proposed that the offsets for the project will be delivered in three stages to reflect the stages of project development. The three stages of offset delivery are presented in Table 49.

These tasks and timeframes are subject to change due to a number of variables, including regulatory approval, regulatory requirements, landholder negotiation, climatic conditions, land access, stakeholder inactivity and other unexpected delays.

Table 49 Offset delivery timeframe

Stage	Task	Estimated timeframe
Pre-Delivery	Submission of the Environmental Offset Package	Q3 2013
	In principle support of the Environmental Offset Package received from regulators	Q4 2013
	Preparation of preliminary Offset Assessment Guides for the preferred package option	
	Completion of subsidence modelling and estimation of proportion of environmental values that will remain. Update of Environmental Offset Package accordingly.	
1 2013 – 2020	If applicable, the provision of offset payments to the Balance the Earth Trust and the provision of indirect offsets	Q4 2014
	If applicable, the establishment of offset transfer arrangements for initial stage of offsets	Q4 2014
	If required, landholder engagement and negotiation with the owners of the identified properties	Q3 2013 to Q4 2014
	Ecological equivalence assessments of the offset sites required for the initial stage of offsets to verify that the values identified through desktop assessments are present, and that they are ecologically equivalent to the impact sites Preparation of final Offset Assessment Guides for Australian Government offsets	Q4 2013 to Q2 2014
	Development of Offset Area Management Plans for the initial stage of offsets in accordance with the requirements of the relevant offset policies	Q4 2013 to Q2 2014
	Application of a legally binding mechanism to secure the environmental values of the offset area in perpetuity	Q4 2014
	Implementation of the Offset Area Management Plan including ongoing monitoring and reporting	Q1 2015 ongoing
	Review of impacts of Stage 1 of project to identify any oversupply of offsets	Q3 2020
2 2021 – 2031	Submission of a Revised Environmental Offset Package to regulators for approval	2021
	Implementation of the Environmental Offset Package for Stage 2 offset requirements	2022 - ongoing
	Review of impacts of Stage 2 of project to identify any oversupply of offsets	Q3 2031
3 2032 - 2071	Submission of a Revised Environmental Offset Package to regulators for approval	2032
	Implementation of the Environmental Offset Package for Stage 3 offset requirements	2033 – ongoing

8.7.3 Subsidence modelling

Due to the uncertainty associated with subsidence impacts in the Galilee Basin, Adani has included an assessment considering a potential full offset of all subsidence impacts for Stage 1 activities and revise offset requirements pending detailed modelling of surface impacts. Preliminary results of this modelling suggest that the key impacts associated with subsidence will be surface cracking and altered water flows, which lead to 'ponding'. The extent of these impacts has been assessed and provided under Volume 4 Appendix I Draft Subsidence Management Plan. Ecological equivalence

Ecological equivalence assessment of the impact and offset areas will be conducted in accordance with the Ecological Equivalence Methodology Guideline (Version 3) to ensure that the environmental values in the offset areas are equivalent to those being impacted by the project. Ecological equivalence assessments have been completed for the Offsite Infrastructure Areas (undertaken by GHD) and have commenced for the Mining Areas (undertaken by Ecological Australia). The results of the ecological equivalence assessments and landholder consultation will be used to finalise the configuration of offsets.

8.7.4 Landholder engagement and negotiation

Landholder engagement has commenced on potential offset areas that are located within GBOS. Under the GBOS, landholders owning property possessing significant biodiversity offset values initially receive information about the GBOS and have the opportunity to register their interest in the strategy. Should landholders wish to decline their involvement in the GBOS, alternative offset areas will be identified.

8.7.5 Offset assessment guide

The Offset Assessment Guide will be applied by Adani to assess the suitability of offsets for matters of NES (including listed species and Brigalow threatened ecological community). Adani is in the process of preparing preliminary Offset Assessment Guides for the preferred package option which will be supplied to the Australian Government. These preliminary guides will be refined based on the results of upcoming field assessments. Following finalisation, Offset Assessment Guides for all matters of NES will be presented to the Australian Government, accompanied by clear explanation and justification of the assumptions made in each.

8.7.6 Field assessment of offset areas

Field assessments of each offset option will be undertaken, including ecological equivalence assessments and flora and fauna surveys where appropriate. The aim of the field assessment is to verify that the values identified through desktop assessments are present on each offset option and confirm the suitability of the property as an offset. Assessments will also inform the size of the offset area and the management requirements of each offset property. Replacement properties will be utilised should the results of field assessments indicate that the identified environmental values are not present on the ground.

8.7.7 Property reports

If required, individual property reports will be prepared to:

- Outline the results of field assessments and landholder engagement
- Further define the matters of NES that will be offset on the property
- Describe the compliance of the proposed offset with the relevant offset policies, including results of the ecological equivalence assessment and the offsets assessment guide.

8.7.8 Offset area management plans (OAMPs)

OAMPs will be developed for each offset property. These plans will be based on field assessments and will outline the specific management objectives and outcomes for each property. Each OAMP will be developed in consultation with regulators, Adani and the relevant landholders and will then be submitted to the regulators for review and endorsement. OAMPs will include:

- A map of the offset area, including GPS points
- The type and location of values to be offset
- The ecological equivalence assessment of the offset area, if appropriate
- The offset area management objectives and outcomes
- Activities that will be undertaken to achieve the management objectives and outcomes
- An analysis of the risks to achieving the management objectives and outcomes
- A monitoring and reporting program
- Estimated time until the offset management objectives and outcomes will be achieved
- Identification of all registered interests including mortgages, leases, subleases, covenants, easements and building statements, that have been registered on title under the *Land Act 1994* and *Land Title Act 1994*.

8.7.9 Legally binding mechanisms

All offsets must be secured by a legally binding mechanism. The appropriate mechanism for each offset will be determined through negotiation with regulators, Adani and the landholder. Legally binding mechanisms may include the following, as recognised by the NC Act:

- Conservation Park - under the NC Act a conservation park is to be managed to:
  - conserve and present the area’s cultural and natural resources and their values
  - provide for the permanent conservation of the area’s natural condition to the greatest possible extent
  - ensure that any commercial use of the area’s natural resources, including fishing and grazing, is ecologically sustainable
- Nature refuge - A nature refuge is a voluntary agreement between a landholder and the Queensland Government that acknowledges a commitment to manage and preserve land with significant conservation values while allowing compatible and sustainable land uses to continue. Under the NC Act a nature refuge is to be managed to:
  - conserve the area’s significant cultural and natural resources
  - provide for the controlled use of the area’s cultural and natural resources
  - provide for the interests of landholders to be taken into account
- Resource reserve - under the NC Act a resources reserve is to be managed to:
  - recognise and, if appropriate, protect the area’s cultural and natural resources
  - provide for the controlled use of the area’s cultural natural resources
  - ensure that the area is maintained predominantly in its natural condition

- eliminate the felling of timber for a commercial purpose

- National park - under the NC Act a national park is to be managed to:
  - provide, to the greatest possible extent, for the permanent preservation of the area's natural condition and the protection of the area's cultural resources and values - the cardinal principle for the management of national parks
  - present the area's cultural and natural resources and their values
  - ensure that the only use of the area is nature-based and ecologically sustainable.

Legally binding mechanisms may include conservation agreements under the EPBC Act. This involves an agreement between the Australian Government Environment Minister and another person for the protection and conservation of biodiversity in an area of land or sea. A conservation agreement may provide for:

- activities that promote the protection and conservation of the following:
  - biodiversity
  - the world heritage values of declared World Heritage properties
  - the National Heritage values of National Heritage places
  - the Commonwealth Heritage values of Commonwealth Heritage places
  - the ecological character of a declared Ramsar wetland
  - the environment, in respect of the impact of a nuclear action
  - the environment in a Commonwealth marine area
  - the environment on Commonwealth land
- financial, technical or other assistance from the Commonwealth
- monitoring compliance with the agreement

Offsets may also be protected through a Voluntary Declaration as recognised under the VM Act. A voluntary declaration is registered on the property title. For the area to be considered for declaration as an area of high nature conservation value the area must be one or more of the following:

- A wildlife refuge—an area where a species or a group of species has retreated due to a threatening process (e.g. Climatic change)
- A centre of endemism—an area containing concentrations of species that are largely restricted to the area
- An area containing a vegetation clump or corridor that contributes to the maintenance of biodiversity
- An area that makes a significant contribution to the conservation of biodiversity
- An area that contributes to the conservation value of a wetland, lake or spring
- Another area that contributes to the conservation of the environment

8.8 Conclusion

Adani is committed to delivering a comprehensive offset program to compensate for the residual project impacts on environmental values resulting from the development of the Carmichael Coal Mine and Rail Project.

This Environmental Offset Package demonstrates that it is possible to deliver compliant offsets in accordance with Australian and Queensland Government offset legislation through direct, land-based offsets supplemented with indirect and compensatory measures. The preferred offset package option consists of securing four offset areas that also match broader regional priorities as outlined in the Galilee Basin Offset Strategy.

As part of the implementation of the package, Adani will conduct landholder engagement and ecological surveys to confirm the suitability of the preferred package option. Following this Adani will refine the package which may include acquitting its obligation through offset payments and/or indirect offsets, which are likely to be in the form of contribution to species-specific management plans and targeted recovery actions.

Through the desktop and field studies undertaken for the Carmichael Coal Mine and Rail EIS and SEIS, Adani has gained a thorough knowledge and understanding of the residual impacts and hence offset obligations under both State and Commonwealth legislation.

Adani believes the residual impacts to the black-throated finch (southern) can be offset within the Galilee Basin Bio-Region and that suitable offset properties exist and can be secured for this purpose. Of the five proposed offset properties listed in the Offsets Strategy (Section 8 of the MNES Report), the black-throated finch (southern) has been confirmed present on one of these. And the other four properties have potentially suitable habitat to support the lack-throated finch (southern). With a thorough understanding of the black-throated finch's habitat preferences gained through a series of detailed monitoring programs, Adani has an excellent understanding of the key requirements for this species and hence the ability to identify and confirm suitable offset properties.

Once the Australian and Queensland Governments endorse the package, the package will be implemented in a staged approach to correspond with the sequential development of coal extraction over the production life of the mine.

9. Framework for impact and offset management, monitoring and reporting

9.1 Approach

Historical land use associated with agricultural activities (most notably broad scale clearing) over several decades has impacted more than 90 percent of the Brigalow Belt Bioregion and Burdekin Basin (Sattler and Williams, 1999; Dight, 2009). This has significantly altered the landscape in the region, such that the conservation status of remnant vegetation and a number of flora and fauna species has increasingly become a concern to government organisations and local and scientific communities. Notwithstanding the recent efforts by landholders, governments, private industry and research organisations to restore vegetation communities and species habitats through improved contemporary land management practices, there remains concern that future development within the region will hinder the recovery of remnant vegetation, species and habitats.

As is described in the following sections, it is recognised that significant impacts associated with this Project to a number of ecological values within the Study Area will occur as a result of Mine operations. In recognition of the nature and scale of impacts, and the impact previous land use has had on biodiversity in the region, a framework is proposed to manage these impacts and assist with biodiversity recovery over the life of Project operations. It is critically important that implementation of the framework becomes a collaboration between the proponent, land managers, research organisations and government so that the package of mitigation measures are able to meet the framework's objective.

In recognition of the variable, staged disturbance that will occur over the life of the Mine, the framework will provide detailed adaptive management[2] strategies across a number of key elements that require mitigation. Indeed, the framework will be underpinned by monitoring programs and on-going research such that management actions can be appropriately targeted, implemented, and where required, modified. This approach will need to be linked to the offsets strategy for the Project so that enhancement of biodiversity occurs at both local and regional scales. The local scale is assumed to include the Study Area and the regional scale considers biodiversity values and connectivity across the landscape to tens of kilometres from the Study Area to take account of potential cumulative influences within the region of multiple projects.

Prior to the commencement of Project operations, there will be a requirement to further develop the framework so that detailed plans and strategies contribute to its effective implementation. At this stage of the assessment process, the framework is conceptually presented. Subsequent to

[2] Adaptive management:

- Management under uncertainty
- An iterative process, with feedback via monitoring
- Hypothesis driven/information driven
- Revision and updating of management and monitoring over time based on new information and changed goals

the EIS process, substantial investment and collaborative efforts between key stakeholders will further develop the framework to achieve an operational platform that prescribes the structure for effective management, monitoring and reporting of findings from offsetting and mitigation measures targeted at minimising impacts of relevance to this Project, and tracking improved environmental condition in areas not affected by this Project. Operationalising this framework is likely to require negotiation with regulating agencies.

9.2 Framework constituents

The framework will incorporate:

- Management of land and watercourses within the Study Area that will not be subject to direct impacts during the duration of the Mine's operation phase (i.e. areas above the proposed underground mining footprint, the riparian corridor of the Carmichael River, areas to be mined in later stages of the staged development etc.)
- Management (rehabilitation) of land and watercourse/drainage lines post-disturbance (i.e. areas where open cut pits and out of pit waste dumps were located)
- Enhancement of regional biodiversity values through land procurement (including ongoing management) and research as part of the Project's Revised Project Offset Strategy (SEIS Volume 4, Appendix F)

It is proposed that as part of this framework, a detailed implementation schedule be prepared, outlining the timing and location of the applicable management actions, to reflect the staged development of the Mine. Specifically, a series of plans will be developed, that consider individual elements of the framework to meet the overall objective to enhance local and regional biodiversity values. To achieve this, the actions to be delivered under the framework will aim to:

- Prevent or minimise, to the greatest extent possible, impacts to ecological values (i.e. vegetation communities, fauna habitats, flora and fauna species, watercourses) at the Study Area. This specifically relates to all those parts of the Study Area that will not be exposed to habitat clearing, either for the duration of the Mine's operational life, or at discrete time periods during the Project's operation phase. It includes management of those areas that are currently characterised by remnant vegetation, as well as rehabilitation and management of those parts of the Study Area that are currently cleared. It encompasses management of a range of habitats including riparian, wetland, open woodland and native grasslands communities, and should not be limited to TECs, threatened REs or habitats specific only to threatened species. The prevention/minimisation of impacts will be achieved through the implementation of the mitigation and management measures detailed within the following plans:
  - Project Land Management (Flora and Fauna) Plan
  - Project Vegetation Management Plan
  - Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail Applications)
  - Project Erosion and Sediment Management Plan
  - Project Waste and Resource Management Plan and Hazardous Substances Management Plan

- Project Bushfire Management Plan (SEIS Volume 4, Appendix S2 Rail Bushfire Management Plan)
- Rehabilitate any areas disturbed during the course of staged mining operations (i.e. former open cut blocks, sites of out of pit waste dumps, drainage lines), to the extent that they provide the habitat features and values (including aquatic) that were available prior to disturbance – to be implemented in accordance with the Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2).
- Provide offsite biodiversity benefits in the region, through the development and implementation of the Revised Project Offset Strategy (SEIS Volume 4, Appendix F). This strategy, to be implemented in recognition of the staged operations of the Mine, will seek to identify measures to protect and enhance the region's biodiversity, through a combination of procurement and management of land within the Study Area and offsite, monitoring and research.

In developing this framework further, to a point where it can be implemented prior to the commencement of Mine operations, a number of key tasks will need to be undertaken, including (but not limited to):

- Consultation with relevant stakeholders to inform and develop targeted onsite (Study Area) and offsite management actions. This will include, but not be limited to: landowners adjacent to the Study Area, threatened species recovery teams (e.g. Black-throated Finch Recovery Team), research institutions (e.g. James Cook University, Central Queensland University), and government (DSEWPaC , DEHP and DNRM). As limited discussions have been undertaken at this stage, this will be a priority task so that detailed plans can be prepared that meet the framework objectives.
- Collaboration with organisations that may be able to assist with development and implementation of on-ground management, monitoring and research actions. This may or may not require assistance from the organisations listed above, but will require assistance from a broad range of stakeholders including natural resource management groups, research institutions, conservation organisations, threatened species recovery teams and land managers. On-ground management actions will also need to be linked to offsets for the Project, so that appropriate land procurement (that meets offset policy requirements) and monitoring and research programs are implemented. Given the nature of what is proposed in this framework, the research component will be ongoing, and linked to management measures (adaptive management).
- Following the approvals process, ongoing consultation with regulatory agencies with respect to Government expectations and requirements will be required. Changes in policy, legislation and other conservation drivers will need to be considered throughout the various stages of operation, making government agencies key stakeholders in this framework.
- Complementary aims and objectives between this framework and the Project Offsets Strategy so that identification of offsite areas are appropriate, meet biodiversity conservation and enhancement outcomes and appropriate, targeted management and robust research inform management throughout the operation phase of the Project.

It is important to note that the constituent elements of this framework will require frequent revision and updating, over the Mine's 60 year operational life and the rail's 90 year operational life, so that they remain reflective of the most current political, social and environmental circumstances. The Environmental Management Plan (operation) will allow for revision of management aspects and monitoring requirements at least every 10 years (if not more frequently). This will enable assessment of the response of aquatic and terrestrial ecosystems to both the mining operation (and management actions) and other non-project related factors (for example climate and other impactive activities in the region). Regular review will identify whether additional or alternative management actions are required to be applied to the Project to conserve ecosystem values than are identified by the Project at its outset.

The framework's key attributes, including component management plans, objectives, actions, timeframes and stakeholders, are summarised in Table 50.

Table 50 Overview of operation phase management framework

Management Plan	Primary Objective	Key Actions	Timeframes	Stakeholders
Management of land within the Study Area that will not be subject to direct impacts during parts of, or for the duration of the Mine's operation phase				
Project Land Management (Flora and Fauna) Plan	To manage unmined land within the Study Area such that adverse impacts to the terrestrial ecological values are minimised, while all opportunities for maintenance and enhancement of these values are identified and realised.	Identify priorities for further field studies and targeted research in the Study Area Undertake mapping on and offsite to identify areas to be managed under this plan (and the sub-plans listed below). This should be done in consideration of staged Project operations Identify parts of the Study Area that should be targeted for ecological management, so as to enhance the value of these areas. This should be done in consideration of staged Project operations. Develop monitoring programs, research projects and natural resource management trials to inform flora and fauna management. Incorporate the findings of onsite research and monitoring into management activities (as detailed in sub-plans listed below).	This overarching management plan (and the component sub-plans) listed below will be prepared prior to the commencement of Mine operations. The actions detailed in this overarching management plan (and its component sub-plans) will be implemented throughout the Mine's operation phase. Five yearly revision and updating of this plan (and its component sub-plans) will be undertaken to reflect regulatory and environmental circumstances, and will incorporate the most up to date scientific information, including that collected from ongoing research and monitoring programs at and near the Study Area.	Adani Mining Pty Ltd Commonwealth, State and local government Research organisations (i.e. universities) Conservation groups (i.e. Black-throated Finch Recovery Team) Natural resource management groups (Burdekin Dry Tropics NRM group) Land holders in the region Local governments
Project Vegetation Management Plan	Management of ecological values associated with remnant vegetation located both within unmined areas and areas where vegetation is to remain but may be subject to subsidence.	Map areas of remnant vegetation to be managed, in for each of the staged Project operations. Develop and implement a monitoring protocol, involving demarcated sites in managed areas within the Study Area, and reference sites outside of the Study Area. Collaborate with research institutions to determine a program to identify	Management plan to be prepared prior to commencement of Project operations. Plan's actions to be implemented throughout life of Mine operations. Five yearly revisions and updating of this plan based on currency of information available. Initiate program at commencement of underground	Adani Mining Pty Ltd Commonwealth, State and local government Research organisations (i.e. universities) Natural resource management groups Land holders in the region

Management Plan	Primary Objective	Key Actions	Timeframes	Stakeholders
		remnant vegetation changes resulting from subsidence, with the objective of informing management of this process and retaining environmental values.	mining operations.	
Project Species Specific Management Plan(s)	Identification and management of key habitats within the Study Area (and in the vicinity of the Study Area) for priority species that occur, or are likely to occur, within the Study Area.	Develop and implement programs to provide a greater level of detail on the ecology of threatened species at the Study Area – to be undertaken in collaboration with applicable research organisations, conservation groups and government agencies. With respect to the black-throated finch (southern), research initiatives (and habitat management) to be directed by the recovery actions presented in the National Recovery Plan for the Black-throated Finch Southern Subspecies (Black-throated Finch Recovery Team, 2007). Adani will provide a Draft Black-throated Finch Management Plan for approval prior to the commencement of construction. The Plan will include the following: • A management framework that aligns with the other project management plans • Clear statements regarding the intent, approval requirements, objectives and actions • Details of how the management plan will be applied across the project phases – pre construction / construction / operation / post operations, offset areas • Details of the current and proposed adaptive monitoring program to	Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail Applications) has been prepared. Implement targeted ecology and threatened species programs prior to and during Mine operations Five yearly revisions and updating of this plan based on currency of information available.	Adani Mining Pty Ltd Commonwealth, State and local government Research organisations (i.e. universities) Conservation groups (i.e. Black-throated Finch Recovery Team) Natural resource management groups Land holders in the region

Management Plan	Primary Objective	Key Actions	Timeframes	Stakeholders
		support the plan objectives. • Details of how experts will be used in a review capacity to inform ongoing monitoring and management • Incorporates all proposed management and mitigation measures, including reference to how these will align with the Significant Impact Guidelines and the National Recovery Plan. Specific performance targets and how these will be measured and reported. Manage habitats at (and in the vicinity of) the Study Area, in accordance with the findings of ongoing research at the site. Implement a monitoring program to review the efficacy of management actions.		
Groundwater Dependant Ecosystems Management Plan	To manage and minimise adverse impacts to Groundwater Dependant Ecosystems associated with Mining Operations including the Doongmabulla Springs and Mellaluka Springs complex's and the Carmichael River corridor. Ensure opportunities for maintenance and enhancement of these values are identified and realised.	Adani will provide a Draft Groundwater Dependant Ecosystem (GDE) Management Plan for approval prior to the commencement of construction. This plan will address impacts to the following GDE's: • Doongmabulla Springs Complex • Mellaluka Springs Complex • Carmichael River , particularly the Waxy Cabbage Palm The Plan will include the following: • A management framework that aligns with the other project management plans • Clear statements regarding the	Management plan to be prepared prior to commencement of Project operations. Plan's actions to be implemented throughout life of Mine operations. Five yearly revisions and updating of this plan based on currency of information available.	Adani Mining Pty Ltd; Commonwealth, State and local government; Research organisations (i.e. Universities); Natural resource management groups; Land holders in the region

Management Plan	Primary Objective	Key Actions	Timeframes	Stakeholders
		intent, approval requirements, objectives and actions • Details of how the management plan will be applied across the project phases – pre construction / construction / operation / post operations, offset areas • Details of any proposed adaptive monitoring program to support the plan objectives. • Details of how experts will be used in a review capacity to inform ongoing monitoring and management • Incorporate all proposed management and mitigation measures, including reference to relevant State and Federal Guidelines of relevance to these GDE's. • Specific performance targets and how these will be measured and reported.		
Project Weed and Pest Management Plan (weeds)	Monitoring and management/eradication of weeds (namely weeds on national significance and declared plants under the LP Act), where they have the potential to reduce the value of vegetation communities and habitats for native species, both in areas that will not be disturbed by mining activities and areas that will be rehabilitated.	Identification of weed infested areas at the Study Area (Year 1 of Project life) Development and implementation of protocols for eradicating weeds at the Study Area (Year 2 of Project life). Implementation of measures to minimise the introduction and spread of weeds at the Study Area (i.e. provision of weed wash down facilities, requirement for weed-free certification of vehicles entering Study Area) – throughout life of Mine. Development and implementation of a	Management plan to be prepared prior to commencement of Project operations. Five yearly revisions and updating of this plan based on currency of information available.	Adani Mining Pty Ltd Commonwealth, State and local government Research organisations (i.e. universities) Conservation groups (i.e. Greening Australia) Natural resource management groups Land holders in the region

Management Plan	Primary Objective	Key Actions	Timeframes	Stakeholders
		weed monitoring program for the Study Area – throughout life of Mine.		
Project Weed and Pest Management Plan (introduced animals)	Monitoring and management/eradication of introduced animals, where they have the potential to reduce the value of vegetation communities and habitats for native species, particularly listed species. Focus species will include pigs, rabbits and cats.	Development and implementation of protocols for eradicating/controlling introduced animals at the Study Area (Year 1 and 2 of Project life) Development and implementation of an introduced animals monitoring program for the Study Area – throughout life of Mine.	Management plan to be prepared prior to commencement of Project operations. Five yearly revisions and updating of this plan based on currency of information available.	Adani Mining Pty Ltd Commonwealth, State and local government Research organisations (i.e. universities) Natural resource management groups Land holders in the region
Project Erosion and Sediment Management Plan	Management of operation phase activities where they have the potential to degrade habitats as a result of erosion.	Identify and map erosive soils and potential erosion areas across Study Area – Year 1 of Mine life. Implement standard erosion control measures wherever operations have the potential to facilitate erosion – throughout life of Mine. Monitor the efficacy of erosion control measures, such that measures can be constantly improved – throughout life of Mine.	Management plan to be prepared prior to commencement of Project operations. Plan's actions to be implemented throughout life of Mine operations. Five yearly revisions and updating of this plan based on currency of information available.	Adani Mining Pty Ltd Research organisations (i.e. universities)
Project Waste and Resource Management Plan and Project Hazardous Substances Management Plan	Management of materials associated with the Mine's operation phase, where these materials have the potential to degrade habitats.	Design storage and handling facilities of hazardous and waste materials, such that potential for accidental release (i.e. leaks, spills, explosions) is minimised to the greatest extent possible. Develop a protocol for the management of hazardous material/waste products in instances where spills, leaks or explosions occur.	Management plan to be prepared prior to commencement of Project operations. Plan's actions to be implemented throughout life of Mine operations. Five yearly revisions and updating of this plan based on currency of information available.	Adani Mining Pty Ltd Research organisations (i.e. universities)
Project Bushfire Management Plan	A documented approach to managing fire onsite, such that the potential for adverse ecological outcomes as a result of fire	Develop a protocol for fire management at the Study Area. Ecological considerations, informed by onsite studies and input from relevant	Management plan to be prepared prior to commencement of Project operations. The Rail Bushfire Management Plan has been	Adani Mining Pty Ltd Commonwealth, State and local government

Management Plan	Primary Objective	Key Actions	Timeframes	Stakeholders
	(frequency and intensity) are minimised.	stakeholders (i.e. university researchers, government agencies), should be incorporated into this protocol, to the extent that Mine operations and safety are not compromised.	developed (refer to SEIS, Volume 4, Appendix S2). Plan's actions to be implemented throughout life of Mine operations. Five yearly revisions and updating of this plan based on currency of information available.	Research organisations (i.e. universities) Natural resource management groups Land holders in the region
Management (rehabilitation) of land post-disturbance				
Draft Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Draft Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2)	Rehabilitation of any areas disturbed during the course of staged mining operations, to the extent that they provide the habitat features and values that were available prior to disturbance.	Review existing literature relating to Mine rehabilitation, and consult with applicable organisations (universities, government agencies) to determine a detailed procedure for rehabilitation of land post-disturbance. Where required, undertake/contribute to onsite and offsite research (including trials) relating to post-mining rehabilitation, so as to increase the knowledgebase on this subject, and inform the design of the rehabilitation protocol to be implemented at the Study Area. Develop and implement a monitoring protocol to assess rehabilitated areas.	Draft Closure and Rehabilitation Strategy – Mine (SEIS, Volume 4, Appendix R1 and the Draft Closure and Rehabilitation Strategy – Offsite (SEIS Volume 4, Appendix R2) prepared – to be finalised prior to conclusion of the first stage of mining operations at the Study Area. Research trials to commence with mining operations. Rehabilitation to commence immediately following conclusion of staged mining operations, and continue to such time that pre-determined rehabilitation targets/benchmarks have been achieved (as revealed through on-going monitoring of rehabilitated areas).	Adani Mining Pty Ltd Commonwealth, State and local government Research organisations (i.e. universities) Natural resource management groups

Management Plan	Primary Objective	Key Actions	Timeframes	Stakeholders
Enhancement of regional biodiversity values				
Project Biodiversity Offsets Package	Identification and implementation of measures to protect and enhance the region's biodiversity, through a combination of procurement and management of land within the Study Area and offsite, monitoring and research.	Prepare a framework for the identification of opportunities to enhance biodiversity values within the Study Area and in the region. Secure offsets as identified through the Revised Project Offset Strategy (SEIS Volume 4, Appendix F), and undertake all management and research obligations committed to through the securement of these offsets.	Revised Offset Strategy Report has been prepared (SEIS Volume 4, Appendix F). Identified offsets (in accordance with staging of Mine operations) to be secured/committed to prior to commencement of staged mining operations, such that net loss of ecological values is prevented or minimised.	Adani Mining Pty Ltd Commonwealth, State and local government Research organisations (i.e. universities) Natural resource management groups

9.3 Monitoring

Rigorous implementation of the proposed mitigation strategies, largely via the development and execution of the abovementioned plans, should assist in minimising the potential for impacts at and near the Study Area. Regular, standardised monitoring will be a core component of the successful implementation of these plans, and provide the means for adaptive management to maintain relevance of proposed actions across the life cycle of the Project.

Site works across all phases of the Project (Mine and Rail) will require the clearing of remnant vegetation, diversion, spanning or removal of watercourses and/or standing water bodies, and fragmentation of the landscape, amongst other impacts. The various impacts to be realised as a result of the construction and operational phases of the Project as they relate to matters of NES have been described under Sections 2 through 5. These will result in impacts across the site of:

- Clearing and fragmentation of lands
- Removal of water resources and alteration of groundwater from drawdown
- Alteration of topography associated with subsidence over underground mining pits and placement of overburden
- Potential introduction of weeds and exotic pests

Each of these impacts will reduce local biodiversity and may potentially affect regional biodiversity and consideration has been given to the significance of these impacts as they relate to matters of NES. Through this process a number of environmental monitoring and reporting requirements have been identified. Those targeted at matters of NES are identified under Sections 2 through 6. Those commitments are aligned with actions identified elsewhere within the EIS for protection of environmental values that are not listed under the EPBC Act. Collectively the intent of these commitments is to:

- Provide additional baseline data pre-construction to:
  - Inform and refine the potential for impact upon specific environmental features such as the black-throated finch and groundwater draw-down potential
  - Inform offset requirements for specific environmental features
  - Establish site specific thresholds for application of effective monitoring of environmental receptors
  - Enable applicable management and mitigation measures to be developed
  - Confirm relevancy of findings from EIS studies immediately prior to construction work commencement to show currency of data at that time
- Achieve implementation of Project offset commitments
- Demonstrate efficacy of Project offset commitments during the life of the Project
- Achieve monitoring of specific environmental features to demonstrate management actions are effective during construction and operational works
- Enable feedback to improve and amend management and mitigation measures applied to construction and operational works as required to maintain efficacy of those measures in protecting the environment.

A comprehensive monitoring program will be developed as part of the site water management plan. The site water management plan will include the following monitoring measures as outlined in SEIS Volume 4, Appendix Q1 Environmental Management Plan for the Mine:

- Surface flows will be monitored on an ongoing basis prior to construction, during operation and post operation upstream, downstream and within the Study Area to measure changes
- All regulated water management infrastructures (dams, levees, diversion dams) will be annually inspected at a minimum by a suitably qualified and experienced person. A report will be produced with any recommendations required to ensure the structural integrity, as recommended in the DEHP (2012) guidelines *Structures which are dams or levees constructed as part of environmentally relevant activities (EM634)*
- Dam capacity must be reviewed annually to ensure that sufficient capacity exists to meet the design storage allowance as determined by the *Manual for assessing hazard categories and hydraulic performance of dams (EM635)*
- Diversion drains, floodplains and discharge points to downstream waterways will be inspected regularly during the wet season and after any flow event to identify any scouring, instability or erosion. Corrective action will be taken promptly.

All environmental monitoring requirements across the Project have been summarised into a Project Commitments statement, is provided in SEIS Volume 4, Appendix G. The Project Commitments section of the SEIS clarifies pre-construction requirements, offset commitments, environmental monitoring and management requirements during construction and operation and links the various commitments to the environmental feature of relevance.

All relevant environmental management actions for control of potential impacts have been developed into dedicated Environmental Management Plans to be applied to construction and operational phases of both the Mine and Rail. The revised plans are provided under SEIS Volume 4, Appendix R1 Environmental Management Plan (Mine) and SEIS Volume 4, Appendix W Environmental Management Plan (Rail). As such, the environmental controlling provisions for protection of matters of NES are also summarised from the preceding sections of this document into those dedicated Environmental Management Plans and are not repeated here.

Reporting commitments and agency liaison requirements from all monitoring and research are similarly identified within the Project Commitments and Project Environmental Management Plans. These are not repeated here.

All Project Environmental Management Plans will be informed by monitoring works to be completed pre-construction and during delivery of the Project. They will be adaptable and include provision for revision and update based on monitoring feedback, changes in operational or construction work plans, changes in legislation and to maintain currency against political, social and environmental circumstances.

10. Conclusions and recommendations

10.1 Conclusions

Assessment of the potential to affect matters of NES has been achieved by integrating knowledge from desktop and field surveys. This has enabled a description of the existing environment to be developed and confirm the presence and prevalence of any matters of NES within the Study Area. Where limited data exists potential habitat mapping has informed likelihood of species occurrence within the Mine and Rail Study Areas.

In consideration of construction and operational activities of the Mine and rail components of the Project, potential impacts have been identified and described with respect to flora and fauna species, potential habitat and vegetation communities that occur within or are considered likely to occur within the Study Area.

Potential impacts arising from construction and operational works of the Project include:

- Loss of remnant vegetation in the form of REs, flora habitat and vegetation community extents
- Loss of habitat (roosting, shelter, foraging, breeding) for native fauna including conservation significant fauna
- Degradation of terrestrial and aquatic habitat adjacent to and downstream of cleared areas
- Landscape fragmentation, reduction in connectivity and reduced capacity for fauna dispersal
- Fauna mortality

An assessment of the potential impacts on the matters of NES of relevance to the Project has been carried out. The significance of residual impacts, post-mitigation, was evaluated with consideration to the DSEWPaC significance criteria, which are provided in the Significant Impact Guidelines (DEWHA, 2009a).

In considering impacts to listed species assessment was also made to identify relevant matters for impact assessment in relation to the following:

- An important population – for listed vulnerable threatened species
- Habitat critical to survival – for listed threatened species
- Important habitat – for migratory species

Mitigation measures to avoid and minimise impacts to identified matters of NES resulting from the construction and operational activities associated with the Project have been proposed and offsets have been identified. Findings of the assessment are summarised against the controlling provisions for the Project.

10.1.1 World Heritage Properties, National Heritage Places and the Great Barrier Reef Marine Park

The DSEWPaC Protected Matters Search Tool did not identify any world heritage properties or National Heritage Places of relevance to the Project.

The Wet Tropics WHA is located over 270 km north of the Study Area with no direct terrestrial, aquatic or biodiversity links to the Study Area. No influences from the Project are predicted to occur on the Wet Tropics WHA.

The GBRWHA is located over 300 km downstream of the Study Area and although connected hydrologically via watercourses, substantial hydrological barriers and other catchment land uses exist between the ocean and the Study Area, including the Burdekin River Dam. The catchment within which the Project is situated provides little contribution to flows that influence the coast from this region and onsite control measures will manage potential for offsite impacts. The number of hydrological barriers and catchment land uses between the Mine Area and the coast influence the quality and quantity of water that flows into Upstart Bay within the GBRWHA. Given the distance, barriers, mitigation and management measures and conditions that will be imposed as part of the environmental authority for the Project, no onsite impacts are expected to detrimentally affect the values for which the GBR is recognised. No impacts associated with the Project are expected to result in a substantial and measurable change in the hydrological regime of the GBRWHA waters or systems that feed those waters and, therefore, no effects on the GBRMP are predicted to occur.

The Tree of Knowledge and curtilage at Barcaldine is the closest National Heritage Place to the Study Area. It is located approximately 200 km south-west of the western extent of the Study Area. No direct or indirect influences on this Place will occur as a consequence of the Project.

The Project is not predicted to impact upon any World Heritage Areas, National Heritage Places or the GBRMP.

10.1.2 Wetlands – Ramsar

The closest wetlands of international importance (Ramsar Wetland) are the Bowling Green Bay wetland, approximately 236 km northeast of the Study Area and the Shoalwater and Corio Bays Areas, approximately 380 km south-east of the Study Area.

No areas of Ramsar wetland are predicted to be impacted by this Project. No areas of internationally important wetland will be lost, destroyed or substantially modified as a result of the Project nor will the hydrological regime of those wetlands be affected. Proposed mitigation measures to manage offsite impacts will be implemented and form conditions for the environmental authority for the Project. Accordingly, no impacts to Ramsar wetlands are predicted to occur as a result of this Project.

The Project is not predicted to impact upon any internationally important wetland or Ramsar wetland.

10.1.3 Listed threatened species and communities

The listed threatened species or ecological communities that could be affected by the Project, as determined by site assessments and desktop studies include:

- Threatened flora:
  - Waxy cabbage palm (*Livistona lanuginosa*) - vulnerable under the EPBC Act; confirmed present at Mine Study Area and unlikely to occur at Rail Study Area
- Threatened fauna:
  - Black-throated finch (southern) (*Poephila cincta cincta*) – endangered EPBC Act; confirmed present at Mine and likely to occur at Rail Study Area
  - Squatter pigeon (southern) (*Geophaps scripta scripta*) – vulnerable EPBC Act; confirmed present across both Mine and Rail Study Areas
  - Ornamental snake (*Denisonia maculata*) – vulnerable EPBC Act; confirmed present across both Mine and Rail Study Areas
  - Yakka skink (*Egernia rugosa*) - vulnerable EPBC Act; likely to occur across Mine Study Area
- Threatened Ecological Communities:
  - Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered under EPBC Act; confirmed present in Study Area
  - The community of native species dependant on natural discharge of groundwater from the Great Artesian Basin (GAB) – endangered under EPBC Act; confirmed present west of Mine Study Area, may be subject to indirect impacts

Given no representatives of *D. queenslandicum* were found on site, the Project is not expected to lead to a long-term decrease in the size of this vulnerable species population. As no representatives were detected, it is not considered that the Project could fragment any populations, adversely affect habitat critical to the survival of these species, including for reproduction, or reduce their area of occupancy.

The assessment identified that the Project is not expected to have a significant impact upon any of the identified threatened flora or fauna except the waxy cabbage palm and black-throated finch (southern).

Waxy cabbage palms have been identified occurring immediately west of the Mine site associated with the Moses Springs and also along the riparian corridor of the Carmichael River but were not detected during surveys of the Rail Area or Mine (Offsite) Area. Mine plan design has been optimised as far as possible to limit direct impact to approximately five individuals and 4 ha of potential habitat for the waxy cabbage palm.

Based on the currently available information acquired from desktop and field studies, and in consideration of the Significant Impact Guidelines (DEWHA, 2009a), it is considered that the Study Area supports an 'important population' of the waxy cabbage palm.

As part of the proposed management measures detailed monitoring and research is proposed which will significantly increase the current level of information for the waxy cabbage palm particularly as the species has not previously been recorded within the locality.

A combination of mitigation and management measures to reduce impacts and offsets to address inevitable residual impacts to individuals of the species will be implemented to avoid significant impacts to the waxy cabbage palm, including the development of a Project Species Management Plan (under the overarching Project Land Management (Flora and Fauna) Plan).

With regard to the black-throated finch (southern) a significant impact to this species of NES is predicted to occur as a consequence of habitat losses resulting from the Project. Based on the currently available information (acquired from desktop and field studies) and in consideration of the Significant Impact Guidelines, (DEWHA, 2009a), it is considered that the Study Area, in particular the Mine Study Area, does support a 'population' of the black-throated finch (southern).

A total of 9, 730ha of identified black-throated finch (southern) potential habitat are proposed to be impacted by vegetation clearing over the life of the Project. This represents 0.16 percent of the total potential habitat within these Desert Uplands and Brigalow Belt bioregions within which the Project occurs. This impact has been minimised through implementation of mine plan changes such that a reduction in direct impact of approximately 40 percent has been achieved.

The area of direct impact has been minimised as far as possible throughout the design and development of the mine plan. Through relocation of the out of pit stockpiles the area of direct impact was reduced by approximately 7,000 ha. This change to the mine plan resulted in an approximately 40 percent reduction in the potential area of direct impact.

Management and mitigation measures implemented in respect to indirectly impacted project areas, such as above underground mining areas with low subsidence impacts, will be undertaken in order to retain habitat that will maintain a viable population of Black-throated finch.

Offsets via direct land based and indirect research and monitoring have been identified to address residual impacts.

Habitat management, informed by ongoing research and monitoring, will occur during the life of the Project to minimise potential to realise a significant impact upon this species. Research works will contribute to the maintenance of this subspecies within this bioregion and therefore, in general, 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).

Information obtained from such studies will be incorporated into the Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail Applications) for the subspecies (under the overarching Project Land Management (Flora and Fauna) Plan).

The Brigalow TEC will be affected as a direct result of vegetation clearing. It is expected that 27 ha of this TEC will be cleared to facilitate the rail corridor infrastructure development. Within the Mine Study Area an extant patch of Brigalow TEC occurs south of the Carmichael River. In total, across the Mine Study Area, 581 ha of this TEC will be affected by vegetation clearing to facilitate mining and stockpiling works. Vegetation clearing is an unavoidable consequence of the Project. Where possible, the Project footprint has been located in existing cleared areas. However, where the clearing of remnant vegetation, including that protected under the EPBC Act, is unavoidable and cannot be satisfactorily avoided, managed and mitigated, offsets are likely to be provided in accordance with the relevant EPBC Act and State offset policy (refer SEIS Volume 4 Appendix F Revised Offsets Strategy).

It is not expected that the Project will significantly affect the prevalence of the Brigalow TEC regionally as management measures will be implemented to minimise habitat losses within the Study Area and to ensure that no losses of this TEC will be realised outside the Study Area.

The nearest GAB discharge spring is the Doongmabulla Springs complex. The Doongmabulla Springs complex comprises discrete pools and patches of grassland, sedgeland and woodland created by the outflow of artesian water from a cluster of spring groups (Joshua, Moses and Little Moses). The Doongmabulla Springs complex is approximately 4.5 km in diameter, and is located approximately 9.8 km directly west of the western Project Area boundary. This wetland contains six flora species of conservation significance, including two species known to be endemic to the Doongmabulla Springs (the herb *Erygynium fontanum* and the grass *Sporobolus pamelae*).

The main threatening processes for this TEC are aquifer drawdown, excavation of springs, exotic flora and fauna invasion and stock damage, access by tourism, and impoundments (Fensham et al., 2010). This Project will realise a reduction in the pressure in the aquifer which has potential to impact upon this TEC. Conservative (i.e. worst case) modelling indicates the influence of Mine dewatering reaches the location of the Doongmabulla Springs with a maximum predicted reduction in pressure in the aquifer of between <0.05 and 0.12 m (operation phase) and <0.05 and 0.12 m (post-closure).

These reductions in pressure are expected to have a minor impact on the springs and associated wetlands, falling within the range of seasonal fluctuations to which the springs are already adapted. Therefore, it is thought that the reduction in flow will be within a tolerable range.

10.1.4 Listed migratory species

The desktop assessment indicated that a number of EPBC Act listed migratory species have been previously recorded or are predicted to occur within the Mine and Rail Study Areas. Of these, three were confirmed present during field surveys and eleven are likely to occur:

- Confirmed present:
  - Eastern great egret (*Ardea modesta*)
  - Rainbow bee-eater (*Merops ornatus*)
  - Satin flycatcher (*Myiagra cyanoleuca*)
- 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*)

It is recognised that, in spite of the recommended management and mitigation measures, and the active rehabilitation of disturbed areas that will occur through the Project's operational life, unavoidable loss of habitat for migratory species will occur.

Active, targeted management of habitats adjacent to the clearing footprint can improve their quality for migratory species. Establishing alternative habitats for migratory species adjacent to the Project through active management prior to clearing will encourage individuals to disperse from proposed clearing areas (or attract them to adjacent areas). This may include, but not be limited to, improving forage and nesting resources, increasing access to watering locations, and management of pest and weed species, to enhance the value of adjacent areas. This action will seek to minimise habitat loss (through replacement) and will also act to minimise potential for mortality by providing migratory species with habitat refugia within the operational landscape. The details for such management approaches and actions will consider the staged nature of operations, and will be detailed within Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail applications) (under the overarching Project Land Management (Flora and Fauna) Plan).

The potential to realise a significant impact upon migratory species within the Study Area has been considered against criteria identified by DSEWPaC. Based on current knowledge the assessment identifies that the Project is not expected to have a significant impact upon any migratory species. This finding is on the basis that:

- The Study Area does not support an important population of any of these species
- The Study Area does not support an ecologically significant proportion of the population of a migratory species
- Measures identified in Sections 5.2 to 5.4 are expected to manage the potential to directly or indirectly impact these species
- The species are well represented in landscapes that surround the Study Area, where suitable alternative habitat is prevalent and will persist
- The species are not considered to be dependent upon any habitat within the Study Area for any particular lifecycle stages

As such, while large tracts of habitat suitable for these matters of NES will be affected, alternative habitat suitable for these species exists adjacent to the Study Area and within the region. Accordingly, the Project is not predicted to adversely impact migratory species.

10.1.5 Water resources

The mining activities, in particular the development of the pits and underground workings are expected to have an impact on surface water at and around the Project (Mine) area. The designed water management strategy focusses strongly on reusing water on site as much as possible and on minimising volumes of Mine affected water (MAW) on site.

The water balance predicts total discharges to the Carmichael River of MAW to be in the order of magnitude of 3,000 to 4,000 ML per year for the first 40 years of the Mine life, and approximately 5,500 ML per year for the last 20 years of the Mine life.

Subsequent modelling of the Carmichael River corridor with this proposed infrastructure in place and modelling of all the diversion drains indicated the ability of this infrastructure to protect the Mine site from large flood events.

The potential effects of construction activities on surface water hydrology and hydraulics include:

- Temporary increased surface runoff as a result of vegetation clearance, topsoil removal and soil compaction on land adjacent to watercourses
- Changed flow velocities, increased erosion and subsequent changes in bed and bank stability as a result of works within or adjacent to watercourses
- Change in local flows (higher in some regions, lower in others) as a result of watercourse diversions or temporarily restricted flows during construction. This would be a localised effect and not expected to impact outside of the construction area.

Works within the river floodplain can potentially cause scour and erosion leading to water quality problems and obstruction of flow leading to velocity and flood level problems. The creeks and streams located adjacent to the proposed construction works are ephemeral and relatively small in size. Effects of any change to surface water flows within these creeks are therefore likely to be confined to the local vicinity. Furthermore, given the relatively small area of catchments to be disturbed during construction, it is unlikely that any loss of catchment area will substantially change runoff flow volumes.

The key mitigation measure in relation to construction impacts on hydrology and hydraulics is to design all diversions and structures to minimise impacts on the natural hydrology of the catchment. Construction activities should be undertaken in a way that minimises the disturbance in and immediately adjacent to waterways.

Temporary creek crossings such as causeways or culvert crossings should be implemented immediately for any creek crossing where water is expected to flow during the time the crossing will be used. Allowing stream flows to pass over or under the crossing will minimise impacts on natural flows and allow water to reach downstream ecosystems.

Construction activities have the potential to impact on water quality via mobilisation of sediments and pollutants. Without controls, significant impacts on downstream water users may arise from major diesel spills, prolonged release of smaller quantities of hydrocarbons and release of untreated sewage. Suitable mitigation measures are available to avoid or mitigate potential impacts and risks to surface water quality and with these measures in place, significant impact or risk is not expected.

Operational activities have the potential to impact on water quality via discharge of contaminants to the environment. The potential for this to occur will be managed by a range of site water management strategies and environmental authority permit conditions. This is expected to negate any impacts to water quality of the site. There is however residual risk in the potential for events larger than design capacity to occur in extreme circumstances and cause uncontrolled releases of MAW or SAW into the environment.

Minimal impacts to the water quality of surface water resources onsite are expected to be realised from operational water usage if the reuse quality characteristics are achieved. The most likely parameter to be impacted is salinity, should MAW be used for operational water requirements.

Measures to mitigate and/or manage potential impacts have been identified, including those that will be implemented through engineering design, management plans and monitoring programs. Implementation of identified measures is considered to substantially reduce the risk of impact to water quality, such that the majority of actions are considered to have no residual risk.

10.2 Offsets

The key Federal offsets policy, which applies to the Project, is the EPBC Act Environmental Offsets Policy (DSEWPaC , 2012a) which is applicable to Project (Mine) and Project (Rail).

A number of potential direct and indirect impacts have been identified within the Project footprint, including the direct loss of protected vegetation communities, habitat for threatened species and resources as a result of vegetation clearing. The delivery of offsets must meet the specific offset requirements outlined in all relevant environmental offset policies. In general there are two options for delivering offsets, these being either land-based offsets (direct or indirect) and/or offset payments.

Matters of NES recorded from the Project (Mine) footprint that are predicted to carry offset obligations under the EPBC Act include:

- One threatened ecological community:
  - Brigalow (*Acacia harpophylla* dominant and co-dominant) – EPBC Act endangered
- One threatened flora species confirmed present:
  - Waxy cabbage palm (*Livistona lanuginosa*) – threatened EPBC Act, not predicted to occur in Study Area, detected in field assessments
- One threatened fauna species confirmed present:
  - Black-throated finch (southern) (*Poephila cincta cincta*) – endangered EPBC Act

Matters of NES recorded from the Project (Rail) footprint (including quarries) that are predicted to carry offset obligations under the EPBC Act include:

- One threatened ecological community :
  - Brigalow (*Acacia harpophylla* dominant and co-dominant) – EPBC Act endangered
- One threatened fauna species considered likely to occur:
  - Black-throated finch (southern) (*Poephila cincta cincta*) – endangered EPBC Act

Adani has developed an offset package consisting of five properties within the Galilee Basin Offset Strategy. As part this package Adani proposes to initially meet all offset requirements identified from project activities relating to direct impacts such as vegetation clearing. Due to the uncertainty of how subsidence associated with underground mining activities will impact matters of NES and SSBV, Adani has undertaken an assessment to identify areas least likely to be adversely affected by subsidence to potentially assign some retained value.

The proposed offsets package demonstrates that it is possible to deliver compliant offsets in accordance with Australian and Queensland Government offset legislation through direct, land-based offsets supplemented with indirect and compensatory measures.

Through the desktop and field studies undertaken for the Carmichael Coal Mine and Rail EIS and SEIS, Adani has gained a thorough knowledge and understanding of the residual impacts and hence offset obligations under both State and Commonwealth legislation.

Adani believes the residual impacts to the Black-throated finch can be offset within the Galilee Basin Bio-Region and that suitable offset properties exist and can be secured for this purpose. Of the five proposed offset properties listed in the Offsets Strategy (Section 8 of the MNES Report), the Black-throated finch has been confirmed present on one of these. And the other four properties have potentially suitable habitat to support the Black-throated finch. With a thorough understanding of the Black-throated finch's habitat preferences gained through a series of detailed monitoring programs, Adani has an excellent understanding of the key requirements for this species and hence the ability to identify and confirm suitable offset properties.

10.3 Recommendations

In recognition of the nature and scale of impacts, and the impact previous land use has had on biodiversity in the Galilee Basin, a framework is proposed to manage these impacts and assist with biodiversity recovery over the life of Project operations. It is critically important that implementation of the framework becomes a collaboration between the proponent, land managers, research organisations and government so that the package of mitigation measures is able to meet the framework's objective.

The framework will provide detailed adaptive management strategies across a number of key elements that require mitigation. The framework will be underpinned by monitoring programs and on-going research such that management actions can be appropriately targeted, implemented, and where required, modified. This approach will need to be linked to the offsets strategy for the Project so that enhancement of biodiversity occurs at both local and regional scales.

The prevention/minimisation of impacts will be achieved through the implementation of the mitigation and management measures detailed within the following plans:

- Project Land Management (Flora and Fauna) Plan
- Project Vegetation Management Plan
- Project Species Specific Management Plan(s) (SEIS Volume 4 Appendix C3 Rail Applications)
- Project Erosion and Sediment Management Plan
- Project Waste and Resource Management Plan and Hazardous Substances Management Plan
- Project Bushfire Management Plan (SEIS Volume 4 Appendix S2 Rail Bushfire Management Plan)
- Closure and Rehabilitation Management Plans

Regular, standardised monitoring will be a core component of the successful implementation of these plans, and provide the means for adaptive management to maintain relevance of proposed actions across the life cycle of the Project.

A number of Project commitments have been identified as part of this assessment including:

- Provide additional baseline data pre-construction to:

   - Inform and refine the potential for impact upon specific environmental features such as the black-throated finch (southern) and groundwater draw-down potential
   - Inform offset requirements for specific environmental features
   - Establish site specific thresholds for application of effective monitoring of environmental receptors
   - Enable applicable management and mitigation measures to be developed
   - Confirm relevancy of findings from EIS studies immediately prior to construction work commencement to show currency of data at that time
- Achieve implementation of Project offset commitments
- Demonstrate efficacy of Project offset commitments during the life of the Project
- Achieve monitoring of specific environmental features to demonstrate management actions are effective during construction and operational works
- Enable feedback to improve and amend management and mitigation measures applied to construction and operational works as required to maintain efficacy of those measures in protecting the environment.

All Project Environmental Management Plans will be informed by monitoring works to be completed pre-construction and during delivery of the Project. They will be adaptable and include provision for revision and update based on monitoring feedback, changes in operational or construction work plans, changes in legislation and to maintain currency against political, social and environmental circumstances.

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Appendices

Appendix A – Protected Matters Search

EPBC Act Protected Matters Report

10 July 2010 10:28

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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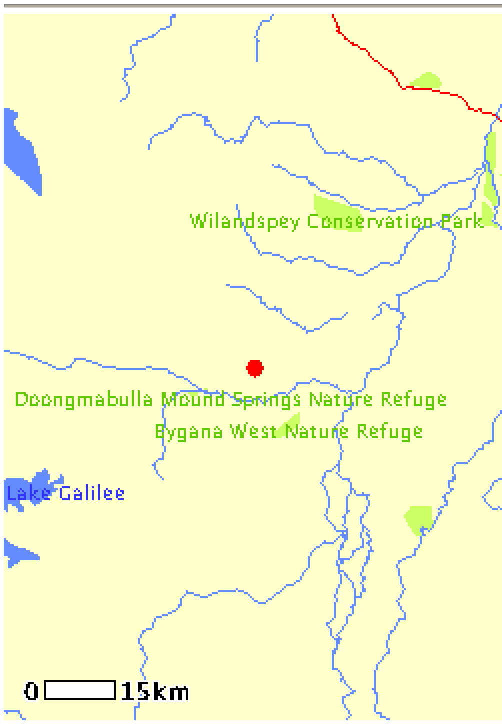

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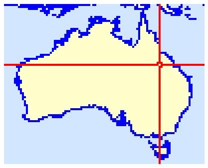

Report Contents:

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	1
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	2
Threatened Species:	11
Migratory Species:	12

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Places on the RNE:	3
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	2
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Wetlands of International Significance [Dataset Information] (Ramsar Sites)	
COONGIE LAKES	Within same catchment as Ramsar site

Threatened Ecological Communities [Dataset Information]	Status	Type of Presence
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	Community known to occur within area
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	Endangered	Community known to occur within area

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Erythrotriorchis radiatus Red Goshawk	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern)	Vulnerable	Species or species habitat likely to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern)	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Black-throated Finch (southern)	Endangered	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Mammals		
Lasiorhinus krefftii Northern Hairy-nosed Wombat, Yaminon	Endangered	Species or species habitat likely to occur within area
Reptiles		
Denisonia maculata Ornamental Snake	Vulnerable	Species or species habitat likely to occur within area
Furina dunmalli Dunmall's Snake	Vulnerable	Species or species habitat may occur within area

Plants		
Acacia ramiflora	Vulnerable	Species or species habitat likely to occur within area
Eriocaulon carsonii Salt Pipewort, Button Grass	Endangered	Species or species habitat likely to occur within area
Eryngium fontanum Blue Devil	Endangered	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Species or species habitat likely to occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Migratory	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose	Listed - overfly marine area	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Species or species habitat likely to occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Listed - overfly	Species or species habitat may occur within area

	marine area	
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Natural

Epping Forest National Park (1978 Boundary) QLD

Lake Buchanan and Catchment QLD

Wilandspey Environmental Park QLD

Extra Information

State and Territory Reserves [Dataset Information]

Epping Forest National Park (Scientific), QLD

Wilandspey Conservation Park, QLD

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria

- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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